



# **AM/FM SIGNAL GENERATORS 2023A, 2023B, 2025**



## **Maintenance Manual**

Document part no. 46892/377

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# **AM/FM SIGNAL GENERATORS**

## **2023, 2023A, 2023B, 2024 & 2025**

**Includes information on:**

- Option 1: No attenuator**
- Option 2: DC operation**
- Option 3: High power**
- Option 4: High stability frequency standard**
- Option 5: Rear panel connectors**
- Option 7: Fast pulse modulation**
- Option 10: 1 V peak mod input**
- Option 11: Fast pulse and high power**
- Option 12: SINAD**

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## About this manual

This manual provides servicing information down to a defined circuit area for the 2023, 2023A, 2023B, 2024 and 2025 AM/FM Signal Generators.

### Intended audience

The book is intended for qualified service engineers and assumes a knowledge of the instrument to a level covered in:

Operating Manual 46882-225      for 2023 and 2024

Operating Manual 46882-373      for 2023A, 2023B and 2025.

### Structure

#### Chapter 1 Technical description

This includes block diagrams and detailed board circuit descriptions. The circuit descriptions refer directly to the servicing diagrams contained in Chapter 7.

#### Chapter 2 Maintenance

Refer to this chapter for board and unit access, service policy and routine safety testing and inspection.

#### Chapter 3 Adjustment procedures

Refer to this chapter for information on password use and adjustment procedures.

#### Chapter 4 Initial repair

What to do if the instrument shows no signs of life.

#### Chapter 5 Fault diagnosis

Based on error message reports; narrows the search down to a defined circuit area.

#### Chapter 6 Replaceable parts

Contains instrument and board component parts, and a section on miscellaneous mechanical parts.

#### Chapter 7 Servicing diagrams

Contains interconnection drawings, board circuits and component layout diagrams.

### Associated publications

Refer to the relevant Operating Manual (part number 46882-225 for 2023 and 2024, part number 46882-373 for 2023A, 2023B and 2025) for an up-to-date list of associated publications.

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## Precautions

**WARNING****CAUTION****Note**

These terms have specific meanings in this manual:

**WARNING**

**Information to prevent personal injury.**

**CAUTION**





**Information to prevent damage to the equipment.**

**Note**

**Important general information.**

## Symbols used on this product

The meaning of hazard symbols appearing on the equipment is as follows:

Symbol	Nature of hazard
	General hazard
	Dangerous voltage
	Toxic hazard
	Static-sensitive components

## General conditions of use

This product is designed and tested to comply with the requirements of IEC/EN61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use', for Class I portable equipment and is for use in a pollution degree 2 environment. The equipment is designed to operate from an installation category I and II supply.

Equipment should be protected from the ingress of liquids and precipitation such as rain, snow, etc. When moving the equipment from a cold to a hot environment, it is important to allow the temperature of the equipment to stabilize before it is connected to the supply to avoid condensation forming. The equipment must only be operated within the environmental conditions specified in Chapter 1 'Performance data' in the Operating manual, otherwise the protection provided by the equipment may be impaired.

This product is not approved for use in hazardous atmospheres or medical applications. If the equipment is to be used in a safety-related application, e.g. avionics or military applications, the suitability of the product must be assessed and approved for use by a competent person.

**WARNING**

### Electrical hazards (AC supply voltage)

This equipment conforms with IEC Safety Class I, meaning that it is provided with a protective grounding lead. To maintain this protection the supply lead must always be connected to the source of supply via a socket with a grounded contact.

Be aware that the supply filter contains capacitors that may remain charged after the equipment is disconnected from the supply. Although the stored energy is within the approved safety requirements, a slight shock may be felt if the plug pins are touched immediately after removal.

## Fuses

Note that the internal supply fuse is in series with the live conductor of the supply lead. If connection is made to a 2-pin unpolarized supply socket, it is possible for the fuse to become transposed to the neutral conductor, in which case, parts of the equipment could remain at supply potential even after the fuse has ruptured.

## Removal of covers

Disconnect the supply before removing the covers so as to avoid the risk of exposing high voltage parts. If any internal adjustment or servicing has to be carried out with the supply on, it must only be performed by a skilled person who is aware of the hazard involved.

### WARNING



## Electrical hazards (DC supply voltage)

This equipment conforms with IEC safety Class III, meaning that for continued safety it must only be connected to supplies and signal sources which conform to 'Separated Extra-Low Voltage' (SELV and SELV-E) voltage and insulation requirements. No hazardous voltages are generated internally. See under 'Performance data' in Chapter 1 of the Operating Manual for the maximum permitted voltage levels that can be applied.

### WARNING



## Fire hazard

Make sure that only fuses of the correct rating and type are used for replacement.

If an integrally fused plug is used on the supply lead, ensure that the fuse rating is commensurate with the current requirements of this equipment. See under 'Performance data' in Chapter 1 in the Operating manual for power requirements.

### WARNING



## RF hazard

Do not disconnect RF cables which are carrying high levels of RF power. High voltages, which can cause RF burns, may be present at the end of the unterminated cables due to standing waves.

Switch off the transmitter or other source of RF power before disconnecting the cable from the equipment.

### WARNING



## Toxic hazards

Some of the components used in this equipment may include resins and other materials which give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

### WARNING



## Beryllia

Beryllia (beryllium oxide) is used in the construction of the following components in this equipment :

TR808 on AA1 and AA1/1;  
TR1 and TR2 on AA2/1 and AA2/7.

This material, when in the form of fine dust or vapor and inhaled into the lungs, can cause a respiratory disease. In its solid form, as used here, it can be handled quite safely although it is prudent to avoid handling conditions which promote dust formation by surface abrasion.

Because of this hazard, you are advised to be very careful in removing and disposing of these components. Do not put them in the general industrial or domestic waste or despatch them by post. They should be separately and securely packed and clearly identified to show the nature of the hazard and then disposed of in a safe manner by an authorized toxic waste contractor.

### WARNING



## Beryllium copper

Some mechanical components within this instrument are manufactured from beryllium copper. This is an alloy with a beryllium content of approximately 5%. It represents no risk in normal use.


The material should not be machined, welded or subjected to any process where heat is involved.

It must be disposed of as “special waste”.

It must NOT be disposed of by incineration.

### CAUTION

## Static-sensitive components

The presence of static-sensitive components is indicated in the equipment by yellow disks, flags or labels bearing the symbol . Certain handling precautions should be observed to prevent these components being permanently damaged by static charges or fast surges:

1. If a static-sensitive component is to be removed or replaced, the following anti-static equipment should be used:
  - A **work bench** with a grounded conductive surface.
  - **Metallic tools** grounded either permanently or by repeated discharges.
  - A **low-voltage** grounded soldering iron.
  - A **grounded wrist strap** and a conductive **grounded seat cover** for the operator whose outer clothing should not be of man-made fiber.
2. If a printed board containing static-sensitive components (as indicated by warning disk or flag) is removed, it must be temporarily stored in a conductive plastic bag.
3. As a general precaution, avoid touching the leads of a static-sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.
4. If using a freezer aerosol in fault finding, take care not to spray programmable ICs as this may affect their contents.

### CAUTION

## Suitability for use

This equipment has been designed and manufactured by IFR Ltd. to generate VHF and UHF signals for the testing of radio communications apparatus. IFR Ltd. has no control over the use of this equipment and cannot be held responsible for events arising from its use other than for its intended purpose.

# Précautions

## WARNING

## CAUTION

## Note

Les termes suivants ont, dans ce manuel, des significations particulières:

### WARNING

contient des informations pour éviter toute blessure au personnel.

### CAUTION




contient des informations pour éviter les dommages aux équipements.

### Note

contient d'importantes informations d'ordre général.

## Symboles

La signification des symboles liés à cet équipement est la suivante:

Symbole	Nature du risque
	Risques généraux
	Tension dangereuse
	Danger produits toxiques

## Conditions générales d'utilisation

Ce produit a été conçu et testé pour être conforme aux exigences des normes CEI/EN61010-1 "Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire", pour des équipements Classe I portables et pour une utilisation dans un environnement de pollution de niveau 2. Cet équipement est conçu pour fonctionner à partir d'une alimentation de catégorie I et II.

Cet équipement doit être protégé de l'introduction de liquides ainsi que des précipitations d'eau, de neige, etc... Lorsqu'on transporte cet équipement d'un environnement chaud vers un environnement froid, il est important de laisser l'équipement se stabiliser en température avant de le connecter à une alimentation afin d'éviter toute formation de condensation. L'appareil doit être utilisé uniquement dans le cadre des conditions d'environnement spécifiées au chapitre 1 "Performance data" du manuel d'utilisation, toute autre utilisation peut endommager les systèmes de protection.

Ce produit n'est pas garanti pour fonctionner dans des atmosphères dangereuses ou pour un usage médical. Si l'équipement doit être utilisé pour des applications en relation avec la sécurité, par exemple des applications militaires ou aéronautiques, la compatibilité du produit doit être établie et approuvée par une personne compétente.

### WARNING



## Sécurité électrique (tension d'alimentation alternative)

Cet appareil est protégé conformément à la norme CEI de sécurité Classe 1, c'est-à-dire que sa prise secteur comporte un fil de protection à la terre. Pour maintenir cette protection, le câble d'alimentation doit toujours être branché à la source d'alimentation par l'intermédiaire d'une prise comportant une borne de terre.

Notez que les filtres d'alimentation contiennent des condensateurs qui peuvent encore être chargés lorsque l'appareil est débranché. Bien que l'énergie contenue soit conforme aux exigences de sécurité, il est possible de ressentir un léger choc si l'on touche les bornes sitôt après débranchement.

## Fusibles

Notez que le fusible d'alimentation interne est en série avec la phase du câble d'alimentation. Si la prise d'alimentation comporte deux bornes non polarisées, il est possible de connecter le fusible au



neutre. Dans ce cas, certaines parties de l'appareil peuvent rester à un certain potentiel même après coupure du fusible

### Retrait des couvercles

L'appareil doit être débranché avant de retirer les couvercles afin d'éviter tout contact avec les éléments haute tension. Si toutefois un réglage interne ou une réparation nécessitent la présence de l'alimentation, ils devront être effectués par une personne qualifiée et avisée des risques encourus.

#### WARNING



### Sécurité électrique (tension d'alimentation continue)

Cet équipement est conforme aux normes de sécurité CEI Classe III, c'est-à-dire qu'il ne doit être connecté qu'à des sources d'alimentation ou de signaux qui suivent les recommandations de tension et d'isolement du type 'Tension extra-faible séparée' (SELV at SELV-E). Aucune tension dangereuse n'est générée en interne. "Performance data" dans le chapitre 1 du manuel d'utilisation précise les niveaux de tension maximum acceptables en entrée.

#### WARNING



### Risque lié au feu

Lors du remplacement des fusibles vérifiez l'exactitude de leur type et de leur valeur.

Si le câble d'alimentation comporte une prise avec fusible intégré, assurez vous que sa valeur est compatible avec les besoins en courant de l'appareil. Pour la consommation, reportez-vous au "Performance data" dans le chapitre 1 du manuel d'utilisation.



### Danger RF

Ne jamais débrancher un câble RF connecté à une source de puissance RF en fonctionnement. Il peut y avoir, à l'extrémité d'un câble non chargé, des tensions très importantes susceptibles de causer des brûlures graves. Toujours éteindre la source de puissance RF avant de débrancher le câble sur l'équipement.

#### WARNING



### Danger produits toxiques

Certains composants utilisés dans cet appareil peuvent contenir des résines et d'autres matières qui dégagent des fumées toxiques lors de leur incinération. Les précautions d'usages doivent donc être prises lorsqu'on se débarrasse de ce type de composant.

#### WARNING



### Le Béryllia

Le Béryllia (oxyde de Béryllium) entre dans la composition des composants suivants:

TR808 sur AA1 et AA1/1;

TR1 et TR2 sur AA2/1 et AA2/7.

Cette matière peut, lorsqu'elle est inhalée sous forme de vapeur ou de fine poussière, être la cause de maladies respiratoires. Sous sa forme solide, comme c'est le cas ici, cette matière peut être manipulée sans risque, bien qu'il soit conseillé d'éviter toute manipulation pouvant entraîner la formation de poussière par abrasion de la surface.

Il est donc conseillé, pour éviter ce risque, de prendre les précautions requises pour retirer ces composants et s'en débarrasser. Ne les jetez pas avec les déchets industriels ou domestiques ou ne les envoyez pas par la poste. Il faut les emballer séparément et solidement et bien indiquer la nature du risque avant de les céder, avec précautions, à une entreprise spécialisée dans le traitement de déchets toxiques.

**WARNING****Bronze au béryllium**

Dans cet équipement, certaines pièces mécaniques sont à base de bronze au béryllium. Il s'agit d'un alliage dans lequel le pourcentage de béryllium ne dépasse pas 5%. Il ne présente aucun danger en utilisation normale.

Toutefois, cet alliage ne doit pas être travaillé, soudé ou soumis à un processus qui implique l'utilisation d'une source de chaleur.

En cas de destruction, il sera entreposé dans un container spécial. IL ne devra pas être détruit par incinération.

## Vorsichtsmaßnahmen

**WARNING**

**CAUTION**

**Note**

Diese Hinweise haben eine bestimmte Bedeutung in diesem Handbuch:

**WARNING**

dienen zur Vermeidung von Verletzungsrisiken.

**CAUTION**

dienen dem Schutz der Geräte.

**Note**

enthalten wichtige Informationen.

## Symbole

Die Gefahrensymbole auf den Geräten sind wie folgt:

**Symbol**

**Gefahrenart**



Allgemeine Gefahr



Gefährliche Spannung



Warnung vor giftigen Substanzen

## Allgemeine Hinweise zur Verwendung

Dieses Produkt wurde entsprechend den Anforderungen von IEC/EN61010-1 "Sicherheitsanforderungen für elektrische Ausrüstung für Meßaufgaben, Steuerung und Laborbedarf", Klasse I transportabel zur Verwendung in einer Grad 2 verunreinigten Umgebung, entwickelt und getestet. Dieses Gerät ist für Netzversorgung Klasse I und II zugelassen.

Das Gerät sollte vor dem Eindringen von Flüssigkeiten sowie vor Regen, Schnee etc. geschützt werden. Bei Standortänderung von kalter in wärmere Umgebung sollte das Gerät wegen der Kondensation erst nach Anpassung an die wärmere Umgebung mit dem Netz verbunden werden. Das Gerät darf nur in Umgebungsbedingungen wie in Kapitel 1 "Leistungsdaten (Performance data)" der Bedienungsanleitung beschrieben, betrieben werden; ansonsten wird der vom Gerät vorgesehene Schutz des Anwenders beeinträchtigt.

Dieses Produkt ist nicht für den Einsatz in gefährlicher Umgebung (z.B. Ex-Bereich) und für medizinische Anwendungen geprüft. Sollte das Gerät für den Einsatz in sicherheitsrelevanten Anwendungen wie z.B. im Flugverkehr oder bei militärischen Anwendungen vorgesehen sein, so ist dieser von einer für diesen Bereich zuständigen Person zu beurteilen und genehmigen.

**WARNING**



### Elektrische Schläge (Wechselspannungsversorgung)

Das Gerät entspricht IEC Sicherheitsklasse 1 mit einem Schutzleiter nach Erde. Das Netzkabel muß stets an eine Steckdose mit Erdkontakt angeschlossen werden.

Filterkondensatoren in der internen Spannungsversorgung können auch nach Unterbrechung der Spannungszuführung noch geladen sein. Obwohl die darin gespeicherte Energie innerhalb der Sicherheitsmargen liegt, kann ein leichter Spannungsschlag bei Berührung kurz nach der Unterbrechung erfolgen.

## Sicherungen

Die interne Sicherung in der Spannungszuführung ist in Reihe mit der spannungsführenden Zuleitung geschaltet. Bei Verbindung mit einer zweipoligen, nicht gepolten Steckdose kann die Sicherung in der Masseleitung liegen, so daß auch bei geschmolzener Sicherung Geräteteile immer noch auf Spannungspotential sind.

## Abnahme von Abdeckungen

Die Spannungsversorgung muß vor Abnahme von Gehäuseabdeckungen unterbrochen sein, damit hochspannungsführende Teile gefahrlos zugänglich sind. Falls Abgleiche oder Servicearbeiten unter Spannung notwendig werden, dürfen solche Arbeiten nur von fachkundigem Personal durchgeführt werden, das die Gefahren kennt.

### WARNING



## Elektrische Schläge (Gleichspannungsversorgung)

Dieses Gerät entspricht der IEC Sicherheitsklasse III. Aus Sicherheitsgründen darf es nur an Netzgeräte und Signalquellen angeschlossen werden, die in Spannung und Isolation der SELV und SELV-E Richtlinie genügen ("Getrennte Niederspannung"). Im Gerät werden keine gefährlichen Spannungen erzeugt. Im Handbuch, Kapitel 1, "Performance data" (Leistungsdaten), werden die anschließbaren Höchstspannungen definiert.

### WARNING



## Feuergefahr

Es dürfen nur Ersatzsicherungen vom gleichen Typ mit den korrekten Spezifikationen entsprechend der Stromaufnahme des Gerätes verwendet werden. Siehe hierzu Kapitel 1 "Leistungsdaten (Performance data)" der Bedienungsanleitung.

### WARNING



## Hochfrequenzstrahlung

Lösen Sie keine Kabel an welchen größere Pegel von Hochfrequenzleistung anliegen. An den nichtabgeschlossenen Enden von HF Kabeln können auf Grund von Stehwellen hohe Spannungen auftreten. Diese verursachen unter Umständen Verbrennungen. Schalten Sie den Sender oder die Quelle der HF-Leistung vor dem Lösen des HF-Kabels ab.

### WARNING



## Warnung vor giftigen Substanzen

In einigen Bauelementen dieses Geräts können Epoxyharze oder andere Materialien enthalten sein, die im Brandfall giftige Gase erzeugen. Bei der Entsorgung müssen deshalb entsprechende Vorsichtsmaßnahmen getroffen werden.

### WARNING



## Beryllium Oxid

Beryllium Oxid wird in den folgenden Bauelementen dieses Geräts verwendet:

TR808 auf AA1 und AA1/1;  
TR1 und TR2 auf AA2/1 und AA2/7.

Als Staub inhaliert kann Beryllium zu Schädigungen der Atemwege führen. In fester Form kann es ohne Gefahr gehandhabt werden, wobei Staubabrieb vermieden werden sollte.

Wegen dieser Gefahren dürfen diese Bauelemente nur mit der entsprechenden Vorsicht ausgebaut und entsorgt werden. Sie dürfen nicht mit Industrie oder Hausmüll vermengt oder per Post versandt werden. Sie müssen separat verpackt und entsprechend der Gefährdung markiert werden. Die Entsorgung muß über einen autorisierten Fachbetrieb erfolgen.

### WARNING



### **Beryllium Kupfer**

In diesem Gerät sind einige mechanische Komponenten aus Beryllium Kupfer gefertigt. Dies ist eine Verbindung welche aus einem Berylliumanteil von ca. 5 % besteht. Bei normaler Verwendung besteht kein Gesundheitsrisiko.

Das Metall darf nicht bearbeitet, geschweißt oder sonstiger Wärmebehandlung ausgesetzt werden.

Es muß als Sondermüll entsorgt werden.

Es darf nicht durch Verbrennung entsorgt werden.

## Precauzioni

**WARNING****CAUTION****Note**

Questi termini vengono utilizzati in questo manuale con significati specifici:

**WARNING**

riportano informazioni atte ad evitare possibili pericoli alla persona.

**CAUTION**




riportano informazioni per evitare possibili pericoli all'apparecchiatura.

**Note**

riportano importanti informazioni di carattere generale.

## Simboli

Significato dei simboli di pericolo utilizzati nell'apparato:

Simbolo	Tipo di pericolo
	Pericolo generico
	Tensione pericolosa
	Pericolo sostanze tossiche

## Condizioni generali d'uso

Questo prodotto è stato progettato e collaudato per rispondere ai requisiti della direttiva IEC/EN61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use' per apparati di classe I portatili e per l'uso in un ambiente inquinato di grado 2. L'apparato è stato progettato per essere alimentato da un alimentatore di categoria I e II.

Lo strumento deve essere protetto dal possibile ingresso di liquidi quali, ad es., acqua, pioggia, neve, ecc. Qualora lo strumento venga portato da un ambiente freddo ad uno caldo, è importante lasciare che la temperatura all'interno dello strumento si stabilizzi prima di alimentarlo per evitare formazione di condense. Lo strumento deve essere utilizzato esclusivamente nelle condizioni ambientali descritte nel capitolo 1 'Performance data' del manuale operativo, in caso contrario le protezioni previste nello strumento potrebbero risultare non sufficienti.

Questo prodotto non è stato approvato per essere usato in ambienti pericolosi o applicazioni medicali. Se lo strumento deve essere usato per applicazioni particolari collegate alla sicurezza (per esempio applicazioni militari o avioniche), occorre che una persona o un istituto competente ne certifichi l'uso.

**WARNING**

### Pericoli da elettricità (alimentazione c.a.)

Quest 'apparato è provvisto del collegamento di protezione di terra e rispetta le norme di sicurezza IEC, classe 1. Per mantenere questa protezione è necessario che il cavo, la spina e la presa d'alimentazione siano tutti provvisti di terra.

Il circuito d'alimentazione contiene dei filtri i cui condensatori possono restare carichi anche dopo aver rimosso l'alimentazione. Sebbene l'energia immagazzinata è entro i limiti di sicurezza, purtuttavia una leggera scossa può essere avvertita toccando i capi della spina subito dopo averla rimossa.

### Fusibili

Notare che un fusibile è posto sul filo caldo del cavo di alimentazione. Qualora l'alimentazione avvenga tramite due poli non polarizzati, è possibile che il fusibile vada a protezione del neutro per cui anche in caso di una sua rottura, l'apparato potrebbe restare sotto tensione.

### Rimozione dei coperchi

Prima di rimuovere i coperchi occorre scollegare la spina d'alimentazione onde evitare il rischio di esposizione di parti ad alta tensione. Eventuali operazioni di manutenzione che richiedono la presenza dell'alimentazione dovranno essere eseguite solo da parte di personale specializzato ed a conoscenza dei pericoli coinvolti.

#### WARNING



### Pericoli da elettricità (alimentazione a c.c.)

Questo strumento rispetta le norme IEC, classe III, e quindi, per una completa sicurezza, deve essere collegato solo ad alimentatori e generatori di segnali che rispettano I requisiti di tensione ed isolamento SELV e SELV-E (Separated Extra-Low Voltage). Nessuna tensione pericolosa è generata al suo interno. Vedi capitolo 1 del manuale operativo per quanto concerne I livelli massimi di tensione applicabili.

#### WARNING



### Pericolo d'incendio

Assicurarsi che, in caso di sostituzione, vengano utilizzati solo fusibili della portata e del tipo prescritti.

Se viene usata una spina con fusibili, assicurarsi che questi siano di portata adeguata ai requisiti di alimentazione richiesti dallo strumento. Tali requisiti sono riportati nel cap. 1 "Performance data" del manuale operativo.

#### WARNING



### Rischio a RF

Non sconnettere cavi RF sui quali si stia trasmettendo un segnale RF ad alta potenza. Un'alta tensione, che può causare bruciature, potrebbe essere presente alla fine di cavi non terminati a causa delle onde stazionarie. Spegnerne il trasmettitore od altra sorgente di segnale RF prima di disconnettere il cavo dall'apparato.

#### WARNING



### Pericolo sostanze tossiche

Alcuni dei componenti usati in questo strumento possono contenere resine o altri materiali che, se bruciati, possono emettere fumi tossici. Prendere quindi le opportune precauzioni nell'uso di tali parti.

#### WARNING



### Berillio

Berillio (ossido di berillio) è utilizzato nella costruzione dei seguenti componenti di quest'apparato:

TR808 schema AA1 e AA1/1;  
TR1 e TR2 schema AA2/1 e AA2/7.

Questo materiale, se inalato sotto forma di polvere fine o vapore, può causare malattie respiratorie. Allo stato solido, come è usato qui, può essere maneggiato con sufficiente sicurezza anche se è prudente evitare condizioni che provochino la formazione di polveri tramite abrasioni superficiali.

A cause di questi pericoli occorre essere molto prudenti nella rimozione e nella locazione di questi componenti. Questi non devono essere gettati tra i rifiuti domestici o industriali né vanno spediti per posta. Essi devono essere impacchettati separatamente ed in modo sicuro e devono indicare chiaramente la natura del pericolo e quindi affidate a personale autorizzato.

**WARNING**



**Rame berillio**

Alcuni componenti meccanici in questo strumento sono realizzati in rame berillio. Si tratta di una lega con contenuto di berillio di circa il 5%, che non presenta alcun rischio in usi normali.

Questo materiale non deve essere lavorato, saldato o subire qualsiasi processo che coinvolge alte temperature.

Deve essere eliminato come "rifiuto speciale". Non deve essere eliminato tramite "inceneritore".



## Precauciones

**WARNING**
**CAUTION**
**Note**

Estos términos tienen significados específicos en este manual:

**WARNING**

contienen información referente a prevención de daños personales.

**CAUTION**




contienen información referente a prevención de daños en equipos.

**Note**

contienen información general importante.

## Símbolos

Los significados de los símbolos de peligro que aparecen en los equipos son los siguientes:

Símbolo	Naturaleza del peligro
	Peligro general
	Voltaje peligroso
	Aviso de toxicidad

## Condiciones generales de uso

Este producto ha sido diseñado y probado para cumplir los requerimientos de la normativa IEC/EN61010-1 “Requerimientos de la normativa para equipos eléctricos de medida, control y uso en laboratorio”, para equipos clase I portátiles y para uso en un ambiente con un grado de contaminación 2. El equipo ha sido diseñado para funcionar sobre una instalación de alimentación de categorías I y II.

Debe protegerse el equipo de la entrada de líquidos y precipitaciones como nieve, lluvia, etc. Cuando se traslada el equipo de entorno frío a un entorno caliente, es importante aguardar la estabilización del equipo para evitar la condensación. Sólo debe utilizarse el aparato en las condiciones ambientales especificadas en el capítulo 1 “Especificaciones” o “Performance data” del Manual de Instrucciones/Manual de Operación, en caso contrario la propia protección del equipo puede resultar dañada.

Este producto no ha sido aprobado para su utilización en entornos peligrosos o en aplicaciones médicas. Si se va a utilizar el equipo en una aplicación con implicaciones en cuanto a seguridad, como por ejemplo aplicaciones de aviónica o militares, es preciso que un experto competente en materia de seguridad apruebe su uso.

**WARNING**


### Nivel peligroso de electricidad (tensión de red)

Este equipo cumple las normas IEC Seguridad Clase 1, lo que significa que va provisto de un cable de protección de masa. Para mantener esta protección, el cable de alimentación de red debe de conectarse siempre a una clavija con terminal de masa.

Tenga en cuenta que el filtro de red contiene condensadores que pueden almacenar carga una vez desconectado el equipo. Aunque la energía almacenada está dentro de los requisitos de seguridad, pudiera sentirse una ligera descarga al tocar la clavija de alimentación inmediatamente después de su desconexión de red.

## Fusibles

Se hace notar que el fusible de alimentación interno está en serie con el activo del cable de alimentación a red. Si la clavija de alimentación de red cuenta con sólo dos terminales sin polaridad, el fusible puede pasar a estar en serie con el neutro, en cuyo caso existen partes del equipo que permanecerían a tensión de red incluso después de que el fusible haya fundido.

## Para retirar las tapas

Desconectar de red antes de retirar las tapas para evitar el riesgo que supone tener accesibles aquellas partes del equipo expuestas a alta tensión. Aquellas operaciones que requieran tener alimentación con las tapas abiertas para mantenimiento o ajuste deben de ser realizadas por personal cualificado, que esté al tanto de los riesgos implicados.

### WARNING



## Nivel peligroso de electricidad (tensión de alimentación DC)

Este equipo cumple con la norma de seguridad IEC clase III, lo que significa que para total seguridad debe ser conectado a alimentaciones y fuentes de señal que cumplan los requerimientos de tensión y aislamiento “Tensión Separada Extra-Baja” (SELV y SELV-E). Ninguna tensión generada internamente implica riesgo para el operario.

En el capítulo 1 “Especificaciones” del Manual de Instrucciones/Manual de Operación podrá encontrar los valores máximos permitidos que pueden aplicarse.

### WARNING



## Peligro de incendio

Asegúrese de utilizar sólo fusibles del tipo y valores especificados como repuesto.

Si se utiliza una clavija con fusible incorporado, asegúrese de que los valores del fusible corresponden a los requeridos por el equipo. Ver sección de especificaciones del capítulo 1 del Manual de Instrucciones/Manual de Operación/Funcionamiento para comprobar los requisitos de alimentación.

### WARNING



## Peligro de RF

No desconecte cables de RF que transporten niveles altos de potencia de RF. Es posible la presencia de altas tensiones, capaces de causar quemaduras por RF, en el extremo del cable sin terminar, debido a ondas estacionarias. Desactive el transmisor u otra fuente de potencia de RF antes de desconectar el cable de los equipos."

### WARNING



## Aviso de toxicidad

Alguno de los componentes utilizados en este equipo pudieran incluir resinas u otro tipo de materiales que al arder produjeran sustancias tóxicas, Por tanto, tome las debidas precauciones en la manipulación de esas piezas.

### WARNING



## Berilio

Berilio (óxido de berilio), se ha utilizado en la fabricación de los siguientes componentes del equipo:

TR808 en AA1 y AA1/1;  
TR1 y TR2 en AA2/1 y AA2/7.

La inhalación de este material, en forma de polvo fino o vapor, entrando en los pulmones, puede ser causa de enfermedades respiratorias. En forma sólida, como se utiliza en este caso, puede manipularse con bastante seguridad, aunque se recomienda no manejarlo en aquellas condiciones que pudieran favorecer la aparición de polvo por abrasión de la superficie.

Por todo lo anterior, se recomienda tener el máximo cuidado al reemplazar o deshacerse de estos componentes, no tirándolos en basuras industriales o domésticas y no utilizar el correo para su envío. Deben, ser empaquetados de forma segura y separada, y el paquete debidamente etiquetado e identificado, señalando claramente la naturaleza del riesgo y ponerlo a disposición de un destructor autorizado de productos tóxicos.

### WARNING



#### **Berilio-cobre**

Algunos componentes mecánicos contenidos en este instrumento incorporan berilio-cobre en su proceso de fabricación. Se trata de una aleación con un contenido aproximado de berilio del 5%, lo que no representa ningún riesgo durante su uso normal.

El material no debe ser manipulado, soldado, ni sometido a ningún proceso que implique la aplicación de calor.

Para su eliminación debe tratarse como un "residuo especial". El material NO DEBE eliminarse mediante incineración.

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# Chapter 1

## TECHNICAL DESCRIPTION

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## Introduction

The 2023, 2023A, 2023B, 2024 and 2025 AM/FM Signal Generators cover the following frequency ranges:

9 kHz to 1.2 GHz	2023 and 2023A
9 kHz to 2.05 GHz	2023B
9 kHz to 2.4 GHz	2024
9 kHz to 2.51 GHz	2025

Output levels from -140 dBm to +13 dBm are available. Factory fitted options are available to extend the level to +25 dBm (+19 dBm above 1.2 GHz) and to provide SINAD measurement capability. Fig. 1-1 is a block diagram of the frequency synthesis and signal processing circuits.

## Synthesizer

A VCXO operating at 100 MHz is phase locked to the internal (or external) frequency standard using a phase comparator at 10 MHz. The VCXO signal is divided by 20 to give a 5 MHz reference frequency for the fractional-N loop phase comparator.

A fractional-N loop is used to lock a multiplied low-noise VCO to the reference with a resolution of 1 Hz. The VCO tunes from 400 to 535 MHz and is multiplied by three, four or five to yield a signal in the range 1.2 to 2.51 GHz. A high speed programmable divider is used to divide the multiplied VCO frequency down to 5 MHz and a phase comparator compares this signal with the reference derived from the VCXO. The output from the phase comparator corrects the VCO frequency. In order to provide the required division ratio, the programmable divider is required to act as a fractional divider. The fractional-N gate array controls the division ratio of the programmable divider. The variation of this division ratio by the controller enables the loop to lock, with non-integer division ratios, to the reference with the resolution of 1 Hz without introducing spurious signals.

FM is produced using a two-point modulation scheme. The FM signal is inserted into the loop by summing the FM signal with the VCO tune line to modulate the VCO directly. Simultaneously, the FM signal is fed to the fractional-N controller via a 1-bit oversampled A-D converter which converts an analogue input into a bit stream of '1's and '0's. The controller uses this input to modulate the division ratio in sympathy with the modulation. This allows frequencies less than the loop bandwidth, including DC, to modulate the output frequency.

In order to maintain good FM performance of the two-point modulation system, the VCO FM tracking characteristics are required to be known. The sensitivity of the FM system via the 1-bit oversampled A-D converter is VCO independent and accurately calibrated by a DC calibration system. The VCO tracking is derived by an automatic FM SELFCAL routine during calibration. During an FM SELFCAL, the error signal on the tune line, for a frequency near the loop bandwidth, is monitored while varying the FM calibration numbers, allowing the variation in VCO sensitivities to be calibrated out. This will remove any perturbation of FM flatness near the loop bandwidth due to mismatch of two modulation paths.

## RF processing

The VCO on board AA1 operates in the range 400 to 535 MHz and feeds to a harmonic generator whose 3rd, 4th and 5th harmonics are selected by voltage-tuned band-pass filters to provide a frequency in the range 1.2 to 2.4 GHz (2.51 GHz on board AA1/1). To generate frequencies below 1.2 GHz this signal is divided by factors of two to produce frequencies in the range 10 MHz to 1.2 GHz. A bank of switched half octave harmonic filters follows which is used to reduce unwanted harmonics at the output. Then the signal passes through the amplitude modulator where the output level envelope is controlled. The output from the modulator is peak detected. For frequencies less than 10 MHz the signal is mixed with an input from the 100 MHz VCXO. The resulting output in the frequency range 9 kHz to 2.4 or 2.51 GHz is fed from the output amplifier to attenuator board AA2. For pulse operation the signal is taken to the pulse modulator which operates in the range 30 MHz to 2.51 GHz. Otherwise the pulse modulator is bypassed and the signal is fed to the output attenuator. This is controlled by relays and provides attenuation in steps of 11 dB up to 132 dB. The attenuator also includes an RPP (Reverse Power Protection) system to protect the instrument from accidental application of reverse power.

### **LF processing**

The LF processing all takes place on control board AB1 or AB1/1, and may be conveniently subdivided into the following major functional elements.

#### **LF output**

A DSP (Digital Signal Processor) is used to generate the audio frequency signals used for internal modulation. One output from the DSP is used to supply the front panel LF OUTPUT socket.

For external modulation the signal applied to the EXT MOD INPUT socket first passes through AC/DC coupling selection and then can either be applied directly or via an ALC (Automatic Level Control) circuit to the audio multiplexers. The external direct signal can also be summed with the audio frequency from the DSP.

#### **AM and level control**

For amplitude modulation the modulation depth is set by a 12-bit A-D converter. A second A-D converter is used to produce the ALC reference for the RF board. Square law correction is applied to both signals.

#### **FM/ $\phi$ M**

For frequency modulation the signal amplitude controls the FM deviation. For phase modulation the signal is passed through a differentiator circuit.

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*Fig. 1-1 Signal generator block schematic*





## AA1, AA1/1 RF board

### Carrier frequency synthesis

The RF carrier of the instrument should be as clean in frequency (and level) as possible. To achieve this goal the instrument relies on a single-loop fractional-N Synthesizer scheme and a harmonic multiplier and UHF oscillator covering the fundamental range from 1.2 to 2.4 GHz (AA1) or 1.2 to 2.51 GHz (AA1/1). Using this approach minimizes the RF processing circuitry normally associated with conventional frequency doubling or mixing schemes.

A carrier frequency resolution of 1 Hz cannot be achieved easily without the use of non-integer division. In this instrument this operation is controlled by a dedicated ASIC which modifies the division ratio of a programmable divider so that the average frequency is a non-integer division of the input.

### RF board: Carrier generation (sheet 1)

Frequencies from 1.2 to 2.4 GHz (AA1) or 1.2 to 2.51 GHz (AA1/1) are generated by multiplication from a 400 to 535 MHz low-noise oscillator. The tuned circuit is formed by C102, C108, varactor diodes D101 to D106 and printed inductors. A maintaining transistor TR101 is tapped into the tuned circuit. The oscillator is tuned by a differential voltage applied to the varactor diodes via L101 to L103. The VCO TUNE LOW line is used to phase lock the oscillator and inject FM whilst the VCO TUNE HIGH line is used to pre-steer the VCO.

The signal from the VCO is buffered by IC101 and then amplified by TR102 to provide a suitable level to drive the harmonic multiplier. The collector of TR102 is tuned by L104, C114 and C116. Harmonics are generated by D107 which acts as a step recovery diode. The diode is self-biased to improve the efficiency of harmonic generation by the network R110, R108 and C111. The harmonics generated by D107 are filtered by a four stage band-pass filter with a centre frequency in the range of 1.2 to 2.4 GHz (AA1) or 1.2 to 2.5 GHz (AA1/1). Each filter stage is formed by a pair of parallel coupled lines. Each line is capacitively loaded at one end by a pair of back-to-back varactor diodes to allow tuning over an octave. The stages are separated by buffer amplifiers IC104 to IC107. These amplifiers compensate for the loss and frequency response inherent in each filter stage and provide isolation so that tuning of the stages is independent. A pad at the output of each buffer amplifier increases the isolation and provides a better match to the input of the next filter stage. The filtered signal at the output of IC107 is split by R149 and R150 to feed the synthesizer dividers (sheet 3) and the output dividers (sheet 7). The filter stages are tuned by a voltage in the range of 1 to 24 V (AA1) or 1 to 31 V (AA1/1) derived from octal DAC IC103. This is applied via scaling amplifier IC102a and buffer IC102b. Diodes D125 and D126 allow fast tuning by shorting out R124 to reduce the charging time constant and so shorten the filter settling time whenever the frequency is changed. A 1.25 V reference for the DAC is provided by IC108 via IC102c. Table 1-3 below gives the relationship between the VCO frequency, the harmonic and the final output frequency.

#### Note

When the varactor diodes (D108 - D123) need replacing, they must be replaced as a set. If the alternative type diodes are fitted, resistor R717 will need repositioning accordingly.

Table 1-1: Carrier generation

Output frequency (MHz)	Harmonic number (N)	VCO frequency (MHz)
1200 - 1600	3	400 - 533.3
1600 - 2000	4	400 - 500
2000 - 2510	5	400 - 502

## RF board: VCXO loop (sheet 2)

### 100 MHz VCXO

The 100 MHz VCXO is used to derive all of the clock signals necessary for the fractional-N Synthesizer. The use of a high frequency eliminates the need for a second phase-locked oscillator to generate the necessary local oscillator frequency for the BFO. The reference divider provides a 5 MHz clock for the fractional-N Synthesizer and the FM A-D converter.

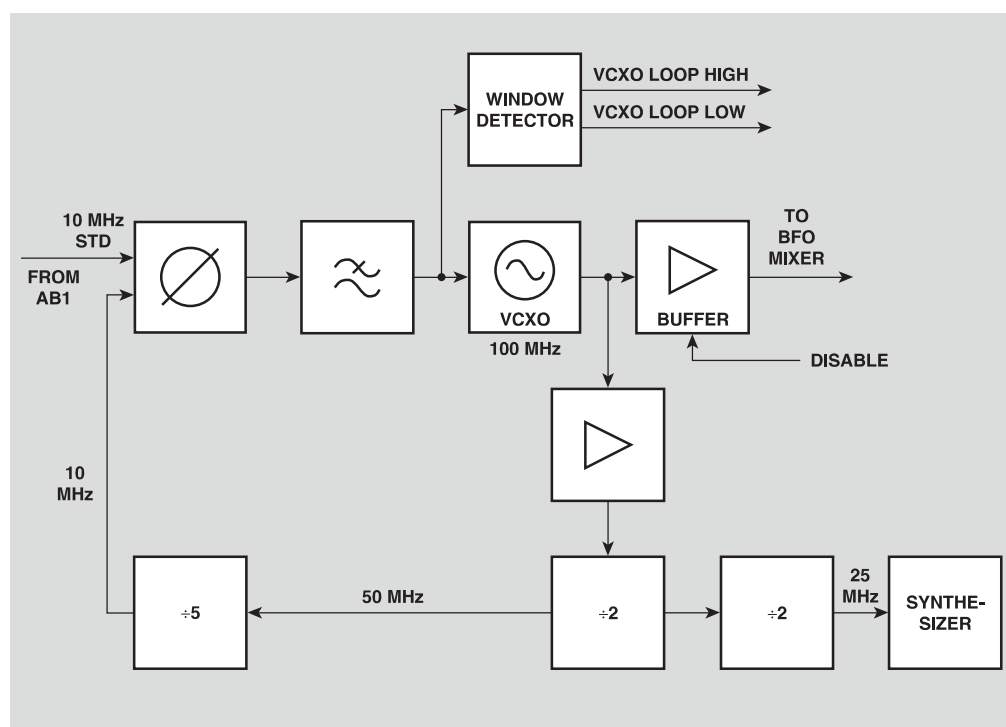
### VCXO operation

The 100 MHz oscillator is built around TR201. Crystal XL201 together with L202 and D201 provide a series resonant circuit in the emitter circuit of TR201. At resonance it increases the gain of the common-emitter stage and together with 180 degree phase shift network L204, C216, C215, C219 and C220 connected between the base and collector of TR201 provides the necessary conditions for oscillation. L203 tunes out the parasitic capacitance of the crystal package and prevents other spurious oscillations from occurring.

A facility to fine tune the phase shift network is provided by C215. At the resonant frequency, the circuit operates at maximum power levels when the correct phase shift is achieved around the transistor. TR202 provides a buffered signal to the VCXO loop divider IC205. A second buffer, TR203 provides local oscillator drive (at typically +3 dBm) to the BFO mixer (sheet 9). The BFO DRIVE line to TR204 allows the second buffer amplifier to be powered down when the BFO is not in use to prevent leakage of the 100 MHz LO onto the instrument output.

### 100 MHz phase-locked loop

The VCXO is used to provide a reference signal to the fractional-N loop and to the BFO band mixer and is locked to the 10 MHz frequency standard provided from control board AB1 or AB1/1 via PLAB. The buffered 100 MHz signal is divided down to 10 MHz before phase comparison. An integrator and active low-pass filter ensures the removal of the reference frequency from the VCXO tune line. A window comparator monitors the VCXO tune line to detect when the oscillator is outside its normal operating range. The block diagram of the phase-locked loop is shown in Fig. 1-2.



C2737

Fig. 1-2 100 MHz phase-locked loop

### Loop operation

The 100 MHz signal from the VCXO is buffered and amplified by TR205 to yield a CMOS logic compatible signal for the dividers which follow. The signal is divided by two by IC205a and then by five by IC202 to give 10 MHz for phase comparison. IC201 and IC203 form the loop phase-frequency comparator. R203 and C208 remove the fast edges from the output of the phase detector. A broken integrator is formed around IC204b. This has a break frequency of 80 Hz and a gain at high frequency of four. IC204a, which follows, is a second-order active low-pass filter with a cut-off of 700 Hz and a gain of two. The resulting loop bandwidth is approximately 150 Hz. The output from the active low-pass filter is further filtered by R212 and C213 to remove any high frequency signals.

IC204c and d form a window comparator which detects when the VCXO tuning voltage range is exceeded. The outputs from the comparators are attenuated to logic levels by R216 to R219 to give VCXO LOOP HIGH and VCXO LOOP LOW lines to provide status interrupts to the main processor via IC704 (sheet 8).

## RF board: Synthesizer (sheet 3)

### Synthesizer operation

Frequency synthesis control is performed by a dedicated ASIC, IC305. This generates all of the necessary division ratios for programmable divider IC307 to synthesize any frequency within the range 1.2 to 2.4 GHz (AA1) or 1.2 to 2.51 GHz (AA1/1). Synthesizer operation is summarized in Fig. 1-3.

The 1.2 to 2.51 GHz (AA1) or 1.2 to 2.51 GHz (AA1/1) input signal from the harmonic generator (sheet 1) is buffered by TR305 (sheet 3) to prevent divider spurious signals from IC309 reaching the instrument output. Signal feedback is not used with this stage, to give high reverse isolation.

The buffered signal is divided by two by IC309 and then amplified by IC308 to obtain a sufficient level to drive the input of programmable divider IC307. The programmable divider is used to provide integer division in the range 120 to 240. Fractional division is achieved by the modification of the integer division ratios, under the control of ASIC IC305, in such a way that the average frequency over time is not an integer division ratio of the original. Control inputs to IC307 are TTL compatible. The control outputs from ASIC IC305 are inverted by IC306 to provide the correct polarity for IC307. Resistors R316 to R323 and R343 to R350 reduce the amplitude of the control signals to 2.5 V. The outputs of IC307 are converted from ECL to TTL levels by differential pair TR302 and TR303 and a single-ended amplifier TR304. Diode D307 provides Schottky clamping for TR304 to ensure fast switching. The signal on the collector of TR304 is an all active edge squarewave at a 2.5 MHz rate. The fractional control ASIC and phase detector both require a clock with active positive edges. IC310d converts the 2.5 MHz signal to a 5 MHz signal with a short duty cycle and an active positive edge. The remaining gates of IC310 provide buffering. The division ratio generated by ASIC IC305 will be modified every time a positive edge is received at pin 51.

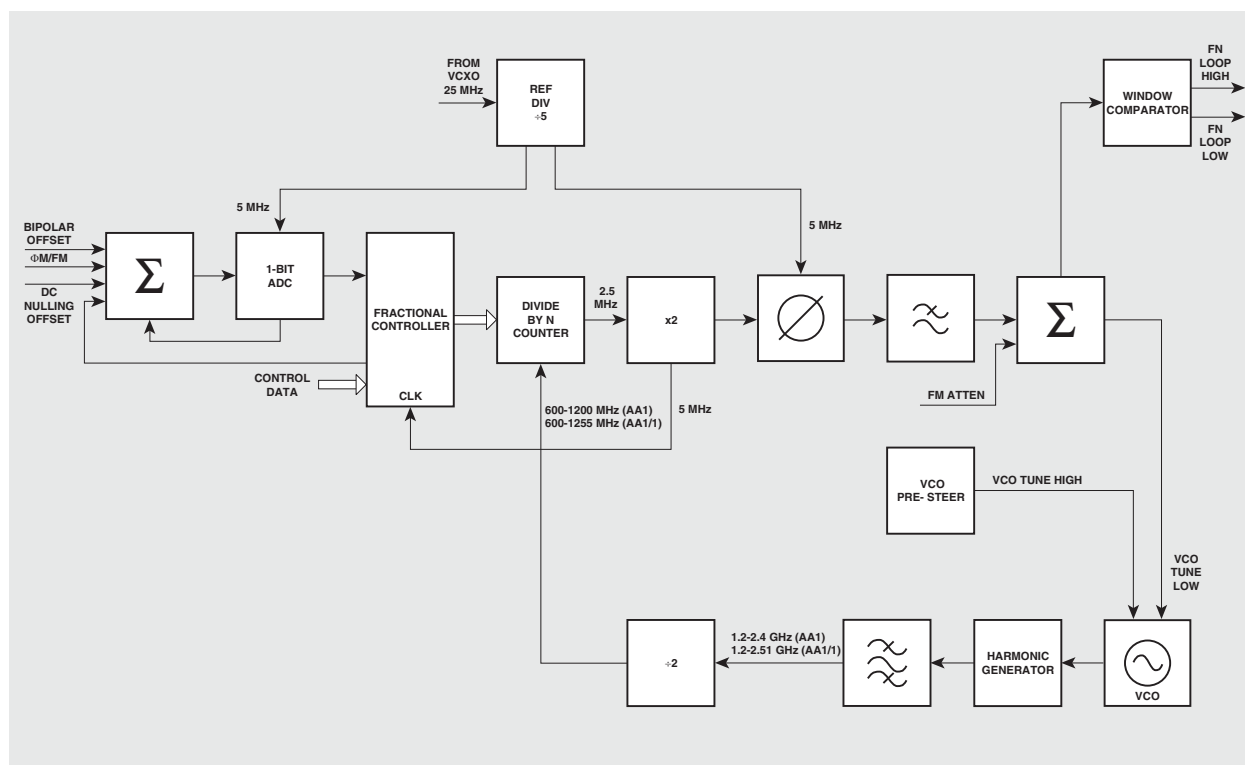
The reference for the main loop is obtained by dividing the 25 MHz signal present at IC302 pin 2 by five. The output of IC302 pin 11 is a 5 MHz rate pulse with a duty cycle of 40 ns. The clock for the 1-bit oversampled A-D converter is obtained from IC302 pin 13 after buffering and inversion by IC303a. The reference and divided output signal are compared by a phase frequency comparator comprising IC311, IC312b and IC313a. The phase detector output to the loop integrator and filter is available on pin 12 of IC311d. Under normal phase lock this will be a 5 MHz squarewave with nearly 50% duty cycle.

### 1-bit A-D converter

The DC input path to the Synthesizer consists of a third-order, single-bit, oversampling A-D converter, whose bit stream output is used to dynamically control the Synthesizer frequency via the Synthesizer ASIC.

Pin 6 of IC301b is used as the summing junction for four currents. These are: the input current from control board AB1 or AB1/1 via R307 and R352; a negative offset current via R306; the bit stream feedback via R310; and the DC nulling offset current via R311. IC301b integrates the sum of these currents, and its output is further integrated by broken integrators IC301c and d. In these, when the frequency rises to a point where C301 and C302 are at low impedance, the ICs act as unity-gain amplifiers. Diodes D301 to D304 are used to enable the converter to recover cleanly from an overload.

The output from the last integrator is fed via comparator TR301, which converts the input to TTL levels, to D-latch IC304a, which is clocked at the same rate as the Synthesizer ASIC. The output from the D-latch is fed back into the summing junction to close the converter control loop. The output from IC304a is a pseudo random bit stream that represents the analogue FM input to IC301b. The bit stream is used by the Synthesizer ASIC to control the main carrier frequency.



C4438

Fig. 1-3 Frequency synthesis

The DC nulling offset current is supplied from a 1-bit oversampling D-A converter in the Synthesizer ASIC. This balances the input current to make the converter read zero when DC nulling and when in AC coupled FM mode.

## RF board: Loop filter and autocal (sheet 4)

### Loop filter

The input on the PHASE DETECTOR line is filtered by R404 and C401 to remove fast edges before the signal reaches loop integrator IC402. The loop integrator has a break frequency set by C402 of approximately 1.5 kHz and gain at high frequency of 1.2. The network R414, R415, C405 and C406 provides rejection of unwanted noise in the 10 to 30 kHz range without introducing a large phase shift at the loop bandwidth. IC404 is a unity gain second-order active low-pass filter with a cut-off frequency of 40 kHz. The filtered signal from IC404 is attenuated and summed with the FM drive signal on the FM ATTN line by R433. This results in the VCO TUNE LOW output to the VCO (sheet 1). Loop bandwidth is approximately 3 kHz.

Correct phase lock is monitored by IC406c and d which detect when the voltage at the output of IC406a exceeds  $\pm 8$  V. Hysteresis is provided by R443 and R444. The detected outputs from D408 and D409 on the FN LOOP HIGH and FN LOOP LOW lines are attenuated to logic levels by R449 to R452. Loss of phase lock is signaled by interrupting the main processor via IC703 and IC704 (sheet 8).

### VCO pre-steer

The VCO PRE-STEER voltage is generated by octal DAC IC103 (sheet 1). The signal from the DAC is amplified by IC401a and b to provide a tuning voltage in the range 1 to 22 V. Temperature compensation for the VCO is provided by D414. Under normal operation the pre-steer voltage is filtered by R423 and C411 to prevent noise injection onto the VCO tune line. Diode D415 and IC408 allow fast tuning by shorting out R423 to reduce the charging time constant. IC408 is only switched on using the PRE-STEER SWITCH line during frequency changes that involve updating the pre-steer voltage.

### Autocalibration

Dedicated hardware has been added to the Synthesizer to allow fast automatic calibration of the VCO pre-steer and FM frequency response. Pre-steer calibration is achieved by minimizing the loop error voltage present at the output of IC406a. This is achieved by IC406b which forms a simple zero-crossing detector.

The FM frequency response calibration is performed by applying FM to the carrier with a 2 kHz modulating tone. Calibration is performed by minimizing the amplitude of the resulting 2 kHz tone present at the output of the loop filter. The magnitude of the FM drive voltage applied to the VCO is adjusted automatically whilst the phase relationship between the loop error tone and the applied modulating tone is monitored. The correct drive level is found at the point where the phase switches from being in phase to being out of phase. IC407a is used to amplify the loop error tone. TR402 and C417 are used to implement a crude charge pump phase detector. IC407d is used to clip the 2 kHz modulating tone so that TR402 gate is driven with a squarewave. The output from the phase detector is filtered by two RC sections and buffered by IC407b. The sign of the filtered voltage, and hence the point of phase reversal is monitored by IC407c. The output of IC407c is converted to logic levels by D412, R457 and R458. Forward biasing D404, D405, D411 and D413 using the CAL DISABLE line suppresses the operation of the autocalibration hardware.

### AA2 board identification

The AA2 BOARD SENSE line indicates one of three conditions to the processor: a standard attenuator board AA2 is fitted; a high-power attenuator board AA2/1 is fitted ; no attenuator is fitted. PLAE 15 indicates these conditions respectively by being: shorted to earth; open circuit; connected to earth via a 1 k $\Omega$  resistor. The two output lines BOARD ID (A) and BOARD ID (B) are connected by pull-up resistors R723 and R724 to IC705 (sheet 8). The logic is shown in Table 1-2. below.

**Table 1-2: Attenuator board identification**

Board type	PLAE 15			BOARD ID	
		TR406	TR407	(A)	(B)
Standard	Shorted to earth	OFF	OFF	H	H
High power	Open circuit	ON	ON	L	L
No attenuator	Resistor	ON	OFF	L	H

### Power amp cal comparator

Comparator IC401c compares the power amplifier detector level output from high power attenuator board AA2/1 with the POWER AMP CAL signal on IC401c pin 10. The latter signal comes from DAC IC103 (sheet 1). The comparator circuit performs a dual function. In instrument calibration mode the AA2/1 detector output is calibrated using the POWER AMP CAL signal to find the 'trip level', when the POWER AMP CAL output changes state. In normal instrument operation the high power DAC signal is set 6 dB below the expected detector level. Then, if due to some failure the power amplifier output falls by more than 6 dB, POWER AMP CAL will flag an error, resulting in an error message being generated on the screen.

### RF board: FM drive (sheet 5)

FM adjusts the instantaneous RF frequency in direct sympathy with the modulating signal. The amount of frequency deviation is directly proportional to the magnitude of the modulation source. With phase modulation the frequency deviation is also proportional to the frequency of modulation.

For moderate modulation rates the signal is injected straight onto the VCO tune line after suitable scaling by D-A converters (giving fine control) and fixed attenuators (giving coarse control). The block diagram of the FM drive is shown in Fig. 1-4.

Inside the loop bandwidth this method is not valid as the loop cannot distinguish between FM and other VCO frequency errors. It would therefore try to compensate for the modulation tone by returning the carrier back to the original requested frequency. A digital system is used to overcome this effect, which also has the benefit of extending the modulation range down to DC.

The modulation is sampled by a 1-bit oversampling A-D converter whose output controls the Synthesizer gate array controller ASIC in such a way as to offset the carrier frequency in proportion to the magnitude of the modulation. The speed at which the ASIC can perform this function sets a limit to the overall bandwidth of the system. At frequencies above the loop bandwidth the analogue system dominates.

### Operation

The FM input to the RF module feeds the 1-bit oversampling A-D converter and the analogue FM attenuator. The analogue attenuator provides the FM drive signal to the VCO and consists of two stages. A 12-bit multiplying D-A converter, IC409, allows fine setting of the FM drive level. Coarse setting is achieved by IC403 and by a pad switched by RLA. IC403 is an analogue multiplexer; it is used to provide attenuation of 0, 20 or 40 dB, and can be used to connect the FM input to ground. IC405a has 10 dB of gain and provides a high current drive for the final attenuator stage. The final attenuator stage is switched by RLA and gives either 10 or 50 dB of attenuation. The output from the final attenuator stage on the FM ATTEN line is summed with the control voltage from the fractional-N loop across R431 and R432 (sheet 4) which provides a 25  $\Omega$  drive to the VCO. The FM attenuator control settings are given in Table 1-3.

**Table 1-3: Attenuator control settings**

Atten (dB)	AT2	AT1	AT0
OFF	0	0	0
20	1	0	0
40	1	1	0
60	0	1	0
80	0	1	1





TR503 base-emitter variations with temperature. Resistors R521, R546, R547 and R555, R556 set the RF gain of this stage.

The control voltage input to the modulator is converted into a digital word by an analogue to digital converter. This converter is implemented with comparator IC501a and FILTER CAL from one of the DACs in IC103, the status of the comparator being available as FILTER PEAK. This measurement is used for self-calibration of the voltage-tuned band-pass filters on sheet 1 and also for instrument fault diagnosis.

### Peak detector and control loop

D510 is the Schottky detector diode used to detect the peak RF voltage on the microstrip line. The output from this detector is not linear at low RF levels but obeys a square law transfer function, hence if modulation distortion is to be eliminated, the control voltage from the control board must compensate for this effect. Schottky diode D511 is used for temperature compensation of D510. The modulation voltage on the AM INPUT line from control board AB1 or AB1/1 is larger than that required by the control loop and is attenuated by R527 and R517. The voltage level from the control board is approximately 1.4 V average with the modulation superimposed on it. An error amplifier consisting of IC802a amplifies the differential error voltage between the modulation input and the detector output. The output of this error amplifier then controls the pin modulator as necessary to keep the error voltage as small as possible. Feedback in the form of C511 and R526 reduces the effective gain and phase shift of the error amplifier at high frequencies to ensure adequate gain and phase margins.

### Level modulator

The level modulator is based around PIN diodes D512 and D513 and is split into two sections with amplifier stage TR508 in between. The input level to the modulator is nominally -4 dBm (10 MHz to 2.4 GHz), and it has an inherent loss of up to 3 dB. The modulator diodes are controlled by the LEVEL MOD input line from leveling loop integrator IC802 (sheet 9). The loop integrator input (in the range  $\pm 10$  V) sets the amount of current through diode packages D512 and D513 by controlling TR504 and TR505 collector current levels. When D512 and D513 pins 1 are at -10 V the two series diodes are fully ON and the shunt diode is reverse biased, resulting in minimum RF signal loss (low attenuation limit). When D512 and D513 pins 1 go positive with respect to pins 3 and 4, the two series diodes become reverse biased and the shunt diodes forward biased resulting in maximum RF signal loss in the modulator (high attenuation limit). TR507 sets the DC biasing condition for TR508.

### Output unlevelled

The comparator configuration around IC501b detects the condition where the level modulator drive signal gets close to the positive supply rail value. It compares the LEVEL MOD input with the +11 V supply, and signals on the OUTPUT UNLEVELED line that the level modulator is close to or at the minimum attenuation limit and therefore the output may be unlevelled.

### Pulse modulation drive

The pulse modulator driver is based around IC503a and is basically a level translating buffer stage. The input on the PULSE I/P line from control board AB1 or AB1/1 to the driver is at TTL levels. The output is clamped by zener diodes D508 and D509 at approximately  $\pm 8$  V. When the input is LOW (0 V) the output is at -8 V and when the input is HIGH (+5 V) the output is at +8 V. The output on the PULSE O/P line drives the pulse modulator on attenuator board AA2. When the pulse signal input is LOW, the pulse modulator goes into low isolation (RF ON) mode and vice versa.

## RF board: Frequency generator (sheet 7)

### Frequency generation

A UHF VCO, step recovery diode and voltage tuned band-pass filter (sheet 1) are used to generate a fundamental octave between 1.2 and 2.4 GHz which is phase locked to the instrument reference.

To generate frequencies below 1.2 GHz, a fixed  $\div 2$  prescaler and a programmable  $\div 2^n$  prescaler (on this sheet) are used to divide the input frequency of 1.2 to 2.4 GHz down to frequencies between 10 MHz and 1.2 GHz. Switched low-pass filters (LPF) are then used to reduce unwanted harmonics at the output. To produce frequencies between 9 kHz and 10 MHz, the 100 MHz instrument reference is mixed with the divider generated signal of between 100 MHz and 110 MHz to produce a beat note below 10 MHz (sheet 9).

### Frequency band selection

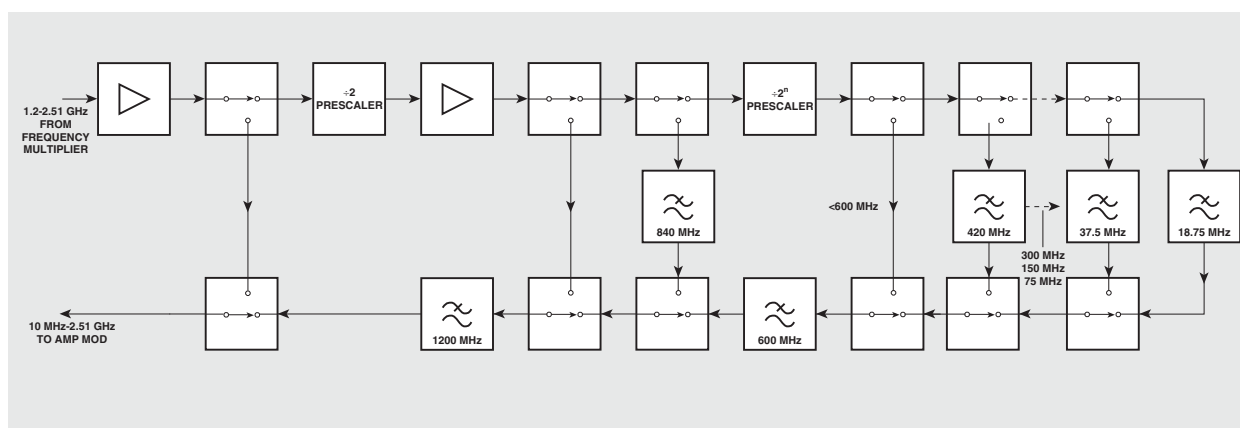
A serial communications link between the RF board and control board AB1 or AB1/1 is used to control the operation of the RF board. Data latch IC709 (sheet 8) converts the serial data input from the control board into the parallel control bits required to select a particular frequency band. Frequency band selection is shown in Fig. 1-5.

Four control bits (BS0 to BS3) are required to specify the required frequency from the dividers and filters. Control bit BS0 selects the upper or lower  $\frac{1}{2}$  octave but is only required for selected frequencies between 300 MHz and 1.2 GHz and is set to zero for selected frequencies outside these limits (BS0 is set high for the lower  $\frac{1}{2}$  octave). Control bits BS1 to BS3 select the required octave of output frequency from the dividers. Table 1-4 below lists the control bits required for the selection of each frequency band.

**Table 1-4: Frequency band selection**

BS3	BS2	BS1	BS0	Selected band
0	0	0	0	420 - 600 MHz
0	0	0	1	300 - 420 MHz
0	0	1	0	150 - 300 MHz
0	1	0	0	75 - 150 MHz
0	1	1	0	37.5 - 75 MHz
1	0	0	0	18.75 - 37.5 MHz
1	0	1	0	10 - 18.75 MHz
1	1	0	0	1.2 - 2.51 GHz
1	1	1	0	0.84 - 1.2 GHz
1	1	1	1	600 - 840 MHz

This particular mapping enables these same control bits to be used for LPF selection as well as to control the division ratio of IC602 which is a programmable divider. IC603 and IC608 are each three to eight line decoders which produce a logic low level on the particular output specified by the band selection bits, all other outputs remaining high. Each of the decoder outputs corresponds to one particular signal path which is switched in with pin diodes. These pin diodes cannot operate directly with standard logic levels so IC604 to IC606 convert the logic level outputs of IC603 and IC608 into the required levels for driving the pin diodes.



C4439

*Fig. 1-5 Frequency band selection*

## Fundamental octave

The 1.2 to 2.4 GHz from the voltage tuned band-pass filter (sheet 1) is the fundamental octave and is amplified by IC607 to ensure adequate drive for the subsequent circuitry. When a frequency within this fundamental octave is selected, the 1.2 to 2.4 GHz switch is selected by the SW1 control line going negative. Diodes D603 to D605 are then reverse biased whilst a half each of diodes D601 and D602 are forward biased. Hence the prescalers and sub 1.2 GHz filters are bypassed.

## 600 MHz to 1.2 GHz generation

IC601 is a fixed ÷2 prescaler used to divide the fundamental octave down to between 600 MHz and 1.2 GHz. TR606 and R636 are used to bias IC601 off when not required, this prevents IC601 from self-oscillating. TR601 is selected whenever one of switch lines SW2 to SW10 is low, TR601 being used to detect this condition, switch TR606 off as required and hence enable IC601. The output level of this prescaler is not high enough to drive programmable prescaler IC602 directly, so TR603 and TR604 form a balanced amplifier to boost the output level. When 600 MHz to 1.2 GHz is selected, balun T601 transforms the amplified balanced output of IC601 into an unbalanced output appropriate for microstrip, D607 being used to connect one output of T601 to ground.

The 600 MHz to 1.2 GHz octave is split into two half-octaves because the second-harmonic content of the output is too high to allow octave filtering.

The 1200 MHz LPF is permanently in place for frequencies below 1.2 GHz, and a simple switch consisting of D608 to D612 is used to route the output of T601 through to the 1200 MHz filter. The sub-840 MHz half-octave path switch is similar but also contains the 840 MHz LPF.

## Programmable divider

IC602 is the programmable divider which is used to produce frequencies down to 10 MHz. This divider is only useable up to 1.5 GHz, hence the need for prescaler IC601 which is useable to at least 2.5 GHz. The required division ratio is set by control bits BS1 to BS3 and represents a power of 2. The division ratio selected is related to the selection bits by the following expression:

$$\text{Division ratio} = 2^{[(4 \times \text{BS3}) + (2 \times \text{BS2}) + \text{BS1} + 1]}$$

The output of IC602 is balanced and is converted to a single ended output by balun T602 which is identical to T601. The output level of this divider is already high enough not to require any extra amplification. For frequencies below 300 MHz, the output is balanced well enough to require only octave filtering thereby reducing the number of filters required to meet the harmonic performance requirement. Between 300 MHz and 600 MHz however, two half octave filters are used. D606 and R635 are required to short out the 600 MHz LPF when the 840 MHz filter is selected to prevent D615 from resonating with the 600 MHz filter.

## RF board: Interface and attenuator drive (sheet 8)

### Serial bus interface

The serial bus from control board AB1 or AB1/1 is connected to PLAC and fed to serial to parallel converters IC702 and IC706. These ICs supply address and data information to the fractional-N controller (sheet 3) and data to decoder IC707. The outputs from IC707 provide clock signals to parallel to serial converters IC708 to IC710 and enable signals to IC704 and IC705. AT0 to AT2 from IC708 select the FM drive fine setting. IC709 provides parallel control bits BS0 to BS3 used for frequency band selection.

IC704 and IC705 perform parallel to serial conversion for the transmission of board status signals to the processor. IC705 is monitored by the processor, and when OR-gate IC703 detects a fault condition, for example, RPP TRIPPED going high, the processor is aware of a fault condition but does not know what the fault is. It then performs a serial poll of the inputs to IC704 to determine the actual fault.

## Attenuator drive

The attenuator pad data comes via the serial bus and is latched by serial-to-parallel converter latch register IC710. When a pad control line output is LOW (0 V) the corresponding attenuator pad is selected via one of the transistor switches TR701 to TR707. Conversely when the latch output goes HIGH (+5 V) the pad is deselected. There are five attenuator pads which need controlling, they are labeled PAD A (33 dB), PAD B (22 dB), PAD C (33 dB), PAD D (11 dB) and PAD E (33 dB). This gives a total attenuation of 132 dB, selectable in 11 dB steps. The pad control lines can source up to 200 mA. The pad selection combinations for any required attenuation setting are shown in Table 1-5 below.

**Table 1-5: Attenuator selection**

Attenuation	A (33 dB)	B (22 dB)	C (33 dB)	D (11 dB)	E (33 dB)
0	1	1	1	1	1
11	1	1	1	0	1
22	1	0	1	1	1
33	1	1	1	1	0
44	1	1	1	0	0
55	1	0	1	1	0
66	1	1	0	1	0
77	1	1	0	0	0
88	1	0	0	1	0
99	1	0	0	0	0
110	0	1	0	0	0
121	0	0	0	1	0
132	0	0	0	0	0

## Pulse modulation

There are two control lines related to pulse modulation, one is the PULSE I/P line (sheet 6) which comes from the rear panel via control board AB1 or AB1/1 and the other is the PULSE MOD ENABLE line obtained by decoding the serial bus. When the output is LOW the pulse modulator path is selected. Conversely, when the output is HIGH, the straight-through path is selected and the pulse modulator is set to low isolation mode (pulse input set LOW). This line is capable of sourcing 200 mA.

## RPP control

The Reverse Power Protection (RPP) circuit has two lines on this board. The RPP TRIPPED readback line from attenuator board AA2 is normally LOW and goes HIGH when the RPP has tripped. The RPP RESET control line is normally HIGH and switched LOW (for less than 1 ms) to reset the RPP relay.

## High power amplifier option

The high power amplifier, when fitted, is switched on attenuator board AA2 by a single control line from this board. When the HIGH POWER ENABLE control line is LOW the amplifier is selected and when HIGH it is deselected.

## RF board: Output amplifier (sheet 9)

### Output amplifier

The output amplifier consists of four, common-emitter, transistor stages (TR806 to TR808 and TR814). The first two stages are only used down to 10 MHz and are switched OFF to obtain high isolation below 10 MHz. Frequencies between 10 kHz to 10 MHz are obtained by mixing the input with a 100 MHz local oscillator. The switching between these two paths from the MODULATED RF input is controlled by the BFO SELECT line. When this line is in LOW state, TR810 is OFF and TR811 is ON and the corresponding transistors TR801 to TR803 are ON and TR804 and TR805 are OFF. In this state transistors TR801 and TR802 set the RF transistors TR806 and TR807 in amplifying mode and TR805 sets TR812 in isolation mode. Transistors TR803 and TR804 set D801 bias by forward biasing the diode between pins 1 and 4 and reverse biasing the diode between pins 1 and 3, thereby selecting the high frequency path via C806. Conversely, when the BFO SELECT line goes HIGH, the high frequency path is set to isolation mode and the BFO low frequency path via C802 is selected. Since all four transistor amplifier stages have similar active biasing arrangements, only the final stage will be described here. Resistors R847 and R848 and diode D808 fix the base of TR809. TR809 in turn forward biases TR808 base-emitter junction until TR809 collector is one diode drop above the base potential. L808 has about 15  $\Omega$  winding resistance, and with R849 and R875 also set to 15  $\Omega$ , the TR808 collector current is approximately 110 mA with 16 V across it. Note that diode D808 is only added to temperature compensate the base-emitter junction voltage. Below 10 MHz the BFO path is selected and TR806 and TR807 are switched OFF; this results in D802 being reverse biased through R839. This increases the isolation of the straight-through path.

<b>Note</b>
-------------

**The lead dimensions of leaded capacitor and resistor components are critical to the instrument's performance. Make sure these components are replaced in identical fashion.**

### BFO-band frequency generation

Transistors TR815 to TR820 are configured as a double-balanced Gilbert cell mixer. The resistors improve the noise performance because the transconductance of the upper switching transistors is now limited by the resistors instead of increasing with the bias current. Hence the signal handling capability of the mixer can be improved, by increasing the bias current, without increasing the output noise. The disadvantage with this is that the local oscillator (LO) signal must now be larger to overcome the increased voltage drop across these resistors.

An LO level of 0.5 V is adequate to guarantee complete switching of the balanced signal currents from TR819 and TR820. The LO signal is derived from the 100 MHz internal reference on sheet 2, hence the input RF frequency to the mixer should be 100 MHz more than the desired output frequency. The RF input signal for the mixer is produced by the dividers and harmonic filters on sheet 6 and is switched into the mixer by D801 as described above. Output is on the RF OUTPUT line to attenuator board AA2.

### RF leveling detector

The leveling detector is basically a directional bridge configuration based on D804. The detector has a good match at both ports but is relatively more sensitive to RF signals coming from output amplifier TR808 than to any signals traveling in the opposite direction. The main disadvantage with this arrangement is that the detector diode 'sees' only a fraction of the RF voltage. The detector diode is biased through R860 and R861 and the detected voltage appears on the inverting input of integrator amplifier IC802c. The input from 8-bit DAC IC103 (sheet 1) on the OFFSET TRIM line is used to calibrate out detector offsets. Diodes D805 and D810 are used to temperature compensate detector diode D804. The required RF level is set by applying twice the detector volts (of opposite sign) to the RF LEVEL input line from control board AB1 or AB1/1.

## ALC loop

The Automatic Level Control (ALC) requires an input voltage range of from 0 to -5 V with 12-bit resolution. The 0 V input corresponds to minimum RF level, and -5 V to the maximum level. The AM signal is superimposed on the level control voltage and the sum is prevented from exceeding the -5 V limit.

The 50 Hz low-pass filter, based on IC802b in the level control loop, is used to limit the ALC bandwidth when the AM signal is applied. Normally, the filter is switched out of the loop as shown on the circuit diagram and the bandwidth is high, resulting in a short ALC settling time. When AM is selected the filter is switched in to stop the ALC loop removing the AM signal from the carrier. Capacitor C841 is also switched with the filter to keep the loop stable. Since the AM signal is also superimposed on the level control input, the AM is useable down to DC level.

The filter is switched IN and OUT of the ALC loop by IC803. The filter is selected when the AM-FILTER control line from IC709 (sheet 8) is HIGH and deselected when the line is LOW. The ALC output unlevelled status LEVEL MOD line is normally in a LOW state and goes HIGH when the modulator is driven hard on.

## Offset trim

The +11 V supply line is monitored to provide the OFFSET TRIM REF voltage for IC103 which, in turn, supplies the OFFSET TRIM output used to linearize the level detector.

# AA2 Attenuator board

## Circuit functions

Attenuator board AA2 provides the following instrument functions:

- (1) Pulse modulation facility.
- (2) Step attenuation in five switchable stages with a total attenuation depth of 132 dB.
- (3) Reverse Power Protection (RPP) facility.

## Pulse modulation

The pulse modulator works from 30 MHz to 2.51 GHz with an ON/OFF ratio of greater than 40 dB. When the MOD line from RF board AA1 is LOW to RLA and RLB, pulse modulation is selected; when HIGH, the straight-through path is selected. When the PULSE INPUT line is in the HIGH (+8 V) state, series diodes D1 and D7 are reverse biased and the shunt diodes D2 to D6 are forward biased, shunting RF signal to ground. The shunt diodes are selected for very low ON resistance, which results in higher isolation. Resistors R1 and R2 are added to maintain reasonable input/output match to 50  $\Omega$ .

When the PULSE INPUT line switches to LOW (-8 V) state, the series diodes are forward biased and the shunt diodes become reverse biased, allowing RF signals to propagate from RLA to RLB with minimum attenuation. The shunt diodes are interconnected with thin inductive tracks such that, together with the diode capacitance, the circuit behaves like a low-pass filter with roll-off above the desired maximum frequency. This results in lower insertion loss and better matching characteristics.

C1, C2 and L1 as well as C3, C4 and L2 form high-pass filters. These filters attenuate the pulse modulating signals and thereby prevent their propagation down the RF lines. R3, L4 and L3 as well as R7, L8 and L7 form broadband RF chokes. Inductor L17 is inserted to arrest sharp pulse input rise/fall edges from the pulse drive circuit.

## Attenuator

The attenuator section consists of five attenuating pads constructed from thick film resistors. There are three pads of 33 dB value and one each of 22 dB and 11 dB, giving a maximum attenuation depth of 132 dB. The four higher value pads consist of two  $\Pi$  resistor stages connected in series to facilitate the use of smaller value resistors, with lower parasitics, resulting in

a flatter frequency response. These pads are switched with two separate relays in order to obtain greater isolation between the input and output of each pad. The 11 dB single relay pad is switched with a higher isolation type relay. All the relays are mounted on the ground side of the board and sit in individual 'pockets' in the RF module.

All relay control lines from RF board AA1 or AA1/1 are decoupled using ceramic feedthrough  $\Pi$  filters. On some lines further decoupling is achieved by the addition of inductors L9 to L14 and capacitors C14 to C24. Diodes D10 to D15 are added to prevent damage to the relay drive circuitry on the RF board. Also two wall 'intrusions' are introduced along the attenuator length to prevent surface wave propagation.

### Reverse power protection

The Reverse Power Protection (RPP) consists of a reed-relay (RLM), capable of switching up to 50 W of RF power, with associated RF level detection and relay drive circuitry.

In normal operation the reed-relay contacts are closed and a small fraction of the RF voltage appears at the junction of R44 and R45. Both positive and negative RF voltage peaks are detected by the dual detector diode package D8. IC1 is a dual comparator package with open collector outputs. The peaks of the RF voltage waveform are detected by D8 and charge capacitors C8 and C9 to the peak RF level. When the voltage on C8, for a positive peak, becomes greater than the voltage threshold set on non-inverting input pin 3 of IC1a, the output of the comparator goes LOW switching TR1 OFF so that RLM becomes open circuit. In a similar fashion when C9 causes comparator IC1b non-inverting input pin 5 to become more negative than inverting input pin 6, the output on pin 7 switches to the LOW state. The RPP trip status is indicated on the RPP TRIPPED line. High voltage zener diode D9 is used to limit the coil EMF voltage and to keep this voltage relatively high in order to quickly discharge the magnetic field and thereby shorten the relay switching time.

In normal operation TR1 is ON and the RPP RESET line is set HIGH keeping TR2 in the OFF state. When an overload occurs TR1 switches OFF as described above. This allows the collector voltage of TR1 to feed back to the inverting input of comparator IC1b inverting input, clamping it at a voltage greater than 0 V. This has the desired effect of preventing the RPP relay from being reset even after the RF signal has been removed. Thereafter the RPP can only be reset by switching the RPP RESET line LOW to switch on TR2, which, via IC1b, switches TR1 back into the ON state.

When an attenuator stage is switched between the two matched states (resistive pad or through-line positions), the relay contacts momentarily become open circuit, creating a large standing wave. Inductors L15 and L16 are inserted to slow down these transients and thereby prevent false RPP tripovers.

In order to keep board connections to a minimum, the +5 V line is generated locally using voltage regulator IC2.

## AA2/1 High power attenuator board

### Circuit functions

Attenuator board AA2/1 provides the following instrument functions:

- (1) Pulse modulation facility.
- (2) Step attenuation in five switchable stages with a total attenuation depth of 132 dB.
- (3) Switchable power amplifier stage with up to +25 dBm power output capability.
- (4) Reverse Power Protection (RPP) facility.

## High power attenuator board: Pulse mod & attenuator (sheet 1)

### Pulse modulation

The pulse modulator works from 30 MHz to 2.51 GHz with an ON/OFF ratio of greater than 40 dB. When the MOD line from RF board AA1 is LOW to RLA and RLB, pulse modulation is selected; when HIGH, the straight-through path is selected. When the PULSE INPUT line is in the HIGH (+8 V) state, series diodes D1 and D7 are reverse biased and the shunt diodes D2 to D6 are forward biased, shunting RF signal to ground. The shunt diodes are selected for very low ON resistance, which results in higher isolation. Resistors R1 and R2 are added to maintain reasonable input/output match to 50  $\Omega$ .

When the PULSE INPUT line switches to LOW (-8 V) state, the series diodes are forward biased and the shunt diodes become reverse biased, allowing RF signals to propagate from RLA to RLB with minimum attenuation. The shunt diodes are interconnected with thin inductive tracks such that, together with the diode capacitance, the circuit behaves like a low-pass filter with roll-off above the desired maximum frequency. This results in lower insertion loss and better matching characteristics.

C1, C2 and L1 as well as C3, C4 and L2 form high-pass filters. These filters attenuate the pulse modulating signals and thereby prevent their propagation down the RF lines. R3, L4 and L3 as well as R7, L8 and L7 form broadband RF chokes. Inductor L25 is inserted to arrest sharp pulse input rise/fall edges from the pulse drive circuit.

### Attenuator

The attenuator section consists of five attenuating pads constructed from thick film resistors. There are three pads of 33 dB value and one each of 22 dB and 11 dB, giving a maximum attenuation depth of 132 dB. The four higher value pads consist of two  $\Pi$  resistor stages connected in series to facilitate the use of smaller value resistors, with lower parasitics, resulting in a flatter frequency response. These pads are switched with two separate relays in order to obtain greater isolation between the input and output of each pad. The 11 dB single relay pad is switched with a higher isolation type relay. All the relays are mounted on the ground side of the board and sit in individual 'pockets' in the RF module.

All relay control lines from RF board AA1 or AA1/1 are decoupled using ceramic feedthrough  $\Pi$  filters. On some lines further decoupling is achieved by the addition of inductors L9 to L14 and capacitors C8 to C17 and C20. Diodes D8 to D13 are added to prevent damage to the relay drive circuitry on the RF board. Also two wall 'intrusions' are introduced along the attenuator length to prevent surface wave propagation.

## High power attenuator board: Power amp & RPP (sheet 2)

### Power amplifier

The power amplifier consists of two RF amplifying stages and an RF detector for approximate level indication. The first amplification stage is based around transistor TR1. Feedback resistor R55 and the emitter resistors R47 to R50 set the low frequency gain of this stage; with the values shown the gain is approximately 12 dB. The inductor chain L15 to L17 and L24 forms a broad band RF choke. The biasing condition for this stage is controlled by TR3. The base of TR3 is fixed at approximately 17 V; this sets the R57/L24 junction around 17.7 V. Resistors R56 and R57 in turn set the collector current to approximately 100 mA. The gain of the amplifier drops with increasing temperature: this effect can be minimized by a gradual reduction in the collector current of TR1 with increasing temperature. Diodes D14 and D15 and the thermistor R51 are used to produce this desired effect. When the temperature increases, TR3 base potential rises, resulting in a decrease in TR1 collector current. The current variation is only around  $\pm 10\%$  over the 0 to 55°C temperature range. 3 dB attenuator pad R44 to 46 is inserted to improve the amplifier input match and thereby reduce the level inaccuracy due to mismatch.

The output RF transistor stage biasing configuration for TR2 is very similar to that for TR1. The collector voltage is fixed at around +16 V and the collector current is nearly 300 mA.



Temperature compensation on this stage is very subtle in order to maintain high power output, with only a few milliamps of current variation available from diode pair D16 and D17.

Components R69 and C36 are inserted to selectively improve the low frequency output match. Diode detector D18 detects RF signals down to around +5 dBm. The difference between the detected voltage and the 'dummy' detector (D22) voltage is amplified by the difference amplifier based around IC02a. The dummy detector provides offset and temperature compensation.

### Reverse power protection

The Reverse Power Protection (RPP) consists of a reed-relay (RLM), capable of switching up to 50 W of RF power, with associated RF level detection and relay drive circuitry.

In normal operation the reed-relay contacts are closed and a small fraction of the RF voltage appears at the junction of R72 and R73. Both positive and negative RF voltage peaks are detected by the dual detector diode package D19. IC1 is a dual comparator package with open collector outputs. The peaks of the RF voltage waveform are detected by D19 and charge capacitors C39, C40 and C41, C42 to the peak RF level. When the voltage on C39, C40, for a positive peak, becomes greater than the voltage threshold set on non-inverting input pin 3 of IC1a, the output of the comparator goes LOW switching TR6 OFF so that RLM becomes open circuit. In a similar fashion when C41, C42 causes comparator IC1b non-inverting input pin 5 to become more negative than inverting input pin 6, the output on pin 7 switches to the LOW state. The RPP trip status is indicated on the RPP TRIPPED line. High voltage zener diode D20 is used to limit the coil EMF voltage and to keep this voltage relatively high in order to quickly discharge the magnetic field and thereby shorten the relay switching time.

In normal operation TR6 is ON and the RPP RESET line is set HIGH keeping TR9 in the OFF state. When an overload occurs TR6 switches OFF as described above. This allows the collector voltage of TR6 to feed back to the inverting input of comparator IC1b inverting input, clamping it at a voltage greater than 0 V. This has the desired effect of preventing the RPP relay from being reset even after the RF signal has been removed. Thereafter the RPP can only be reset by switching the RPP RESET line LOW to switch on TR9, which, via IC1b, switches TR6 back into the ON state.

When an attenuator stage is switched between the two matched states (resistive pad or through-line positions), the relay contacts momentarily become open circuit, creating a large standing wave. Inductors L21 and L22 are inserted to slow down these transients and thereby prevent false RPP tripovers.

In order to keep board connections to a minimum, the +5 V line is generated locally using voltage regulator IC3.

## AA2/2 Signal output board

### Circuit function

This board is used when no attenuator is fitted, where it serves to connect the signal input from RF board AA1 or AA1/1 to the signal output back to AA1 or AA1/1.

## AA2/5 Fast pulse modulator board

### Circuit functions

Fast pulse modulator board AA2/5 provides the following functions:

- (1) High performance pulse modulation facility.
- (2) Step attenuation in five switchable stages with a total attenuation depth of 132 dB.
- (3) Reverse Power Protection (RPP) facility.

## Fast pulse modulator board: Pulse mod (sheet 1)

### Pulse modulation

The pulse modulator is designed using GaAs FET switch technology and is located before the step attenuator section. It is split into two identical sections which are separated by a metal wall in order to achieve high RF isolation. Each section is composed of two FET switches (ICs 4,5 and ICs 6,7) and a FET driver (IC8 and IC9). The FET devices are low insertion loss GaAs switches with each switch providing more than 20 dB of isolation at 2 GHz. These switches are controlled by a dedicated driver chip (IC8 and 9). The driver IC input comes from an external modulating source (50  $\Omega$  impedance) at TTL levels. When the level at input pin 4 is HIGH outputs at pins 1 and 8 are set to the voltages connected to pins 6 (+0.3 V) and 5 (-5 V) respectively, resulting in ICs 4 to 7 being switched to low insertion loss mode. When pin 4 goes LOW, the voltages on pins 1 and 8 are interchanged, which in turn puts switches ICs 4 to 7 into isolation mode. The delay from the time that the TTL level changes to switching the RF signal is less than 100 ns.

Relays RLA and RLB are used to select or bypass the pulse modulator circuit. These relays are latching type RF performance devices with high isolation and low insertion loss. Resistors R1 and R90 are used to terminate the 'open' contacts in order to maximize isolation further.

### Amplifier

The single RF amplifying stage is located on the output port of the modulator and before the step attenuators. The amplifier is based on FET TR4. Its gain is set by R85, with R89 added to improve the output match. The DC biasing network is a standard arrangement.

## Fast pulse modulator board: RPP and atten (sheet 2)

### Step attenuator

The attenuator section consists of five attenuating pads constructed from thick film resistors. There are three pads of 33 dB value and one each of 22 dB and 11 dB, giving a maximum attenuation depth of 132 dB. The four higher value pads consist of two  $\Pi$  resistor stages connected in series to facilitate the use of smaller value resistors, with lower parasitics, resulting in a flatter frequency response. These pads are switched with two separate relays in order to obtain greater isolation between the input and output of each pad. The 11 dB single relay pad is switched with a higher isolation type relay. All the relays are mounted on the ground side of the board and sit in individual 'pockets' in the RF module.

All relay control lines from RF board AA1 or AA1/1 are decoupled using ceramic feedthrough  $\Pi$  filters. On some lines further decoupling is achieved by the addition of inductors L10 to L14 and capacitors C16 to C24. Diodes D11 to D15 are added to prevent damage to the relay drive circuitry on the RF board. Also two wall 'intrusions' are introduced along the attenuator length to prevent surface wave propagation.

### Reverse power protection

The Reverse Power Protection (RPP) consists of a reed-relay (RLM), capable of switching up to 50 W of RF power, with associated RF level detection and relay drive circuitry.

In normal operation the reed-relay contacts are closed and a small fraction of the RF voltage appears at the junction of R44 and R45. Both positive and negative RF voltage peaks are detected by the dual detector diode package D8. IC1 is a dual comparator package with open collector outputs. The peaks of the RF voltage waveform are detected by D8 and charge capacitors C8 and C9 to the peak RF level. When the voltage on C8, for a positive peak, becomes greater than the voltage threshold set on non-inverting input pin 3 of IC1a, the output of the comparator goes LOW switching TR1 OFF so that RLM becomes open circuit. In a similar fashion when C9 causes comparator IC1b non-inverting input pin 5 to become more negative than inverting input pin 6, the output on pin 7 switches to the LOW state. The RPP trip status is indicated on the TRIP line. High voltage zener diode D9 is used to limit the coil EMF voltage and to keep this voltage relatively high in order to quickly discharge the magnetic field and thereby shorten the relay switching time.

In normal operation TR1 is ON and the RPP RESET line is set HIGH keeping TR2 in the OFF state. When an overload occurs TR1 switches OFF as described above. This allows the collector voltage of TR1 to feed back to the inverting input of comparator IC1b inverting input, clamping it at a voltage greater than 0 V. This has the desired effect of preventing the RPP relay from being reset even after the RF signal has been removed. Thereafter the RPP can only be reset by switching the RESET line LOW to switch on TR2, which, via IC1b, switches TR1 back into the ON state.

When an attenuator stage is switched between the two matched states (resistive pad or through-line positions), the relay contacts momentarily become open circuit, creating a large standing wave. Inductors L15 and L16 are inserted to slow down these transients and thereby prevent false RPP tripovers.

In order to keep board connections to a minimum, the +5 V line for the RPP circuit is generated locally using voltage regulator IC2.

## AA2/7 Fast pulse and high power board

### Circuit functions

Fast pulse modulator board AA2/7 provides the following functions:

- (1) High performance pulse modulation facility.
- (2) Step attenuation in five switchable stages with a total attenuation depth of 132 dB.
- (3) Switchable power amplifier stage with up to +25 dBm power output capability.
- (3) Reverse Power Protection (RPP) facility.

### Fast pulse and high power board: Pulse mod (sheet 2)

#### Pulse modulation

The pulse modulator is designed using GaAs FET switch technology and is located before the step attenuator section. It is split into two identical sections which are separated by a metal wall in order to achieve high RF isolation. Each section is composed of two FET switches (ICs 204, 205 and ICs 206, 207) and a FET driver (IC208 and IC209). The FET devices are low insertion loss GaAs switches with each switch providing more than 20 dB of isolation at 2 GHz. These switches are controlled by a dedicated driver chip (IC208 and 209). The driver IC input comes from an external modulating source (50  $\Omega$  impedance) at TTL levels. When the level at input pin 4 is HIGH outputs at pins 1 and 8 are set to the voltages connected to pins 6 (+0.3 V) and 5 (-5 V) respectively, resulting in ICs 204 to 207 being switched to low insertion loss mode. When pin 4 goes LOW, the voltages on pins 1 and 8 are interchanged, which in turn puts switches ICs 204 to 207 into isolation mode. The delay from the time that the TTL level changes to switching the RF signal is less than 100 ns.

Relays RLA and RLB are used to select or bypass the pulse modulator circuit. These relays are latching type RF performance devices with high isolation and low insertion loss. Resistors R201 and R290 are used to terminate the 'open' contacts in order to maximize isolation further.

#### Amplifier

The single RF amplifying stage is located on the output port of the modulator and before the step attenuators. The amplifier is based on FET TR204. Its gain is set by R285, with R289 added to improve the output match. The DC biasing network is a standard arrangement.

### Fast pulse and high power board: Attenuator (sheet 3)

#### Attenuator

The attenuator section consists of five attenuating pads constructed from thick film resistors. There are three pads of 33 dB value and one each of 22 dB and 11 dB, giving a maximum attenuation depth of 132 dB. The four higher value pads consist of two  $\Pi$  resistor stages

connected in series to facilitate the use of smaller value resistors, with lower parasitics, resulting in a flatter frequency response. These pads are switched with two separate relays in order to obtain greater isolation between the input and output of each pad. The 11 dB single relay pad is switched with a higher isolation type relay. All the relays are mounted on the ground side of the board and sit in individual 'pockets' in the RF module.

All relay control lines from RF board AA1 or AA1/1 are decoupled using ceramic feedthrough  $\Pi$  filters. On some lines further decoupling is achieved by the addition of inductors L10 to L14 and capacitors C10 to C17 and C20. Diodes D9 to D13 are added to prevent damage to the relay drive circuitry on the RF board. Also two wall 'intrusions' are introduced along the attenuator length to prevent surface wave propagation.

## Fast pulse and high power board: Power amp & RPP (sheet 4)

### Power amplifier

The power amplifier consists of two RF amplifying stages and an RF detector for approximate level indication. The first amplification stage is based around transistor TR1. Feedback resistor R55 and the emitter resistors R47 to R50 set the low frequency gain of this stage; with the values shown the gain is approximately 12 dB. The inductor chain L15 to L17 and L24 forms a broad band RF choke. The biasing condition for this stage is controlled by TR3. The base of TR3 is fixed at approximately 17 V, this sets the R57/L24 junction around 17.7 V. Resistors R56 and R57 in turn set the collector current to approximately 100 mA. The gain of the amplifier drops with increasing temperature. This effect can be minimized by a gradual reduction in the collector current of TR1 with increasing temperature. Diodes D14 and D15 and the thermistor R51 are used to produce this desired effect. When the temperature increases, TR3 base potential rises resulting in a decrease in TR1 collector current. The current variation is only around  $\pm 10\%$  over the 0 to 55°C temperature range. 3 dB attenuator pad R44 to 46 is inserted to improve the amplifier input match and thereby reduce the level inaccuracy due to mismatch.

The output RF transistor stage biasing configuration for TR2 is very similar to that for TR1. The collector voltage is fixed at around +16 V and the collector current is nearly 300 mA. Temperature compensation on this stage is very subtle in order to maintain high power output, with only a few milliamps of current variation available from diode pair D16 and D17.

Components R69 and C36 are inserted to selectively improve the low frequency output match. Diode detector D18 detects RF signals down to around +5 dBm. The difference between the detected voltage and the 'dummy' detector (D22) voltage is amplified by the difference amplifier based around IC02a. The dummy detector provides offset and temperature compensation.

### Reverse power protection

The Reverse Power Protection (RPP) consists of a reed-relay (RLM), capable of switching up to 50 W of RF power, with associated RF level detection and relay drive circuitry.

In normal operation the reed-relay contacts are closed and a small fraction of the RF voltage appears at the junction of R72 and R73. Both positive and negative RF voltage peaks are detected by the dual detector diode package D19. IC1 is a dual comparator package with open collector outputs. The peaks of the RF voltage waveform are detected by D19 and charge capacitors C39, C40 and C41, C42 to the peak RF level. When the voltage on C39, C40, for a positive peak, becomes greater than the voltage threshold set on non-inverting input pin 3 of IC1a, the output of the comparator goes LOW switching TR6 OFF so that RLM becomes open circuit. In a similar fashion when C41, C42 causes comparator IC1b non-inverting input pin 5 to become more negative than inverting input pin 6, the output on pin 7 switches to the LOW state. The RPP trip status is indicated on the RPP TRIPPED line via R93. High voltage zener diode D20 is used to limit the coil EMF voltage and to keep this voltage relatively high in order to quickly discharge the magnetic field and thereby shorten the relay switching time.

In normal operation TR6 is ON and the RPP RESET line is set HIGH keeping TR9 in the OFF state. When an overload occurs TR6 switches OFF as described above. This allows the collector voltage of TR6 to feed back to the inverting input of comparator IC1b inverting input, clamping it at a voltage greater than 0 V. This has the desired effect of preventing the RPP relay from being

reset even after the RF signal has been removed. Thereafter the RPP can only be reset by switching the RPP RESET line LOW to switch on TR9, which, via IC1b, switches TR6 back into the ON state.

When an attenuator stage is switched between the two matched states (resistive pad or through-line positions), the relay contacts momentarily become open circuit, creating a large standing wave. Inductors L21 and L22 are inserted to slow down these transients and thereby prevent false RPP tripovers.

In order to keep board connections to a minimum, the +5 V line is generated locally using voltage regulator IC3.

## AB1, AB1/1 Control board

### Introduction

This board contains the microprocessor, memory and audio frequency generator and provides all the instrument clocks as well as controlling and conditioning all the modulation signals ready for their use in the RF module. It also provides a serial communications link over which the RF module is controlled and it also supplies the RF module with the filtered power rails it requires. Finally, it interfaces with the front panel display, key pad and control knob and provides GPIB and RS-232 communications ports.

#### AB1/1

A voltage converter generates +31 V, which is fed to the AA1/1 RF board to allow operation up to 2.51 GHz.

### Control board: Microprocessor and memory (sheet 1)

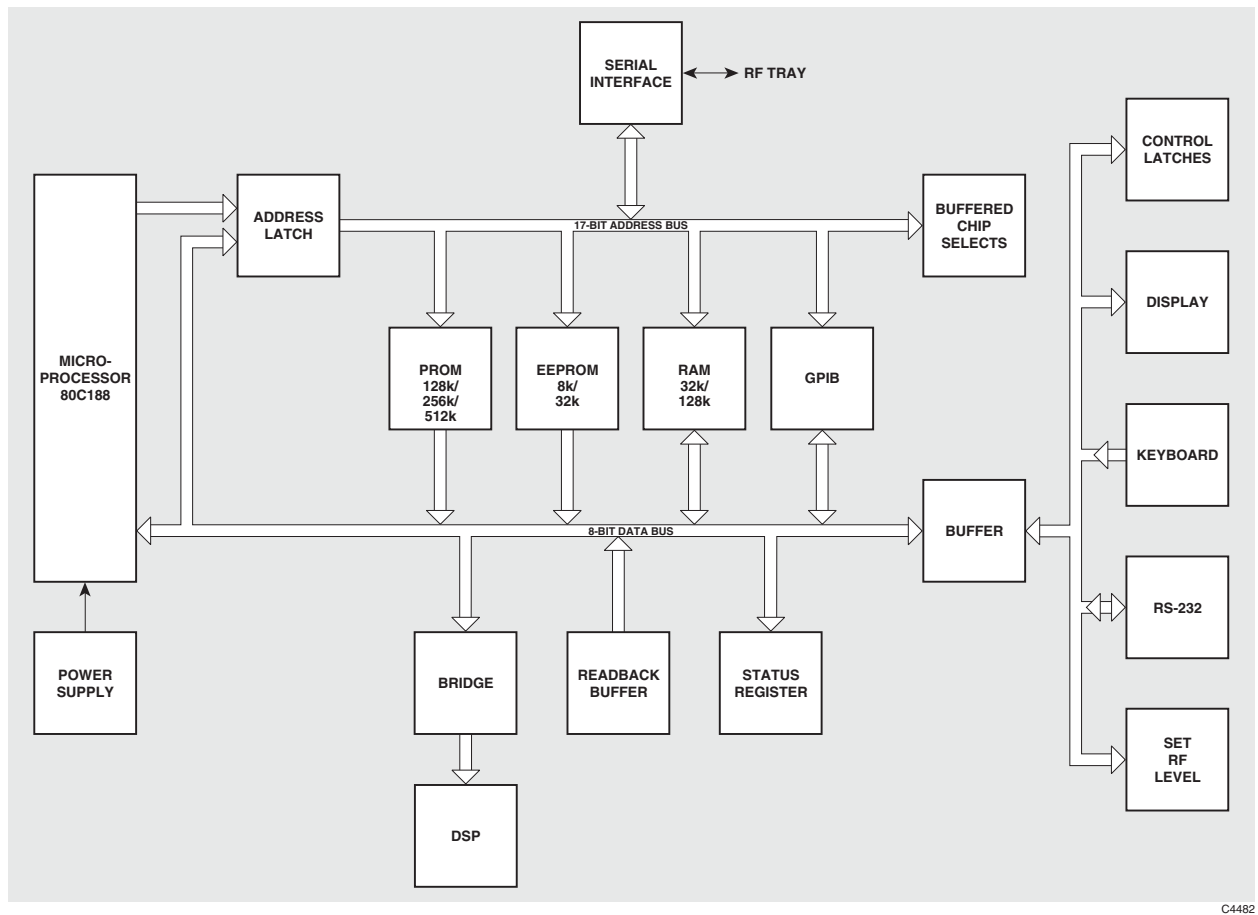
#### Microprocessor

Microprocessor IC2, which is used to control the instrument, is an 80C188. It contains the CPU (Central Processor Unit) and several peripheral devices including an interrupt controller for five direct interrupt inputs, a DMA (Direct Memory Access) controller, timers and seven programmable chip select outputs. The microprocessor uses an 8-bit data and a 20-bit address bus to address the memory. The data bus is multiplexed to provide either eight bits of data or the lower eight bits of the address. The block diagram of the phase-locked loop is shown in Fig. 1-6.

Control signals TMR\_IN0 and TMR\_IN1 for the internal programmable timer and SRDY and ARDY for asynchronous/synchronous data transfer are tied high, the functions unused.  $\overline{\text{TEST}}$ , HOLD and DRQ1 are disabled by being held low. The 20 MHz clock input, X1, is derived from the DSP 10 MHz clock output. Power supply monitoring circuitry provides the MRESET (L) signal to the microprocessor and a write inhibit signal MRESET (H) to EEPROM IC7 on power-up and also in the event of a power failure or brown-out (incipient power failure) occurring. This circuitry holds the microprocessor in reset at power-up long enough for the internal clock oscillator and the rest of the circuitry to stabilize. When released from reset the microprocessor retrieves and runs its program data from the instrument PROM, IC5.

$\overline{\text{WR}}$  (write) and  $\overline{\text{RD}}$  (read) asserted low enable the memory or I/O device selected by the address bus to be written into or read out from respectively.  $\overline{\text{DEN}}$  is the data enable line for the data bus buffer.  $\overline{\text{PCS0}}$  to  $\overline{\text{PCS6}}$  provide active-low Peripheral Chip Select signals.  $\overline{\text{LCS}}$  and  $\overline{\text{MCS}}$  provide chip select signals for RAM IC6 and EEPROM IC7 respectively.  $\overline{\text{MCS3}}$  provides a chip select signal for serial bus operation. TMR\_OUT1 provides a timing signal for the DSP. The RESET output is used to reset the GPIB controller.

The processor uses a multiplexed data bus to accommodate the 20-bit address. Output lines A8 to A19 carry the high order memory address. Input/output lines AD0 to AD7 carry the low order memory address during the first clock cycle and then carry data during the second and third machine state clock cycles.  $\overline{\text{ALE}}$  (Address Latch Enable) is used to differentiate between data and address; when it is taken high the contents of the data bus are treated as part of the address and latched in IC4.  $\overline{\text{ALE}}$  also latches A16 - A19 into IC3 in order to complete the 20-bit address. When  $\overline{\text{ALE}}$  is taken low lines AD0 to AD7 carry data.



C4482

Fig. 1-6 Microprocessor and control block diagram

## Interrupts

The 80188 has four interrupt inputs, INT0 to INT3. Interrupt INT0, the highest priority interrupt, is supplied by GPIB INT from the GPIB controller. INT1 is supplied from the RS-232 controller. INT2 is generated by the interrupt handler on the STAT\_INT line to indicate that a status line has changed state. INT3 on the TRIGGER line is requested whenever an external trigger signal is applied to the TRIGGER socket on the rear panel.

The functions of the microprocessor interrupt inputs and the chip selects are summarized in Table 1-6 below:

**Table 1-6: Interrupts and chip selects**

INT0	GPIB interrupt	PCS0	GPIB enable
INT1	RS-232 interrupt	PCS1	Interrupt handler enable
INT2	Interrupt handler	PCS2	Quiet bus enable
INT3	Trigger interrupt	PCS3	DSP bridge enable
		PCS4	Input buffer enable
NMI	Knob interrupt	PCS5	Trigger latch clear
		PCS6	Serial bus control enable
		LCS	RAM enable
		MCS0	EEPROM enable
		MCS1	Not used
		MCS2	Not used
		MCS3	Serial bus data enable
		UCS	Not used

## Memory bank

The operating program is contained in PROM (Programmable Read Only Memory) IC5. IC6 is the RAM (Random Access Memory) used for scratch-pad read/write operations. Unlike the other memory ICs which are non-volatile, the contents of the RAM are lost when the instrument is switched off. EEPROM (Electrically Erasable PROM) IC7 provides non-volatile storage for calibration data, user stores, etc. IC6 and IC7 are selected by chip select lines MCS0 and LCS respectively; IC5 is selected by address line A19. Memory bank addressing is summarized in Table 1-7 below.

Provision has been made for several different sizes of memory to be fitted as required, the sizes and types of memory catered for are shown below. The EPROM is fitted into a socket on the board to enable easy software upgrades.

**Table 1-7: Memory bank addressing**

EPROM, IC5	128k/ 256k/ 512k	A0-A18	addressed using the A19 line,
RAM, IC6	32k/ 128k	A0-A16	addressed using the LCS line,
EEPROM, IC7	8k/ 32k	A0-A14	addressed using the MCS0 line.

## Data transfer

On power-up or reset the processor transfers modulation setting data to the DSP using DMA (Direct Memory Access). Subsequent modulation settings are performed normally. Normal data transfer is done using the  $\overline{WR}$  (write) and  $\overline{RD}$  (read) lines.

All system switching, control and flag reads are done via a two-way buffer on the microprocessor bus. By this means the data bus following the buffer is free from the continuous data train of pulses on the normal microprocessor bus, thus reducing the possibility of interference to the analogue circuits.

## Control board: DSP audio generator (sheet 2)

The audio generator is based on Digital Signal Processor (DSP) IC12. This is booted up on power-up or reset from the microprocessor using a DMA dump of data to the DSP over a bridge.

The bridge has two modes of operation: the first is used on power-up for the DMA memory dump and is controlled by  $\overline{\text{BMS}}$  and  $\overline{\text{BR}}$  on the DSP and by DRQ0 on microprocessor IC2. The second mode is used once the DSP has been booted up and is running normally; this uses  $\overline{\text{DMS}}$  on the DSP to control it.

#### AB1

On power-up the DSP's  $\overline{\text{BMS}}$  line goes low to initiate the down-loading of data from the boot memory. This condition sets the output of D-type bistable IC11a to a high state; this line is tied to the DRQ0 input on the microprocessor, so this line going high initiates a DMA memory dump to the DSP bridge. This entails the microprocessor down-loading a byte of data each time the DRQ0 line goes high. The  $\overline{\text{BMS}}$  line going low also sets the output of another D-type bistable, IC11b, to a low state. This line is fed to the  $\overline{\text{BR}}$  input of the DSP, causing the DSP to release control of the data bus and not read or write to it until the  $\overline{\text{BR}}$  line has returned high. When the microprocessor writes data to bridge latch IC10, it resets bistable IC11a output to a low and clocks bistable IC11b so that the output goes high. When the DSP sees the  $\overline{\text{BR}}$  line is high, it does a read of the bridge using the  $\overline{\text{BMS}}$  line to enable the output of the bridge latch. This in turn sets in motion another cycle of the down-loading sequence. This cycle continues until the DMA down-load is completed. When it reaches the end of the DMA data, the microprocessor ignores the next DRQ0 command and sends the start-up signal to the DSP.

Once the DMA down-load is completed the DSP bridge goes into its second mode of operation, namely that for normal operation. In this mode, when data is written to the bridge latch using  $\overline{\text{PCS3}}$  and  $\overline{\text{WR}}$ , D-type bistable IC51b is clocked so that a high appears on the output. This line goes to the DSP to let it know that data has been written to the bridge, and also to data input latch IC1, which the microprocessor polls to see when the data has been read from the bridge. When the DSP sees this line go high, it knows that data is waiting on the bridge and reads it from there using the  $\overline{\text{RD}}$  and  $\overline{\text{DMS}}$  lines. The  $\overline{\text{RD}}$  line enables the output of the bridge latch and the  $\overline{\text{DMS}}$  line resets the output of bistable IC51b to a low. When the bistable output goes low, the microprocessor knows that the last data byte has been read and it can write the next data byte. In this way the microprocessor controls the DSP audio generator.

#### AB1/1

On power-up the DSP's  $\overline{\text{BMS}}$  line goes low to initiate the down-loading of data from the boot memory. This sets the DRQ0 output of the DSP bridge within FPGA IC23 to a high state; this line is tied to the DRQ0 input on the microprocessor, so this line going high initiates a DMA memory dump to the DSP bridge. This entails the microprocessor down-loading a byte of data each time the DRQ0 line goes high. The  $\overline{\text{BMS}}$  line going low also sets the DSPBR output of IC23 to a low state. This line is fed to the  $\overline{\text{BR}}$  input of the DSP, causing the DSP to release control of the data bus and not read or write to it until the  $\overline{\text{BR}}$  line has returned high. When the microprocessor writes data to the bridge latch within IC23, it resets the DRQ0 output low and the DSPBUSY output high. When the DSP sees the  $\overline{\text{BR}}$  line is high, it does a read of the bridge using the  $\overline{\text{BMS}}$  line to enable the output of the bridge latch. This in turn sets in motion another cycle of the down-loading sequence. This cycle continues until the DMA down-load is completed. When it reaches the end of the DMA data, the microprocessor ignores the next DRQ0 command and sends the start-up signal to the DSP.

Once the DMA down-load is completed the DSP bridge in IC23 goes into its second mode of operation, namely that for normal operation. In this mode, when data is written to the bridge latch using  $\overline{\text{PCS3}}$  and  $\overline{\text{WR}}$ , the bridge is clocked so that a high appears on the DSPBUSY output. This line goes to the DSP to let it know that data has been written to the bridge. The D0 bit is also set on the readback buffer within IC23; the microprocessor polls the readback buffer to see when the data has been read from the bridge. When the DSP sees the DSPBUSY line go high, it knows that data is waiting on the bridge and reads it from there using the  $\overline{\text{RD}}$  and  $\overline{\text{DMS}}$  lines. The  $\overline{\text{RD}}$  line enables the output of the bridge latch and the  $\overline{\text{DMS}}$  line resets the DSPBUSY output low. When this occurs, the microprocessor knows that the last data byte has been read and it can write the next data byte. In this way the microprocessor controls the DSP audio generator.

#### Both boards

The DSP is used to generate the audio frequency signals which are used for internal modulation. It does this by outputting serial data on its serial port to 16-bit serial DAC IC13. The DAC output is then passed through filter chip IC207 which has been configured as an eighth-order Bessel low-



pass filter with a 3 dB cut-off frequency of 20 kHz. After the filter the signal is buffered and amplified by IC15a to 2 V RMS and routed to the front panel from PLK (or to the rear panel via SKB if the rear-exit option is fitted). The filtered signal is also fed, via buffer IC15b, on the INTERNAL MOD line to the audio multiplexers (sheet 4).

The DSP uses the 10 MHz standard generated on the control board, but it also has a clock output line which outputs the 10 MHz clock with a 50% duty cycle. This clock output from the DSP is doubled to 20 MHz using a simple doubling circuit based on XOR-gate IC46b and an RC delay line (R150 and C7). The 20 MHz CLOCK is then used as the microprocessor clock input.

### Trigger

The trigger input comes from SKA on the rear panel and is voltage protected to 50 V by series 10 k $\Omega$  resistors R4 and R8. This signal is active low and uses pull-up resistor R7 to +5 V to enable operation using a simple external switch. The input is routed to microprocessor IC2 to enable triggering of functions to be carried out, and to DSP IC12 where it is used as one of two FSK modulation data lines.

The trigger input to the microprocessor is fed via Schmitt inverter IC206d. The trigger input line to the DSP is buffered using OR-gate IC50c and is fed to the D17 data line of the DSP where it is used as the data input A for digital modulation.

### Pulse modulation

The pulse modulation circuitry on the control board is limited to enabling or disabling the pulse modulation line and to determining whether an internal or external pulse modulation source is used.

The pulse modulation input comes from SKC on the rear panel and is voltage protected to 50 V by series 10 k $\Omega$  resistor R18. This input has a pull-down resistor, R17, to 0 V. The pulse modulation input line is buffered by OR-gate IC50d and is fed to the D18 data line of DSP IC12 where it is used as the data input B for FSK modulation.

## Control board: Interrupts and serial interface (sheet 3)

### Interrupt handler

#### AB1

The interrupt handler works around 8-bit magnitude comparator IC18 which compares eight live inputs with eight latched inputs. Latched inputs contain data written to interrupt handler latch IC17 by microprocessor IC2. Live inputs are interrupts from other parts of the control board circuitry. Only seven of the eight inputs are used; the eighth is tied low. When the two 8-bit inputs differ, an interrupt is generated which is fed to the INT2 input on the microprocessor. The microprocessor then reads interrupt handler input buffer IC19 to find out which input line has changed state. Before dealing with the interrupt the microprocessor writes this new data back to the interrupt handler latch to remove the interrupt at the microprocessor. When the interrupt has been dealt with, a second interrupt is generated which lets the microprocessor know that this input line is back in its normal state, so it writes the original data back into the interrupt handler latch. The interrupt line to the microprocessor has a de-glitch circuit in it based around IC24a, R151 and C3; this ensures that the live input to the interrupt handler is an interrupt and not just a momentary glitch on one of the interrupt lines. The interrupt handler is addressed using the PCS $\bar{I}$  chip select line. Inputs to the interrupt handler are shown in Table 1-8 below.

**Table 1-8: Interrupt lines**

Name	Function
D0	ALC HI
D1	ALC LO
D2	OCXO HI
D3	OCXO LO
D4	EXT STD DETECT
D5	KBRD INT
D6	SERIAL BUS INT
D7	Not used

#### AB1/1

The interrupt handler is incorporated within FPGA IC23. An 8-bit magnitude comparator compares eight live inputs with eight latched inputs containing data written by microprocessor IC2. Live inputs are interrupts from other parts of the control board circuitry. When the two 8-bit inputs differ, an interrupt is generated (STAT\_INT), which is fed to the INT2 input on the microprocessor. The microprocessor then reads an interrupt handler input buffer to find out which input line has changed state. Before dealing with the interrupt the microprocessor writes this new data back to the interrupt handler latch to remove the interrupt at the microprocessor. When the interrupt has been dealt with, a second interrupt is generated which lets the microprocessor know that this input line is back in its normal state, so it writes the original data back into the interrupt handler latch. The interrupt line to the microprocessor has a de-glitch circuit in it based around IC24a, R151 and C3; this ensures that the live input to the interrupt handler is an interrupt and not just a momentary glitch on one of the interrupt lines. The interrupt handler is addressed using the PCSI chip select line. Inputs to the interrupt handler are shown in Table 1-8 below.

**Table 1-9: Interrupt lines**

Name	Function
D0	ALC HI
D1	ALC LO
D2	OCXO HI
D3	OCXO LO
D4	EXT STD DETECT
D5	KBRD INT
D6	RF SER BIT INT
D7	LCL SER BIT INT

#### Serial bus

##### AB1

There are two serial buses generated on the control board: the first is a buffered serial bus used to control the RF module and the second is a local serial bus which is used on the control board for controlling octal DAC IC34. The serial bus is made up of three lines: a data line down which the serial address and data is sent, a clock line which synchronizes the data recovery and an enable line which enables the receiving devices on the other end of the serial link when data is being transmitted.

The serial bus data line is fed from two parallel-to-serial shift registers onto which the data and address bytes are loaded. The serial output of data register IC21 is fed into the serial input of address register IC23, so when the two shift registers are clocked together the address and then the data are sent down the data line of the serial bus one after the other. The clock and enable lines for both the local and RF module serial buses are provided by latch IC22. This latch also clocks

the data through the shift registers and onto the serial data line. All the RF module serial bus lines and the data line of the local serial bus are buffered using tri-state buffers IC28. The buffers on the RF module clock and enable lines are permanently enabled, and the buffers on both of the serial buses' data lines can be individually enabled using serial bus latch IC22. By being able to tri-state the data line of the RF module serial bus, this line may be used to read back a data bit from the location addressed. This serial bit is read in on data input latch IC1 addressed using  $\overline{PCS4}$ . The serial bus latch is addressed using  $\overline{PCS6}$  and the shift registers are addressed using  $\overline{MCS3}$ .

## AB1/1

There are two serial buses generated on the control board: the first is a buffered serial bus used to control the RF module and the second is a local serial bus which is used on the control board for controlling octal DAC IC34. The serial bus is made up of three lines: a data line down which the serial address and data is sent, a clock line which synchronizes the data recovery and an enable line which enables the receiving devices on the other end of the serial link when data is being transmitted.

The serial bus data line is fed from two parallel-to-serial shift registers onto which the data and address bytes are loaded. The serial output of the data register is fed into the serial input of the address register, so when the two shift registers are clocked together the address and then the data are sent down the data line of the serial bus one after the other. The clock and enable lines for both the local and RF module serial buses are generated within IC23, which also clocks the data through the shift registers and onto the serial data line. All the RF module serial bus lines and the data line of the local serial bus are buffered using tri-state buffers IC28. The buffers on the RF module clock and enable lines are permanently enabled, and the buffers on both of the serial buses' data lines can be individually enabled. By being able to tri-state the data line of the RF module serial bus, this line may be used to read back a data bit from the location addressed. This serial bit is read in on a data input latch addressed using  $\overline{PCS4}$ . The serial bus latch is addressed using  $\overline{PCS6}$  and the shift registers are addressed using  $\overline{MCS3}$ .

## Buffered data bus and control lines

### AB1

Certain devices on the control board require a buffered data bus and buffered control lines (lines that remain quiet when not in use). The data bus is buffered using bi-directional tri-state buffer IC27 which has pull-down resistors R185 to R192 to ground on the quiet side of the buffer. The control lines buffered are A0, A1, A2,  $\overline{RD}$  and  $\overline{WR}$  and they are buffered using OR-gates IC16 and IC9b. Also, extra chip select lines are required for the buffered devices; these are provided by address decoder IC20 which provides an extra eight buffered chip select lines. The buffered lines and chip selects are all addressed on  $\overline{PCS2}$ .

The control lines supplied by buffered hardware control latches IC25 and IC26 are shown in Table 1-10 below.

**Table 1-10: Latch control lines**

IC25		IC26	
Q0	1 MHz/10 MHz	Q0	not used
Q1	INT/EXT	Q1	$\phi$ M/FM
Q2	PLL/DAC	Q2	AM S0
Q3	AC/DC	Q3	AM S1
Q4	DSP RESET	Q4	AM S2
Q5	INT PULSE ENABLE	Q5	FM S0
Q6	EXT PULSE ENABLE	Q6	FM S1
Q7	INT STD OUT	Q7	FM S2

The buffered chip select lines are used to address the functions shown in Table 1-11 below.

**Table 1-11: Buffered chip selects**

Line	Signal	Function
Y0	$\overline{\text{BCS0}}$	Keyboard interface enable
Y1	$\overline{\text{BCS1}}$	LCD display enable
Y2	$\overline{\text{BCS2}}$	RS-232 interface enable
Y3	$\overline{\text{BCS3}}$	Dual 12-bit DAC IC35 enable
Y4	$\overline{\text{BCS4}}$	Control latch IC25 enable
Y5	$\overline{\text{BCS5}}$	Control latch IC26 enable
Y6	$\overline{\text{BCS6}}$	Dual 12-bit DAC IC3 update
Y7	$\overline{\text{BCS7}}$	Knob interface enable

#### AB1/1

Certain devices on the control board require a buffered data bus and buffered control lines (lines that remain quiet when not in use). The data bus is buffered within IC23, which has pull-down resistors R185 to R192 to ground on the quiet side of the buffer. Control lines A0, A1, A2,  $\overline{\text{RD}}$  and  $\overline{\text{WR}}$  are buffered also within IC23. Extra chip select lines are required for the buffered devices, these are provided by address decoder IC20 which provides an extra eight buffered chip select lines. The buffered lines and chip selects are all addressed on PCS3.

The buffered control lines supplied by buffered hardware control latches IC25 and IC26 are shown in Table 1-10 below.

**Table 1-12: Latch control lines**

IC25		IC26	
Q0	1 MHz/10 MHz	Q0	MOD I/O
Q1	INT/EXT	Q1	$\phi\text{M/FM}$
Q2	PLL/DAC	Q2	AM S0
Q3	AC/DC	Q3	AM S1
Q4	DSP RESET	Q4	AM S2
Q5	INT PULSE ENABLE	Q5	FM S0
Q6	EXT PULSE ENABLE	Q6	FM S1
Q7	INT STD OUT	Q7	FM S2

The buffered chip select lines are used to address the functions shown in Table 1-11 below.

**Table 1-13: Buffered chip selects**

Line	Signal	Function
Y0	$\overline{\text{BCS0}}$	Keyboard interface enable
Y1	$\overline{\text{BCS1}}$	LCD display enable
Y2	$\overline{\text{BCS2}}$	RS-232 interface enable
Y3	$\overline{\text{BCS3}}$	Dual 12-bit DAC IC35 enable
Y4	$\overline{\text{BCS4}}$	Control latch IC25 enable
Y5	$\overline{\text{BCS5}}$	Control latch IC26 enable
Y6	$\overline{\text{BCS6}}$	Dual 12-bit DAC IC3 update
Y7	$\overline{\text{BCS7}}$	Knob interface enable

PLS is a 6-way plug which provides a programming connection to FPGA IC23.

**Control board: Modulation and level (AB1 sheet 4, AB1/1 sheets 4 & 5)****External modulation input**

This input (PLL or optionally SKE) has a nominal input impedance of 100 k $\Omega$  in the standard version of the instrument, although provision has been made to enable a 600  $\Omega$  input impedance version to be offered as an option by fitting R155 and R156. This input can be either AC or DC coupled by opening or closing relay RLA by means of the AC/DC line to TR1. From here the signal is reduced from the nominal 1 V RMS input voltage to 1 V pk-pk using potential divider R203 and R204. It is then passed from buffer IC30a either directly to the modulation conditioning circuitry or through an ALC circuit to be leveled to 1 V pk-pk. The ALC circuit works by using variable resistor TR6 to adjust the gain of amplifier IC48. The variable resistor is voltage controlled by a pair of positive and negative peak detectors based around D12 and C27, and D14 and C28 whose outputs are averaged to reduce errors induced by complex waveforms. The ALC output is monitored by a window comparator formed by IC47a, b and d to provide out-of-range signals on the ALC HI and ALC LO lines to the microprocessor.

**Composite modulation**

The composite modulation signal basically sums, with equal weighting, the internal and external modulation signals and feeds the result on for use in either the AM or FM/ $\phi$ M modulation paths. The external modulation signal summed is the direct input signal.

The signals on the INTERNAL MOD and EXT MOD DIRECT PATH are summed into the inverting input of operational amplifier IC38a through resistors R133 and R134. The output from this operational amplifier is fed into the inverting input of IC38b which inverts the signal again and adjusts its amplitude to 1 V pk-pk.

**Amplitude modulation**

Analogue multiplexer IC31 can feed a number of sources onto the AM modulation signal path. The sources available are external modulation direct, external modulation ALC, internal modulation, 1 V calibration voltage, composite modulation or ground. Voltage divider R102 and R103 provide the 1 V calibration voltage via IC38c.

After the multiplexer the signal is buffered and has its amplitude adjusted for losses in this path by operational amplifier IC33a. It then passes through 12-bit DAC IC35b which sets the depth-of-modulation (range 0 to 4000) in 0.1% steps. The DAC has a maximum output of 99.9% with 100% being equal to 1 V pk. After this the signal path splits into two.

The first path can have a DC voltage offset applied to it by the b-section of 8-bit octal DAC IC34. The signal then passes through a square-law correction circuit based on IC33c and TR4 and is then amplified by IC33d before being passed out to the RF module as the AM signal. The AM square law correction circuit is adjusted using the a-section of octal DAC IC34.

The second path can have a DC offset applied to it by the c-section of octal DAC IC34. The signal is then amplified by IC37a and fed to 12-bit DAC IC35a which sets the RF level (range 40 to 4000) in 0.1 dB steps. After the DAC the signal passes through a square law correction circuit, based on IC37c and TR5, which can be adjusted using the d-section of octal DAC chip IC34. Finally, it is routed to the RF module via amplifier IC37d as the RF LEVEL REF signal.

**AB1/1**

Additional circuitry allows the local serial bus to address more than one device. On the AB1 board, the only device using the local serial bus on the control board is octal 8-bit DAC IC34 (sheet 5). This is written to using 16 bits, of which the first eight are address bits and the next eight data bits. The DAC uses only the last 12 bits received; the first four bits are clocked out of the device and discarded. On the AB1/1 board, however, the serial-data-out line from the octal DAC is fed into quad D-type latch IC21, where the first four bits clocked down the line are clocked through the DAC and into the four latches, and are decoded into an address using AND gates IC22. This address is used for other applications on the serial bus such as the SINAD board. The address of the octal DAC is 0000.

## Frequency/Phase modulation

The FM/ $\phi$ M path can be fed a signal from a number of sources by analogue multiplexer IC32. The sources available are external modulation direct, external modulation ALC, internal modulation, 1 V calibration voltage, composite modulation or ground.

After the multiplexer the signal can be either amplified to 1.4 V pk and routed to the RF module via PLD as the FM signal, or it can pass through a differentiator circuit, which has a slope of 6 dB/octave, and be passed on to the RF module as the  $\phi$ M signal. Analogue switch IC29b is used to determine which path is selected. The FM or  $\phi$ M conversion is done by a high output current operational amplifier, IC49b, which is required to drive the load on the RF module.

### AB1/1

When the PLL circuit is not in operation a fixed tuning voltage can be applied to the oscillator using switch IC36. The fixed tuning voltage is generated using the f-section and g-section of octal DAC IC34. These generate a tuning voltage with a range of +1 V to +4 V which is set during calibration in the factory. Voltage dividers R178 and R179 provide the reference voltage via IC47c for the DAC.

## Control board: Standard selection (AB1 sheet 5, AB1/1 sheet 6)

### Clock circuitry

This includes the internal 10 MHz standard, which supplies 10 MHz to the control board and the RF module, and which is divided down to provide a 2 MHz clock for the GPIB interface and the RS-232 serial link. It also includes the external standard conditioning circuitry and phase-locked loop (PLL) circuitry to allow the internal oscillator to be phase locked to an external 1 MHz or 10 MHz clock. Frequency standard selection is summarized in Fig. 1-7.

The +5 V supply for all the clock circuitry is locally regulated down from the +11 V rail using regulator IC59. This is required to prevent noise from the digital circuitry on the standard +5 V rail causing jitter in the PLL when it is in operation. The control board has a dual oscillator footprint on it to allow either a 10 MHz OCXO or a 10 MHz TCXO to be used as the internal oscillator; which option is fitted can be read back on data input latch IC1 (AB1) or FPGA IC23 (AB1/1). The signal from oscillator X1 is buffered using inverters IC45, and then routed to the DSP and to the RF module via switch IC42. When enabled by INT STD OUT, IC62 also directs the internal standard to the rear panel FREQ STD IN-OUT socket via SKF. The 10 MHz is also divided by five using IC61a to provide a 2 MHz clock for the GPIB and the RS-232 interfaces. This 2 MHz clock is then further divided by two using IC61a to produce a 1 MHz clock with 50% duty cycle which is used to clock one half of the PLL circuit.

The PLL circuit based on IC44a, b and IC43a, b takes two inputs at 1 MHz, one derived from the internal standard and one from the external standard, and generates a voltage output which varies according to the phase difference between the two inputs. Two output voltages are produced by this circuit because the OCXO and the TCXO require tuning voltages with opposite senses to make them phase lock correctly. If the tuning voltage gets too high or too low an appropriate OCXO HI or OCXO LO out-of-range signal is generated using the window detector based round comparators IC43c and d. This tuning voltage is applied to the oscillator voltage control input to adjust the frequency output accordingly.

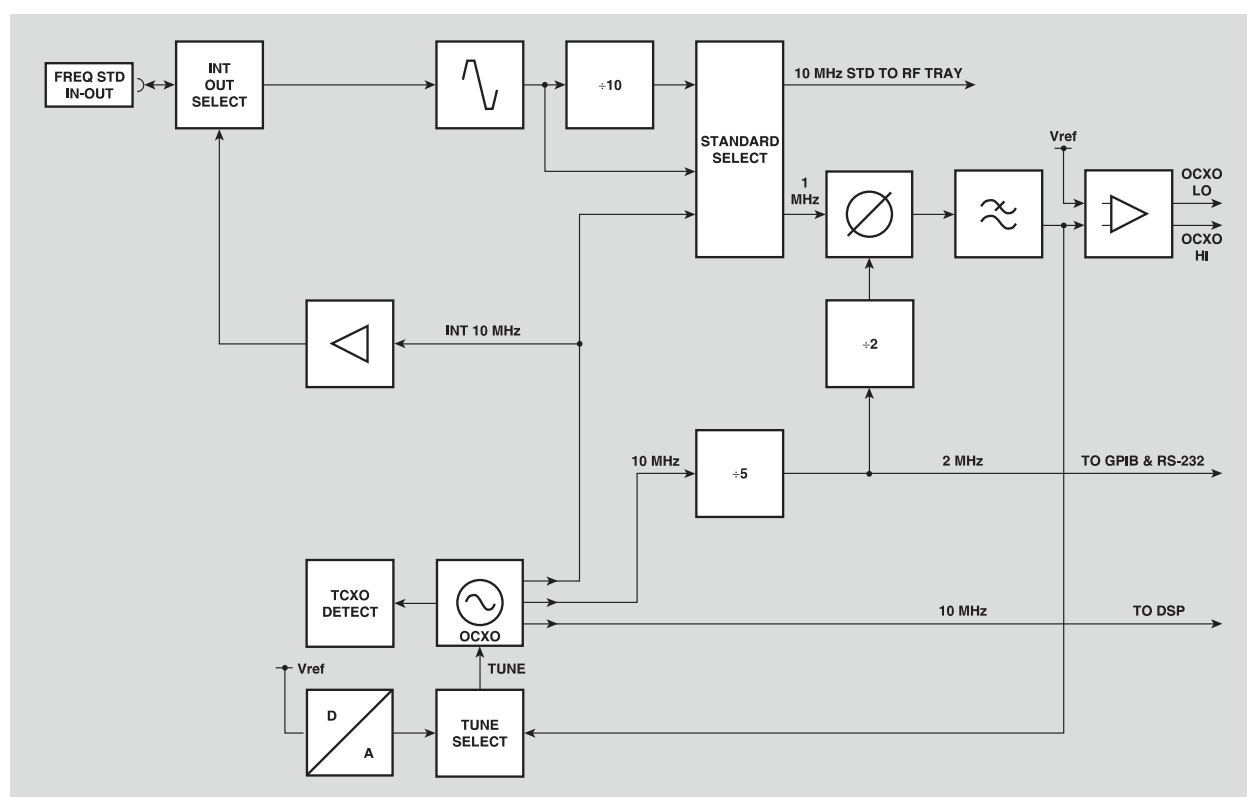
### AB1

When the PLL circuit is not in operation a fixed tuning voltage can be applied to the oscillator using switch IC36. The fixed tuning voltage is generated using the f-section and g-section of octal DAC IC34. These generate a tuning voltage with a range of +1 V to +4 V which is set during calibration in the factory. Voltage dividers R178 and R179 provide the reference voltage via IC47c for the DAC.

## Both boards

The circuit automatically detects if a TCXO or an OCXO is fitted by monitoring the current supply to the TCXO Vcc input. When the OCXO is fitted there is only the quiescent current of IC60 passing through the current sense resistor R205 and this is not enough to generate the voltage drop required to turn on transistor TR8, so the TCXO DETECT line is held low. When the TCXO is fitted the voltage drop across R205 causes TR8 to turn on, which pulls the TCXO DETECT line to +5 V. The TCXO DETECT line is fed to input buffer IC1 (sheet 1), and also to IC36 where it is used to automatically route the tuning voltage from the PLL.

The external standard first passes through some conditioning circuitry based on TR2 and TR3 which ensures that it is at the correct logic levels when it is passed on to the rest of the circuitry. It can then either be routed directly to switch IC42 or it can be divided by 10 using IC41a and then routed to the switch; it is at this stage that the external signal is detected using TR7. Switch IC42 is used to route the external standard to one of the PLL inputs either directly if the external standard is 1 MHz or after it has been divided by ten if it is a 10 MHz external standard. Switch IC42 is used to route either the 10 MHz external standard or the 10 MHz internal standard as required to the RF module.



C2736

Fig. 1-7 Frequency standard selection

## Control board: Interface (AB1 sheet 6, AB1/1 sheet 7)

### GPIB

The GPIB interface is provided using a standard chipset consisting of GPIB controller IC56 and transceivers IC57 and IC58. The +5 V GPIB power supply is locally filtered by L1, C34 and R145 to prevent noise leakage out of the instrument. The controller is addressed using PCS0, and the GPIB interrupt is fed into the INT0 input of microprocessor IC2 (sheet 1). A 2 MHz clock is provided which enables the controller to internally derive the transfer rate of the link. The GPIB signal lines are fed from the controller through the transceivers to the board-mounted rear panel GPIB connector SKP.

## RS-232

The RS-232 serial link is provided by one of the two serial interfaces present in asynchronous communications controller IC53. The controller is supplied with a 2 MHz clock which enables it to internally derive the baud rate of the link. This IC uses the buffered data bus and control lines to prevent noise leakage from the instrument. The RS-232 serial link is addressed using  $\overline{\text{BCS2}}$ , and the RS-232 interrupt is fed to the INT1 input on microprocessor IC2 (sheet 1). The RS-232 lines are fed through multiple driver and receiver IC52 before going to the board-mounted rear panel RS-232 connector SKR. The driver and receiver IC contains the three output drivers and the five input receivers that are required for the RS-232 link.

## Knob

The knob signals come from the front panel on a 40-way ribbon cable which plugs into PLH on the control board. These signals are generated by an optical shaft encoder on the front panel and are in phase quadrature with each other; the direction of rotation of the knob can be determined by detecting the sequence of changes of these two signals. This is done using the second serial interface on the asynchronous communications controller IC53. The CTSI and the DSR1 inputs are the only two lines used on this serial interface, the rest are tied low. When either of these two lines changes state an interrupt is generated, this interrupt is fed into the  $\overline{\text{NMI}}$  input on microprocessor IC2. The microprocessor then reads the serial interface internal buffer, using  $\overline{\text{BCS7}}$ , and compares this new data with the last reading taken to determine the direction of rotation of the knob.

## Key pad

The key pad is driven by the parallel port on asynchronous communications controller IC53 and is addressed using  $\overline{\text{BCS0}}$ . Eight data lines, Y0 to Y7, are used as outputs to hold the columns of the key pad low and the  $\overline{\text{ERR}}$ , SLCT, BUSY, PE and  $\overline{\text{ACK}}$  lines are used as inputs to read the five rows of the key pad. These five input lines have pull-up resistors to +5 V to hold them high unless a key is pressed. They are also fed into eight-input NAND-gate IC54 which generates an interrupt signal whenever one of its inputs is pulled low. One of the remaining three input lines to the NAND-gate is connected to the  $\overline{\text{INT}}$  line of the IC53 parallel port and is used as an interrupt enable line (the remaining two NAND-gate inputs are pulled high). The keyboard interrupt is routed to the interrupt handler which then generates an interrupt on INT2 of microprocessor IC2. When an interrupt is received the microprocessor first reads which row is pulled low and then switches all eight data line outputs high and pulses them low in turn to determine which column is being used; in this way the microprocessor can read which key is being pressed on the key pad.

## Front panel display

The front panel LCD display requires two connectors. The first connector provides power for the cold cathode fluorescent lamp used to illuminate the LCD display and is provided by an inverter module in the power supply area of the instrument. The second connector provides all the logic signals and power supplies for the LCD display itself, and these all come from the control board.

The contrast voltage for the LCD display has a voltage range of about -11 V to -7 V and is generated using the h-section of octal DAC chip IC34. The voltage from the DAC can vary between -3 V and +3 V, this is then conditioned and temperature compensated by comparator IC55a, a thermistor and resistors R125 to R129. The thermistor is positioned on the front panel PCB to detect the temperature at the display. The display uses the buffered data bus and is addressed using  $\overline{\text{BCS1}}$ .

## Control board: PSU filtering and regulation (AB1 sheet 7, AB1/1 sheet 9)

Power for the control board and for the RF module enters the control board from the switched mode power supply on the PLN connector, it is then filtered and smoothed and routed appropriately. The power supply rails are monitored to detect power rail failure or brown-out (incipient power failure) conditions. In either of these events microprocessor IC2 is put into reset and EEPROM IC7 (both sheet 1) is inhibited from being written to.



The power supplies required on the control board are +5 V,  $\pm 11$  V and a stable +5 V reference voltage. The power supplies delivered to the RF module, via the PLD connector, are +24 V, +21 V,  $\pm 11$  V, +5 V, +5 V<sub>clean</sub> and +5 V<sub>fracn</sub>.

The +5 V supply is only used for the digital circuitry on the control board and is taken off directly from the power supply input with only filtering by C232 and C234 applied to it. It is further filtered by L205, C213, C235 and C236 before going to the RF module. The +5 V<sub>fracn</sub> supply is separately filtered (by L207, C221 and C224) from the standard +5 V line and is used to power only the fractional-N divider on the RF board. The +5 V<sub>ref</sub> voltage required by the control board is supplied by voltage reference IC204 powered from the +24 V rail. The +5 V (clean) voltage supply required on the RF module is regulated down from the +12 V rail using regulator IC203.

The +11 V rail is regulated down from the +12 V input from the switched mode power supply using a low-drop regulator based around IC205a, R212, R213 and TR201. Filtering is provided by L206, C211 and C231. Additional filtering for the +11 V rail is provided by L203 and C215 to C219 before it is used on the RF module.

The -11 V rail is not regulated and so is only approximately -11 V; it relies on the voltage drop across transistor TR202 to set the level of this voltage rail. TR202 is used in conjunction with L201, C205 and C208 to actively filter this rail before use on the control board. Additional filtering for the -11 V rail is provided by L204, C202, C225, C226 and C227 before it is used on the RF module.

The +24 V rail is initially filtered by C203, C204 and C228, and is further filtered by L202 and C206 before being used on the RF module. The +24 V rail is also routed to voltage regulator IC201 where it is regulated down to +21 V for use on the RF module. Output filtering is provided by C207 and C209.

IC201, IC203 and TR201 are all mounted on heatsinks to prevent damage by overheating at higher temperatures. The heatsinks also allow operation at ambient temperature with no air flow over the board, such as might occur during servicing.

### Processor reset

The microprocessor monitoring circuit, based around comparator IC202, provides a reset signal to microprocessor IC2 and a write inhibit signal to EEPROM IC7 (both sheet 1). It does this on power-up and also in the event of a power failure or brown-out (incipient power failure) situation occurring on the +5 V supply rail. This circuit holds the microprocessor in reset at power-up long enough for the internal clock oscillator and the rest of the circuit to stabilize.

It does this by monitoring the +5 V and +24 V power rails and asserting the reset line if the voltage on either of these rails falls beneath a pre-determined level. The monitoring circuit is made up of open-collector output comparators IC202a and IC202b. These are powered off the +12 V and 0 V rails, and have their outputs wire-ORed together through R222 and R226. The combined output is then pulled up to the +12 V rail via R223 which combines with capacitor C233 to give a power-on delay. The reset output is prevented from going too high by being clamped to +5 V by diode D206. The signal is then fed to the input of Schmitt-trigger inverter IC206b.

The non-inverting input to the first comparator, IC202a, comes from the +5 V power rail through 1 k $\Omega$  resistor R218. The negative input is the +5 V REF rail voltage divided down to about 4.6 V by R220 and R221. This ensures that if the +5 V rail is less than about +4.6 V the reset line will be pulled LOW.

The non-inverting input of the second comparator, IC202b, has a pull-down resistor to 0 V and has 15 V zener diode D207 tying it to the +24 V rail; this holds this input at about +9 V. The inverting input of this comparator is tied directly to the +5 V REF rail. This ensures that if the +24 V rail is less than +15 V, the reset line will be pulled LOW. The +24 V power rail has to be included in the reset circuit because the +5 V REF line, which is used as the reference for the +5 V rail comparator, is powered from it. If the +24 V rail voltage drops, reset will be asserted when it reaches about +20 V, which ensures that the +5 V REF is still being generated.

If the +12 V rail goes down the comparators lose their power supply and pull-up resistor R223 pulls the reset line LOW instead of the comparators.

## Control board: Power supplies (AB1 sheet 8)

### AB1

This sheet shows the board power supply table. All unused ICs are also shown.

**Note:** For AB1/1, this information is distributed on the individual drawings.

## Control board: 31 V dc power supply (AB1/1 sheet 8)

### AB1/1

An additional dc-dc voltage converter generates +31 V, which can be fed to the AA1/1 RF board to allow it to operate at frequencies up to 2.51 GHz. If the AB1/1 control board is used with an AA1 RF board, the voltage must be limited to +24 V. A 1  $\Omega$  resistor is fitted in either the R152 (+31 V) or R153 (+24 V) position on the board (sheet 9) to select the appropriate voltage: only one position should be occupied.

SKT is a 20-way socket which caters for the SINAD daughter board. It carries +12 V, -12 V, +5 V, 0 V, local serial bus data, clock and enable lines, reset (L), and 10 MHz clock.

## AB2 SINAD board

The SINAD board can be fitted to any 2023A, 2023B and 2025 standard instrument or with any valid combination of other options fitted. The board allows the instrument to measure the SINAD of a unit without additional test equipment.

SINAD is defined as the ratio, expressed in dB, of the total power of the received audio signal to the power of the received signal after filtering to remove the modulation signal. The modulation is nominally 1 kHz.

The board samples an analogue signal and digitally processes it to produce a value for the SINAD; this value is sent through a serial link to the microprocessor on the control board.

The signal can be measured unweighted, or as defined in ITU-T O41 (commonly referred to as CCITT P53), or as defined by the North American C-message filter. These filters are implemented in software.

The board consists of a DSP system, a serial bus interface, analogue signal conditioning, an A-D converter and power conditioning.

**Note:** The SINAD board can be replaced only as a complete module, so no replaceable parts or circuit diagrams are included in this manual.

## AC1 Backlight inverter board

This board performs two functions: the first is to provide the cold cathode fluorescent tube on the display with its power, the second is to provide a filtered power supply to the fan.

The cold cathode fluorescent tube is powered by DC-to-AC inverter module X1. This requires a power supply of +5 V which is filtered by C1 to C4 and L1 before being fed into the inverter module. Output from the module at PLCB is a 450 V RMS sinusoidal waveform at a frequency of 30 kHz.

A +5 V fan is used (as opposed to the more usual +12 V fan) to prevent noise from the fan being introduced onto the +12 V rail, used for the more sensitive analogue areas of the instrument. The power supply for the fan is filtered by L2, L3 and C5, C6. The fan requires a maximum current of 165 mA.

## AF1 Front panel

The front panel is a replaceable unit and therefore no technical description is given. The unit does not include the control knob encoder, cables or display LCD. If a fault occurs with the unit it is recommended that the complete unit is replaced. However, as an aid to fault finding, the keyboard circuit diagram is given under AF1 in Chapter 7, together with front panel access and removal instructions which are given in Chapter 2.

## AC power supply

The standard AC power supply is a replaceable unit and therefore no technical description is given. If a fault occurs with the unit it is recommended that the complete unit is replaced. However, as an aid to fault finding, the power supply connections are shown on the interconnection diagram in Chapter 7, together with unit removal instructions which are given in Chapter 2. The DC outputs are additionally identified in Chapter 4.

## AC/DC power supply

The AC/DC power supply module, supplied as Option 2, is a switched mode design which operates from both an AC supply of 90 to 132 or 188 to 264 V, 47 to 63 Hz, or a DC supply of 11 to 32 V. The battery charging facility is not used in this instrument. Fig. 1-8 shows a block diagram of the AC/DC power supply module.

The circuits of the instrument require the supplies shown in Table 1-14 below.

**Table 1-14: Power supplies**

+5 V	2.8 A
+12 V	2.3 A
-12 V	0.6 A
+24 V	0.6 A output

The AC supply enters the instrument through a connector on the rear panel and passes through a fuse and two poles of a triple pole, double throw on/off switch. The supply then enters the power supply module where it is fed to a bridge rectifier in the AC-DC converter to produce an unregulated DC supply. The voltage of this depends on the supply voltage as the full range of AC input voltage is covered without range switching.

The second stage of the AC-DC converter produces semi-regulated DC supplies of 24 V using a 60 kHz switched mode oscillator and transformer coupling. This transformer also provides the safety isolation barrier.

The DC external or the DC supply from the AC-DC converter is used to drive the DC-DC converter.

The DC output circuits producing the four regulated output supplies are each fed from an individual winding on the DC-DC converter output transformer.

Regulation is applied to the DC-DC converter from the output current and voltage sensing circuits.

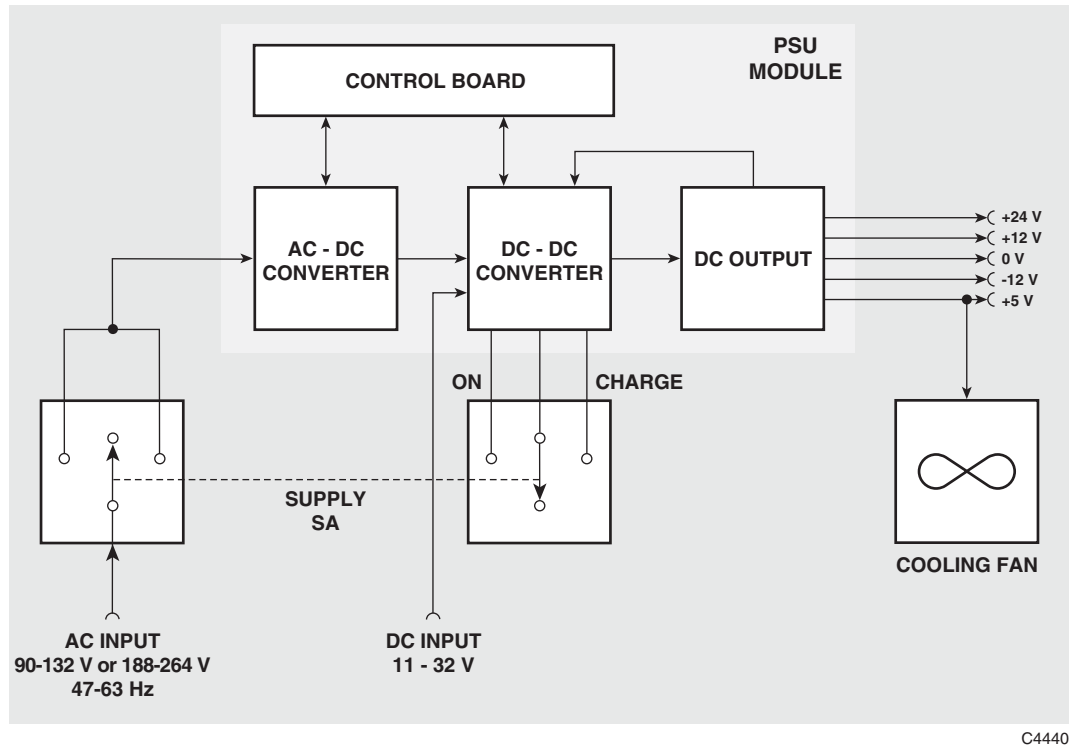


Fig. 1-8 Block diagram of AC/DC power supply module (the charging facility is not used in this instrument)

Current monitoring to provide regulation is obtained from the three common-return supplies and voltage monitoring from the +5 V supply.

The 24 V supply has a voltage regulator configured within it.

A control circuit PCB contains the components for frequency control and regulation of both converters.

The third pole of the power on-off switch is connected to the DC-DC converter circuits through plugs and sockets.

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## Chapter 2

# MAINTENANCE

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## General precautions

### Chip components

Numerous chip capacitors and resistors are fitted in this instrument. These have silver palladium end cap terminations with nickel barriers. When soldering these devices the following precautions should be observed:

- (1) Use a low melting point solder, and a soldering iron set to 315°C (600°F). The use of a high wattage soldering iron will minimize the time taken to solder the device.
- (2) Take care to avoid mechanical damage from flexing the PCB.

### Static sensitive components

The CMOS integrated circuits used in this instrument have extremely high input resistance and can be damaged by accumulation of static charges (see preliminary pages, 'Precautions'). Boards that have such integrated circuits all carry warning notices against damage by static discharge. Take care also when using freezer sprays to aid fault finding. These can create a static charge likely to change the programmed memory of (E)PROMs.

### Bulkhead connectors and gasket

To ensure that no RF leakage occurs all bulkhead connectors and lid sealing gaskets must be securely fitted. It is essential that the unit lids are correctly relocated in their slotted recesses after removal and all the screw-type connectors are tightened up to their specified torque (see 'Torque settings' below).

### Torque settings

Unless otherwise stated it is imperative that when replacing semi-rigid pipe connections the following torque setting is used: SMA : 99 to 106

Unless otherwise stated all screws have the following torque setting: 70 Ncm

## Compatibilities

2023A, 2023B and 2025 signal generators may contain a modified RF board (AA1/1) and control board (AB1/1). These support the extended carrier frequency range to 2.51 GHz, and the availability of Option 12, the SINAD measurement option using an AB2 board. Although the AB1/1 control board has provision for accommodating the SINAD board, it can be configured to work with 2023 and 2024 instruments by fitting R153 and removing R152. The AA1/1 RF board, however, will function only with the AB1/1 control board in the 2023A, 2023B or 2025.

2023A, 2023B and 2025 instruments may contain various combinations of control and RF boards. Only certain combinations of these are practicable, which should be borne in mind if replacement of a complete board, or an upgrade to SINAD, is envisaged.

Control board	RF board	Compatible combination of RF and control boards?
AB1	AA1	Yes*
AB1/1	AA1	Yes <sup>†</sup>
AB1/1	AA1/1	Yes (2025 standard fit) <sup>†</sup>
AB1	AA1/1	No

\* In order to fit SINAD to this combination, a replacement control board AB1/1 is needed (2023A and 2023B only).

<sup>†</sup> SINAD may be fitted to these combinations.

## Access to units and boards

The procedures below follow the order of access for servicing, then removal of units and boards.

### Access for servicing

#### Removal of instrument cover

Before any servicing of the instrument can be performed, the instrument cover must be removed as follows:

- (1) Remove four M4 screws from the side panels, two each side adjacent to the front panel handles.
- (2) Remove two M3 screws holding the cover to the rear panel.
- (3) Remove two M4 screws, one from each rear stand-off.
- (4) Remove the case by pulling it to the rear.

Ensure that when refitting the cover, the rear panel gasket is not damaged.

#### Access to boards AA1 and AA1/1

Turn the instrument upside down to gain access to the underside. A view of the instrument from below is shown in Fig. 2-2 . Remove 25 M3 × 6 mm screws on the periphery of the RF tray cover, then remove the remaining 22 M3 × 20 mm screws holding the cover to the RF screens. Remove the tray cover, which exposes the top surface of double-sided RF board AA1 or AA1/1.

When refitting take care that the gaskets are correctly fitted and undamaged.

#### Access to boards AA2/1, AA2/2, AA2/5, AA2/7

To gain access to these boards, first of all remove board AB1 or AB1/1 (see 'Removing AB1 and AB1/1 board' below) to expose the attenuator cover. Remove the cover after removing 22 M3 screws (torque setting 50 Ncm). A view of the attenuator tray with cover removed is shown in Fig. 2-7 .

When refitting the cover take care that the gasket is correctly fitted and undamaged.

#### Access to boards AB1, AB1/1, AB2

Removing the instrument cover gives immediate access from above to control board AB1 or AB1/1 and (where fitted) SINAD board AB2. A view of the instrument from above showing board AB1 is given in Fig. 2-1. A view of the instrument fitted with an AB2 SINAD board and AB1/1 control board is shown in Fig. 2-3

#### Access to PSU and board AC1

Removing the power supply cover gives access to the power supply unit and backlight inverter board AC1. Remove the cover after removing 11 M3 screws. Views of the instrument from above with the power supply cover removed are shown in Fig. 2-4 for the AC power supply and in Fig. 2-5 for the optional AC/DC power supply.

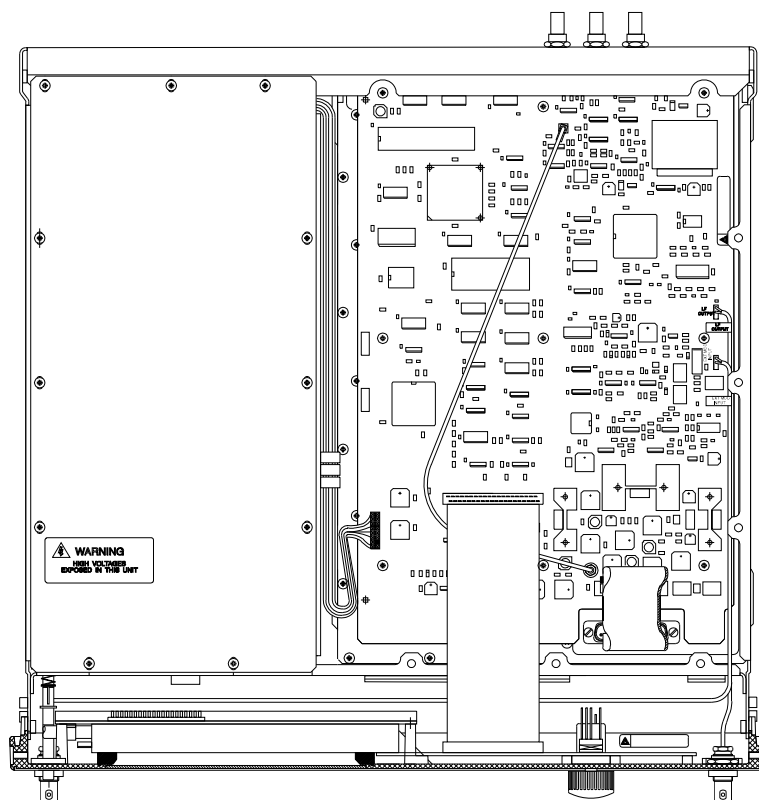


Fig. 2-1 Standard instrument - View from above with instrument cover removed

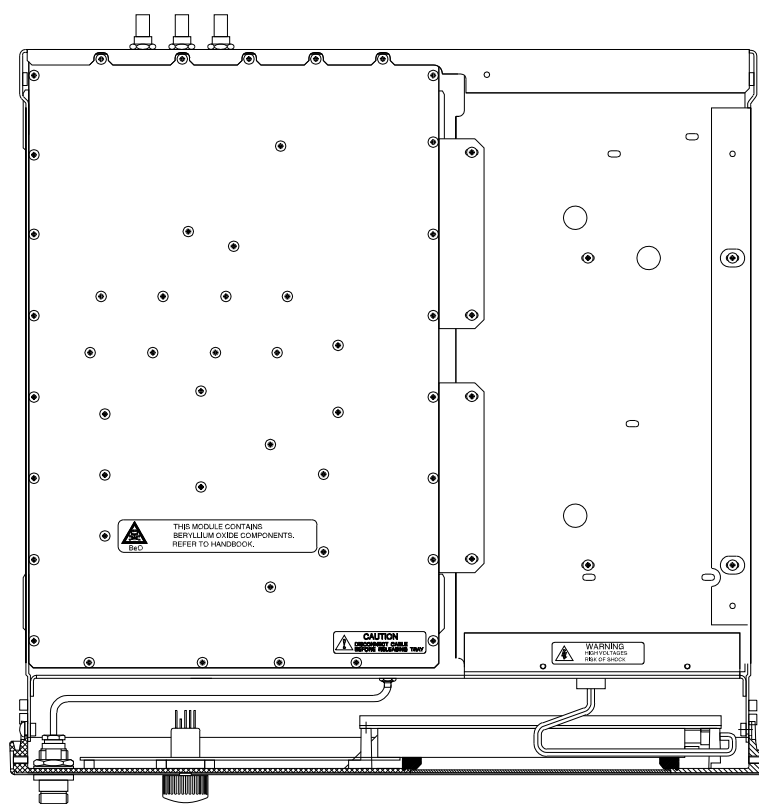


Fig. 2-2 Standard instrument - View from below with instrument cover removed



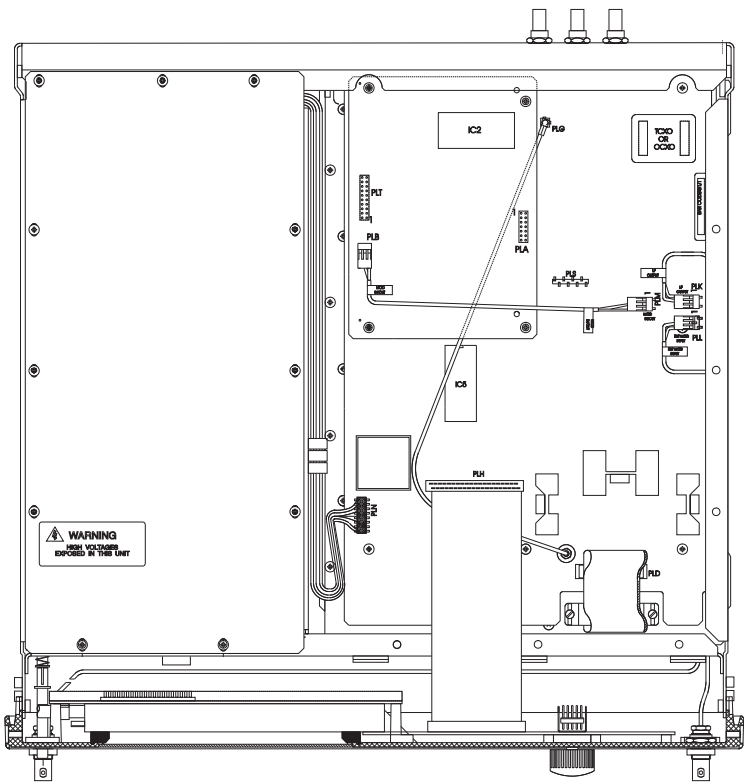


Fig. 2-3 SINAD option - View from above with instrument cover removed

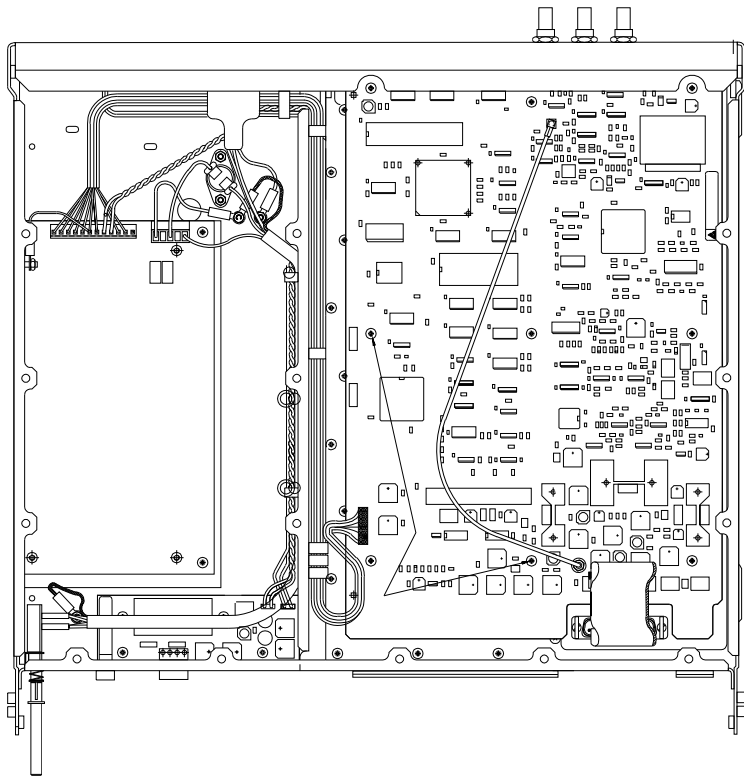
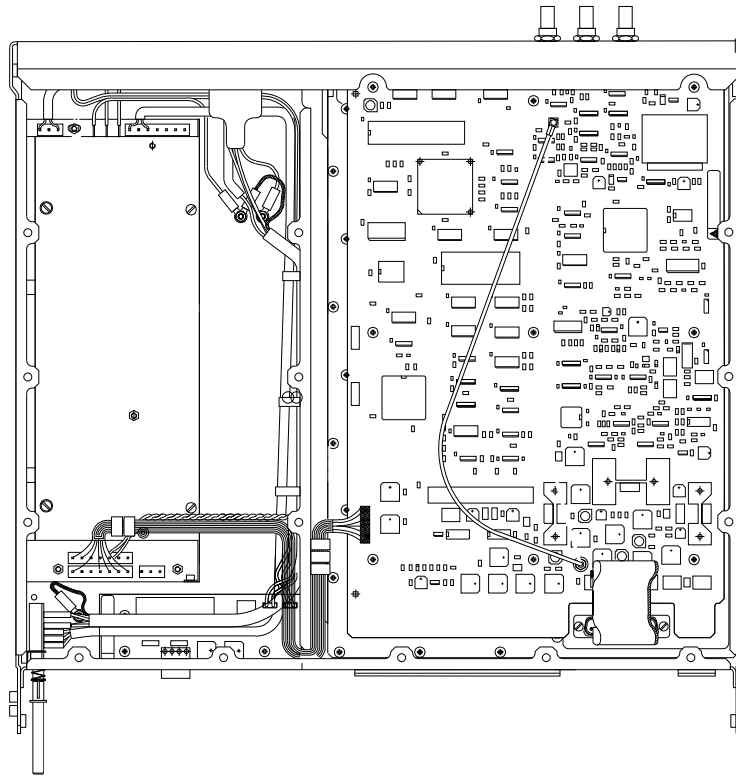


Fig. 2-4 Standard instrument - View from above with PSU cover and front panel removed



*Fig. 2-5 AC/DC option - View from above with PSU cover and front panel removed*

## Access to keyboard and display

Access to the front panel boards is gained after removing the front panel (see 'Removing front panel' below) from the instrument. Figs. 2-1 and 2-2 show the positions of the boards.

## Removal of units and boards

### Removing RF tray

Before removing the RF tray, board AB1 or AB1/1 must be removed (see 'Removing boards AB1 and AB1/1' below). Then proceed as follows:

- (1) Remove the four sideframe screws holding the tray.
- (2) Turn the instrument upside down and unscrew the semi-rigid RF OUTPUT cable at the RF tray end. (The torque setting at the front panel end is 1.6 Nm.)
- (3) Remove the four screws from the two side plates connecting to the PSU.
- (4) Remove the two screws connecting to the rear panel. Remove the tray.

### Removing front panel

Proceed as follows:

- (1) Disconnect the semi-rigid cable at the RF tray end.
- (2) Pull off the following connectors:
  - (a) Ribbon cable connector to PLH labelled TO FRONT PANEL on board AB1 or AB1/1.
  - (b) Connector to PLL labelled EXT MOD I/F on board AB1 or AB1/1.
  - (c) Connector to PLK labelled LF OUT on board AB1 or AB1/1.
  - (d) Front panel power supply connector at the PSU end after first pressing the catch underneath the connector to release it.

- (3) Release the front panel by removing four M4 screws (torque setting 1.6 Nm), two each side of the front panel. Pull the front panel forwards so that the hole in the panel clears the SUPPLY switch. Make sure that the flexible cables are free.

When refitting the semi-rigid cable use a torque of 1.0 Nm at the RF tray end.

## Removing AC power supply unit

Remove the power supply cover (see 'Access to PSU and board AC1' above). A view of the instrument from above with the power supply cover removed is shown in Fig. 2-4 . Then proceed as follows:

- (1) Pull off the two connectors to the board.
- (2) Unscrew and remove the earthing tag.
- (3) Remove two side panel screws.
- (4) Remove four screws from underneath the instrument. The complete unit can now be lifted out.

## Removing AC/DC power supply unit

Remove the power supply cover (see 'Access to PSU and board AC1' above). A view of the instrument from above with the power supply cover removed is shown in Fig. 2-5 . Then proceed as follows:

- (1) Pull off the three multi-way connectors at the front of unit.
- (2) Pull off the two multi-way connectors at the rear of unit.
- (3) Pull off the three single connectors at the rear , noting the colour and position of each: red to +ve, black to -ve, green/yellow to E.
- (4) Remove 10 screws (five on bottom, five at side) securing the unit to the main frame. The complete unit can now be lifted out.

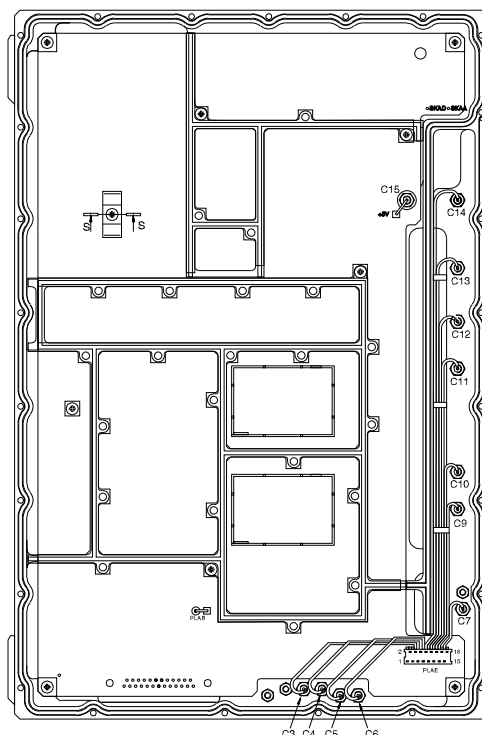
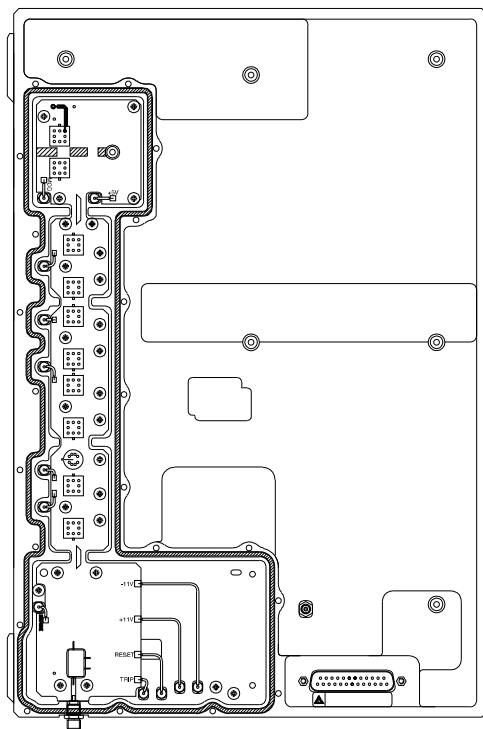


Fig. 2-6 Standard instrument - View of RF tray with cover removed



*Fig. 2-7 Standard instrument - View of attenuator tray with cover removed*

To obtain access to the PCBs within the unit, remove the four screws holding the protective cover in place, then remove the cover.

### Removing boards AA1 and AA1/1

Remove the RF cover (see 'Access to boards AA1 and AA1/1' above). A view of the RF tray with cover removed showing board AA1 (AA1/1 looks similar) is given in Fig. 2-6 . Then proceed as follows:

- (1) Remove the four M3 × 8 mm screws holding the amplifier and synthesizer RF screens in place and remove the screens together with their gaskets.
- (2) Unsolder PLAB and one feed-through in a cut-out on the board.
- (3) Unplug PLAE.
- (4) Unscrew and remove the pillar holding the sprung earth contact.
- (5) Unsolder SKAA and SKAD at the junction of the inner and outer wall.
- (6) Unscrew the studmounts for PLAC from the other side of the tray.
- (7) Unscrew and remove the four screws at the outer corners of the board and one near the board edge. Remove the board.

When replacing the board, remember to refit the connector gasket.

### Removing boards AA2, AA2/1, AA2/5 and AA2/7

Remove the attenuator cover (see 'Access to boards AA2/1, AA2/2, AA2/5, AA2/7' above). Then proceed as follows:

- (1) Unsolder 12 feed-throughs (15 for AA2/1 and AA2/7) at the board ends.
- (2) Unsolder the connection to the RF O/P SMA socket.
- (3) Unsolder the RF input and pulse input connections.
- (4) Remove two M2.5 screws either side of TR2 on AA2/1 and AA2/7.
- (5) Remove 23 M3 screws (25 for AA2/1 and AA2/7) and lift out the board.

## Removing board AA2/2

Remove the attenuator cover (see 'Access to boards AA2/1, AA2/2, AA2/5, AA2/7' above). Then proceed as follows:

- (1) Unsolder the connection to the RF O/P SMA socket.
- (2) Unsolder the RF input and pulse input connections.
- (3) Remove 12 M3 screws and lift out the board.

**Note:** When replacing the board, ensure that the 12 screws are tightened evenly to a torque of 70 Nm.

## Removing boards AB1 and AB1/1

Board AB1/1 only: if an AB2 SINAD daughter board is fitted, remove it first (see 'Removing board AB2' below).

Proceed as follows:

- (1) Unscrew and remove the nuts holding each of the rear panel BNC sockets.
- (2) Unscrew and remove the fastenings holding the RS232 and IEEE 488.2 connectors to the rear panel.
- (3) Pull off the following board connectors:
  - (a) Connector to PLL labelled EXT MOD I/F.
  - (b) Connector to PLK labelled LF OUT.
  - (c) Connector to PLN labelled FROM POWER SUPPLY.
  - (d) Ribbon cable connector to PLH labelled TO FRONT PANEL.
  - (e) Connector to PLG, 10 MHz standard, at the RF tray end.

Note that when replacing PLL and PLK, the polarity is not important.

- (4) Unscrew and pull off the ribbon cable connector to PLD labelled TO RF TRAY at the RF tray end.
- (5) AB1: Remove nine M3 screws holding the board to the RF tray.  
AB1/1: Remove five M3 screws and four hex. pillars holding the board to the RF tray.
- (6) Lift the board out whilst sliding it forward so that the rear connectors clear the cut-outs in the rear panel.

For servicing purposes the control board may be removed and operated, still connected to the instrument by its cables. After board removal insert the board fingers in the bracket provided at the display end of the main frame (the bracket can be seen in Figs. 2-3 and 2-4.)

## Removing board AB2

Proceed as follows:

- (1) Remove the socket and cable connected to PLB. Note that when replacing this, the polarity is not important.
- (2) Remove four screws at the corners of the board.
- (3) Carefully lift the board vertically to disconnect it from connector PLT underneath, then move it forwards to clear the instrument's chassis.

## Removing board AC1

Remove the power supply cover (see 'Access to PSU and board AC1' above). Then proceed as follows:

- (1) Pull off the front panel power supply connector at the PSU end after first pressing the catch underneath the connector to release it.
- (2) Pull off the fan supply connector PLCA.
- (3) Pull off the power supply connector PLCC.
- (4) Unscrew and remove four M3 board holding screws and lift out the board.

## **Routine maintenance**

### **Safety testing and inspection**

In the UK, the 'Electricity at Work Regulations' (1989) section 4(2) places a requirement on the users of equipment to maintain it in a safe condition. The explanatory notes call for regular inspections and tests together with a need to keep records.

The following electrical tests and inspection information are provided for guidance purposes and involve the use of voltages and currents that can cause injury. It is important that these tests are only performed by competent personnel.

Prior to carrying out any inspection and tests, the instrument must be disconnected from the mains supply and all external signal connections removed. All tests should include the instrument's own supply lead, all covers must be fitted and the equipment supply switch must be in the 'ON' position.

The recommended inspection and tests fall into three categories and should be carried out in the following sequence:

1. Visual inspection
2. Earth bonding tests
3. Insulation resistance test.

#### **1. Visual inspection**

A visual inspection should be carried out on a periodic basis. This interval is dependent on the operating environment, maintenance and use, and should be assessed in accordance with guidelines issued by the Health and Safety Executive (HSE). As a guide, this instrument when used indoors in a relatively clean environment would be classified as 'low risk' equipment and hence should be subject to safety inspections on an annual basis. If the use of the equipment is contrary to the conditions specified, you should review the safety re-test interval.

As a guide, the visual inspection should include the following where appropriate:

Check that the equipment has been installed in accordance with the instructions provided (for example, that ventilation is adequate, supply isolators are accessible, supply wiring is adequate and properly routed).

The condition of the mains supply lead and supply connector(s).

Check that the mains supply switch isolates the instrument from the supply.

The correct rating and type of supply fuses.

Security and condition of covers and handles.

Check the supply indicator functions (if fitted).

Check the presence and condition of all warning labels and markings and supplied safety information.

Check the wiring in re-wireable plugs and appliance connectors.

If any defect is noted this should be rectified before proceeding with the following electrical tests.

#### **2. Earth bonding tests**

Earth bonding tests should be carried out using a 25 A (12 V maximum open circuit voltage) DC source. Tests should be limited to a maximum duration of 5 seconds and have a pass limit of 0.1  $\Omega$  after allowing for the resistance of the supply lead. Exceeding the test duration can cause damage to the equipment. The tests should be carried out between the supply earth and exposed case metalwork, no attempt should be made to perform the tests on functional earths (for example, signal carrying connector shells or screen connections) as this will result in damage to the equipment.

### 3. Insulation resistance test

A 500 V DC test should be applied between the protective earth connection and combined live and neutral supply connections with the equipment supply switch in the 'ON' position. It is advisable to make the live/neutral link on the appliance tester or its connector to avoid the possibility of returning the instrument to the user with the live and neutral poles linked with an ad-hoc strap. The test voltage should be applied for 5 seconds before taking the measurement. IFR products employ reinforced insulation in their construction and hence a minimum pass limit of 7 M $\Omega$  should be achieved during this test.

Where a DC power adapter is provided with the instrument, the adapter must pass the 7 M $\Omega$  test limit.

We do not recommend dielectric flash testing during routine safety tests. Most portable appliance testers use AC for the dielectric strength test which can cause damage to the supply input filter capacitors.

### 4. Rectification

It is recommended that the results of the above tests are recorded and checked during each repeat test. Significant differences between the previous readings and the measured values should be investigated.

If any failure is detected during the above visual inspection or tests, the instrument should be disabled and the fault should be rectified by an experienced Service Engineer who is familiar with the hazards involved in carrying out such repairs.

Safety critical components should only be replaced with equivalent parts, using techniques and procedures recommended by IFR Ltd.

The above information is provided for guidance only. IFR products are designed and constructed in accordance with International Safety Standards such that in normal use they represent no hazard to the operator. IFR Ltd reserves the right to amend the above information in the course of continuing its commitment to product safety.

## Chapter 3

# ADJUSTMENT PROCEDURES

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## Introduction

This chapter describes adjustments which will restore the instrument to its peak operating condition. Test equipment recommended for this purpose is listed in Table 3-1 below and summarized before each adjustment procedure. All the routine adjustments for the instrument can be carried out from the front panel.

**Note:** The adjustment procedures cover, unless specifically stated otherwise, the following instruments: 2023, 2023A, 2023B, 2024 and 2025. Calibration points are included for all instruments, up to the 2.51 GHz output frequency of the 2025: please ignore calibration points above the upper cut-off frequency of your particular unit.

## Test equipment

To ensure minimum errors and uncertainties when making measurements, it is important to always use recently calibrated test equipment, with any correction figures taken into account, so as to establish a known traceable limit of performance uncertainty. This uncertainty must be allowed for in determining the accuracy of measurements.

## Warm-up time

Allow all instruments to warm up for at least 30 minutes before commencing adjustments.

## Unlocking procedure

In order to access the adjustment routines it is necessary to unlock the instrument to Level 2 by pressing:

[MENU]

80 [ENTER]

Select *Level 2:* and enter the six digit password (the default password is 123456)

## Resetting the password

To reset the password unlock the instrument then press:

[MENU]

81 [ENTER]

Select *Set Level 2 Password:* and enter the six digit password.

**ENSURE THAT A RECORD OF THE MODIFIED PASSWORD IS KEPT.**

For this purpose it is recommended that the adjustment form at the end of this chapter is duplicated and the modified password recorded on the duplicate.

## Adjustments

If more than one adjustment is to be performed, they must be performed in the order below.

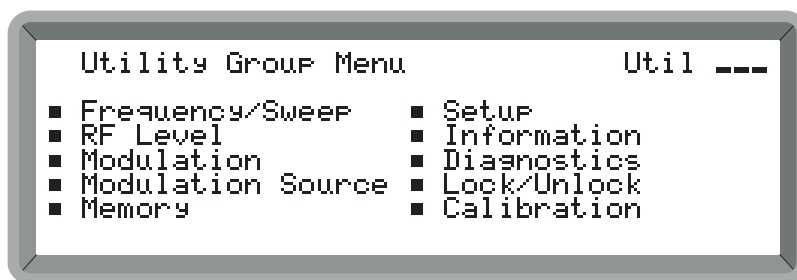
The adjustments are as follows:

UTIL 100	Synthesizer	
UTIL 101	Prediction factor	
UTIL 102	Frequency standard	
UTIL 103	Ext mod reference	
UTIL 104	Int mod offset	
UTIL 105	Int mod amplitude	
UTIL 106	FM factor	
UTIL 107	Unleveled mod	
UTIL 108	FM tracking	
UTIL 109	Leveled (ALC) mod	
UTIL 110	PM factor	
UTIL 111	RF level	
UTIL 112	AM	
UTIL 113	AM flatness	
UTIL 114	Normal system level	
UTIL 115	Pulse system level	
UTIL 116	High power system	(Units fitted with Option 3 or 11)
UTIL 117	High power & pulse	(Units fitted with Option 3 or 11)
UTIL 118	Attenuator pads	(Not units fitted with Option 1)
UTIL 119	Set calibration date	

To ensure that the adjustment remains in specification throughout the calibration period it is advisable to ensure that the figures remain within the limits stated at the beginning of each section.

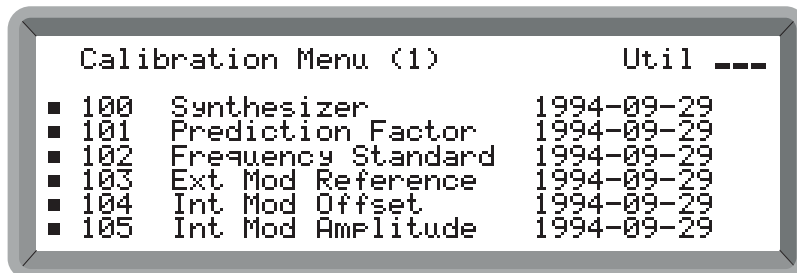
## Menu operation

Pressing [MENU] from the signal generator main screen or the step setting screen will display the *Utility Group Menu*. From this menu you can directly enter the utility number (in the range 100 to 118) to access the required calibration utility. Alternatively, by using the [NEXT] and [PREV] keys you can move the highlighter onto *Calibration* in order to select the calibration group of menus, at which point pressing [SELECT] will bring up the *Calibration Menu (1)*. From here all four pages of the menu can be scrolled through using the [NEXT] and [PREV] keys, and selection of the required utility made with the [SELECT] key. The menus are illustrated below.



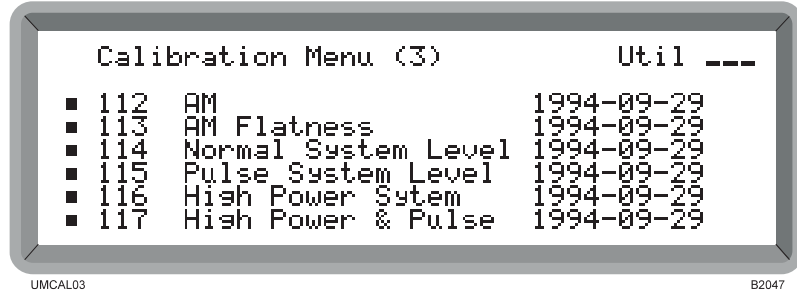
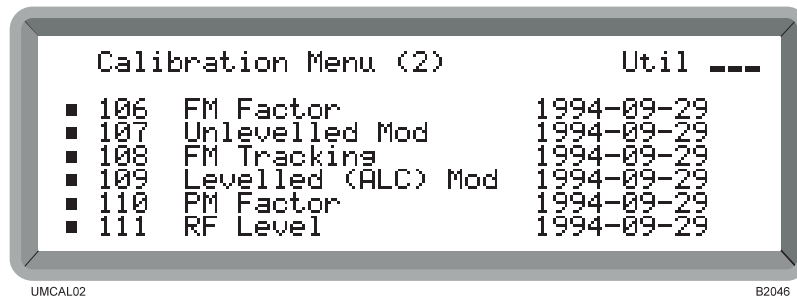
UG01

B2033



UMCAL01

B2045



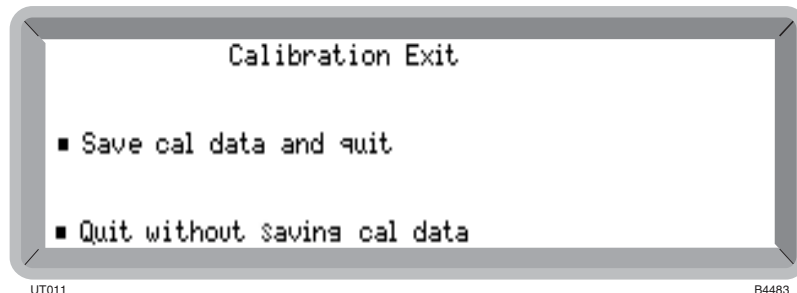
## Adjusting calibration data

This can be achieved in most cases by using the rotary control or single-stepping using the [x10 ↓] and [÷10 ↑] keys. Alternatively, a number can be entered using the keypad terminated by the [ENTER] key.

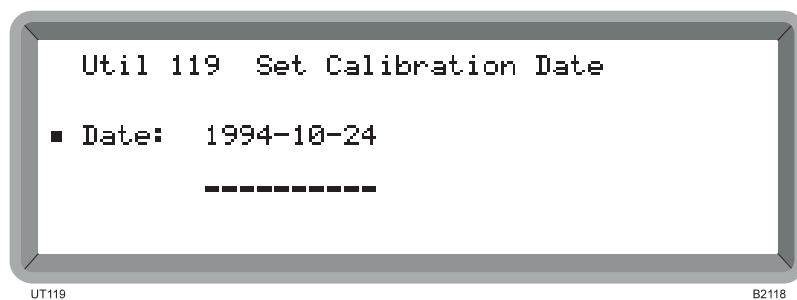
If any DAC adjustment value falls outside 10% limits from either end of the DAC range (<25 or >230 in the case of an 8 bit DAC), then investigate the measurement further to ensure that a fault condition does not exist.

## Date setting and calibration exit

Before carrying out any adjustments, the date may be set such that when selecting *Save cal data and quit* after the appropriate adjustment has been *successfully* completed, the date of the adjustment will be recorded. Selecting *Quit without saving cal data* (which may be used if a calibration has been unsuccessful), will not set the new date or save any data.



To set the current date select UTIL 119, Set Calibration Date, and enter the date in the form YYYY MM DD; the dashes are inserted automatically.



## Recommended test equipment

The test equipment recommended for these procedures is shown below. Alternative equipment may be used provided it complies with the stated minimum specification.

**Table 3-1 Recommended test equipment**

Description	Minimum specification	Example
Power meter	$\pm 0.1$ dB from 10 kHz to 2.51 GHz	IFR* 6960B with 6912 Sensor
Modulation meter	AM, FM and $\Phi$ M 50 kHz to 2.51 GHz. Accuracy $\pm 1\%$ at 1 kHz modulation frequency	IFR* 2305
Digital voltmeter	DC voltage measurement	Solartron 7150+
Counter	10 kHz to 2.51 GHz frequency range	HP53181A + OPT 30

\*IFR Ltd was previously known as Marconi Instruments Ltd.

## Adjustment procedures

Each adjustment procedure relies on the UUT (Unit Under Test) being set to its power-up conditions. To avoid switching the instrument off and back on, reset the UUT by selecting:

**[RCL] 999 [ENTER]**

At the end of this chapter are a set of adjustment forms. These tables should be photocopied and used to record the data values of all the adjustments made.

Adjustments for the options, where necessary, are included with the tests for the standard instrument, with the exception of Options 3 and 11 (High Power and High Power + Fast Pulse Modulation respectively) which have a dedicated section on page 3-22.

### 1 Synthesizer (self-calibration)

No test equipment required



The synthesizer calibration resets the VCO presteer DAC values and realigns the voltage tuned filters (both on the AA1 or AA1/1 RF board).

- (1) Select:
 

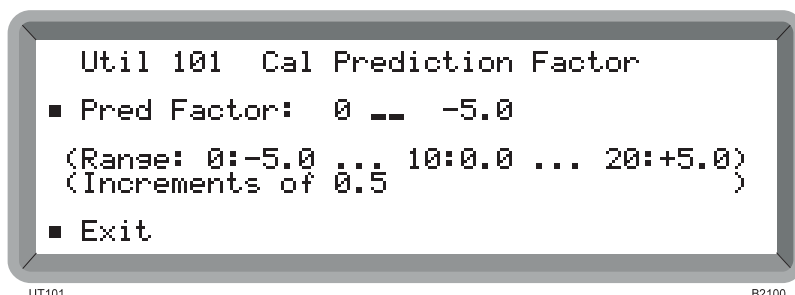
[MENU]  
[SELECT]
100 [ENTER]

This calibration will take only about 10 seconds.

- (2) Select the appropriate calibration exit.

### 2 Prediction factor

No test equipment required



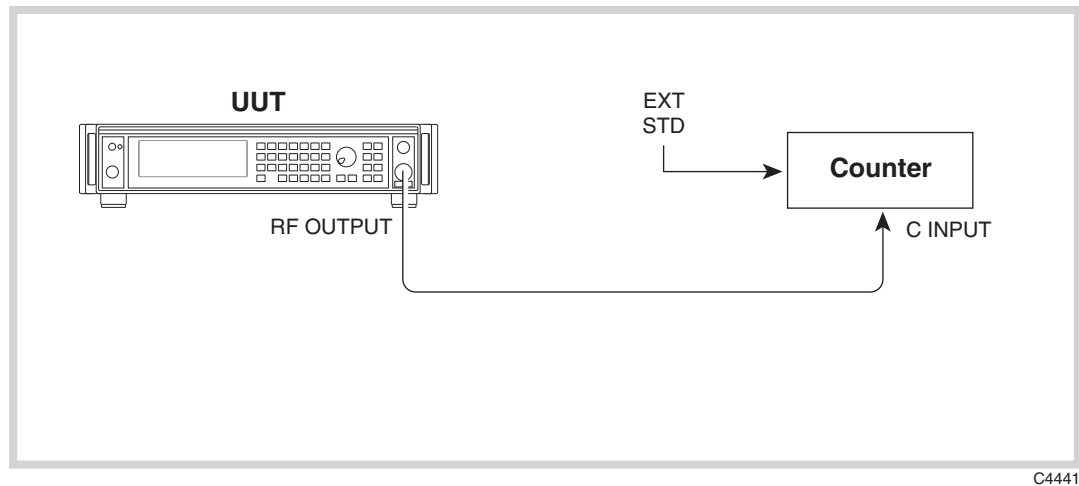
The prediction factor is set in the factory with default data and requires no further adjustment. In the event of this data becoming corrupted or an EEPROM change, the default prediction factor to be entered is 8.

### 3 Frequency standard

#### Test equipment

Description	Minimum specification	Example
Counter	10 Hz to 2.51 GHz	HP53181A + OPT 30

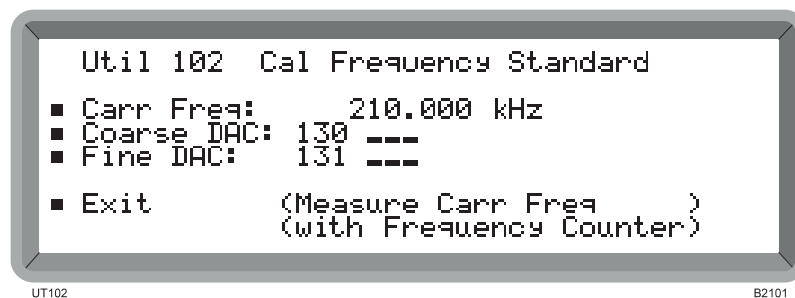
#### Adjustment procedure



C4441

Fig. 3-1 Frequency adjustment test set-up

- (1) Apply an external frequency reference to the counter and connect the test equipment as shown in Fig. 3-1.



UT102

B2101

- (2) On the UUT select:  
[MENU] 102 [ENTER]

Adjust the coarse DAC then the fine DAC until a frequency as close as possible to 1200 MHz is displayed on the counter.

- (3) Select the appropriate calibration exit.



## 4 Ext mod reference

### Test equipment

Description	Minimum specification	Example
Digital voltmeter	DC voltage measurement	Solartron 7150+

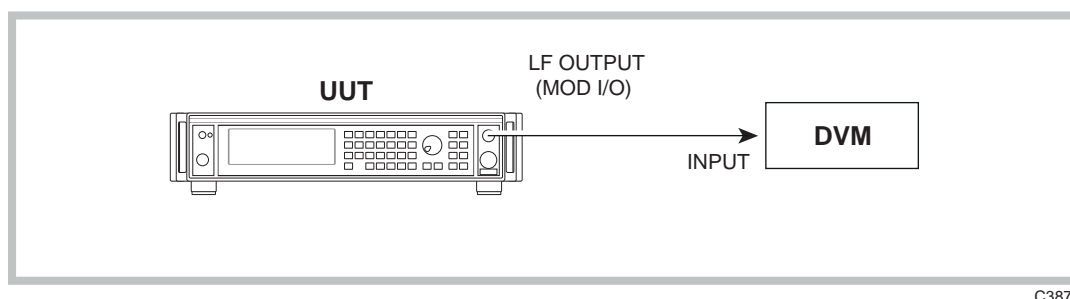
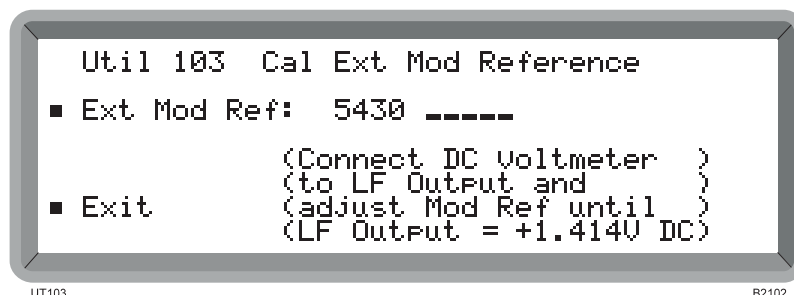


Fig. 3-2 Ext mod reference adjustment test set-up

This sets the output level of the DSP audio generator to provide an accurate DC level from the LF OUTPUT (MOD I/O for instruments fitted with Option 7 or 11) socket for the purpose of Unleveled mod adjustment (Section 8).

- (1) Connect the test equipment as shown in Fig. 3-2.
- (2) Set the digital voltmeter to read DC volts.



- (3) On the UUT select:  
[MENU] 103 [ENTER]

Adjust the Ext Mod Ref DAC until a voltage as close as possible to 1.414 V (1.000 V for instruments fitted with Option 10) is displayed on the digital voltmeter.

- (4) Select the appropriate calibration exit.

## 5 Int mod offset

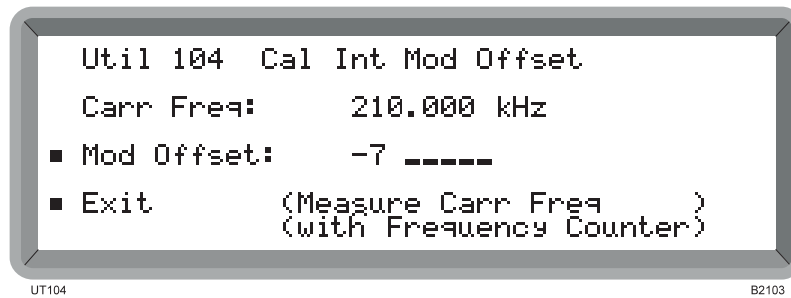
### Test equipment

Description	Minimum specification	Example
Counter	10 Hz to 2.51 GHz	HP53181A + OPT 30

### Adjustment procedure

This ensures that with the UUT in DC FM mode with 0 V applied to the EXT MOD INPUT socket (or grounded) and with the DC nulling carried out, there is minimal carrier frequency shift.

- (1) Apply an external frequency reference to the counter and connect the test equipment as shown in Fig. 3-1.



- (2) On the UUT select:
- |             |             |
|-------------|-------------|
| [CARR FREQ] | 1 [GHz]     |
| [RF LEVEL]  | 0 [dB]      |
| [MENU]      | 104 [ENTER] |

Adjust the Mod Offset DAC until a frequency as close as possible to 1000 MHz is displayed on the counter.

- (3) Select the appropriate calibration exit.

## 6 Int mod amplitude

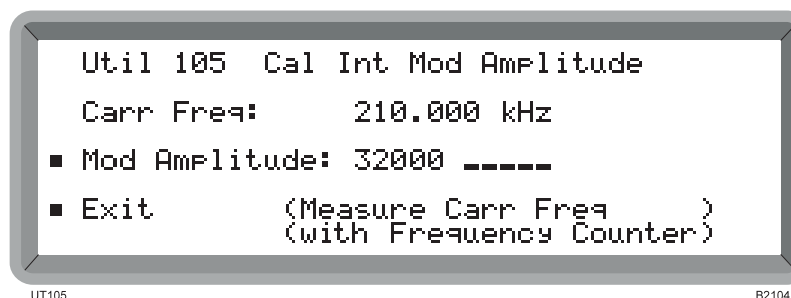
### Test equipment

Description	Minimum specification	Example
Counter	10 Hz to 2.51 GHz	HP53181A + OPT 30

### Adjustment procedure

This makes the voltages delivered by the internal and external paths the same by making the peak internal voltage equal to the leveler reference voltage.

- (1) Apply an external frequency reference to the counter and connect the test equipment as shown in Fig. 3-1.



- (2) On the UUT select:
- |             |             |
|-------------|-------------|
| [CARR FREQ] | 1 [GHz]     |
| [RF LEVEL]  | 0 [dB]      |
| [MENU]      | 105 [ENTER] |

Adjust the Mod Amplitude DAC until a frequency as close as possible to 1000 MHz is displayed on the counter.

- (3) Select the appropriate calibration exit.

## 7 FM factor

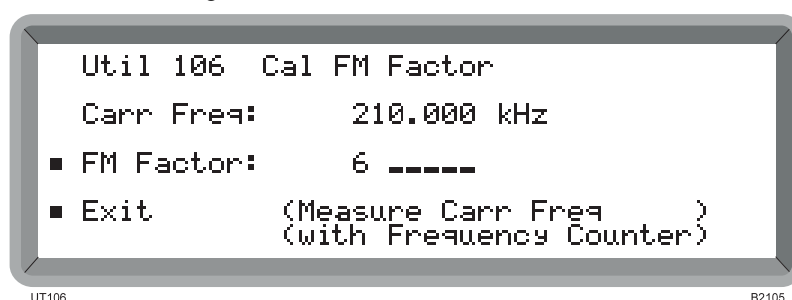
### Test equipment

Description	Minimum specification	Example
Counter	10 Hz to 2.51 GHz	HP53181A + OPT 30

### Adjustment procedure

This provides the overall FM accuracy adjustment. In DC FM mode, the UUT is internally set 100 kHz below the displayed frequency, so the adjustment *at* the carrier frequency is setting the 100 kHz deviation.

- (1) Apply an external frequency reference to the counter and connect the test equipment as shown in Fig. 3-1.



- (2) On the UUT select:  
[CARR FREQ] 1 [GHz]  
[RF LEVEL] 0 [dB]  
[MENU] 106 [ENTER]

Adjust the FM Factor DAC until a frequency as close as possible to 1000 MHz is displayed on the counter.

- (3) Select the appropriate calibration exit.

## 8 Unleveled mod

### Test equipment

Description	Minimum specification	Example
Counter	10 Hz to 2.51 GHz	HP53181A + OPT 30

### Adjustment procedure

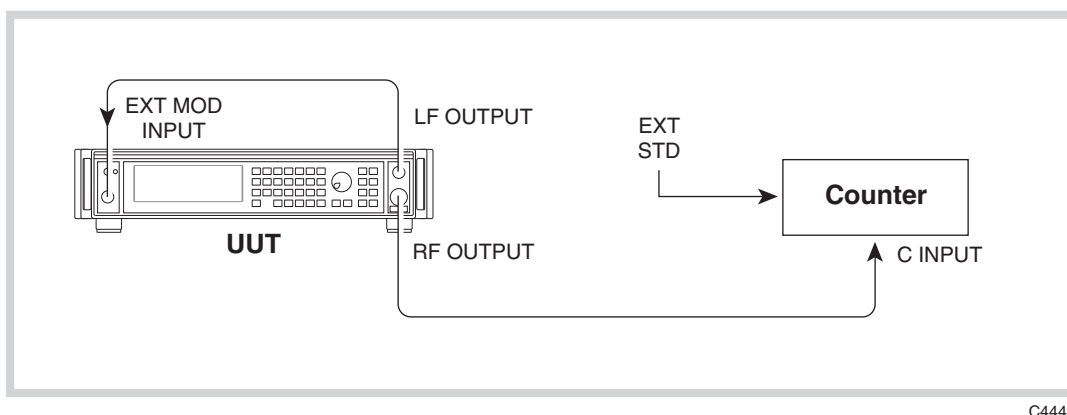


Fig. 3-3 Unleveled mod adjustment test set-up

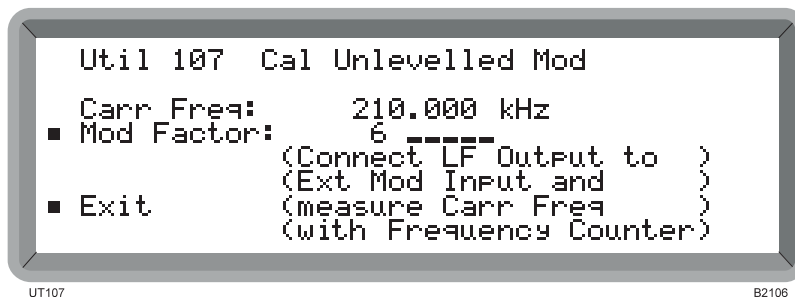
This establishes a value to load into the ALC DAC such that 1 V RMS applied to the EXT MOD INPUT socket gives the same voltage as internal and leveled external.

#### Notes

**Ext Mod Reference (Section 4) and FM Factor (Section 7) must precede this adjustment.**

**The connection shown between EXT MOD INPUT and LF OUTPUT (on the standard instrument) is not required for instruments fitted with Option 7 or 11. With these Options the signal is routed internally.**

- (1) Apply an external frequency reference to the counter and connect the test equipment as shown in Fig. 3-3.



- (2) On the UUT select:
 

[CARR FREQ]	1 [GHz]
[RF LEVEL]	0 [dB]
[MENU]	107 [ENTER]

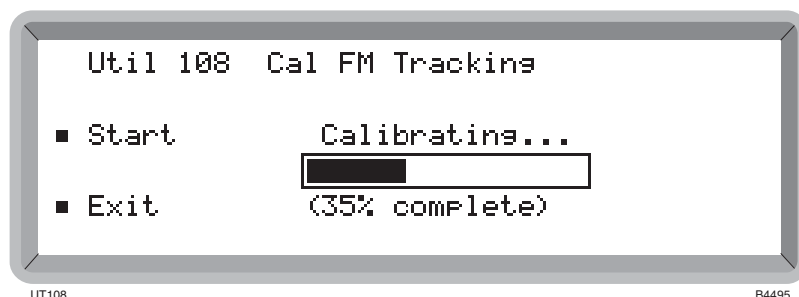
Adjust the Mod Amplitude DAC until a frequency as close as possible to 1000 MHz is displayed on the counter.

- (3) Select the appropriate calibration exit.

## 9 FM tracking (self-calibration)

### No test equipment required

This will ensure that the FM deviation is the same at all carrier frequencies and modulation rates. It does not set the accuracy; this is performed by the FM Factor adjustment in Section 7.



- (1) Select:
 

[MENU]  
[SELECT]
108 [ENTER]

This calibration will only take about 10 seconds.

- (2) Select the appropriate calibration exit.

## 10 Leveled (ALC) mod

### Test equipment

Description	Minimum specification	Example
Modulation meter	FM accuracy $\pm 1\%$ at 1 kHz modulation frequency	IFR 2305

### Adjustment procedure

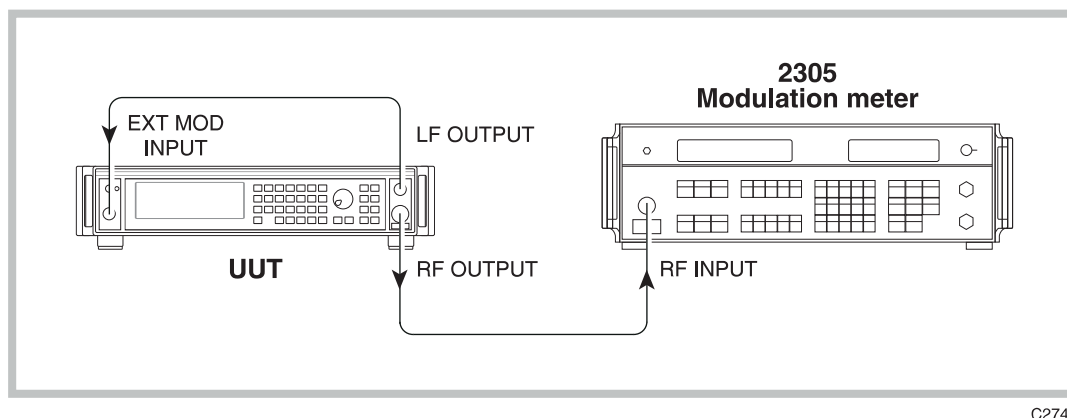
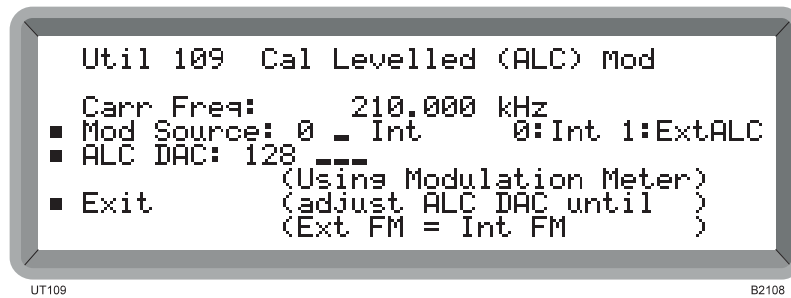


Fig. 3-4 Modulation adjustment test set-up

#### Notes

The connection shown between EXT MOD INPUT and LF OUTPUT (on the standard instrument) is not required for instruments fitted with Option 7 or 11. With these Options the signal is routed internally.

- (1) Connect the test equipment as shown in Fig. 3-4.
- (2) On the modulation meter, select CAL, FM, 50 Hz  $\Rightarrow$  15 kHz filter.



- (3) On the UUT set:
- |             |             |
|-------------|-------------|
| [CARR FREQ] | 1 [GHz]     |
| [RF LEVEL]  | 0 [dB]      |
| [MENU]      | 109 [ENTER] |

Measure the FM deviation on the modulation meter. Set Mod Source to Ext ALC (by pressing 1) and adjust the ALC DAC until the Ext ALC FM deviation equals the Internal deviation.

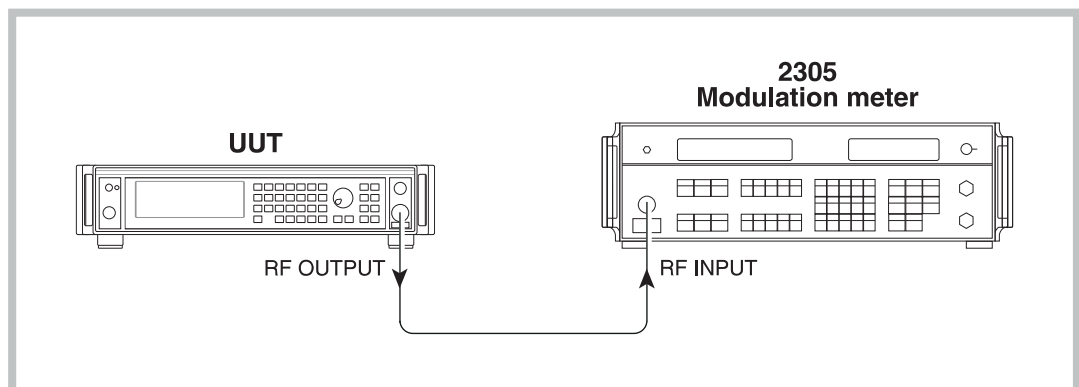
- (4) Select the appropriate calibration exit.

## 11 PM factor

### Test equipment

Description	Minimum specification	Example
Modulation meter	FM accuracy $\pm 1\%$ at 1 kHz modulation frequency	IFR 2305

### Adjustment procedure

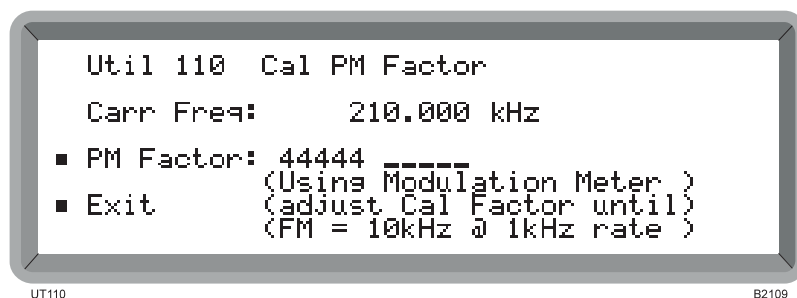


C2742

Fig. 3-5 Modulation adjustment test set-up

This provides the overall phase modulation accuracy adjustment.

- (1) Connect the test equipment as shown in Fig. 3-5.
- (2) On the modulation meter, select CAL, FM, 50 Hz  $\Rightarrow$  15 kHz filter.



- (3) On the UUT select:
- |             |             |
|-------------|-------------|
| [CARR FREQ] | 1 [GHz]     |
| [RF LEVEL]  | 0 [dB]      |
| [MENU]      | 110 [ENTER] |

Adjust the PM Factor DAC until a deviation as close as possible to 10.00 kHz is displayed on the modulation meter.

- (4) Select the appropriate calibration exit.

## 12 RF level

### Test equipment

Description	Minimum specification	Example
Power meter	$\pm 0.1$ dB from 30 kHz to 2.51 GHz	IFR 6960B with 6912 Sensor

### Adjustment procedure

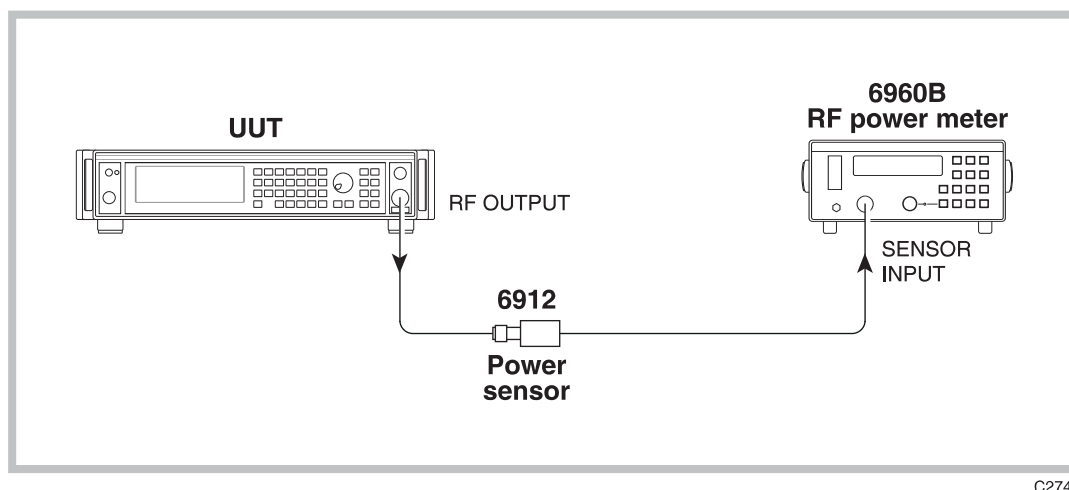
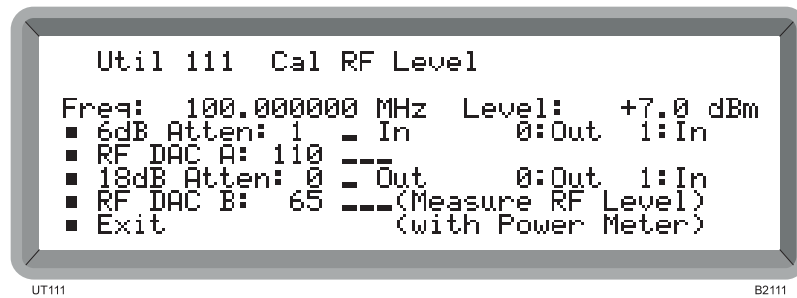


Fig. 3-6 RF output test set-up

This adjustment sets up the correction of the output level detector linearity at low levels as the RF detector diode enters the square-law area.

- (1) ZERO and AUTOCAL the power meter.
- (2) Connect the test equipment as shown in Fig. 3-6.



- (3) On the UUT select:  
[MENU] 111 [ENTER]

The UUT will be set to nominally +7 dBm with 6 dB of attenuation applied.

- (4) On the UUT press 0 to deselect the 6 dB of attenuation.  
 (5) Set a reference on the power meter.  
 (6) On the UUT press 1 to select 6 dB of attenuation.  
 Adjust RF DAC A for 6 dB difference on the power meter.  
 (7) On the UUT deselect the 6 dB attenuation and insert 18 dB of attenuation.  
 (8) Adjust RF DAC B for 18 dB difference on the power meter.  
 (9) Select the appropriate calibration exit.

## 13 AM

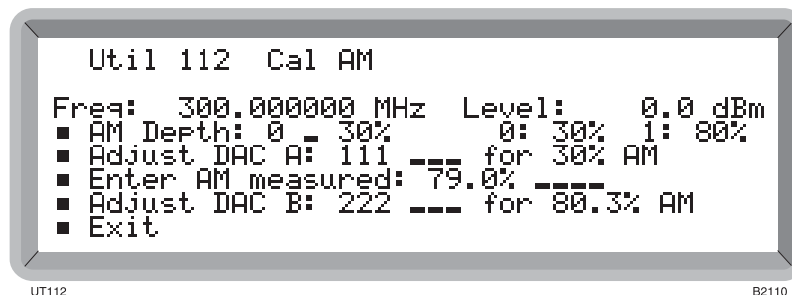
### Test equipment

Description	Minimum specification	Example
Modulation meter	AM accuracy $\pm 1\%$ at 1 kHz modulation frequency	IFR 2305

### Adjustment procedure

This provides the overall amplitude modulation accuracy adjustment.

- (1) Connect the test equipment as shown in Fig. 3-5.  
 (2) On the modulation meter, select CAL, AM, 50 Hz  $\Rightarrow$  15 kHz filter.



- (3) On the UUT select:  
[MENU] 112 [ENTER]

The UUT will be set to 0 dBm with 30% AM on a 300 MHz carrier.

Adjust DAC A until the AM reading displayed on the modulation meter is as close as possible to 30%.

- (4) On the UUT select *AM Depth* and press 1 to set 80%.  
 (5) Enter the AM depth measured on the modulation meter into the UUT.



- (6) Adjust DAC B for the AM depth now indicated by the UUT.
- (7) The adjustment of DAC B will affect DAC A and vice versa, so it will be necessary to repeat steps (3) and (6) until no further adjustment is necessary.
- (8) Select the appropriate calibration exit.

## 14 AM flatness

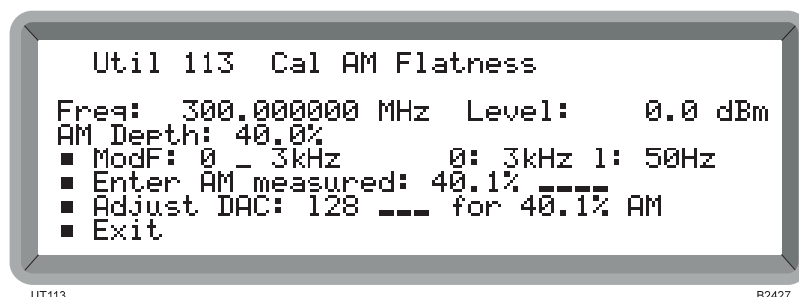
### Test equipment

Description	Minimum specification	Example
Modulation meter	AM accuracy $\pm 1\%$ at 1 kHz modulation frequency	IFR 2305

### Adjustment procedure

This is required to take out any depth errors between the AM leveling loop and the final output leveling loop. As the AM loop has a bandwidth of more than 50 kHz and the leveling loop has a bandwidth of less than 1 kHz, measurement of the mod. depth above and below 1 kHz is made.

- (1) Connect the test equipment as shown in Fig. 3-5.
- (2) On the modulation meter, select CAL, AM, 30 Hz  $\Rightarrow$  50 kHz flat filter.



- (3) On the UUT select:  
[MENU] 113 [ENTER]

The UUT will be set to 0 dBm with 40% AM (at 3 kHz) on a 300 MHz carrier.

Measure the AM depth (nominally 40%).

- (4) On the UUT press 1 to select 50 Hz modulation frequency.

Adjust the DAC until the AM reading displayed on the modulation meter is the same as that measured in step (3) above.

- (5) Select the appropriate calibration exit.

## 15 RF level (normal system)

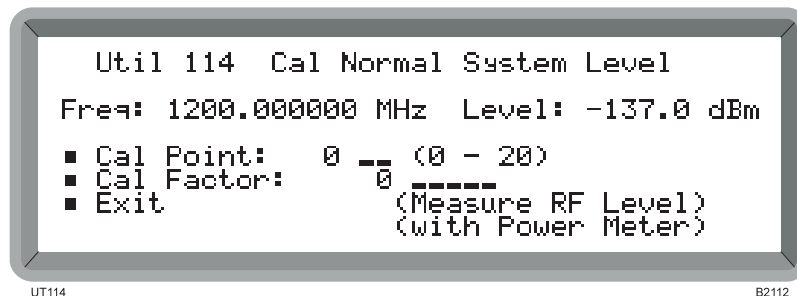
### Test equipment

Description	Minimum specification	Example
Power meter	$\pm 0.1$ dB from 30 kHz to 2.51 GHz	IFR 6960B with 6912 Sensor

### Adjustment procedure

This adjustment sets up the overall RF frequency response in 120 MHz steps. Cal Point 0 is at 10 MHz, Cal Point 1 is at 120 MHz and the remaining cal points are in 120 MHz steps up to the frequency cut-off of the particular UUT.

- (1) ZERO and AUTOCAL the power meter.
- (2) Connect the test equipment as shown in Fig. 3-6.



- (3) On the UUT select:  
[MENU] 114 [ENTER]

The UUT will be set to +7 dBm at 10 MHz (Cal Point 0).

Adjust Cal Factor until the reading displayed on the power meter is as close as possible to +7.00 dBm.

- (4) On the UUT select the Cal Points in turn, adjusting the Cal Factor at each step until the reading displayed on the power meter is as close as possible to +7.00 dBm.

## 16 Pulse system level

### Test equipment

Description	Minimum specification	Example
Power meter	$\pm 0.1$ dB from 30 kHz to 2.51 GHz	IFR 6960B with 6912 Sensor

### Adjustment procedure

This adjustment sets up the overall RF frequency response in pulse modulation mode in 120 MHz steps. Cal Point 0 is at 30 MHz (the lowest specified point in pulse modulation mode), Cal Point 1 is at 120 MHz and the remaining cal points are in 120 MHz steps up to the frequency cut-off of the particular UUT.

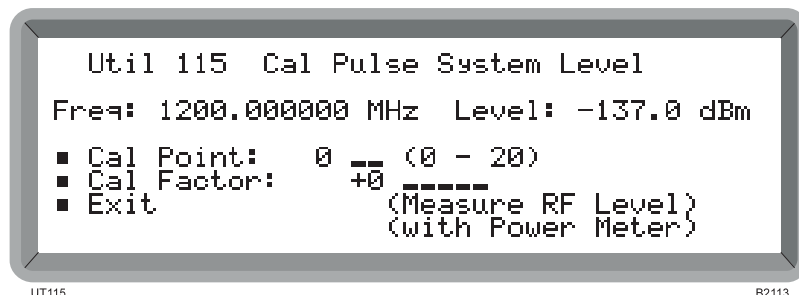
#### Notes

Instruments with software issues less than 1.06 are calibrated at +4 dBm.

Instruments fitted with Option 7 or 11 are calibrated at +7 dBm; Cal Point 0 is at 10 MHz, Cal Point 1 is at 60 MHz and the remaining cal points are at 60 MHz steps up to the frequency cut-off of the particular UUT.

- (1) ZERO and AUTOCAL the power meter.

- (2) Connect the test equipment as shown in Fig. 3-6.



- (3) On the UUT select:  
[MENU] 115 [ENTER]

The UUT will be set to +2 dBm (or +7 dBm for instruments fitted with Option 7 or 11) at Cal Point 0.

Adjust Cal Factor until the reading displayed on the power meter is as close as possible to +2.00 dBm (or +7.00 dBm for instruments fitted with Option 7 or 11).

- (4) On the UUT select subsequent Cal Points in turn, adjusting the Cal Factor at each step until the reading displayed on the power meter is as close as possible to +2.00 dBm (or +7.00 dBm for instruments fitted with Option 7 or 11).

## 17 Attenuator pads (not required for units fitted with Option 1)

### Test equipment

Description	Minimum specification	Example
Power meter	$\pm 0.1$ dB from 30 kHz to 2.51 GHz	IFR 6960B with 6912 Sensor

### Adjustment procedure

This adjustment sets up a calibration value for each attenuator pad at each frequency point. The overall RF frequency responses must be adjusted first. Cal Point 0 is at 10 MHz, Cal Point 1 is at 120 MHz and the remaining cal points are in 120 MHz steps up to the frequency cut-off of the particular UUT.

Each pad is represented by a number; 0 = 33 dB, 1 = 11 dB, 2 = 33 dB, 3 = 22 dB, 4 = 33 dB.

- (1) ZERO and AUTOCAL the power meter.  
(2) Connect the test equipment as shown in Fig. 3-6.



- (3) On the UUT select:  
[MENU] 118 [ENTER]

The UUT will be set to approximately +15 dBm at 10 MHz (Cal Point 0).

- (4) Set a reference on the power meter and AVERAGE 5 ENT.

- (5) Select *In/Out Pad* and press 1 to insert pad 0.

Select *Measured Atten* and enter the reading on the power meter to two decimal places (for example, 33.14 [ENTER]).

- (6) Deselect pad 0.
- (7) Select pads 1 to 4 in turn repeating steps (5) and (6) above.
- (8) Select Cal Points 1 to 20 in turn repeating steps (4) to (7) above.

## Adjustment procedures for instruments fitted with Option 3 or 11

### 18 High power RF level

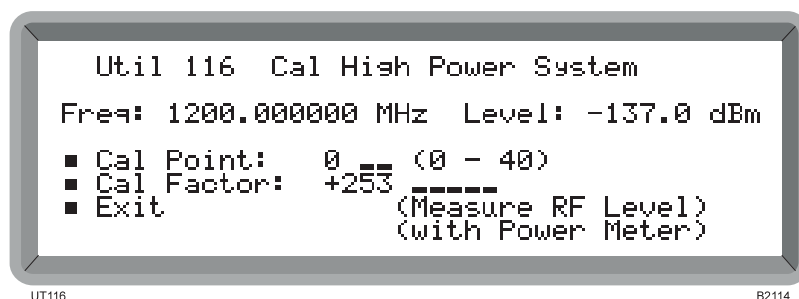
#### Test equipment

Description	Minimum specification	Example
Power meter	$\pm 0.1$ dB from 30 kHz to 2.51 GHz	IFR 6960B with 6912 Sensor

#### Adjustment procedure

This adjustment sets up the overall RF frequency response in 60 MHz steps. Cal Point 0 is at 10 MHz, Cal Point 1 is at 60 MHz and the remaining cal points are in 60 MHz steps up to the frequency cut-off of the particular UUT.

- (1) ZERO and AUTOCAL the power meter.
- (2) Connect the test equipment as shown in Fig. 3-6.



- (3) On the UUT select:  
[MENU] 116 [ENTER]

The UUT will be set to +19 dBm at 10 MHz (Cal Point 0).

Adjust Cal Factor until the reading displayed on the power meter is as close as possible to +19.00 dBm.

- (4) On the UUT select the Cal Points in turn, adjusting the Cal Factor at each step until the reading displayed on the power meter is as close as possible to +19.00 dBm.

### 19 High power pulse system level

#### Test equipment

Description	Minimum specification	Example
Power meter	$\pm 0.1$ dB from 30 kHz to 2.51 GHz	IFR 6960B with 6912 Sensor

#### Adjustment procedure

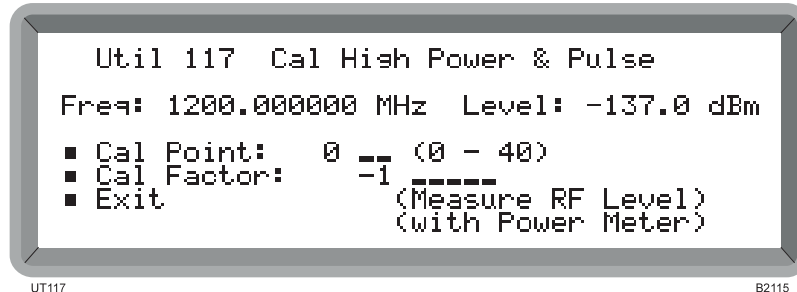
This adjustment sets up the overall RF frequency response in pulse modulation mode in 60 MHz steps. Cal Point 0 is at 30 MHz (the lowest specified point in pulse modulation mode), Cal Point 1 is at 60 MHz and the remaining cal points are in 60 MHz steps up to the frequency cut-off of the particular UUT.

**Notes**

Instruments with software issues less than 1.06 are calibrated at +16 dBm.

For instruments fitted with Option 11, Cal Point 0 is at 10 MHz.

- (1) ZERO and AUTOCAL the power meter.
- (2) Connect the test equipment as shown in Fig. 3-6.



- (3) On the UUT select:  
[MENU]

117 [ENTER]

The UUT will be set to +14 dBm at 30 MHz (10 MHz for instruments fitted with Option 11) Cal Point 0.

Adjust Cal Factor until the reading displayed on the power meter is as close as possible to +14.00 dBm.

- (4) On the UUT select the Cal Points in turn, adjusting the Cal Factor at each step until the reading displayed on the power meter is as close as possible to +14.00 dBm.

## Adjustment procedure tables

For 2023 [ ] signal generator, serial number \_ \_ \_ \_ \_ / \_ \_ \_  
2023A [ ]  
2023B [ ]  
2024 [ ]  
2025 [ ]

Option 1 [ ] no attenuator  
Option 2 [ ] DC operation  
Option 3 [ ] high power  
Option 4 [ ] high stability frequency standard  
Option 7 [ ] fast pulse modulation  
Option 10 [ ] 1 V peak mod input  
Option 11 [ ] high power + fast pulse modulation  
Option 12 [ ] SINAD

Modified password \_ \_ \_ \_ \_

Table 3-2 UTIL 102 Frequency standard adjustment

DAC	Value (0 to 255)
Coarse	_____
Fine	_____

Table 3-3 UTIL 103 Ext mod reference adjustment

DAC	Value (0 to 65535)
Ext mod ref	_____

Table 3-4 UTIL 104 Int mod offset adjustment

DAC	Value (-1000 to +1000)
Mod offset	_____

**Table 3-5 UTIL 105 Int mod amplitude adjustment**

DAC	Value (0 to 65535)
Mod amplitude	_____

**Table 3-6 UTIL 106 FM factor adjustment**

DAC	Value (0 to 65535)
FM factor	_____

**Table 3-7 UTIL 107 Unleveled mod adjustment**

DAC	Value (0 to 65535)
Mod factor	_____

**Table 3-8 UTIL 109 Leveled (ALC) mod adjustment**

DAC	Value (0 to 255)
ALC DAC	_____

**Table 3-9 UTIL 110 PM factor adjustment**

DAC	Value (0 to 65535)
PM factor	_____

**Table 3-10 UTIL 111 RF level adjustment**

DAC	Value (0 to 255)
RF DAC A (6 dB atten)	_____
RF DAC B (18 dB atten)	_____

**Table 3-11 UTIL 112 AM adjustment**

DAC	Value (0 to 255)
DAC A (30%)	_____
DAC B (80%)	_____



Table 3-12 UTIL 113 AM flatness adjustment

ModF	DAC value (0 to 255)
3 kHz	_____
50 Hz	_____

Table 3-13 UTIL 114 RF level (normal system)

Cal point	Cal factor DAC value (-3600 to +3600)
0 (10 MHz)	_____
1 (120 MHz)	_____
2 (240 MHz)	_____
3 (360 MHz)	_____
4 (480 MHz)	_____
5 (600 MHz)	_____
6 (720 MHz)	_____
7 (840 MHz)	_____
8 (960 MHz)	_____
9 (1080 MHz)	_____
10 (1200 MHz)	_____
<b>2023B, 2024, 2025 ONLY</b>	
11 (1320 MHz)	_____
12 (1440 MHz)	_____
13 (1560 MHz)	_____
14 (1680 MHz)	_____
15 (1800 MHz)	_____
16 (1920 MHz)	_____
17 (2040 MHz)	_____
18 (2160 MHz)	_____
<b>2024, 2025 ONLY</b>	
19 (2280 MHz)	_____
20 (2400 MHz)	_____
<b>2025 ONLY</b>	
21 (2510 MHz)	_____

**Table 3-14 UTIL 115 Pulse system level**

Cal point	Cal point (Option 7 or 11 fitted)	Cal factor DAC value (-3600 to +3600)
0 (30 MHz)	0 (10 MHz)	_____
	1 (60 MHz)	_____
1 (120 MHz)	2 (120 MHz)	_____
	3 (180 MHz)	_____
2 (240 MHz)	4 (240 MHz)	_____
	5 (300 MHz)	_____
3 (360 MHz)	6 (360 MHz)	_____
	7 (420 MHz)	_____
4 (480 MHz)	8 (480 MHz)	_____
	9 (540 MHz)	_____
5 (600 MHz)	10 (600 MHz)	_____
	11 (660 MHz)	_____
6 (720 MHz)	12 (720 MHz)	_____
	13 (780 MHz)	_____
7 (840 MHz)	14 (840 MHz)	_____
	15 (900 MHz)	_____
8 (960 MHz)	16 (960 MHz)	_____
	17 (1020 MHz)	_____
9 (1080 MHz)	18 (1080 MHz)	_____
	19 (1140 MHz)	_____
10 (1200 MHz)	20 (1200 MHz)	_____
<b>2023B, 2024, 2025 ONLY</b>		
11 (1320 MHz)	21 (1260 MHz)	_____
	22 (1320 MHz)	_____
12 (1440 MHz)	23 (1380 MHz)	_____
	24 (1440 MHz)	_____
13 (1560 MHz)	25 (1500 MHz)	_____
	26 (1560 MHz)	_____
14 (1680 MHz)	27 (1620 MHz)	_____
	28 (1680 MHz)	_____
15 (1800 MHz)	29 (1740 MHz)	_____
	30 (1800 MHz)	_____
16 (1920 MHz)	31 (1860 MHz)	_____
	32 (1920 MHz)	_____
17 (2040 MHz)	33 (1980 MHz)	_____
	34 (2040 MHz)	_____
<b>2024, 2025 ONLY</b>		
18 (2160 MHz)	35 (2100 MHz)	_____
	36 (2160 MHz)	_____
19 (2280 MHz)	37 (2220 MHz)	_____
	38 (2280 MHz)	_____
20 (2400 MHz)	39 (2340 MHz)	_____
	40 (2400 MHz)	_____
<b>2025 ONLY</b>		
21 (2510 MHz)	41 (2460 MHz)	_____
	42 (2510 MHz)	_____

Table 3-15 UTIL 118 Attenuator pads (not Option 1)

Cal point	33 dB	11 dB	33 dB	22 dB	33 dB
0 (10 MHz)	_____	_____	_____	_____	_____
1 (120 MHz)	_____	_____	_____	_____	_____
2 (240 MHz)	_____	_____	_____	_____	_____
3 (360 MHz)	_____	_____	_____	_____	_____
4 (480 MHz)	_____	_____	_____	_____	_____
5 (600 MHz)	_____	_____	_____	_____	_____
6 (720 MHz)	_____	_____	_____	_____	_____
7 (840 MHz)	_____	_____	_____	_____	_____
8 (960 MHz)	_____	_____	_____	_____	_____
9 (1080 MHz)	_____	_____	_____	_____	_____
10 (1200 MHz)	_____	_____	_____	_____	_____
<b>2023B, 2024, 2025 ONLY</b>					
11 (1320 MHz)	_____	_____	_____	_____	_____
12 (1440 MHz)	_____	_____	_____	_____	_____
13 (1560 MHz)	_____	_____	_____	_____	_____
14 (1680 MHz)	_____	_____	_____	_____	_____
15 (1800 MHz)	_____	_____	_____	_____	_____
16 (1920 MHz)	_____	_____	_____	_____	_____
17 (2040 MHz)	_____	_____	_____	_____	_____
<b>2024, 2025 ONLY</b>					
18 (2160 MHz)	_____	_____	_____	_____	_____
19 (2280 MHz)	_____	_____	_____	_____	_____
20 (2400 MHz)	_____	_____	_____	_____	_____
<b>2025 ONLY</b>					
21 (2510 MHz)	_____	_____	_____	_____	_____

## Option 3 or 11

Table 3-16 UTIL 116 High power RF level (normal system)

Cal point	Cal factor DAC value (-3600 to +3600)	Cal point	Cal factor DAC value (-3600 to +3600)
0 (10 MHz)	_____	<b>2023B, 2024, 2025 ONLY</b>	
1 (60 MHz)	_____	21 (1260 MHz)	_____
2 (120 MHz)	_____	22 (1320 MHz)	_____
3 (180 MHz)	_____	23 (1380 MHz)	_____
4 (240 MHz)	_____	24 (1440 MHz)	_____
5 (300 MHz)	_____	25 (1500 MHz)	_____
6 (360 MHz)	_____	26 (1560 MHz)	_____
7 (420 MHz)	_____	27 (1620 MHz)	_____
8 (480 MHz)	_____	28 (1680 MHz)	_____
9 (540 MHz)	_____	29 (1740 MHz)	_____
10 (600 MHz)	_____	30 (1800 MHz)	_____
11 (660 MHz)	_____	31 (1860 MHz)	_____
12 (720 MHz)	_____	32 (1920 MHz)	_____
13 (780 MHz)	_____	33 (1980 MHz)	_____
14 (840 MHz)	_____	34 (2040 MHz)	_____
15 (900 MHz)	_____	35 (2100 MHz)	_____
16 (960 MHz)	_____	<b>2024, 2025 ONLY</b>	
17 (1020 MHz)	_____	36 (2160 MHz)	_____
18 (1080 MHz)	_____	37 (2220 MHz)	_____
19 (1140 MHz)	_____	38 (2280 MHz)	_____
20 (1200 MHz)	_____	39 (2340 MHz)	_____
		40 (2400 MHz)	_____
		<b>2025 ONLY</b>	
		41 (2460 MHz)	_____
		42 (2510 MHz)	_____

Table 3-17 UTIL 117 High power pulse system level

Cal point	Cal factor DAC value (-3600 to +3600)	Cal point	Cal factor DAC value (-3600 to +3600)
0 (30 MHz)	_____	<b>2023B, 2024, 2025 ONLY</b>	
1 (60 MHz)	_____	21 (1260 MHz)	_____
2 (120 MHz)	_____	22 (1320 MHz)	_____
3 (180 MHz)	_____	23 (1380 MHz)	_____
4 (240 MHz)	_____	24 (1440 MHz)	_____
5 (300 MHz)	_____	25 (1500 MHz)	_____
6 (360 MHz)	_____	26 (1560 MHz)	_____
7 (420 MHz)	_____	27 (1620 MHz)	_____
8 (480 MHz)	_____	28 (1680 MHz)	_____
9 (540 MHz)	_____	29 (1740 MHz)	_____
10 (600 MHz)	_____	30 (1800 MHz)	_____
11 (660 MHz)	_____	31 (1860 MHz)	_____
12 (720 MHz)	_____	32 (1920 MHz)	_____
13 (780 MHz)	_____	33 (1980 MHz)	_____
14 (840 MHz)	_____	34 (2040 MHz)	_____
15 (900 MHz)	_____	35 (2100 MHz)	_____
16 (960 MHz)	_____	<b>2024, 2025 ONLY</b>	
17 (1020 MHz)	_____	36 (2160 MHz)	_____
18 (1080 MHz)	_____	37 (2220 MHz)	_____
19 (1140 MHz)	_____	38 (2280 MHz)	_____
20 (1200 MHz)	_____	39 (2340 MHz)	_____
		40 (2400 MHz)	_____
		<b>2025 ONLY</b>	
		41 (2460 MHz)	_____
		42 (2510 MHz)	_____

---

## Appendix A

# Calibration GPIB commands

This appendix gives details of the operation of the GPIB remote-control commands associated with the 2023, 2023A, 2023B, 2024 and 2025 calibration systems.

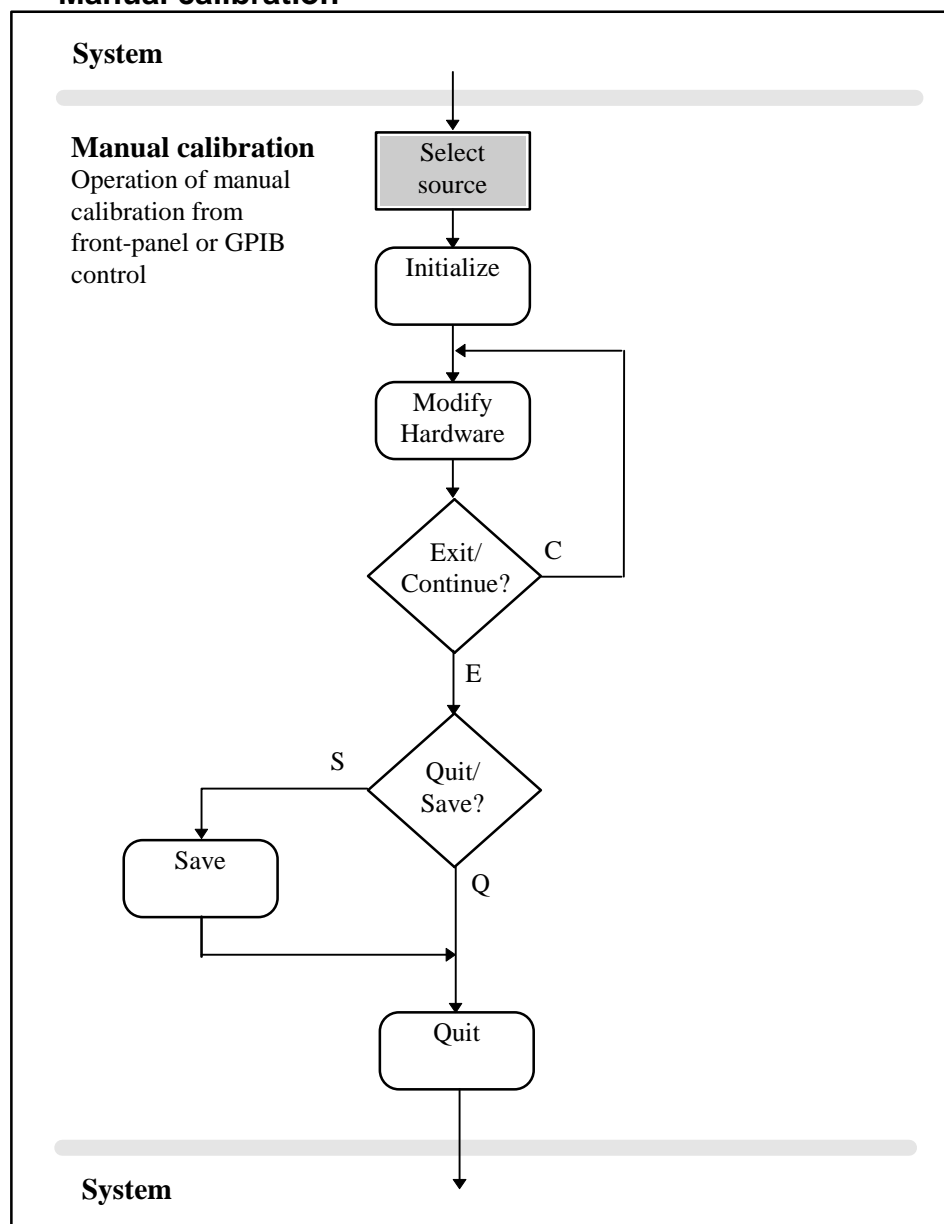
### Operation of calibration

In general a particular calibration process consists of initialising the process, carrying out a set of defined steps and exiting the process.

**Note**

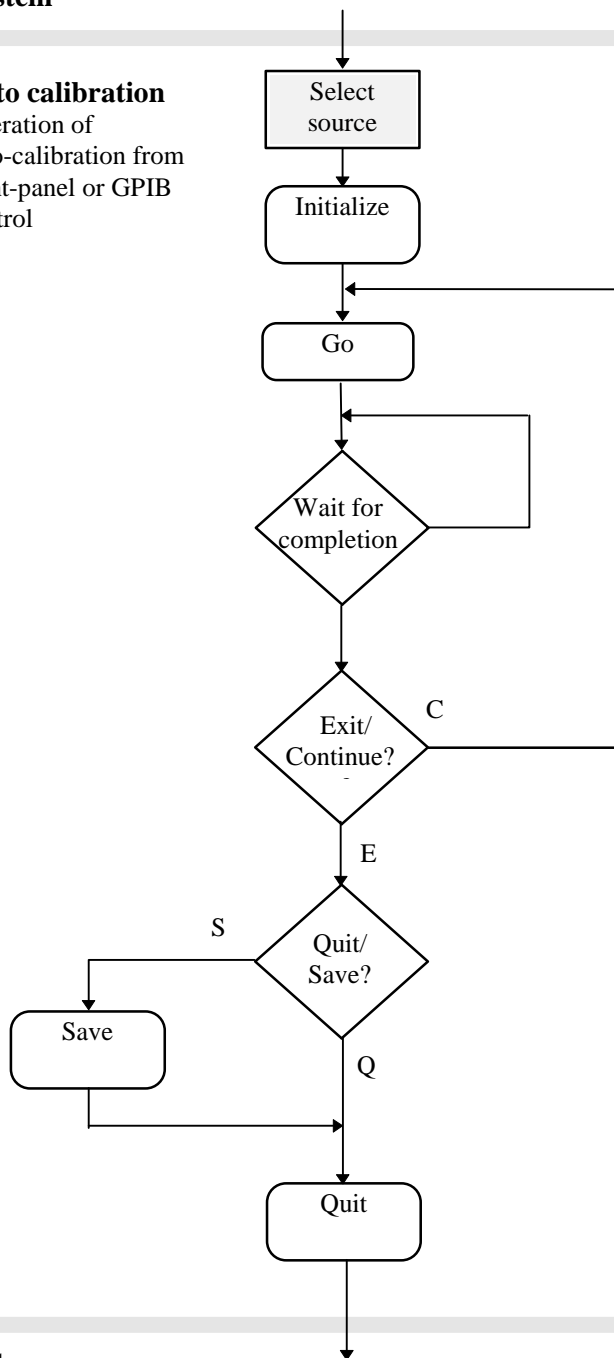
Whilst in a particular calibration process, only commands relevant to that process will be accepted.

### Manual calibration



**Auto calibration****System**

**Auto calibration**  
Operation of  
auto-calibration from  
front-panel or GPIB  
control

**System**

## Order of calibration

Calibration of the instrument should be performed in the following order:

Set calibration date	<i>Before performing your calibrations, set today's date if you wish to correctly date stamp each calibration on completion</i>
Synthesizer self-calibration (VCO pre-steer & VTF tune)	
Prediction factor	
Frequency standard	
External modulation reference	
Internal modulation offset	
Internal modulation amplitude	
FM factor	
Unleveled modulation	
FM tracking self-calibration	
Leveled (ALC) mod	
PM factor	
RF level (O/P leveling detector adjustment & O/P leveling linearize [level bender])	
AM (AM depth adjustment & modulator linearize)	
AM flatness	
Normal system level	
Pulse system level	
High power system	
High power & pulse	
Attenuator pads	

## Remote control operation

The calibration may be performed over the GPIB bus. This is achieved by sending commands from a controller PC.

The mnemonics are listed using both upper and lower case letters. The full mnemonic is always shown, but that part of the mnemonic in upper case represents an abbreviated form which will be recognized by the GPIB parser. Note that the parser is designed such that it will actually accept the minimum number of characters that will uniquely identify the mnemonic: for example, SYNThesizer should also be recognized by SY since no other mnemonic begins with these letters. Using the proper abbreviation will avoid confusion however.

Command programming example:

<b>:DIAGnostic</b>	
<b>:CALibration</b>	
<b>:SYNThesizer</b>	
<b>:INITialize</b>	Initialize calibration mode.
<b>:GO</b>	Start synthesizer self-calibration.
<b>:SAVE</b>	Save calibration data before exiting calibration mode.
<b>:QUIT</b>	Exit from calibration mode.

<i>Data type:</i>	none
<i>Allowed suffices:</i>	none
<i>Default suffix:</i>	none

<i>Examples:</i>	DIAG:CAL:SYNT:INIT
	DIAG:CAL:SYNT:GO

<b>:DIAGnostic</b>	
<b>:CALibration</b>	
<b>:SYNThesizer</b>	
<b>:DATE?</b>	Query date of last calibration.



*Example response:*     **DIAG:CAL:SYNT:DATE?**  
                              "1998-09-30"

so in the above example **DIAG:CAL:SYNT:GO** would start the synthesizer self-calibration process.

Prior to performing a calibration via the GPIB, the specific calibration must be INITialized via the **:DIAGnostic:CALibration:xxxxxxx:INITialize** command. This will have the effect of displaying the specified calibration screen as well as initialising the calibration parameters. For example, before setting or querying any frequency standard calibration parameters, the following command must be sent:

**DIAG:CAL:FST:INIT**

Following this, the relevant calibration commands or queries may then be used, thus:

**DIAG:CAL:FST:CDAC 114**  
**DIAG:CAL:FST:FDAC?**

## Calibration utilities and GPIB commands

This section describes the operation of each of the calibration utilities. The corresponding GPIB commands for that calibration process are listed.

### Synthesizer self-calibration (VCO pre-steer & VTF tune)

Protection level: 2

Self-cal: once started, this will take tens of seconds to complete. If the calibration fails, the appropriate error will appear; otherwise, the message *Calibration complete* appears.

<b>Note</b>
-------------

Once the self-cal has started you will not be able to key in any other function until the calibration has finished. GPIB commands will be buffered and serviced at the end of the calibration routine as normal.

**:DIAGnostic**

**:CALibration**

**:SYNTesizer**

**:INITialize**

Initialize calibration mode.

**:GO**

Start synthesizer self-calibration.

**:SAVE**

Save calibration data before exiting calibration mode.

**:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Examples:*                   DIAG:CAL:SYNT:INIT  
                              DIAG:CAL:SYNT:GO

**:DIAGnostic**

**:CALibration**

**:SYNTesizer**

**:DATE?**

Query date of last calibration.

*Example response:*       DIAG:CAL:SYNT:DATE?  
                              "1998-09-30"

## Prediction factor calibration

Protection level: 2

**:DIAGnostic**  
**:CALibration**  
**:PREDiction**  
**:INITialize**

Initialize calibration mode.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

**:FACTor**

Set prediction factor (0 to 20).

*Data type:* numeric value  
*Allowed suffices:* none  
*Default suffix:* none

**:SAVE**  
**:QUIT**

Save calibration data before exiting calibration mode.  
Exit from calibration mode without saving calibration data.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

*Examples:* DIAG:CAL:PRED:FACT 2  
DIAG:CAL:PRED:SAVE

**:DIAGnostic**  
**:CALibration**  
**:PREDiction**  
**:FACTor?**  
**:DATE?**

Query prediction factor.  
Query date of last calibration.

*Example response:* DIAG:CAL:PRED:FACT?  
2  
  
DIAG:CAL:PSYS:DATE?  
"1998-09-30"

## Frequency standard calibration

Protection level: 2

Connect frequency counter and set the highest frequency that the counter can measure without prescaling. Fine tune this frequency by DAC values.

**:DIAGnostic**

**:CALibration**

**:FSTandard**

**:INITialize**

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

**:CDAC**

Set coarse DAC value (0 to 255).

**:FDAC**

Set fine DAC value (0 to 255).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

**:SAVE**

Save calibration data before exiting calibration mode.

**:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Example:* DIAG:CAL:FST:CDAC 148

DIAG:CAL:FST:FDAC 52

**:DIAGnostic**

**:CALibration**

**:FSTandard**

**:CDAC?**

Query coarse DAC value.

**:FDAC?**

Query fine DAC value.

**:DATE?**

Query date of last calibration.

*Example responses:* DIAG:CAL:FST:FDAC?  
52

DIAG:CAL:FST:DATE?  
"1998-09-30"

**External modulation reference calibration**

Protection level: 2

User adjusts mod oscillator cal value until meter measures +1.414 V DC.

**:DIAGnostic****:CALibration****:MREFerence****:INITialize**

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

**:FACTor**

Set external modulation reference factor (0 to 65535).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

**:SAVE**

Save calibration data before exiting calibration mode.

**:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

**Examples:**

DIAG:CAL:MREF:FACT 43002

DIAG:CAL:MREF:SAVE

**:DIAGnostic****:CALibration****:MREFerence****:FACTor?**

Query external modulation reference factor.

**:DATE?**

Query date of last calibration.

**Example responses:**

DIAG:CAL:MREF:FACT?

43002

DIAG:CAL:MREF:DATE?

"1998-09-30"

## Internal modulation offset calibration

Protection level: 2

Current carrier frequency displayed. Connect frequency counter and measure carrier frequency. Adjust cal factor (can use keyboard/knob) until the difference between the set (displayed) frequency and the measured frequency is minimized.

### **:DIAGnostic**

#### **:CALibration**

##### **:MOFFset**

##### **:INITialize**

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

##### **:VALue**

Set internal modulation offset (-1000 to +1000).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

##### **:SAVE**

Save calibration data before exiting calibration mode.

##### **:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Example:* DIAG:CAL:MOFF:VAL -250

### **:DIAGnostic**

#### **:CALibration**

##### **:MOFFset**

##### **:VALue?**

Query internal modulation offset.

##### **:DATE?**

Query date of last calibration.

*Example response:* DIAG:CAL:MOFF:VAL?  
-250

DIAG:CAL:PSYS:DATE?  
"1998-09-30"

## Internal modulation amplitude calibration

Protection level: 2

Current carrier frequency displayed. Connect frequency counter and measure carrier frequency. Adjust cal factor (can use keyboard/knob) until the difference between the set (displayed) frequency and the measured frequency is minimized.

### **:DIAGnostic**

#### **:CALibration**

##### **:MAMPlitude**

###### **:INITialize**

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

###### **:FACTor**

Set internal modulation amplitude factor (0 to 65535).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

###### **:SAVE**

Save calibration data before exiting calibration mode.

###### **:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Examples:* DIAG:CAL:MAMP:FACT 125

DIAG:CAL:MAMP:QUIT

### **:DIAGnostic**

#### **:CALibration**

##### **:MAMPlitude**

###### **:FACTor?**

Query internal modulation amplitude factor.

###### **:DATE?**

Query date of last calibration.

*Example responses:* DIAG:CAL:MAMP:FACT?  
125

DIAG:CAL:MAMP:DATE?  
"1998-09-30"

## FM factor calibration

Protection level: 2

Current carrier frequency displayed. Connect frequency counter and measure carrier frequency. Adjust cal factor (can use keyboard/knob) until difference between the set (displayed) frequency and measured frequency is minimized.

### **:DIAGnostic**

#### **:CALibration**

##### **:FM**

##### **:INITialize**

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

##### **:FACTor**

Set FM calibration factor (0 to 65535).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

##### **:SAVE**

Save calibration data before exiting calibration mode.

##### **:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Example:* DIAG:CAL:FM:FACT 6427

### **:DIAGnostic**

#### **:CALibration**

##### **:FM**

##### **:FACTor?**

Query FM calibration factor.

##### **:DATE?**

Query date of last calibration.

*Example response:* DIAG:CAL:FM:FACT?  
6427

DIAG:CAL:PSYS:DATE?  
"1998-09-30"



## Unleveled modulation calibration

Protection level: 2

Current carrier frequency displayed. Use the calibrated instrument LF output (+1.414 V DC) as external voltage reference and measure carrier frequency with frequency counter. Adjust mod factor (can use keyboard/knob) until difference between the set (displayed) frequency and measured frequency is minimized.

### **:DIAGnostic**

#### **:CALibration**

##### **:UMODulation**

##### **:INITialize**

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

##### **:FACTor**

Set mod factor (0 to 65535).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

##### **:SAVE**

Save calibration data before exiting calibration mode.

##### **:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Example:* DIAG:CAL:UMOD:FACT 2048

### **:DIAGnostic**

#### **:CALibration**

##### **:UMODulation**

##### **:FACTor?**

Query mod factor setting.

##### **:DATE?**

Query date of last calibration.

*Example responses:* DIAG:CAL:UMOD:FACT?  
2048

DIAG:CAL:UMOD:DATE?  
"1998-09-30"

## FM tracking self-calibration

Protection level: 2

Self-cal: once started, this will take tens of seconds to complete. If the calibration fails, the appropriate error will appear; otherwise the message *Cal Completed* appears.

<b>Note</b>
-------------

Once the self-cal has started you will not be able to key in any other function until the calibration has finished. GPIB commands will be buffered and serviced at the end of the calibration routine as normal.

**:DIAGnostic**

**:CALibration**

**:FMTRacking**

**:INITialize**

Initialize calibration mode.

**:GO**

Start FM tracking self-calibration.

**:SAVE**

Save calibration data before exiting calibration mode.

**:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Example:* DIAG:CAL:FMTR:INIT

**:DIAGnostic**

**:CALibration**

**:FMTRacking**

**:DATE?**

Query date of last calibration.

*Example response:* DIAG:CAL:FMTR:DATE?  
"1998-09-30"

## Leveled (ALC) modulation calibration

Protection level: 2

Carrier frequency and ALC DAC value displayed. Connect modulation meter and measure frequency deviation for int FM. Adjust ALC DAC (can use keyboard/knob) until ext FM = int FM.

### **:DIAGnostic**

#### **:CALibration**

##### **:LMOdulation**

###### **:INITialize**

Initialize calibration mode.

Data type: none  
Allowed suffices: none  
Default suffix: none

###### **:SOURce**

Select source as internal FM or external ALC.

Data type: INTERNAL | EXTERNAL  
Allowed suffices: none  
Default suffix: none

###### **:ALCDac**

Set ALC DAC (0 to 255).

Data type: numeric value  
Allowed suffices: none  
Default suffix: none

###### **:SAVE**

Save calibration data before exiting calibration mode.

###### **:QUIT**

Exit from calibration mode without saving calibration data.

Data type: none  
Allowed suffices: none  
Default suffix: none

#### *Examples:*

DIAG:CAL:LMOd:SOUR EXT  
DIAG:CAL:LMOd:ALCD 35

### **:DIAGnostic**

#### **:CALibration**

##### **:LMOdulation**

###### **:SOURce?**

Query modulation source.

###### **:ALCDac?**

Query ALC DAC setting.

###### **:DATE?**

Query date of last calibration.

#### *Example responses:*

DIAG:CAL:LMOd:SOUR?  
EXT

DIAG:CAL:LMOd:ALCD?  
35

DIAG:CAL:PSYS:DATE?  
"1998-09-30"

**PM factor calibration**

Protection level: 2

**:DIAGnostic****:CALibration****:PM****:INITialize**

Initialize calibration mode.

*Data type:* none*Allowed suffices:* none*Default suffix:* none**:FACTor**

Set PM calibration factor (0 to 65535).

*Data type:* numeric value*Allowed suffices:* none*Default suffix:* none**:SAVE**

Save calibration data before exiting calibration mode.

**:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none*Allowed suffices:* none*Default suffix:* none*Example:* DIAG:CAL:PM:FACT 65535**:DIAGnostic****:CALibration****:PM****:FACTor?**

Query PM calibration factor.

**:DATE?**

Query date of last calibration.

*Example responses:* DIAG:CAL:PM:FACT?  
65535DIAG:CAL:PM:DATE?  
"1998-09-30"

## RF level calibration

Protection level: 2

Carrier frequency and RF level displayed. Set 6 dB atten IN and measure level. Set atten OUT and measure new level. Iterate IN/OUT and adjust DAC A until measured 6 dB difference. Now do same for 18 dB atten and adjust DAC B until measured 18 dB difference.

<b>Note</b>
-------------

**If the instrument is powered up with a blank EAROM, the default values in DAC A and DAC B will not be valid, in which case you will need to enter appropriate default values.**

### :DIAGnostic

#### :CALibration

##### :RFLevel

##### :INITialize

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

##### :ATTenuator

Set either 6 dB or 18 dB attenuator IN or both OUT.

*Data type:* OUT | A6 | A18

*Allowed suffices:* none

*Default suffix:* none

##### :DACA

Set RF DAC A (0 to 255).

##### :DACB

Set RF DAC B (0 to 255).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

##### :SAVE

Save calibration data before exiting calibration mode.

##### :QUIT

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

#### *Examples:*

DIAG:CAL:RFL:ATT A18

DIAG:CAL:RFL:DACB 113

### :DIAGnostic

#### :CALibration

##### :RFLevel

##### :ATTenuator?

Query attenuator selection.

##### :DACA?

Query RF DAC A setting.

##### :DATE?

Query date of last calibration.

#### *Example responses:*

DIAG:CAL:RFL:ATT?

A18

DIAG:CAL:RFL:DACB?

113

**AM calibration** (AM depth adjustment & modulator linearize [bender])

Protection level: 2

**Note**

Operation over the GPIB does not require an 'AM Measured' value. Rather, the controller is expected (by means of some algorithm) to calculate the error and then set the correct DAC B value.

**:DIAGnostic****:CALibration****:AM****:INITialize**

Initialize calibration mode.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

**:DEPTH**

Select depth of either 30% or 80%.

*Data type:* D30 | D80  
*Allowed suffices:* none  
*Default suffix:* none

**:DIAGnostic****:CALibration****:AM****:DACA**

Set AM DAC A (0 to 255).

**:DACB**

Set AM DAC B (0 to 255).

*Data type:* numeric value  
*Allowed suffices:* none  
*Default suffix:* none

**:SAVE**

Save calibration data before exiting calibration mode.

**:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

*Examples:* DIAG:CAL:AM:DEPT D80  
 DIAG:CAL:AM:DACB 112

**:DIAGnostic****:CALibration****:AM****:DEPTH?**

Query depth setting.

**:DACA?**

Query DAC A setting.

**:DACB?**

Query DAC B setting.

**:DATE?**

Query date of last calibration.

*Example response:* DIAG:CAL:AM:DEPT?  
 D80

## AM flatness calibration

Protection level: 2

This calibration routine must be done after the RF level and AM calibration routines, but before the normal system level calibration routine (otherwise all levels will be offset by a small amount). To calibrate this latch, a modulation meter will be required.

- (1) Set the carrier frequency to 300 MHz and 0 dBm.
- (2) Set amplitude modulation to 40% and 3 kHz.
- (3) Measure the modulation depth on the mod meter and record this.
- (4) Set amplitude modulation to 40% and 50 Hz.
- (5) Adjust RF Offset DAC latch until measured mod depth is equal to that measured at step (3) above.
- (6) Store this latch setting and use when instrument powers up.

### **:DIAGnostic**

#### **:CALibration**

##### **:AMFLatness**

###### **:INITialize**

Initialize calibration mode.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

###### **:FREQuency**

Set modulation frequency to either 50 Hz or 3 kHz.

*Data type:* F50 | F3000  
*Allowed suffices:* none  
*Default suffix:* none

###### **:DAC**

Set RF offset DAC (0 to 255).

*Data type:* numeric value  
*Allowed suffices:* none  
*Default suffix:* none

###### **:SAVE**

Save calibration data before exiting calibration mode.

###### **:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

*Examples:* DIAG:CAL:AMFL:FREQ F50  
DIAG:CAL:AMFL:DAC 36

### **:DIAGnostic**

#### **:CALibration**

##### **:AMFLatness**

###### **:FREQuency?**

Query modulation frequency setting.

###### **:DAC?**

Query RF offset DAC setting.

*Example responses:* DIAG:CAL:AMFL:FREQ?  
F3000

DIAG:CAL:AMFL:DAC?  
152

## Normal system level calibration

Protection level: 2

Enter *Cal Point* (0 to 20). Carrier frequency and target level displayed. Adjust *Cal Factor* until measured level = target level. Do for each point.

### :DIAGnostic

#### :CALibration

##### :NSYSstem

##### :INITialize

Initialize calibration mode.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

##### :POINT

Select calibration point (0 to 20).

##### :FACTor

Set calibration factor (-3600 to +3600).

*Data type:* numeric value  
*Allowed suffices:* none  
*Default suffix:* none

##### :SAVE

Save calibration data before exiting calibration mode.

##### :QUIT

Exit from calibration mode without saving calibration data.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

*Examples:* DIAG:CAL:NSYS:POIN 15  
DIAG:CAL:NSYS:FACT -100

### :DIAGnostic

#### :CALibration

##### :NSYSstem

##### :POINT?

Query calibration point.

##### :FACTor?

Query calibration factor.

##### :DATE?

Query date of last calibration.

*Example responses:* DIAG:CAL:NSYS:POIN?  
15

DIAG:CAL:NSYS:FACT?  
-100

DIAG:CAL:PSYS:DATE?  
"1998-09-30"



## Pulse system level calibration

Protection level: 2

Enter *Cal Point* (0 to 20). Carrier frequency and target level displayed. Adjust *Cal Factor* until measured level = target level. Do for each point.

### **:DIAGnostic**

#### **:CALibration**

##### **:PSYSstem**

##### **:INITialize**

Initialize calibration mode.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

##### **:POINT**

Select calibration point (0 to 20).

##### **:FACTor**

Set calibration factor (-3600 to +3600).

*Data type:* numeric value  
*Allowed suffices:* none  
*Default suffix:* none

##### **:SAVE**

Save calibration data before exiting calibration mode.

##### **:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none  
*Allowed suffices:* none  
*Default suffix:* none

*Examples:* DIAG:CAL:PSYS:POIN 7  
DIAG:CAL:PSYS:FACT 2981

### **:DIAGnostic**

#### **:CALibration**

##### **:PSYSstem**

##### **:POINT?**

Query calibration point.

##### **:FACTor?**

Query calibration factor.

##### **:DATE?**

Query date of last calibration.

*Example responses:* DIAG:CAL:PSYS:POIN?  
7

DIAG:CAL:PSYS:FACT?  
2981

DIAG:CAL:PSYS:DATE?  
"1998-09-30"

## High power system level calibration

Protection level: 2

Enter *Cal Point* (0 to 40). Carrier frequency and target level displayed. Adjust *Cal Factor* until measured level = target level. Do for each point.

### :DIAGnostic

#### :CALibration

#### :HPSYstem

#### :INITialize

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

#### :POINt

Select calibration point (0 to 40).

#### :FACTor

Set calibration factor (-3600 to +3600).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

#### :SAVE

Save calibration data before exiting calibration mode.

#### :QUIT

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Examples:* DIAG:CAL:HPSY:POIN 32  
DIAG:CAL:HPSY:FACT -710

### :DIAGnostic

#### :CALibration

#### :HPSYstem

#### :POINt?

Query calibration point.

#### :FACTor?

Query calibration factor.

#### :DATE?

Query date of last calibration.

*Example responses:* DIAG:CAL:HPSY:POIN?  
32

DIAG:CAL:HPSY:FACT?  
-710

DIAG:CAL:HPSY:DATE?  
"1998-09-30"

## High power and pulse system level calibration

Protection level: 2

Enter *Cal Point* (0 to 40). Carrier frequency and target level displayed. Adjust *Cal Factor* until measured level = target level. Do for each point.

### **:DIAGnostic**

#### **:CALibration**

##### **:HPPSystem**

##### **:INITialize**

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

##### **:POINT**

Select calibration point (0 to 40).

##### **:FACTor**

Set calibration factor (-3600 to +3600).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

##### **:SAVE**

Save calibration data before exiting calibration mode.

##### **:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Examples:* DIAG:CAL:HPPS:POIN 40  
DIAG:CAL:HPPS:FACT -590

### **:DIAGnostic**

#### **:CALibration**

##### **:HPPSystem**

##### **:POINT?**

Query calibration point.

##### **:FACTor?**

Query calibration factor.

##### **:DATE?**

Query date of last calibration.

*Example responses:* DIAG:CAL:HPPS:POIN?  
40

DIAG:CAL:HPPS:FACT?  
-590

DIAG:CAL:HPPS:DATE?  
"1998-09-30"

## Attenuator pads calibration

Protection level: 2

Select pad to cal (0 to 4). Enter *Cal Point* (0 to 20). Carrier frequency and pad value (11 dB, 22 dB, 33 dB) displayed.

With pad IN measure RF level. Taking pad 0 for example, the level should be around -18.5 dBm. Now remove pad and measure new level, should be around +14.5 dBm. Enter the measured attenuation.

**:DIAGnostic**

**:CALibration**

**:ATTenuator**

**:INITialize**

Initialize calibration mode.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

**:PAD**

Select pad (0 to 4).

**:POINT**

Select calibration point (0 to 20).

*Data type:* numeric value

*Allowed suffices:* none

*Default suffix:* none

**:PSTate**

Set pad IN or OUT.

*Data type:* IN | OUT

*Allowed suffices:* none

*Default suffix:* none

**:MEASured**

Set measured attenuation.

Range is  $\pm 1.27$  dB on the selected pad:  
9.73 dB to 12.27 dB for the 11 dB pad,  
20.73 dB to 23.27 dB for the 22 dB pad,  
31.73 dB to 34.27 dB for the 33 dB pad.

*Data type:* numeric value

*Allowed suffices:* dB

*Default suffix:* dB

**:DIAGnostic**

**:CALibration**

**:ATTenuator**

**:SAVE**

Save calibration data before exiting calibration mode.

**:QUIT**

Exit from calibration mode without saving calibration data.

*Data type:* none

*Allowed suffices:* none

*Default suffix:* none

*Examples:*

DIAG:CAL:ATT:PAD 3

DIAG:CAL:ATT:PST IN

**:DIAGnostic**

**:CALibration**

**:ATTenuator**

**:PAD?**

Query pad.

**:PState?**

Query pad state.

**:DATE?**

Query date of last calibration.

*Example responses:*

DIAG:CAL:ATT:PAD?

3

DIAG:CAL:ATT:PST?

IN

DIAG:CAL:ATT:MEAS?

33.75

**Set calibration date**

Protection level: 2

**:DIAGnostic**  
**:CALibration**  
**:DATE**  
**:YEAR**  
**:MONTH**  
**:DAY**

Set calibration date year.  
Set calibration date month.  
Set calibration date day.

*Data type:* numeric value  
*Allowed suffices:* none  
*Default suffix:* none

*Example:* DIAG:CAL:DATE:YEAR 1998;MONT 1;DAY 31

**:DIAGnostic**  
**:CALibration**  
**:DATE?**

Query current calibration date.

*Example response:* DIAG:CAL:DATE?  
"1998-01-31"

---

## Chapter 4

# INITIAL REPAIR

The following describes the action that should be taken if the instrument appears to be dead, either following delivery or during the normal course of operation. The only test equipment that is required is a suitable screwdriver and a digital voltmeter.

- (1) For an instrument fitted with Option 2 and with the AC operation functioning correctly, check the DC supply, the supply cable and the rear panel DC fuse.
- (2) Check the AC supply, the supply cable and the rear panel AC fuse.
- (3) Remove the instrument cover and check the internal supplies as follows:

### AC power supply

- (1) Check the 2 A fuse.
- (2) Check the following DC outputs:

V1	Orange	+5 V
V2	Red	+12 V
V3	Yellow	+24 V
V4	Gray	-12 V

### AC/DC power supply

- (1) Check connector A:

Pin 1	0 V
Pin 2	Polarizing key
Pin 3	-12 V
Pin 4	+5 V
Pin 5	+12 V
Pin 6	Battery V
Pin 7	Not used

- (2) Check connector B:

Pin 1	0 V
Pin 2	-12 V
Pin 3	Polarizing key
Pin 4	+5 V
Pin 5	+12 V
Pin 6	Not used
Pin 7	+24 V

- (3) Check connector C:

Pin 1	+12 V
Pin 2	0 V
Pin 3	Polarizing key

---

## Chapter 5

# FAULT DIAGNOSIS

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### Introduction

This fault-finding guide is aimed at technically competent service engineers. The guide will narrow down the search for any fault to a circuit area but not down to a component level. It is split into two sections, the first deals with faults that may not result in an error message being reported by the instrument and the second which deals with faults that the instrument will report with an error message on the screen. The UTILS screen showing the full complement of reported errors should be checked before proceeding with any fault-finding exercise to determine where the fault is most likely to lie.

### Latch access

A facility for controlling the instrument DACs and latches is available under the diagnostic menu. Latches are numbered from 0 to 255. These latches are very helpful in diagnosing instrument faults.

## General guide to fault finding

### Instrument dead

There are some faults which may occur which would prevent any error messages being displayed.

#### Screen blank and unlit

Carry out the following:

- (1) Check the input fuse in the mains inlet socket on the back of the instrument and in the mains cable plug.
- (2) Check the primary cables and mains switch and ensure that they are all connected correctly.
- (3) Check the PSU DC outputs to see if they are at the correct level.
- (4) Check that the cables to the front panel are all fitted correctly.

If none of the above work, proceed onto the list below.

#### Fuse

The fuse fitted in the mains inlet socket is a 2A-T, 20 mm x 5 mm cartridge type.

#### Screen blank and lit

Using the control board AB1 or AB1/1 circuit diagrams proceed as follows:

- (1) Check the reset line on IC206; if the instrument is being held in reset it could be because the DC supplies are faulty.
- (2) Check the DC levels of the power supply lines.
- (3) The software could be getting stuck in a loop; this could be due to faulty EEPROM, SRAM or peripheral part of the instrument that requires initialization – the frequency standard or audio generator DSP (see fault finding guide for these sections further on in the document).

### RF level and AM faults

Using the control board AB1 or AB1/1 circuit diagrams proceed as follows:

- (1) Trace the modulation signal, internal or external, through from AM source selection multiplexer IC31 to the output of IC33 (b). DAC IC35 (b) is used to apply the depth of modulation information onto the modulating signal.
- (2) Trace the signal from IC33 (b) through to the output of IC33 (d). This takes the modulating signal and applies square law correction to it and finally amplifies it to an appropriate level for use in the RF tray as the AM modulating signal.

- (3) Trace the signal from IC33 (b) through to the output of IC37 (b). IC37 (a) in this path is used to apply the RF level information onto the modulating signal. This is before square law correction and amplification is applied to it for use in the RF tray as the RF level signal.
- (4) Go to paragraphs covering errors 508 and 509 for the AM and RF level faults on RF board AA1.

### Useful latches for AM and RF level diagnosis

The depth of modulation DAC can be adjusted using latches 62 & 63 in 16-bit mode.

The RF level DAC can be adjusted using latches 66 & 67 in 16-bit mode.

The AM square law correction can be adjusted using latch 65.

The AM offset can be adjusted using latch 64.

The RF level square law correction can be adjusted using latch 69.

The RF offset can be adjusted using latch 68.

Latch 71 can be used to determine which of the inputs is used. This enables the internal 1 Vcal signal to be selected if required.

### FM and $\Phi$ M faults

The internal modulating signal is produced by the digital signal processor on the control board. Either the internal or external modulation source is selected by a multiplexer and the signal is routed to the RF board. On the RF board the signal feeds two paths. The signal is digitized using a one-bit A-D converter and the resulting bit stream is used to directly modulate the synthesizer. It can provide FM with modulation rates from DC to 3 kHz. The signal is also scaled using a multiplying DAC and switched attenuators. This signal modulates the VCO to provide FM with modulation rates from 3 kHz to 100 kHz.

The following tests can be performed without removing the covers:

- (1) Set FM internal, deviation of 10 kHz and mod rate of 100 Hz. Enable modulation and mod source. Using an oscilloscope check to see that there is a 2 V RMS sine wave of 100 Hz at the LF OUTPUT socket. This verifies the internal source is working. If no signal is present, check the DSP audio generator on the control board (Sheet 2).
- (2) Set FM internal, deviation of 10 kHz and mod rate of 100 Hz. Connect a modulation analyzer to the output and observe that the correct deviation and mod rate is produced. This verifies that the internal modulation source routing and the one-bit A-D converter is working. If a fault is found look at FM routing and the FM A-D converter.
- (3) Set FM external, DC coupled and deviation of 10 kHz. Enable modulation and mod source. Perform DC FM nulling. Connect a frequency counter to the RF output. Apply 1 V DC to the EXT MOD INPUT socket. A shift of 7.07 kHz should be observed in the output frequency. This verifies that the one-bit A-D converter and external FM path is working. If a fault is found look at FM routing and the FM A-D converter.
- (4) Set FM external, AC coupled and deviation of 10 kHz. Enable modulation and mod source. Apply a 50 kHz, 1 V RMS sinewave to the EXT MOD INPUT socket. Connect a modulation analyzer to the output and observe that the correct deviation is produced. If a fault is found check the FM attenuator and drive sections on the RF board (Sheet 5).
- (5) Set FM external, ALC coupled and deviation of 10 kHz. Enable modulation and mod source. Apply a 1 kHz, 1 V RMS sinewave to the EXT MOD INPUT socket. Connect a modulation analyzer to the output and observe that the correct deviation is produced. Apply a 1 kHz, 1.5 V RMS sinewave to the EXT MOD INPUT socket and check that the measured deviation does not change. If either test fails then the automatic level control circuit is faulty. Refer to the 'Error messages' section and '511 ALC too high, 512 ALC too low' for more diagnostic information.

- (6) Phase modulation will not work if frequency modulation is not working. If phase modulation is not working but frequency modulation is, then the differentiator section or switch is faulty. Refer to FM routing checks for more diagnostic information.

## **DSP source and FM routing checks**

Using the control board AB1 or AB1/1 circuit diagrams proceed as follows:

- (1) Before removing the covers, enable the modulation and turn it on. Measure the output from the LF OUTPUT socket on the front panel - the signal should be 2 V RMS from a 600  $\Omega$  source impedance. The frequency should be whatever is set as the modulation frequency on the front panel. If this signal is present, carry on with the next stage, if not, check the output of filter chip IC15a to see if the signal is present there. If it is not, trace the signal route back to serial DAC IC13, and to the DSP itself. Also refer to the 'Error messages' section and '513 DSP not responding' for more diagnostic information.
- (2) Trace the modulation signal, internal or external, through from FM source selection multiplexer IC32 to the output of IC49 (b). If FM is selected switch IC29 (b) will be using the 2Y1 input, pin 1, and if  $\Phi$ M is selected switch IC29 (b) will be using the 2Y0 input, pin 2. In FM mode the signal is amplified slightly and remains at a constant level across the input frequency range. In  $\Phi$ M mode the signal is differentiated causing the signal level to vary across the input frequency range at a rate of 6 dB/octave; at 10 kHz the level should be nominally 1 V pk.

### **Latch access:**

Latch 71 can be used to determine which of the inputs is used for the FM source multiplexer. This enables the internal 1 Vcal signal or 0 V to be selected if required.

## **FM D-A converter and FM attenuator checks**

Using the RF board AA1 or AA1/1 circuit diagrams proceed as follows:

- (1) Set FM internal, 1 kHz mod rate and 100 kHz deviation. Enable modulation and mod source. Referring to Sheet 3, ensure that a 1 kHz tone with an amplitude of 1 V pk is present on the input of R352. If not, check the cable between the control board and the RF board.
- (2) Check that IC304(a) pin 4 is not stuck at 0 V. Check that a 5 MHz CMOS compatible clock is present at pin 3. A pseudo random bit-stream should be present at TP10 if the converter is operating.
- (3) Check that -5 V is present on IC301 pin 1 and that +5 V is present on IC304 pin 14. The voltage on TP11 is derived from gate array IC305 and is used to null out voltage offsets. Under normal operating conditions the voltage at TP11 should be close to 1.25 V.
- (4) Check loop integrators IC301(b), (c), (d) and inverter stage TR301 and IC304(a) for correct function.
- (5) Referring to Sheet 5, check that a 1 kHz sine wave with an amplitude of 1 V is present on pin 15 of IC409. Check that a 1 kHz signal is present on pin 7 of IC405(b). The level of this signal is controlled by the data word written to IC409. The word can be accessed using latches 53 and 54 in 16-bit mode. With a full scale of 4095 written to the DAC there should be a 1 V RMS signal on pin 7 of IC405(b).
- (6) Check to ensure that a 1 kHz signal is present on pin 1 of IC405(a). The level of this signal will depend on the setting of the FM attenuator. The attenuator can be controlled using bit 0 and bit 1 of latch 1. Attenuation can be set to 0, 20, or 40 dB or the signal path grounded. The second attenuator stage uses a relay switch and is controlled by bit 2 of latch 1. This has an attenuation of 0 or 40 dB.

## **Pulse modulation faults**

There are one of two different types of pulse modulator fitted in the instrument. Instruments fitted with a slow pin-diode pulse modulator (boards AA2 or AA2/1) have a PULSE I/P socket on the rear panel. The optional fast pulse modulator, based on FET switches and fitted to Option 7 (board AA2/5) and Option 11 (board AA2/7) instruments, has a PULSE INPUT socket on the front panel. The following provides brief diagnostic information for these two modulators:

### **Standard modulator**

Using board AA2 or AA2/1 circuit diagrams proceed as follows:

Before removing the instrument covers check that relays RLA and RLB are switching, by enabling and disabling the modulator via the utility menu UTIL 22 and listening for the relay clicking sound. If the relays appear not to be switching, suspect the drive circuitry located on RF board AA1 or AA1/1. Measure the PULSE I/P socket impedance, which should be around 10 k $\Omega$ . If short or an open circuit, trace it back to the source of the fault after removing the instrument covers. Suspect diodes D1 to D7 if the modulator RF on/off ratio is not correct or if the insertion loss is more than 5 dB. Also check for open circuits due to faulty capacitors C1 to C4.

### **Fast pulse modulator**

Using board AA2/5 or AA2/7 circuit diagrams proceed as follows:

Before removing the instrument covers check that relays RLA and RLB are switching, by enabling and disabling the modulator via the utility menu UTIL 22 and listening for the relay clicking sound. If the relays appear not to be switching, suspect the drive circuitry located on RF board AA1 or AA1/1. Measure the PULSE INPUT socket impedance, which should be between 45 and 55  $\Omega$ . If short or an open circuit, trace it back to the source of the fault after removing the instrument covers. Also check that the pulse input signal applied to the PULSE INPUT socket reaches the modulator by tracing its path.

If the pulse modulator does not appear to translate +5 V and 0 V, at pulse input, to RF on/off, check that the +5 V and -5 V supplies are present on pins 3 and 5 of IC8/9 respectively, and that these voltages also appear on pins 1 and 8 of IC8/9. When logic transition occurs at the PULSE INPUT socket the voltages on pins 1 and 8 of IC8/9 should exchange values. Other low RF level problems are most likely due to faulty FET switches (ICs 4 to 7) or FET amplifier TR4 failures.

## **SINAD board checks**

The SINAD board AB2 has three LEDs that can be seen when the instrument is open.

Looking from the front of the instrument, the left-hand LED is D6. This should start flashing rapidly less than one second after power-up, and continue in all modes. This only requires the DSP (IC1), EPROM (IC2) and ADC (IC12) to be functional. The LED is toggled each time a block of 1024 samples is received from the DSP.

The central LED (D7) should be lit only if there is a delay between the DSP writing a word to the output shift register, and the CPU on the control board reading it. It should never be lit.

The right-hand LED (D8) indicates that measurements are enabled. It should be off if the board is disabled, and on steadily if the board is enabled.

## Error message guide to fault finding

The following is a list of the relevant errors, in numerical order, that may be reported by the instrument to indicate a fault condition:

### 1 EEPROM checksum

The checksum stored in the main EEPROM on the control board does not match the checksum calculated by the processor when it checked the stores on power-up. This probably means that EEPROM IC7 on control board AB1 or AB1/1 needs to be replaced. If this is done, the instrument serial number will have to be re-entered using the super-user password and a full recalibration will have to be performed.

### 2 Pad cal checksum

### 3 RF cal checksum

### 4 Freq. std checksum

### 5 Synthesizer cal checksum

### 6 Mod ref. checksum

### 7 Mod offset checksum

### 8 Mod amp checksum

### 9 ALC cal checksum

### 10 FM cal factor checksum

### 11 FM tracking checksum

### 12 FM cal factor checksum

### 13 System cal checksum

### 14 AM cal checksum

### 15 Store checksum

### 16 Image checksum

None of the error messages from 2 to 16 should ever be seen by the user. These error messages were used for diagnostics when debugging the software. If one of these checksums were to be in error the appropriate EEPROM checksum error message would be seen on the screen instead.

### 20 Frac N out of lock at <freq>

The synthesizer calibration routine attempts to find optimum pre-steer values for the VTF and VCO at 50 MHz intervals from 1200 MHz. This error indicates that the auto-calibration routine could not achieve phase lock of the synthesizer during the auto-calibration. For diagnostic information refer to Error '501,502 Fractional-N loop low, Fractional-N loop high'.

### 21 VCO cal fail at <freq>

This error indicates that the synthesizer auto-calibration routine could not find the optimum pre-steer value. This probably indicates that auto-cal comparator IC406(b) on RF board AA1 or AA1/1 is faulty or the cal disable line is stuck at 5 V.

## 22 VTF tune cal fail at <freq>

The synthesizer calibration routine attempts to find optimum pre-steer values for the VTF and VCO at 50 MHz intervals from 1200 MHz. This error indicates that the auto-calibration routine could not find the optimum pre-steer value for setting the voltage tuned filters. The routine attempts to locate the peak of the filter response by monitoring the control voltage of the AM leveling loop. Check the AM leveling loop on RF board AA1 or AA1/1 or the level readback comparator IC501(a). For more diagnostic information refer to 'Error 508 Amplitude mod unlevelled'. If the AM leveling loop appears to be functioning there may be a problem with low signal level from the VTF. In this case refer to '501,502 Fractional-N loop low, Fractional-N loop high'.

## 23 FM tracking cal fail at <freq>

The synthesizer calibration routine attempts to match the FM deviation produced by modulating the synthesizer with the deviation produced by modulating the VCO. It does this by adjusting FM control DAC IC409 on RF board AA1 or AA1/1. The calibration is performed in 25 MHz steps starting at 1200 MHz. This error indicates that the auto-calibration routine could not match the sensitivity of the two FM paths. This could be due to a fault with the FM auto-cal circuit, IC407 (Sheet 4), or a fault with the FM path or FM source. For more diagnostic information refer to section 'FM and  $\Phi$ M' above.

## 500 RPP tripped

### WARNING



### RF hazard

Using the AA2, AA2/1, AA2/5 and AA2/7 boards' circuit diagrams proceed as follows:

The Reverse Power Protection (RPP) facility protects the instrument from damage-level signals present on the RF OUTPUT socket. This error message may be due to an externally applied offending signal on the output port which can be checked easily by disconnecting anything connected to the output port (**take care to avoid burns – see Warning in Preface**) and terminating it with a 50  $\Omega$  load. If the error message remains it must be due to a number of hardware faults within the instrument. In order to locate the fault go through the following check list:

- (1) If the RPP can not be reset even after terminating the output with 50  $\Omega$ , try switching the instrument OFF and ON again. If the fault goes away measure RPP tripping levels by applying an external DC voltage to the RF OUTPUT socket. The RPP should trip around 4 V for the standard attenuator and 11 V for a high power option. If, however, it is still not resettable the instrument must be opened up to locate and fix the fault. If, however, the instrument does reset continue this sequence.
- (2) RPP trips when switching into or out of the BFO frequency band (9 kHz to 10 MHz) but is resettable. The most likely cause is a large difference in RF level between the straight-through and the BFO band paths, possibly due to a broken capacitor in the path or amplifier failure resulting in different levels.
- (3) If the instrument has a high power option fitted and the RPP only trips above +7 dBm suspect the high power amplifier section (go to 'Error 510 High power amplifier failed').
- (4) If the RPP tripping point is frequency- or level-dependent above 10 MHz or the relay keeps tripping when trying to reset, the most likely cause is a broken RPP reed-relay (RLM) or the output RF level is much higher than set. Check relay (RLM) and RF level output.
- (5) Another cause of RPP tripping could be a large DC voltage on the RF output line due to the breakdown of capacitor C845 on the RF board AA1 or AA1/1. Measure the DC voltage level on the RF output line. If greater than 0.1 V change capacitor C845 and re-measure the DC voltage level.

## 501,502 Fractional-N loop low, Fractional-N loop high.

These error messages can be caused by a number of faults on RF board AA1 or AA1/1.

### Note

The synthesizer section of the 2023, 2023A, 2023B, 2024 and 2025 is similar. However, the variants are software-limited at different frequencies. For example, a 2023 is limited to 1.2 GHz output. When repairing a 2023 synthesizer entering exactly half the frequency specified in the following section will have an identical effect. For instance instead of setting a frequency of 1201 MHz, set a frequency of 600.5 MHz for a 2023.

The following tests can be performed without removing the covers:

- (1) Step the carrier frequency from 1201 MHz to 2400 MHz (2510 MHz for a 2025) in 100 MHz steps and note the frequencies at which the error is displayed. If the error is not present at some of the frequencies it indicates correct operation of main dividers IC307 and IC309, controller IC305, phase detector IC310, 311 and 312, and loop filter and lock detector IC402, IC404 and IC406. If the error appears at all frequencies refer to the 'General synthesizer fault diagnosis' section below.
- (2) The VCO and filter are controlled by pre-steer voltages. If the pre-steer is not correct this will produce lock errors. The VCO pre-steer DAC value must be within  $\pm 3$  of the nominal value for correct lock to occur. The VTF pre-steer DAC value can be as much as  $\pm 15$  from the nominal value before lock errors will occur. The VCO pre-steer DAC (Latch 2) and VTF pre-steer DAC (Latch 3) can be modified using the latch access facility to identify faults caused by incorrect pre-steer values.
- (3) Pre-steer values are derived by an automatic calibration routine (Cal routine 100). If pre-steer problems are suspected, running this routine will cure the problem if no other hardware problems exist. If the routine cannot complete the calibration due to a hardware malfunction an error message is displayed to help identify the problem.
- (4) The top synthesized octave is generated in three ranges. The VTF tunes continuously from 1.2 to 2.51 GHz whilst the VCO is tuned in the three bands shown below:

Synthesizer frequency	VCO frequency
1201 - 1600 MHz	400 - 533 MHz
1601 - 2000 MHz	400 - 500 MHz
2001 - 2510 MHz	400 - 502 MHz

- (a) If a lock error is found to repeat through the bands it is likely that the VCO or harmonic generator is faulty. For example an error at 1201 MHz, 1601 MHz and 2001 MHz would suggest a fault with the VCO at the bottom of its tuning range. Refer to 'VCO and harmonic generator diagnosis' below.
- (b) A fault between 1500 MHz and 1600 MHz only will indicate a problem with the VCO at the top of the band. This could be caused by a pre-steer fault limiting the maximum tuning range, or by a problem with the VCO itself. Refer to 'VCO and harmonic generator diagnosis' below.
- (c) A fault appearing only at the top or bottom of the 1.2 to 2.51 GHz range suggests a problem with the VTF; for example, a fault between 1.2 to 1.3 GHz only or a fault between 2.2 to 2.51 GHz only. Refer to 'VTF fault diagnosis' below.

The following tests will require access to the RF board.

## General synthesizer fault diagnosis

- (1) Check that the voltage on TP14 is outside the range  $\pm 8$  V. If not, check the operation of lock window comparator IC406(c),(d).
- (2) Check that 25 MHz is present on IC205 pin 9 and that 5 MHz is present on pin 3 of IC313. If not, refer to 'Error 506 VCXO loop low' or '507 VCXO loop high' to debug the reference loop.
- (3) Using an oscilloscope examine the signal on TP7. A pulsed signal should be present with an amplitude of 5 V and a pulse width of 25 to 50 ns. If no signal is present check IC307, IC310 and the correct bias of TR302, TR303.
- (4) Using a frequency counter measure the frequency of the signal on TP7. If the signal has a frequency close to 5 MHz ( $\pm 50$  kHz), it is likely that the fault is within the phase detector or loop filter components. If the phase detector is operating, the voltage on pin 3 of IC402 should be at 5 V if the signal is above 5 MHz, or at 0 V if the signal is below 5 MHz. If this is correct, examine loop filter components IC402 and IC404 for correct operation.
- (5) If the frequency on TP7 is a long way from 5 MHz the control ASIC is not setting the correct divide ratio or IC307 does not have a suitable signal input. Check that the DC bias on the input of IC308 is approximately 1.5 V, and 4.5 V on the output. Check that the bias on TR305 collector is approximately 5 V. Set the carrier frequency to 1.4 GHz. Check to see if a signal at 1.4 GHz is present at C339 input with a level in the range  $-5$  dBm to  $+2$  dBm. If the signal is off frequency or at a low level, adjust latch 2 and latch 3 using the latch poke facility. If a signal with the correct power and frequency cannot be obtained refer to 'VCO and harmonic generator diagnosis' and 'VTF fault diagnosis' below. Check to see whether a 700 MHz signal is present at the output of IC309 and at the input of IC307.
- (6) The divide control word can be monitored on the pins of IC307. The table below gives the voltages that should appear for the two different carrier frequencies.

IC307 pin no.	Set carrier 1.32 GHz	Set carrier 2.36 GHz
27 (MSB)	2.5 V	2.5 V
28	0 V	2.5 V
1	0 V	2.5 V
2	0 V	0 V
3	0 V	2.5 V
16	Toggling	Toggling
15	Toggling	Toggling
14 (LSB)	Toggling	Toggling

If no pins are toggling check TP8 to see whether the ASIC clock is present. The ASIC power supply can be checked on pin 25 of the 25-way D-connector. Check that pin 50 of IC305 (panic) is not permanently high. Check the control interface to IC305.

## VCO and harmonic generator diagnosis

Proceed as follows:

- (1) Remove the cover of the 400 to 533 MHz VCO. Connect a spectrum analyzer to the output end of R107. Using the latch access facility set latch 2 to a value of 40. Check that a signal is present with a frequency of 380 to 400 MHz. If no signal is present check bias of TR101. Using the front panel knob tune the latch value from 40 to 220 and check that the frequency can be tuned from 400 to 533 MHz. If the frequency cannot be correctly tuned check VCO pre-steer circuit (Sheet 4), IC401 and associated components. Check correct connection of oscillator varactor diodes D101 to D106.
- (2) Set VCO frequency to 400 MHz using the latch access facility. Disconnect the spectrum analyzer from the VCO. Check that DC bias of IC101 input is about 1.5 V and output is 4.5V. Check that bias of TR102 collector is about 6 V. Adjust trimmer capacitor C114 for a



maximum DC voltage on TP15. The peak voltage should be 0.5 to 1 V. If the voltage is significantly less, check TR102 collector tuning components and D107.

### VTF fault diagnosis

Proceed as follows:

- (1) Check the bias to amplifiers IC104, IC105, IC106 and IC107 within the filter section. The amplifiers should have a nominal voltage at the input pin of 1.5 V and a voltage at the output of 4.5 V.
- (2) Probe the tuning voltage on C156. Using the latch access utility adjust the value of latch 3 between 0 and 255 and make sure that the voltage varies between 0 and 23 V (0 and 30 V for 2025). If not, check IC102 and IC103.
- (3) Probing on the centre point of each pair of varactor diodes D108 to D123, check that the correct tune voltage is present.
- (4) Set the VCO to 400 MHz using latch 2 and the VTF to 1.2 GHz by setting latch 3 to a value of 48. Check signal levels throughout the filter. Amplifiers should give 10 to 12 dB gain and the single filter section loss should be approximately 8 dB.

### 503 Ext. standard missing

Using the control board AB1 or AB1/1 circuit diagrams proceed as follows:

- (1) Check that the external standard is present and connected to the correct rear panel connector.
- (2) Trace the standard signal through the input conditioning circuitry, from C13 to IC63(d).
- (3) Check out the frequency detector circuitry, from IC41(a) to IC63(f).
- (4) If all this looks correct, check the interrupt handler through to the output of IC24(b). Another way to check the interrupt handler is to see if the other interrupts are being reported correctly, (ALC LOW, etc.).

### 504 Ext. standard frequency low

### 505 Ext. standard frequency high

Using the control board AB1 or AB1/1 circuit diagrams proceed as follows:

- (1) Check that the external frequency standard is either 1 MHz  $\pm$  3 Hz or 10 MHz  $\pm$  30 Hz and that the measured frequency corresponds to the selected frequency on the UTILS frequency standard screen.
- (2) Check that multiplexer IC36 is set to the correct settings. If the TCXO detect circuitry is faulty, switch 2 on the multiplexer could be switched to the incorrect input.
- (3) Check the frequency limits window comparator for correct operation, the window comparator is based round IC43(c) & (d) - the window limits are marked on the circuit diagram.
- (4) Check the operation of the phase-locked-loop (PLL) circuit, this is based round IC44, IC40 and IC43(a), and operates at 1 MHz input frequency.
- (5) Check the frequency of the internal frequency standard whilst the instrument is set to run from the internal frequency standard. If this frequency is too far away from the nominal 10 MHz, there might not be enough tuning range for which the PLL can compensate.

### Latch access

Latch numbers 112 & 113 in 16-bit mode can be used to determine the tuning range of the internal frequency standard. These latches control the oscillator tune voltage from DAC IC34(f),(g), and can be set to give from -3 V to +3 V on their outputs.

### 506 VCXO loop low

Refer to board AA1 or AA1/1, Sheet 2, and proceed as follows:

- (1) Check voltage on IC204 pin1. If this is greater than 1 V check lock comparator IC204(d).

- (2) Check TP2 to ensure a 10 MHz  $\pm 100$  Hz squarewave is present with an amplitude greater than 3.5 V. If not, check the cable connecting the 10 MHz standard from the control board.
- (3) Check that the supply voltage to the phase detector and dividers is greater than 4 V. Check that supply IC204 pin 4 is greater than +22 V.
- (4) Check TP3 to ensure a squarewave is present with a frequency close to 10 MHz. If not, check IC202 for divide by 5 and IC205a for divide by 2 operation.
- (5) If the frequency of the squarewave on TP3 is greater than that on TP2, check VCXO tuning components. Otherwise, check voltage on IC204 pin 12. If this is below 2.5 V, check phase detector IC201 and IC203. If the voltage is above 2.5 V, check loop filter IC204(a),(b) and associated components.

## 507 VCXO loop high

Refer to board AA1 or AA1/1, Sheet 2, and proceed as follows:

- (1) Check the voltage on IC204 pin1. If this is less than 19 V, check lock comparator IC204(d).
- (2) Check that the -11 V supply is present on L205.
- (3) Check for a 100 MHz signal on TR202 collector with a pk-pk amplitude of approximately 1 V. If this is not present, check that the bias of TR201 and TR202 is correct. Check the crystal and associated tuning components. If no fault is found, adjust C215 to produce a maximum amplitude signal at TR202 collector. The signal should be a few kHz higher than 100 MHz.
- (4) Check TR205 collector for a signal of approx. 4 V pk-pk at 100 MHz.
- (5) Check IC205 pin 6 for a 50 MHz squarewave with an amplitude greater than 3.5 V. Check TP3 for a 10 MHz squarewave.
- (6) Check TP2 to ensure that a 10 MHz  $\pm 100$  Hz squarewave is present with an amplitude greater than 3.5 V. If not, check cable connecting the 10 MHz standard from the control board.
- (7) Check the voltage on IC204 pin 12. If this is greater than 2.5 V, check phase detector IC201, IC203. Otherwise check loop filter IC204(a),(b) and associated components.

## 508 Amplitude mod unleveled

The amplitude modulator is responsible for applying AM to the carrier. To do this a voltage-controlled pin diode modulator and envelope detector are used in a controlled loop to apply AM to the carrier. The modulator control voltage comes from control board AB1 or AB1/1.

Using RF board AA1 or AA1/1 circuit diagrams proceed as follows:

- (1) If the error only appears at some frequencies and levels and not at others, the most likely cause is insufficient RF level present at the input of the modulator. When this occurs, the AM distortion and AM accuracy will get worse with the loop running out of the leveling range. One of the main reasons for insufficient RF input level is most likely to be a failure of band-pass filters which divide the frequency from 1.2 to 2.51 GHz all the way down to 10 MHz. The following table lists the changeover frequencies for each filter:

No.	Carrier frequency range	Filter type selected
1	10 kHz to 10 MHz	BFO band
2	>10 MHz to 18.75 MHz	18.75 MHz LPF
3	>18.75 MHz to 37.5 MHz	37.5 MHz LPF
4	>37.5 MHz to 75 MHz	75 MHz LPF
5	>75 MHz to 150 MHz	150 MHz LPF
6	>150 MHz to 300 MHz	300 MHz LPF
7	>300 MHz to 420 MHz	420 MHz LPF
8	>420 MHz to 600 MHz	600 MHz LPF
9	>600 MHz to 1200 MHz	1200 MHz LPF
10	>1200 MHz to 2510 MHz	Through band

- (2) If the error only occurs within one filter band frequency, it is most likely that the problem lies with that filter.
- (3) If the error is present at all frequencies, either detector D510 is damaged or other AM related circuitry is malfunctioning.

## **509 Output unlevelled**

Using RF board AA1 or AA1/1 circuit diagrams proceed as follows:

The fine RF output level control range is obtained using an Automatic Level Control (ALC) loop which consists of level modulator D512/D513 followed by RF power amplifiers TR806 to TR808 and TR814 and an RF level detector D804 at the end. The detector output is compared with the corresponding RF level DAC output from control board AB1 or AB1/1 by comparator IC802(c). Comparator output is used to adjust the level. When the adjustment range on the level modulator runs out, *Err 509: Output unlevelled* appears on the screen. There can be a number of causes which result in this error being generated. The main reasons are covered in the following points:

- (a) **Incorrect calibration** - Set RF level to +7 dBm and measure the output level at a frequency where an error is being displayed. If the level is out by more than 1 dB then try the RF levels calibration (UTIL\_114). If the instrument can not be calibrated and/or the error is still displayed, it is not a calibration problem. Continue this sequence.
- (b) **Insufficient gain** - Output unlevelled errors which appear only at certain frequencies and RF levels, especially near the maximum output level, are most likely caused by failure of one or more amplifying stages, resulting in insufficient gain within the ALC loop. Check DC bias conditions on TR806 to TR808 and TR814 (see table below) as well as feedback and coupling capacitors.
- (c) **BFO failure** - Carrier frequencies below 10 MHz are generated by mixing a fixed 100 MHz VCXO with 100 to 110 MHz carrier and low-pass filtering the difference product. This method of obtaining low frequencies is performed using a Beat Frequency Oscillator (BFO). Therefore if the output unlevelled error only occurs below 10 MHz, the fault is most likely to be in the BFO section. Transistors TR815 to TR820 are configured as a double balanced Gilbert cell mixer with TR823 and TR824 configured as constant current sources. Transistors TR812, TR821 and TR822 are buffer amplifiers. Check that BFO TR810, TR811 is switching properly and that all the transistors are biased correctly.

- (d) **Failure of the leveling detector resulting in low detected voltage** - One symptom of this will be a large error in the output RF level. Set the carrier frequency to 1 GHz and adjust the output RF level to +10 dBm and then measure the voltage across detector diode D804. If the voltage is outside the range 0.6 to 1.0 V, the detector is most likely to be damaged; also check other components around the detector diode.

If *Err: 508 Amplitude mod unlevelled* is also displayed, the most likely reason is insufficient RF level going into the level modulator. The input level should be around -2 dBm.

- (e) **Leveling modulator faulty** - Check D512, D513 and TR508 biasing conditions (see table below).

Check comparator IC501(b).

Board	Component ref	Collector voltage
AA1, AA1/1	TR506	7.6 V
AA1, AA1/1	TR508	7.6 V
AA1, AA1/1	TR510	9.0 V
AA1, AA1/1	TR806	9.0 V
AA1, AA1/1	TR807	7.6 V
AA1, AA1/1	TR808	16.4 V
AA1, AA1/1	TR812	7.8 V
AA1, AA1/1	TR814	7.0 V
AA2/1	TR1	16 V
AA2/1	TR2	16 V

**Note:** Collector voltages will normally vary up to 10%.

## 510 High power amplifier failed

Using high power amplifier board AA2/1 or AA2/7 circuit diagrams proceed as follows:

- The high power amplifier is switched by two relays (RLN & RLP) and is only enabled for levels above +7 dBm at all frequencies. Make sure that the RF output is terminated with 50  $\Omega$ . Toggle the RF level between +7 dBm and +8 dBm, using the up and down keys, and listen for the relay clicking sound. If relays appear not to be switching, suspect the drive circuitry for amplifier relay switching on the RF board AA1 or AA1/1 (Sheet 8). If the relays are switching and the RF level above +7 dBm is within the specification, either the high power detector is not calibrated or it is faulty. Unlock the instrument to level 2, then enter the level calibration utility (UTIL: 116 High Power System) and sequence through the 40 calibration points without changing the corresponding cal values. Save the cal data then exit the calibration routine. If the error still persists, check the DAC values.
- If there is large error in the RF output level, suspect the high power amplifier section. Check the biasing of transistors TR1 and TR2. The collector voltages on both transistors should be around +16 V and the collector currents around 100 mA and 300 mA respectively. Also check that the feedback components are not broken.

## 511 ALC too high

## 512 ALC too low

Using the control board AB1 or AB1/1 circuit diagrams proceed as follows:

- Check that the modulation input signal is present and that the level is within the range that can be leveled by the ALC loop. This is given as being between 0.75 V RMS and 1.25 V RMS although the actual leveling range will be greater.
- Trace the signal through the input conditioning circuitry, RLA2 to IC30 (a). At the output of IC30(a) the signal level should be about 73% of the input level.

- (3) Check the output level of IC48. This should be 1 V pk if it is calibrated. If it is not calibrated, it should still be fairly close to 1 V pk.
- (4) Check window comparator IC47(a),(b) for correct operation.
- (5) Check the positive and negative peak detectors, D12 and D14 to IC30(b), and the peak level filter, C26 to IC30(c). These provide the voltage feedback which controls variable resistor TR6 and hence the gain of leveling op-amp IC48.

### Latch access

Latch number 70 can be used to adjust the output level of the ALC circuit; the adjustment range is  $\pm$  a few mV from the mid-point setting.

## 513 DSP not responding

Using the control board AB1 or AB1/1 circuit diagrams proceed as follows:

- (1) Ensure that there is a 10 MHz clock signal present at DSP IC12. If there is no clock, the DSP will not run at all.
- (2) Check the DSP bridge circuitry based around IC10, IC11, IC50(b) and IC51(b) (AB1) or around IC23 (AB1/1). This enables the DSP software to be downloaded by DMA from the microprocessor and then provides the normal DSP bridge signals when in normal operation.

Error messages relating to the SINAD board are:

## 514 SINAD DSP not responding

If the DSP is running (LED D6 flashing rapidly) then the problem is probably with the serial bus interface.

## 515 SINAD under range

This could indicate that the AF signal applied to the SINAD input is too low for an accurate measurement to be made. It could also be caused by a break in the signal path to the SINAD board, or to a failure in the analogue circuitry.

## 516 SINAD overload

This indicates that the input signal is so high that the input to the ADC will be clipping; this will create harmonics, which will cause a worse SINAD reading to be calculated. A serious overload can cause the ADC to shut down temporarily. If the error persists after the input signal is reduced, it could indicate a problem with the analogue circuitry.

**Note:** if a large averaging value is selected, it can take several seconds for Errors 515 and 516 to appear or disappear.

### (549 RF level uncalibrated)

*This error message only appears where an RF level is set that the instrument specification does not support, even though the software allows the level to be set. It does not indicate a hardware fault and can be looked on as being an over-range function.)*

## 590 Main RAM faulty

This would prevent the instrument from running the main instrument software. Check for dry joints on the RAM, IC6 on control board AB1 or AB1/1, and replace the chip if necessary.

## 591 Main PROM faulty

This would probably never get reported since if the main PROM is faulty then, depending on the amount of corruption, the instrument probably would not run at all – the screen would stay blank. Since the PROM is socketed, try a different PROM, IC5 on control board AB1 or AB1/1.

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## Chapter 6

# REPLACEABLE PARTS

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### Introduction

Most sub-assemblies or printed circuit boards in this equipment have been allocated a reference designator code, for example, A0, A1, A2 etc.

The complete component reference includes its reference designator as a prefix, for example, A2C1 (capacitor C1 on sub-assembly A2) but for convenience in the text and diagrams, the prefix is omitted unless it is needed to avoid confusion. However, when ordering replacements or in correspondence, the complete component reference should be quoted where possible.

### Parts lists

The replaceable parts lists for the 2023, 2023A, 2023B, 2024 and 2025 Signal Generators are arranged in the following order:

- (1) A top-level parts list, A0, showing parts common to all instruments.
- (2) List of parts: A1 to A5 plus 1.2 GHz standard attenuator kit, provided in the standard version of the instruments.
- (3) Lists of parts: A6 to A13 plus Option 03 (1.2 GHz high power attenuator), Option 11 (Fast pulse with high power) and Option 12 (SINAD), providing the various options; for example, A6 is the optional AC/DC power supply unit which replaces the standard AC power supply unit A2.
- (4) List of components used on units and boards AA1 onwards in alphabetical order.

### Boards and units

To find out which boards and units are fitted in your instrument refer to Fig. 6-1 for 2023 and 2024, and to Fig. 6-2 for 2023A, 2023B and 2025.

### Component values

One or more of the components fitted in the equipment may differ from those listed in this chapter (see *Supply statement* below).

Components indicated by an \* (or SIC) have their values selected during test to achieve particular performance limits. This may mean that in some instances, no component is fitted.

When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value of component as that found in the equipment.

### Component spares and assemblies

#### Supply statement

- (a) IFR satisfies its material requirements by purchasing components from leading suppliers, who may manufacture in many countries. In most instances, components with different identities and slightly different specifications will be acceptable to us and will be identified under a single IFR part number regardless of manufacturer.

The IFR part number is the definitive reference. Service manuals and recommended service parts lists will give an example of one of the manufacturer's devices that meets our specification requirement.

We reserve the right to supply in manufactured equipment or for service spares any item that meets the requirements of our part number.

- (b) It may be necessary (due for example to obsolescence) to supply an item with a different IFR part number from that identified in our published documentation. Supply of such an alternative item is deemed to satisfy, in full, the requirements of any order or contract.

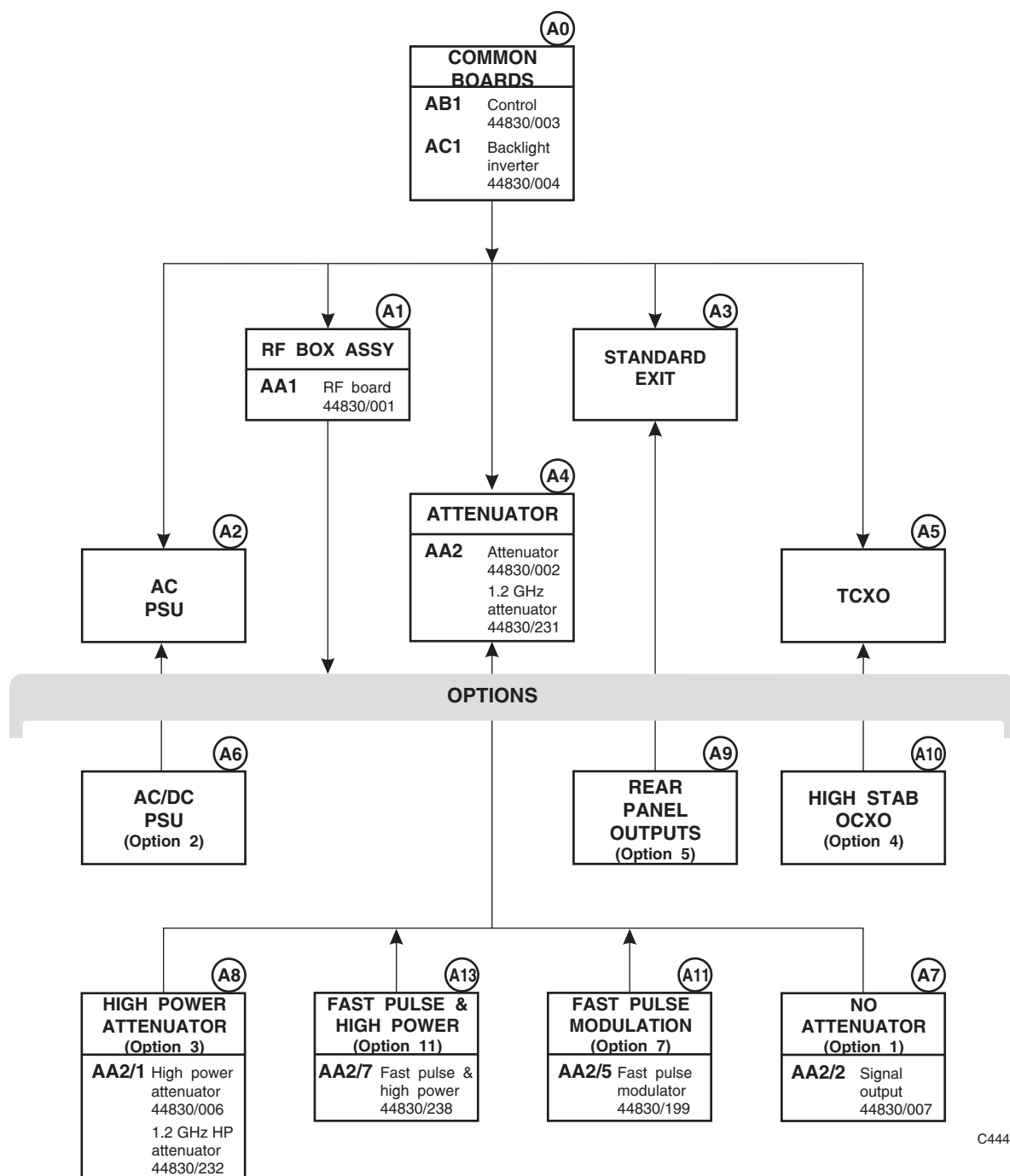
IFR Ltd warrants that the devices supplied under our part numbers will function correctly when placed in the correctly identified circuit locations for such devices in the relevant product.

## **Ordering**

When ordering replacements, address the order to our Service Division (address at rear of manual) or nearest agent and specify the following for each component required:

- Type and serial number of equipment, as given on the serial number label at the rear of the equipment. If this is superseded by a model number label, quote the model number instead of the type number.
- Complete circuit reference.
- Description.
- IFR part number.





C4443

Fig. 6-1 Boards and units fitted to the 2023 and 2024 Signal Generators

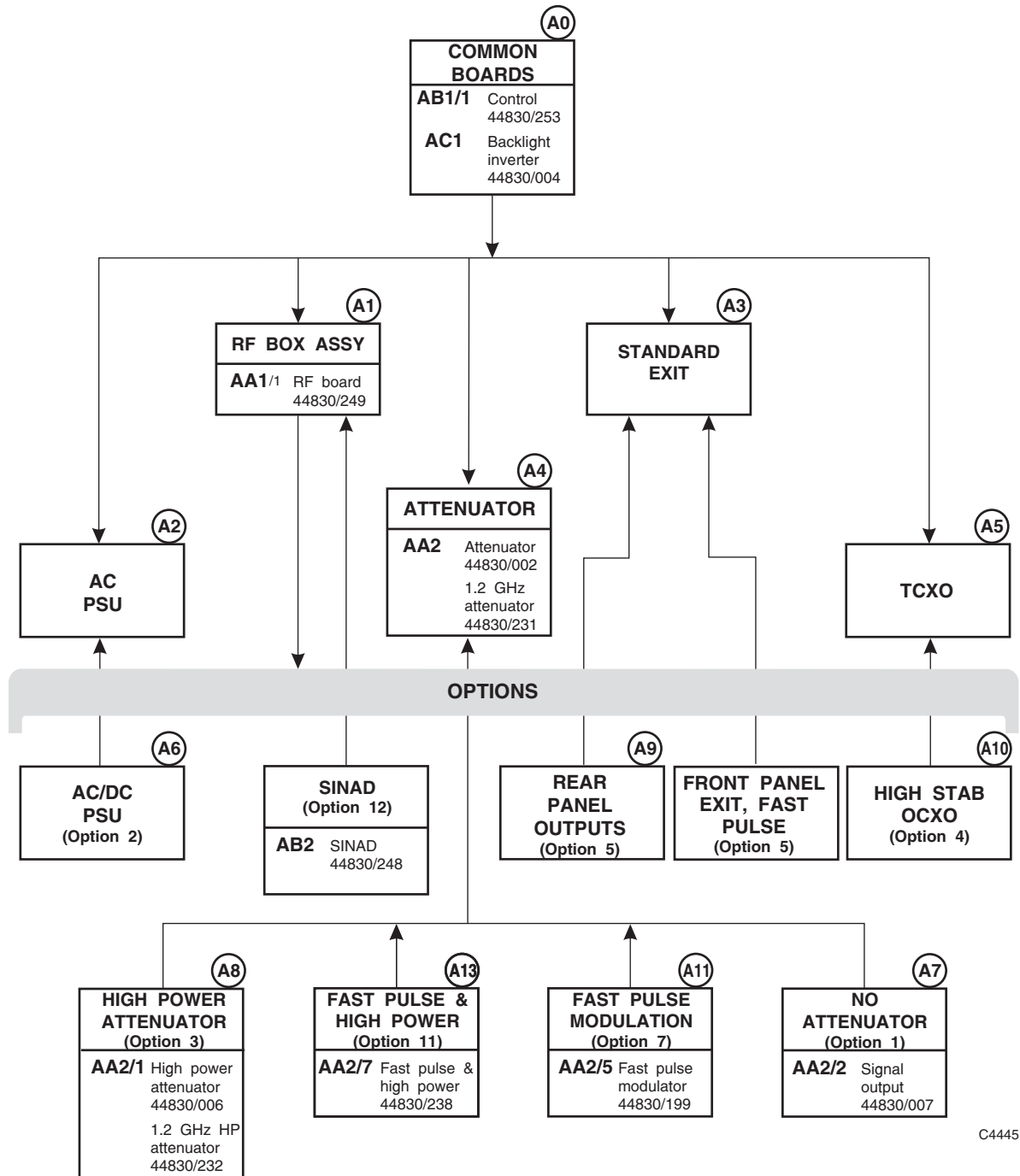


Fig. 6-2 Boards and units fitted to the 2023A, 2023B and 2025 Signal Generators

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
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### Electrical components

**Note:** unless shown otherwise, the manufacturer is IFR Ltd.

#### A0 Common parts

Refer to Fig. 7-1, A0 interconnections.

When ordering, prefix circuit reference with A0.

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
	13880/203	GASKET-RF CORED-KNITTED-WIRE MONEL 0.089mm WIRE	CHOMERICS	01-0901-6601
	15310/701	GASKET-RF CORED-KNITTED-WIRE COPPER SILVER PLATE	KNITMESH LTD	8508
	18150/225	GASKET-RF CONDUCTVE ELASTOMER ROUND, SOLID, SIL	CHOMERICS	10-04-2561-1285/100M
	18150/227	GASKET-RF CONDUCTVE ELASTOMER ROUND, TUBE, SIL	KEMTRON INT'L	EB-1D/1-027
	23411/060	FUSE TIME-LAG 2A20x5mm GLASS SPIRAL	LITTELFUSE	213002.
	23423/177	CONNECTOR MAINS PLUG3-WAY RF-FILTR PANEL-MTG	BULGIN	20/A0620/28
	23424/159	CABLE-ASSY MAINS RT-ANGCEE22- FREE BLACK 2.5mLG	VOLEX PENCON	Z352937
	23435/121	CONNECTOR PCB HEADER36-WAY 0.64mmSQ STRT	FCI	75160-102-36
	23435/564	CONNECTOR-PART SCREWLOCKKIT D-TYPE 4-40UNC	3M UK	3342-1
	23437/809	CONNECTOR-PART SCREWLOCKKIT D-TYPE FEMLE 4-40UNC	ITT CANNON	D20418-50
	23467/264	MODULE OPTO SHAFT ENCODR64 CYCLES/REV	HEWLETT-PACKARD	HRPG-AS64-14R
	23535/191	FAN-ACCESSORY MTG-PADKIT OF 4-CORNERS S/ADH	MICRONEL	F62XX-064A4
	28624/227	DISPLAY LIQUID CRYSTALBLUE 20 CONTACT MODULE	OPTREX	DMF5010NB-FW
	43138/610	RF-CABLE-FLEX RG178 MMCX-M - SMB-F 360mm LG		
	43138/612	RIBBON-LEAD 26 WAY SKT - D-TYPE SKT 115mm LG		
	43138/613	RIBBON-LEAD 40 WAY SKT - SKT 410mm LG		
	43138/616	FAN AXIAL BRUSHLESS, ASSEMBLY, 5V DC 62 mmSQ 15		
	43138/629	WIRE-LEAD-CRIMPED 1 WIRE 24/0.2mm 125mm LG		
	43138/880	WIRE-LEAD-CRIMPED 4 WIRE 7/0.2mm 35mm LG		
	46662/544	KEYBOARD ELASTOMERIC 2023, MARKED		
<b>2023, 2024 only</b>				
	44533/446	IC-PROGRAM EPROM, INSTRUMENT FIRMWARE		
<b>2023A, 2023B, 2025 only</b>				
	44533/472	IC-PROGRAM EPROM INSTRUMENT FIRMWARE, FOR AB1/1 CONTROL BOARD		
	44533/473	IC-PROGRAM EPROM INSTRUMENT FIRMWARE, FOR AB1 CONTROL BOARD (2023A AND 2023B ONLY)		

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
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## A1 RF box assembly

When ordering, prefix circuit reference with A1.

<b>44991/173</b>	<b>Complete kit (2023, 2024)</b>			
<b>44991/328</b>	<b>Complete kit (2023A, 2023B, 2025)</b>			
13860/101	GASKET-RF LINEAR-FINGER-STRIP DOUBLE-EDGED, BERY	INSTRUMENT SPEC	OC97-0436-21 (25ft)	
13860/104	GASKET-RF LINEAR-FINGER-STRIP SINGLE-EDGED, BERY	INSTRUMENT SPEC	0097-0555-17 (24')	
18150/227	GASKET-RF CONDUCTIVE ELASTOMER ROUND, TUBE, SILIC	KEMTRON INT'L	EB-1D/1-027	
23435/562	CONNECTOR-PART SCREWLOCKKIT D-TYPE 4-40UNC	3M UK	3341-1L(SINGLE KIT)	
23437/037	CONNECTOR D-TYPE PLUG25-WAY STRT PCB MTG	SPECTRUM CNTRL	56-721-003-LI	
23437/815	CONNECTOR-PART GASKETD-TYPE 25 WAY MALE WAVED	SPECTRUM CNTRL	572019-00102-70	
23444/331	CONNECTOR-RF SMB RECEPT50-OHM BULKHEAD	ITT CANNON	051-045-0000-910	
23444/512	CONNECTOR-RF SMA JACK50-OHM BULKHEAD	ITT CANNON	050-645-9039-890	
44520/004	CRYSTAL 100 MHz UM1 WIRE LEADS			
<b>2023, 2024 only</b>				
44830/001	PCB-ASSY SURFACE MOUNT AA1			
<b>2023A, 2023B, 2025 only</b>				
44830/249	PCB-ASSY SURFACE MOUNT AA1/1			

## A2 AC power supply

When ordering, prefix circuit reference with A2.

<b>46884/754</b>	<b>Complete kit</b>			
23488/559	THERMOSTAT OPEN-ON-RISE80DEG.C 1 POLE 10A 250V	ELMWOOD SENS	2455R-82-872-L80C	
23725/609	POWER-SUPPLY SWITCH MODE OPEN FRAME, 60W, 85 -	COUTANT LAMBDA	HVI-60-47A	
43138/627	WIRE-LEAD-CRIMPED 6 WIRE 16+24/0.2mm+SCRND 465mm			
43138/628	WIRE-LEAD-CRIMPED 16 WIRE 7+16/0.2mm 500mm LG			

## A3 Standard exit (front panel)

When ordering, prefix circuit reference with A3.

<b>46884/758</b>	<b>Complete kit</b>			
33901/156	MACHINED PANEL NUT, BRASS			
43138/611	RF-CABLE-S/R UT141 SMA-M - N-F 184.5mm LG			
43138/617	RF-CABLE-FLEX RG178 BNC-F - CRIMP SKT 3 WY 650mm			
43138/618	RF-CABLE-FLEX RG178 BNC-F - CRIMP SKT 3 WY 265mm			

## Front exit kit, fast pulse

<b>46884/933</b>	<b>Complete kit</b>			
33901/156	MACHINED PANEL NUT, BRASS			
43138/611	RF-CABLE-S/R UT141 SMA-M - N-F 184.5mm LG			

## REPLACEABLE PARTS

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Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
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### A4 Attenuator

When ordering, prefix circuit reference with A4.

<b>46884/764</b>	<b>Complete kit</b>			
23642/922	FILTER RFI-SUPPRESS 12nF 50V DC FEED-THRO CERAMI	AMP (GB) LTD	128.88xxx-94506	
43133/535	SET-OF-LEADS x10 ATTENUATOR WIRE			
43138/614	RIBBON-LEAD 16 WAY SKT - UNTERM 275mm LG			
44830/002	PCB-ASSY MIXED TECHN 2023/3001, AA2, ATTENUATED			

### 1.2 GHz STD attenuator kit

<b>46884/955</b>	<b>Complete kit</b>			
23642/922	FILTER RFI-SUPPRESS 12nF 50V DC FEED-THRO CERAMI	AMP (GB) LTD	128.88xxx-94506	
43133/535	SET-OF-LEADS x10 2023, ATTENUATOR WIRE,			
43138/614	RIBBON-LEAD 16 WAY SKT - UNTERM 275mm LG			
44830/231	PCB-ASSY MIXED TECHN 2023/3001, 1.2GHz STANDARD			

### A5 TCXO oscillator kit (standard)

When ordering, prefix circuit reference with A5.

<b>46884/800</b>	<b>Complete kit</b>			
28313/892	OSCILLATOR CRYSTAL10MHz 5-PIN MODULE	HY-Q	CO-1009	

### A6 Option 2, DC operation

When ordering, prefix circuit reference with A6.

<b>46884/760</b>	<b>Complete kit</b>			
23411/074	FUSE TIME-LAG 10A20x5mm CERAMIC	SCHURTER	PT-0001-2514	
23635/845	CORE BEAD FERRITE8mmDIA 10mmLG 3mmI/D	PHILIPS	4330-030-33200	
26346/120	CAPACITOR CERAMIC 10nF+/-20% 50V AXIAL	PHILIPS	A41C-103K-DRM	
26582/421	CAPACITOR POLYESTR 4.7uF+/-10% 63V RADIAL	MPE	A1B- or M2B-472-01B	
43130/119	WIRE-LEAD-CRIMPED 2 WIRE 63/0.2mm 2m LG			
43138/631	WIRE-LEAD-CRIMPED 8 WIRE 7/0.2mm+SCRND 495mm LG			
43138/632	WIRE-LEAD-CRIMPED 14 WIRE 7+16/0.2mm 300mm LG			
43138/678	WIRE-LEAD-CRIMPED 2 WIRE 32/0.2mm 82mm LG			
43138/679	WIRE-LEAD-CRIMPED 1 WIRE 32/0.2mm 102mm LG			
43138/680	WIRE-LEAD-CRIMPED 1 WIRE 32/0.2mm 122mm LG			
43138/681	WIRE-LEAD-CRIMPED 1 WIRE 24/0.2mm 140mm LG			
44991/179	POWER-SUPPLY SWITCH MODE 65W, 180 - 264VAC OR 90			

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
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## A7 Option 1, No attenuator

When ordering, prefix circuit reference with A7.

<b>46884/766</b>	<b>Complete kit</b>			
44830/007	PCB-ASSY CONVENTIONAL 2023/3001, AA2/2			

## A8 Option 3, High power attenuator

When ordering, prefix circuit reference with A8.

<b>46884/765</b>	<b>Complete kit</b>			
23642/922	FILTER RFI-SUPPRESS 12nF 50V DC FEED-THRO CERAM	AMP (GB) LTD	128.88xxx-94506	
43138/614	RIBBON-LEAD 16 WAY SKT - UNTERM 275mm LG			
44830/006	PCB-ASSY MIXED TECHN 2023/3001, AA2/1, HIGH POWER			

## Option 3, High power attenuator, 1.2 GHz

<b>46884/956</b>	<b>Complete kit</b>			
23642/922	FILTER RFI-SUPPRESS 12nF 50V DC FEED-THRO CERAMI	AMP (GB) LTD	128.88xxx-94506	
43138/614	RIBBON-LEAD 16 WAY SKT - UNTERM 275mm LG			
44830/232	PCB-ASSY MIXED TECHN 2023, AA2/1, 1.2GHz HIGH PO			

## A9 Option 5, Rear panel outputs

When ordering, prefix circuit reference with A9.

<b>46884/759</b>	<b>Complete kit</b>			
22315/812	GROMMET BLIND 12.7mmHOLE15mmO/D NYLON BLACK	HEYCO	440-2491-BLACK	
23188/373	GROMMET BLIND 15.9mmHOLE18.2mmO/D NYLON BLACK	HEYCO	440-2497-BLACK	
23443/855	CONNECTOR-RF BNC RECEPT50-OHM ELBOW PCB-MTG	AMPHENOL	31-5640-2010	
43138/630	RF-CABLE-S/R UT141 SMA-M - N-F 358mm LG			

## A10 Option 4, high stability OCXO

When ordering, prefix circuit reference with A10.

<b>46884/801</b>	<b>Complete kit</b>			
28313/883	OSCILLATOR CRYSTAL10MHz 5-PIN MODULE	NDK	END3032A	

## REPLACEABLE PARTS

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Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
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### A11 Option 7, Fast pulse modulator

When ordering, prefix circuit reference with A11.

	<b>46884/932</b>	<b>Complete kit</b>		
L200 to L203	23642/959	FILTER RFI-SUPPRESS 1nF100V DC 5A FEED-THRO CER	AMP (GB) LTD	1112517-1
	18150/227	GASKET-RF CONDUCTVE ELASTOMER ROUND, TUBE, SILIC	KEMTRON INT'L EB-1D/1-027	
	18720/651	GASKET-RF CONDUCTVE ELASTOMER STRIP, EXPANDED PT	W.L.GORE & ASS	EDR-21-020-0250-SC
	23642/922	FILTER RFI-SUPPRESS 12nF 50V DC FEED-THRO CERAMI	AMP (GB) LTD	128.88xxx-94506
	43133/535	SET-OF-LEADS x10 2023, ATTENUATOR WIRE,		
	43138/614	RIBBON-LEAD 16 WAY SKT - UNTERM 275mm LG		
	43138/618	RF-CABLE-FLEX RG178 BNC-F - CRIMP SKT 3 WY 265mm		
	43138/864	RF-CABLE-FLEX RG178 SMB-M - UNTERM 250mm LG		
	43138/865	RF-CABLE-FLEX RG178 SMB-F - BNC-F 600mm LG		
	44830/246	PCB-ASSY FAST PULSEMODULATOR BOARD		
	46662/618	KEYBOARD ELASTOMERIC 2023 OP7 MARKD,		

### A13 Option 11, Fast pulse with high power

When ordering, prefix circuit reference with A13.

	<b>46884/968</b>	<b>Complete kit</b>		
L200 to L203	23642/959	FILTER RFI-SUPPRESS 1nF100V DC 5A FEED-THRO CER	AMP (GB) LTD	1112517-1
	18150/227	GASKET-RF CONDUCTVE ELASTOMER ROUND, TUBE, SILIC	KEMTRON INT'L EB-1D/1-027	
	18720/651	GASKET-RF CONDUCTVE ELASTOMER STRIP, EXPANDED PT	W.L.GORE & ASS	EDR-21-020-0250-SC
	23642/922	FILTER RFI-SUPPRESS 12nF 50V DC FEED-THRO CERAM	AMP (GB) LTD	128.88xxx-94506
	43138/614	RIBBON-LEAD 16 WAY SKT - UNTERM 275mm LG		
	43138/618	RF-CABLE-FLEX RG178 BNC-F - CRIMP SKT 3 WY 265mm		
	43138/864	RF-CABLE-FLEX RG178 SMB-M - UNTERM 250mm LG		
	43138/865	RF-CABLE-FLEX RG178 SMB-F - BNC-F 600mm LG		
	44830/238	PCB-ASSY MIXED TECHN 2023, AA2/7, FAST PULSE & H		
	46662/618	KEYBOARD ELASTOMERIC 2023 OP7 MARKD		

### Opt.12, SINAD kit

	<b>46884/994</b>	<b>Complete kit</b>
	43139/025	RF-CABLE-FLEX RG178 SKT3WAY - SKT 3WAY 250mmLG
	44533/474	IC-PROGRAM EPROM x12025 AB2 IC5
	44830/248	PCB-ASSY MIXED TECH2025 AB2 SINAD BOARD

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board</b>				
When ordering, prefix circuit reference with AA1.				
	<b>44830/001</b>	<b>Complete unit</b>		
C101	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C102	26386/762	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5K-220-JAW
C103	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C104	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C105	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C106	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C107	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C108	26386/763	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5K-330-JAW
C109 to C110	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C111	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C112 to C113	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C114	26847/151	CAPACITOR-VAR CERAMIC5-20pF 25V SURFACE-MTG	AVX	CTZ3S-20C-W1-PF
C115	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C116	26386/955	CAPACITOR CERAMIC 10pF+/-2% 100V 0805	AVX	0805-1K-100-GAW-TR
C118	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C119	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C120	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C121 to C122	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C123	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C124 to C125	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C126	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C127 to C128	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C129	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C130 to C131	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C132	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C133 to C134	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C135	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C136	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C137	26451/003	CAPACITOR ALUM 10uF+/-20% 16V 4.3mmSQ	RUBYCON	16-REV-10-M-0450
C138	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C139	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C140 to C141	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C142	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C143 to C144	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C145	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C146 to C147	26386/867	CAPACITOR CERAMIC 2.2nF+/-10% 50V 0805	AVX	0805-5C-222-KAT-1A o
C148 to C149	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o



## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
C150 to C151	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C152 to C153	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C154	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C155	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C156	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C157 to C158	26386/828	CAPACITOR CERAMIC 220pF+/-5% 50V 0805	AVX	0805-5A-221-JAT-1A o
C201 to C202	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C203	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C204 to C205	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C206 to C210	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C211	26386/760	CAPACITOR CERAMIC 220nF+/-10% 50V 1210	PHILIPS	1210-2R-224-K9-BBC
C212 to C213	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C214	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C215	26847/151	CAPACITOR-VAR CERAMIC5-20pF 25V SURFACE-MTG	AVX	CTZ3S-20C-W1-PF
C216	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C217	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C218 to C219	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C220	26386/825	CAPACITOR CERAMIC 120pF+/-5% 50V 0805	AVX	0805-5A-121-JAT-1A o
C221	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C222	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C223	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C224 to C225	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C226	26386/823	CAPACITOR CERAMIC 82pF+/-5% 50V 0805	AVX	0805-5A-820-JAT-1A o
C227	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C228	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C229	26451/003	CAPACITOR ALUM 10uF+/-20% 16V 4.3mmSQ	RUBYCON	16-REV-10-M-0450
C230	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C231	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C232	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C233	26386/813	CAPACITOR CERAMIC 12pF+/-5% 50V 0805	AVX	0805-5A-120-JAT-1A o
C234	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C301 to C302	26386/829	CAPACITOR CERAMIC 270pF+/-5% 50V 0805	AVX	0805-5A-271-JAT-1A o
C303 to C304	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C305	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C306	26386/832	CAPACITOR CERAMIC 470pF+/-5% 50V 0805	AVX	0805-5A-471-JAT-1A o
C307 to C308	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C309	26386/867	CAPACITOR CERAMIC 2.2nF+/-10% 50V 0805	AVX	0805-5C-222-KAT-1A o
C310	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C311	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
C312	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C313 to C316	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C317	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C318	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C319 to C322	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C323	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C324	26343/753	CAPACITOR CERAMIC 6.8pF+/-0.5pF 50V 0805	AVX	0805-5A-6R8-DAT-1A o
C325	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C326	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C327	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C328	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C329 to C330	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C331	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C332	26343/758	CAPACITOR CERAMIC 3.9pF+/-0.5pF 50V 0805	AVX	0805-5A-3R9-DAT-1A o
C333	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C334	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C335	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C336	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C337	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C338	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C339	26386/800	CAPACITOR CERAMIC 1pF+/-0.5pF 50V 0805	AVX	0805-5A-1R0-DAT-1A o
C340 to C341	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C342 to C344	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C345	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C346 to C347	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C348 to C349	26451/003	CAPACITOR ALUM 10uF+/-20% 16V 4.3mmSQ	RUBYCON	16-REV-10-M-0450
C350	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C351	26386/867	CAPACITOR CERAMIC 2.2nF+/-10% 50V 0805	AVX	0805-5C-222-KAT-1A o
C352 to C353	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C354	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C355 to C357	26343/767	CAPACITOR CERAMIC 10pF+/-5% 50V 0805	AVX	0805-5A-100-JAT-1A o
C358 to C359	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C401	26386/873	CAPACITOR CERAMIC 6.8nF+/-10% 50V 0805	AVX	0805-5C-682-KAT-1A o
C402	26585/002	CAPACITOR POLYESTR 220nF+/-10% 25V 2824	PHILIPS	394-28224
C403 to C404	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C405 to C406	26386/759	CAPACITOR CERAMIC 22nF+/-20% 50V 1206	PHILIPS	1206-2R-223-K9-BBC
C407	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C408 to C409	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
C410	26386/873	CAPACITOR CERAMIC 6.8nF+/-10% 50V 0805	AVX	0805-5C-682-KAT-1A o
C411	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C412 to C413	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C414 to C415	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C416 to C417	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C418 to C421	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C422	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C423	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C424 to C425	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C426	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C427	26386/813	CAPACITOR CERAMIC 12pF+/-5% 50V 0805	AVX	0805-5A-120-JAT-1A o
C428	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C429	26386/867	CAPACITOR CERAMIC 2.2nF+/-10% 50V 0805	AVX	0805-5C-222-KAT-1A o
C452 to C453	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C454	26451/003	CAPACITOR ALUM 10uF+/-20% 16V 4.3mmSQ	RUBYCON	16-REV-10-M-0450
C501 to C502	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C503	26386/869	CAPACITOR CERAMIC 3.3nF+/-10% 50V 0805	AVX	0805-5C-332-KAT-1A o
C504 to C506	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C507 to C508	26346/120	CAPACITOR CERAMIC 10nF+/-20% 50V AXIAL	PHILIPS	A41C-103K-DRM
C509	26386/869	CAPACITOR CERAMIC 3.3nF+/-10% 50V 0805	AVX	0805-5C-332-KAT-1A o
C510	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C511	26386/829	CAPACITOR CERAMIC 270pF+/-5% 50V 0805	AVX	0805-5A-271-JAT-1A o
C512	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C513 to C517	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C518	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C519	26386/830	CAPACITOR CERAMIC 330pF+/-5% 50V 0805	AVX	0805-5A-331-JAT-1A o
C520	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C521	26386/830	CAPACITOR CERAMIC 330pF+/-5% 50V 0805	AVX	0805-5A-331-JAT-1A o
C522	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C523	26386/759	CAPACITOR CERAMIC 22nF+/-20% 50V 1206	PHILIPS	1206-2R-223-K9-BBC
C524 to C533	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C534	26346/120	CAPACITOR CERAMIC 10nF+/-20% 50V AXIAL	PHILIPS	A41C-103K-DRM
C535 to C536	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C537	26386/868	CAPACITOR CERAMIC 2.7nF+/-10% 50V 0805	AVX	0805-5C-272-KAT-1A o
C539 to C540	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C601	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C602	26386/804	CAPACITOR CERAMIC 2.2pF+/-0.5pF 50V 0805	AVX	0805-5A-2R2-DAT-1A o
C602	26386/811	CAPACITOR CERAMIC 8.2pF+/-0.5pF 50V 0805	AVX	0805-5A-8R2-DAT-1A o

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
C604 to C605	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C606 to C607	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C608	26343/757	CAPACITOR CERAMIC 3.3pF+/-0.5pF 50V 0805	AVX	0805-5A-3R3-DAT-1A o
C609	26386/808	CAPACITOR CERAMIC 4.7pF+/-0.5pF 50V 0805	AVX	0805-5A-4R7-DAT-1A o
C610	26343/756	CAPACITOR CERAMIC 2.7pF+/-0.5pF 50V 0805	AVX	0805-5A-2R7-DAT-1A o
C611 to C613	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C614 to C615	26386/813	CAPACITOR CERAMIC 12pF+/-5% 50V 0805	AVX	0805-5A-120-JAT-1A o
C616 to C617	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C618	26343/757	CAPACITOR CERAMIC 3.3pF+/-0.5pF 50V 0805	AVX	0805-5A-3R3-DAT-1A o
C619	26343/753	CAPACITOR CERAMIC 6.8pF+/-0.5pF 50V 0805	AVX	0805-5A-6R8-DAT-1A o
C620	26343/757	CAPACITOR CERAMIC 3.3pF+/-0.5pF 50V 0805	AVX	0805-5A-3R3-DAT-1A o
C621	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C622 to C623	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C624	26386/808	CAPACITOR CERAMIC 4.7pF+/-0.5pF 50V 0805	AVX	0805-5A-4R7-DAT-1A o
C625	26343/767	CAPACITOR CERAMIC 10pF+/-5% 50V 0805	AVX	0805-5A-100-JAT-1A o
C626	26386/808	CAPACITOR CERAMIC 4.7pF+/-0.5pF 50V 0805	AVX	0805-5A-4R7-DAT-1A o
C627 to C631	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C632	26343/753	CAPACITOR CERAMIC 6.8pF+/-0.5pF 50V 0805	AVX	0805-5A-6R8-DAT-1A o
C633	26386/813	CAPACITOR CERAMIC 12pF+/-5% 50V 0805	AVX	0805-5A-120-JAT-1A o
C634	26343/753	CAPACITOR CERAMIC 6.8pF+/-0.5pF 50V 0805	AVX	0805-5A-6R8-DAT-1A o
C635	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C636	26343/767	CAPACITOR CERAMIC 10pF+/-5% 50V 0805	AVX	0805-5A-100-JAT-1A o
C637 to C638	26386/815	CAPACITOR CERAMIC 18pF+/-5% 50V 0805	AVX	0805-5A-180-JAT-1A o
C639	26343/767	CAPACITOR CERAMIC 10pF+/-5% 50V 0805	AVX	0805-5A-100-JAT-1A o
C640	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C641	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C642 to C643	26386/819	CAPACITOR CERAMIC 39pF+/-5% 50V 0805	AVX	0805-5A-390-JAT-1A o
C644	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C645	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C646	26386/820	CAPACITOR CERAMIC 47pF+/-5% 50V 0805	AVX	0805-5A-470-JAT-1A o
C647 to C648	26386/823	CAPACITOR CERAMIC 82pF+/-5% 50V 0805	AVX	0805-5A-820-JAT-1A o
C649	26386/820	CAPACITOR CERAMIC 47pF+/-5% 50V 0805	AVX	0805-5A-470-JAT-1A o
C650	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C651	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C652 to C653	26386/827	CAPACITOR CERAMIC 180pF+/-5% 50V 0805	AVX	0805-5A-181-JAT-1A o
C654	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C655	26386/827	CAPACITOR CERAMIC 180pF+/-5% 50V 0805	AVX	0805-5A-181-JAT-1A o
C656 to C657	26386/830	CAPACITOR CERAMIC 330pF+/-5% 50V 0805	AVX	0805-5A-331-JAT-1A o
C658	26386/827	CAPACITOR CERAMIC 180pF+/-5% 50V 0805	AVX	0805-5A-181-JAT-1A o

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
C659 to C665	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C667	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C668 to C669	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C670 to C676	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C677 to C678	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C701	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C702 to C707	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C711	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C801	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C802	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C803	26386/821	CAPACITOR CERAMIC 56pF+/-5% 50V 0805	AVX	0805-5A-560-JAT-1A o
C804	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C805	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C806 to C807	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C808	26346/120	CAPACITOR CERAMIC 10nF+/-20% 50V AXIAL	PHILIPS	A41C-103K-DRM
C809	26343/756	CAPACITOR CERAMIC 2.7pF+/-0.5pF 50V 0805	AVX	0805-5A-2R7-DAT-1A o
C810	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C811	26343/756	CAPACITOR CERAMIC 2.7pF+/-0.5pF 50V 0805	AVX	0805-5A-2R7-DAT-1A o
C812	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C813	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C814	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C815	26343/756	CAPACITOR CERAMIC 2.7pF+/-0.5pF 50V 0805	AVX	0805-5A-2R7-DAT-1A o
C816 to C817	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C818	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C819	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C821 to C822	26386/828	CAPACITOR CERAMIC 220pF+/-5% 50V 0805	AVX	0805-5A-221-JAT-1A o
C823	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C824	26343/756	CAPACITOR CERAMIC 2.7pF+/-0.5pF 50V 0805	AVX	0805-5A-2R7-DAT-1A o
C825	26346/120	CAPACITOR CERAMIC 10nF+/-20% 50V AXIAL	PHILIPS	A41C-103K-DRM
C827	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C828 to C829	26386/828	CAPACITOR CERAMIC 220pF+/-5% 50V 0805	AVX	0805-5A-221-JAT-1A o
C830 to C831	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C832	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C833 to C834	26386/998	CAPACITOR CERAMIC 1uF-20/+80% 25V 1206	MURATA	GRM42-6-Y5V105Z-25PT
C835	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C836 to C837	26386/877	CAPACITOR CERAMIC 15nF+/-10% 50V 0805	AVX	0805-5C-153-KAT-1A o
C839	26386/865	CAPACITOR CERAMIC 1.5nF+/-10% 50V 0805	AVX	805-5C-152-KAT-1A or
C840	26386/869	CAPACITOR CERAMIC 3.3nF+/-10% 50V 0805	AVX	0805-5C-332-KAT-1A o
C841	26386/759	CAPACITOR CERAMIC 22nF+/-20% 50V 1206	PHILIPS	1206-2R-223-K9-BBC

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
C842	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C843	26386/869	CAPACITOR CERAMIC 3.3nF+/-10% 50V 0805	AVX	0805-5C-332-KAT-1A o
C844	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C845	26386/601	CAPACITOR CERAMIC 470nF+/-10% 25V 1210	PHILIPS	1210-2R-474-K8-BBC
C846	26386/873	CAPACITOR CERAMIC 6.8nF+/-10% 50V 0805	AVX	0805-5C-682-KAT-1A o
C847	26343/755	CAPACITOR CERAMIC 1.5pF+/-0.5pF 50V 0805	AVX	0805-5A-1R5-DAT-1A o
C848	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C849	26386/998	CAPACITOR CERAMIC 1uF-20/+80% 25V 1206	MURATA	GRM42-6-Y5V105Z-25PT
C850	26386/808	CAPACITOR CERAMIC 4.7pF+/-0.5pF 50V 0805	AVX	0805-5A-4R7-DAT-1A o
C852 to C855	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C857 to C861	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C863	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
D101 to D106	28381/132	DIODE BB809.. VARI-CAP29pF@3V AXIAL DO-34		
D107	28383/941	DIODE BA682.. BAND SWITCH35V MKD-RED SOD-80	PHILIPS	BA682
D108 to D123	28381/529	DIODE BB811.. VARI-CAP11pF@28V MKD-T/TP SOD123		
D124 to D126	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D201	28381/530	DIODE BB215.. VARI-CAP2.2pF@28V MK-GREEN SOD80		
D202	28372/581	DIODE BZX84-C16.. ZENER16V MKD-Y5 SOT-23	PHILIPS	BZX84-C16
D301 to D302	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D303 to D304	28371/412	DIODE BZX84-C5V1.. ZENER5.1V MKD-Z2 SOT-23	PHILIPS	BZX84-C5V1
D305 to D306	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D307	28383/909	DIODE HSMS-2822.. SMALLSIG DUAL MKD-C2L SOT-23	HEWLETT-PACKARD	HSMS-2822-TR1
D308 to D311	28371/303	DIODE BZX84-C6V2.. ZENER6.2V MKD-Z4 SOT-23	PHILIPS	BZX84-C6V2
D312	28357/030	DIODE 4004.. RECTIFIER400V S/M MELF	GENERAL SEMI	GL41G-46
D401 to D402	28371/412	DIODE BZX84-C5V1.. ZENER5.1V MKD-Z2 SOT-23	PHILIPS	BZX84-C5V1
D403 to D415	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D416	28383/941	DIODE BA682.. BAND SWITCH35V MKD-RED SOD-80	PHILIPS	BA682
D417	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D501 to D507	28383/932	DIODE HSMP-3810.. PIN100V MKD-EOL SOT-23	HEWLETT-PACKARD	HSMP-3810-TR1
D508	28372/032	DIODE BZX84-C10.. ZENER10V MKD-Z9 SOT-23	PHILIPS	BZX84-C10
D509	28371/412	DIODE BZX84-C5V1.. ZENER5.1V MKD-Z2 SOT-23	PHILIPS	BZX84-C5V1
D510 to D511	28349/037	DIODE HSMS-8101..MIXR/DET MKD-R1 SOT-23	HEWLETT-PACKARD	HSMS-8101
D512 to D513	28383/962	DIODE BAR60.. PIN TRIPLE100V MKD-60 SOT-143	SIEMENS	BAR60
D514 to D516	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D601 to D602	28383/961	DIODE BAR16-1.. PINDUAL 100V MKD-L9 SOT-23	SIEMENS	AR16-1-E6327

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
D603 to D648	28383/941	DIODE BA682.. BAND SWTCH35V MKD-RED SOD-80	PHILIPS	BA682
D701 to D702	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D801	28383/962	DIODE BAR60.. PIN TRIPLE100V MKD-60 SOT-143	SIEMENS	BAR60
D802	28383/941	DIODE BA682.. BAND SWTCH35V MKD-RED SOD-80	PHILIPS	BA682
D803	28383/932	DIODE HSMP-3810.. PIN100V MKD-EOL SOT-23	HEWLETT-PACKARD	HSMP-3810-TR1
D804 to D805	28349/037	DIODE HSMS-8101..MIXR/DET MKD-R1 SOT-23	HEWLETT-PACKARD	HSMS-8101
D808 to D809	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D810	28349/037	DIODE HSMS-8101..MIXR/DET MKD-R1 SOT-23	HEWLETT-PACKARD	HSMS-8101
IC101	28461/461	IC-ANALOG MICROWAVE-AMPMSA-0286.. 4-PIN AV-86	MINI-CIRCUITS	MAR-2-SM
IC102	28461/521	IC-ANALOG OP AMPLM6144.. QUAD SO-14	NATIONAL SEMI	LM6144BIM
IC103	28461/003	IC-ANALOG D/A-CONVERTERDAC-8841.. OCTAL SO-24	ANALOG	DAC-8841FS
IC104 to IC106	28461/516	IC-ANALOG MICROWAVE-AMPMAR-7-6.. 4-PIN VV105	MINI-CIRCUITS	MAR-7-6
IC107	28461/450	IC-ANALOG MICROWAVE-AMPMSA-0486.. 4-PIN AV-86	MINI-CIRCUITS	MAR-4-SM
IC108	28461/762	IC-ANALOG VOLTAGE-REFLM385.. SO-8	MOTOROLA	LM385D/1.2
IC201	28462/146	IC-DIGITAL FLIP-FLOP-D74AC74.. DUAL SO-14	FAIRCHILD	74AC74SC
IC202	28464/173	IC-DIGITAL COUNTER74AC161.. SO-16	FAIRCHILD	74AC161SC
IC203	28466/394	IC-DIGITAL NAND-GATE74AC00.. QUAD SO-14	FAIRCHILD	74AC00SC
IC204	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
IC205	28462/153	IC-DIGITAL FLIP-FLOP-JK74AC109.. DUAL SO-16	FAIRCHILD	74AC109SC
IC301	28461/510	IC-ANALOG OP AMPMC33284.. QUAD SO-14	NATIONAL SEMI	LM837M
IC302	28464/173	IC-DIGITAL COUNTER74AC161.. SO-16	FAIRCHILD	74AC161SC
IC303	28466/390	IC-DIGITAL NAND-GATE74HC00... QUAD SO-14	HARRIS	D74HC00M
IC304	28462/638	IC-DIGITAL FLIP-FLOP-D74HC74.. DUAL SO-14	PHILIPS	74HC74D
IC305	28469/603	IC-DIGITAL ARRAY-LOGICAMI6562-042.. PLCC-68	AMERICAN M	28469/603-AMI-6562-
IC306	28469/097	IC-DIGITAL BFR/LINE-DRVR74HC540.. OCT SO-20	HARRIS	CD74HC540M
IC307	28469/568	IC-DIGITAL DIVIDERSP8400.. SO-28	MITEL	SP8400-KG-MPES
IC308	28461/461	IC-ANALOG MICROWAVE-AMPMSA-0286.. 4-PIN AV-86	MINI-CIRCUITS	MAR-2-SM
IC309	28469/647	IC-DIGITAL DIVIDERSP8902.. SO-8	MITEL	SP8902/KG/MP1S
IC310	28466/413	IC-DIGITAL EXCLUSIVE-OR74AC86.. QUAD SO-14	FAIRCHILD	74AC86SC
IC311	28466/394	IC-DIGITAL NAND-GATE74AC00.. QUAD SO-14	FAIRCHILD	74AC00SC
IC312 to IC313	28462/146	IC-DIGITAL FLIP-FLOP-D74AC74.. DUAL SO-14	FAIRCHILD	74AC74SC
IC314	28461/774	IC-ANALOG VOLTAGE-REG78L05AC.. SO-8	NATIONAL SEMI	LM78L05ACM
IC401	28461/521	IC-ANALOG OP AMPLM6144.. QUAD SO-14	NATIONAL SEMI	LM6144BIM
IC402	28461/897	IC-ANALOG OP AMPOP-27GS.. SO-8	ANALOG	OP-27GS
IC403	28469/785	IC-ANALOG MULTIPLEXER74HC4052.. DUAL SO-16	PHILIPS	74HC4052D
IC404	28461/897	IC-ANALOG OP AMPOP-27GS.. SO-8	ANALOG	OP-27GS
IC405	28461/507	IC-ANALOG OP AMPMC33076.. DUAL DIL-8	MOTOROLA	MC33076P1
IC406	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
IC407	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC408	28625/021	MODULE OPTO CPLD ISOLATRH11F1.. DIL-6	QUALITY TECHNOLOGIES	H11F1
IC409	28461/044	IC-ANALOG D/A-CONVERTER7543.. SO-16	MAXIM	X7543GKCWE
IC501	28461/613	IC-ANALOG COMPARATORLM393.. DUAL SO-8	PHILIPS	LM393D
IC503	28461/507	IC-ANALOG OP AMPMC33076.. DUAL DIL-8	MOTOROLA	MC33076P1
IC601	28469/647	IC-DIGITAL DIVIDERSP8902.. SO-8	MITEL	SP8902/KG/MP1S

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
IC602	28469/566	IC-DIGITAL DIVIDERSP8402.. SO-28	MITEL	SP8402-KG-MPES
IC603	28465/055	IC-DIGITAL DECDR/DEMPLEX74HC138.. SO-16	PHILIPS	74HC138D
IC604 to IC606	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
IC607	28461/450	IC-ANALOG MICROWAVE-AMPMSA-0486.. 4-PIN AV-86	MINI-CIRCUITS	MAR-4-SM
IC608	28465/055	IC-DIGITAL DECDR/DEMPLEX74HC138.. SO-16	PHILIPS	74HC138D
IC701	28469/032	IC-DIGITAL INVERTER74HC14.. HEX SO-14	PHILIPS	74HC14D
IC702	28467/554	IC-DIGITAL SHIFT-REGISTR74HC595.. SO-16	ST MICRO	M74HC595M1
IC703	28466/121	IC-DIGITAL OR-GATE74HC4075.. TRIPLE SO-14	PHILIPS	74HC4075D
IC704 to IC705	28469/775	IC-DIGITAL MULTIPLEXER74HC251.. SO-16	PHILIPS	74HC251D
IC706	28467/554	IC-DIGITAL SHIFT-REGISTR74HC595.. SO-16	ST MICRO	M74HC595M1
IC707	28465/055	IC-DIGITAL DECDR/DEMPLEX74HC138.. SO-16	PHILIPS	74HC138D
IC708 to IC710	28467/554	IC-DIGITAL SHIFT-REGISTR74HC595.. SO-16	ST MICRO	M74HC595M1
IC802	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC803	28461/896	IC-ANALOG SWITCHDG413.. QUAD SO-16	MAXIM	DG413DY
L101 to L103	23642/510	INDUCTOR 0.1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R10-J
L104	23642/704	INDUCTOR 0.015uH 10% MOULDED 3.2x2.5mm	MEGGITT	3612-T-015-K
L105	23642/520	INDUCTOR 0.15uH 20% MOULDED 3.2x2.5mm	TDK	NL322522T-R15M
L106 to L108	23642/723	INDUCTOR 0.018uH 10% MOULDED 3.2x2.5mm	MEGGITT	3612-T-018-K
L109	23642/501	INDUCTOR 10uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-100-K
L110	23642/515	INDUCTOR 0.033uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-033-J
L111 to L112	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L113 to L114	23642/537	INDUCTOR 4.7uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-4R7-J
L115	23642/518	INDUCTOR 0.56uH 20% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R56-M
L201	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L202	23642/734	INDUCTOR 0.33uH 10% EPOXY COAT 3.2x2.5mm	COILCRAFT	1008CS-331-XKB-C
L203	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L204	23642/519	INDUCTOR 0.068uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-068-J
L205	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L206	23642/713	INDUCTOR 0.056uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-056-J
L207 to L209	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L210 to L212	23642/723	INDUCTOR 0.018uH 10% MOULDED 3.2x2.5mm	MEGGITT	3612-T-018-K
L301	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L302	23642/704	INDUCTOR 0.015uH 10% MOULDED 3.2x2.5mm	MEGGITT	3612-T-015-K
L304	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L305	23642/723	INDUCTOR 0.018uH 10% MOULDED 3.2x2.5mm	MEGGITT	3612-T-018-K
L306	23642/704	INDUCTOR 0.015uH 10% MOULDED 3.2x2.5mm	MEGGITT	3612-T-015-K
L307	23642/723	INDUCTOR 0.018uH 10% MOULDED 3.2x2.5mm	MEGGITT	3612-T-018-K
L308	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L309 to L310	23642/707	INDUCTOR 100uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-101-J
L311	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L312	23642/528	INDUCTOR 47uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-470-J



## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
L401 to L402	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L501	23642/701	INDUCTOR 2.2uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L502 to L503	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L504	23642/701	INDUCTOR 2.2uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L505	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L506	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L507	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L508	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L509	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L510	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L511	23642/701	INDUCTOR 2.2uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L512	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L513	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L514	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L515	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L516	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L601	23642/744	INDUCTOR 0.003uH 20% EPOXY COAT 0805	COILCRAFT	0805CS-030XMBC
L602	23642/510	INDUCTOR 0.1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R10-J
L603	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L604	23642/510	INDUCTOR 0.1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R10-J
L605	23642/515	INDUCTOR 0.033uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-033-J
L608 to L609	23642/510	INDUCTOR 0.1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R10-J
L612 to L613	23642/510	INDUCTOR 0.1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R10-J
L616	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L617	23642/510	INDUCTOR 0.1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R10-J
L618	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L619 to L620	23642/723	INDUCTOR 0.018uH 10% MOULDED 3.2x2.5mm	MEGGITT	3612-T-018-K
L621	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L622 to L624	23642/515	INDUCTOR 0.033uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-033-J
L625	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L626	23642/519	INDUCTOR 0.068uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-068-J
L627	23642/712	INDUCTOR 0.082uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-082-J
L628	23642/519	INDUCTOR 0.068uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-068-J
L629	23642/535	INDUCTOR 1uH 5% MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L630 to L632	23642/520	INDUCTOR 0.15uH 20% MOULDED 3.2x2.5mm	TDK	NL322522T-R15M
L633	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L634	23642/532	INDUCTOR 0.22uH 20% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R22-M
L635	23642/734	INDUCTOR 0.33uH 10% EPOXY COAT 3.2x2.5mm	COILCRAFT	1008CS-331-XKB-C
L636	23642/532	INDUCTOR 0.22uH 20% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R22-M
L637	23642/518	INDUCTOR 0.56uH 20% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R56-M
L638	23642/720	INDUCTOR 0.68uH 20% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R68-M
L639	23642/518	INDUCTOR 0.56uH 20% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R56-M
L640	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
L641	23642/535	INDUCTOR 1uH 5% MOULDED3.2x2.5mm	MEGGITT	3612-T-1R0-J
L642 to L643	23642/510	INDUCTOR 0.1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-R10-J
L801 to L802	23642/510	INDUCTOR 0.1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-R10-J
L803	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L804	23642/535	INDUCTOR 1uH 5% MOULDED3.2x2.5mm	MEGGITT	3612-T-1R0-J
L805	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L806	23642/535	INDUCTOR 1uH 5% MOULDED3.2x2.5mm	MEGGITT	3612-T-1R0-J
L807	23642/720	INDUCTOR 0.68uH 20% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R68-M
L808	23642/730	INDUCTOR 470uH 10% MOULDED 5.6x5mm	TDK UK LTD	NLC565050T-471K
L809	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L810	23642/535	INDUCTOR 1uH 5% MOULDED3.2x2.5mm	MEGGITT	3612-T-1R0-J
L811	23642/720	INDUCTOR 0.68uH 20% MOULDED 3.2x2.5mm	MEGGITT	3612-T-R68-M
L814	23642/730	INDUCTOR 470uH 10% MOULDED 5.6x5mm	TDK UK LTD	NLC565050T-471K
L815	23642/526	INDUCTOR 470uH 10%MOULDED 3.2x4.5mm	MEGGITT	3613-T-471-K
L816	23642/533	INDUCTOR 10uH 5% MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L817 to L819	23642/535	INDUCTOR 1uH 5% MOULDED3.2x2.5mm	MEGGITT	3612-T-1R0-J
PLAE	23437/063	CONNECTOR PCB HEADER16-WAY 2-ROW SURFACE MTG	MOLEX	90814-0216
R101	24811/163	RESISTOR 392R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-392R-1%-50ppm
R102	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R103 to R104	24321/604	RESISTOR 10R 5% 60mW100V 200ppm 0805	VISHAY	CRCW-0805-100-JT1
R105	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R106 to R107	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R108	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R109	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R110	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R111	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R112	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R113	24811/220	RESISTOR 90K9 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-90K9-1%-50ppm
R114	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R115	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R116	24321/759	RESISTOR 270R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2740-FT
R117	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R118	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R119	24811/917	RESISTOR 332R 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-332R
R120	24321/408	RESISTOR 22R 2% 100mW100V 200ppm 0805	VTM	503-0-22R-1%-100ppm
R122	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R123 to R124	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R125	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R126	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R127	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R128	24321/759	RESISTOR 270R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2740-FT
R129	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R130	24321/408	RESISTOR 22R 2% 100mW100V 200ppm 0805	VTM	503-0-22R-1%-100ppm
R132	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
R133 to R134	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R135	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R136	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R138	24321/759	RESISTOR 270R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2740-FT
R140	24321/408	RESISTOR 22R 2% 100mW100V 200ppm 0805	VTM	503-0-22R-1%-100ppm
R142	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R143	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R145	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R146	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R148	24811/142	RESISTOR 51R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-51R1-1%-50ppm
R149	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R150	24321/424	RESISTOR 100R 1% 100mW100V 100ppm 0805	VTM	503-0-100R-1%-100ppm
R151	24321/759	RESISTOR 270R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2740-FT
R152	24811/142	RESISTOR 51R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-51R1-1%-50ppm
R153	24811/217	RESISTOR 68K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68K1-1%-50ppm
R154	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R201	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R203	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R204	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R206	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R207 to R208	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R209	24811/196	RESISTOR 9K09 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-9K09-1%-50ppm
R210	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R211 to R212	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R213 to R214	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R215 to R217	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R218 to R219	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R220	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R221 to R222	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R223	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R224 to R225	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R226	24811/129	RESISTOR 15R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15R-1%-50ppm
R227	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R228	24811/191	RESISTOR 5K62 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-5K62-1%-50ppm
R229	24811/153	RESISTOR 150R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-150R-1%-50ppm
R230	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R231	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R232	24811/129	RESISTOR 15R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15R-1%-50ppm
R233	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R234	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R235	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
R236 to R238	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R239 to R240	24811/207	RESISTOR 27K4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27K4-1%-50ppm
R241 to R242	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R301 to R302	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R303	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R304	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R305	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R306	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R307 to R309	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R310	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R311 to R312	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R313	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R314	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R315 to R323	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R324 to R325	24811/161	RESISTOR 332R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-332R-1%-50ppm
R326 to R327	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R328	24811/155	RESISTOR 182R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182R-1%-50ppm
R329	24811/161	RESISTOR 332R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-332R-1%-50ppm
R330	24811/153	RESISTOR 150R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-150R-1%-50ppm
R332	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R333	24811/125	RESISTOR 10R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10R-1%-50ppm
R334	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R335	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R336	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R337	24811/161	RESISTOR 332R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-332R-1%-50ppm
R338 to R341	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R343 to R350	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R351	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R352	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R353	24321/406	RESISTOR 18R 1% 100mW100V 100ppm 0805	VTM	503-0-18R-1%-100ppm
R354	24321/422	RESISTOR 82R 1% 100mW100V 100ppm 0805	VTM	503-0-82R-1%-100ppm
R355 to R357	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R358 to R359	24321/424	RESISTOR 100R 1% 100mW100V 100ppm 0805	VTM	503-0-100R-1%-100ppm
R360	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R401	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R402	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R403	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R404	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
R405	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R406	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R407	24811/196	RESISTOR 9K09 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-9K09-1%-50ppm
R408	24811/243	RESISTOR 825K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-825K-1%-50ppm
R409	24811/172	RESISTOR 909R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-909R-1%-50ppm
R410	24811/219	RESISTOR 82K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-82K5-1%-50ppm
R411	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R412	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R413	24811/169	RESISTOR 681R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-681R-1%-50ppm
R414	24811/167	RESISTOR 562R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-562R-1%-50ppm
R415	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R416	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R417	24811/207	RESISTOR 27K4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27K4-1%-50ppm
R418	24321/757	RESISTOR 220R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2210-FT
R419	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R420	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R421	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R422	24811/161	RESISTOR 332R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-332R-1%-50ppm
R423	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R424	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R425	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm
R426	24811/147	RESISTOR 82R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-82R5-1%-50ppm
R427	24811/227	RESISTOR 182K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182K-1%-50ppm
R428	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R429	24811/147	RESISTOR 82R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-82R5-1%-50ppm
R430	24811/195	RESISTOR 8K25 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-8K25-1%-50ppm
R431	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R432	24811/139	RESISTOR 39R2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-39R2-1%-50ppm
R433	24811/169	RESISTOR 681R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-681R-1%-50ppm
R434	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R435 to R437	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R438	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R439	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R440	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R441	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R442	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R443 to R444	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R445	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R446	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R447	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R448	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R449 to R454	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R455	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R456	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R457 to R458	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
R460	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R464	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R465	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R466	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R467	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R468	24811/161	RESISTOR 332R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-332R-1%-50ppm
R469 to R470	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R471 to R474	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R501	24321/412	RESISTOR 33R 1% 100mW100V 100ppm 0805	VTM	503-0-33R-1%-100ppm
R502	24321/757	RESISTOR 220R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2210-FT
R503	24321/412	RESISTOR 33R 1% 100mW100V 100ppm 0805	VTM	503-0-33R-1%-100ppm
R504	24321/757	RESISTOR 220R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2210-FT
R505	24321/412	RESISTOR 33R 1% 100mW100V 100ppm 0805	VTM	503-0-33R-1%-100ppm
R506	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R507	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R508	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R509	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R510	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R511	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R512	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R513	24811/147	RESISTOR 82R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-82R5-1%-50ppm
R514 to R515	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R516	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R517	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R518	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R519	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R520	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R521	24811/155	RESISTOR 182R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182R-1%-50ppm
R522 to R523	24811/243	RESISTOR 825K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-825K-1%-50ppm
R524	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R525	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R526	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R527	24811/191	RESISTOR 5K62 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-5K62-1%-50ppm
R528 to R529	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R530	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R531	24811/167	RESISTOR 562R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-562R-1%-50ppm
R532 to R533	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R534	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R535 to R539	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R540	24811/167	RESISTOR 562R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-562R-1%-50ppm
R541	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R542	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R543	24811/209	RESISTOR 33K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-33K2-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
R544	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R545	24811/191	RESISTOR 5K62 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-5K62-1%-50ppm
R546 to R547	24321/416	RESISTOR 47R 1% 100mW100V 100ppm 0805	VTM	503-0-47R-1%-100ppm
R548	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R549	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R550	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R551	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R552	24321/430	RESISTOR 180R 1% 100mW100V 100ppm 0805	VTM	503-0-180R-1%-100ppm
R553	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R554	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R555 to R560	24321/416	RESISTOR 47R 1% 100mW100V 100ppm 0805	VTM	503-0-47R-1%-100ppm
R561	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R562	24811/186	RESISTOR 3K65 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K65-1%-50ppm
R563	24811/211	RESISTOR 39K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-39K2-1%-50ppm
R564	24811/207	RESISTOR 27K4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27K4-1%-50ppm
R565	24811/217	RESISTOR 68K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68K1-1%-50ppm
R566	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R567 to R568	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R569	24811/191	RESISTOR 5K62 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-5K62-1%-50ppm
R570	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R571 to R572	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R573	24811/155	RESISTOR 182R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182R-1%-50ppm
R574	24811/142	RESISTOR 51R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-51R1-1%-50ppm
R575	24321/604	RESISTOR 10R 5% 60mW100V 200ppm 0805	VISHAY	CRCW-0805-100-JT1
R576	24321/416	RESISTOR 47R 1% 100mW100V 100ppm 0805	VTM	503-0-47R-1%-100ppm
R579	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R580	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R581	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R582 to R585	24321/418	RESISTOR 56R 1% 100mW100V 100ppm 0805	VTM	503-0-56R-1%-100ppm
R586	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R601	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R602 to R603	24811/167	RESISTOR 562R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-562R-1%-50ppm
R604	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R605	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R606 to R607	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R608 to R609	24321/731	RESISTOR 18R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-18R2-FT
R610 to R611	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R612	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R613	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R614 to R624	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
R625 to R626	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R627 to R628	24811/161	RESISTOR 332R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-332R-1%-50ppm
R629 to R630	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R631	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R632	24811/146	RESISTOR 75R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-75R0-1%-50ppm
R633	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R634	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R635	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R636	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R637	24811/137	RESISTOR 33R2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-33R2-1%-50ppm
R638	24321/604	RESISTOR 10R 5% 60mW100V 200ppm 0805	VISHAY	CRCW-0805-100-JT1
R639 to R640	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R701 to R707	24811/181	RESISTOR 2K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K21-1%-50ppm
R708	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R709 to R711	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R712 to R715	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R716	24811/237	RESISTOR 475K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475K-1%-50ppm
R717	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R718 to R721	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R723 to R724	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R725	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R726 to R727	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R728	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R729	24811/155	RESISTOR 182R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182R-1%-50ppm
R801	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R802 to R805	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R806	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R807	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R808	24321/731	RESISTOR 18R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-18R2-FT
R809 to R810	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R811 to R812	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R813	24811/135	RESISTOR 27R4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27R4-1%-50ppm
R814	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R815	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R816	24321/430	RESISTOR 180R 1% 100mW100V 100ppm 0805	VTM	503-0-180R-1%-100ppm
R817	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R818 to R821	24811/125	RESISTOR 10R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10R-1%-50ppm



## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
R822	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R823	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R824	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R825	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R826	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R827	24321/418	RESISTOR 56R 1% 100mW100V 100ppm 0805	VTM	503-0-56R-1%-100ppm
R828 to R829	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R830	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm
R831	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R832 to R833	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R834	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R835	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R836 to R837	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R838	24321/430	RESISTOR 180R 1% 100mW100V 100ppm 0805	VTM	503-0-180R-1%-100ppm
R839	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R840	24321/731	RESISTOR 18R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-18R2-FT
R841	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R842	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R843	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R844	24811/125	RESISTOR 10R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10R-1%-50ppm
R845	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R846	24321/422	RESISTOR 82R 1% 100mW100V 100ppm 0805	VTM	503-0-82R-1%-100ppm
R847	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R848	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm
R849	24811/129	RESISTOR 15R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15R-1%-50ppm
R850 to R851	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R852	24764/708	RESISTOR 330R 2% 400mW200V 50ppm LO-IND AXIAL	BEYSCHLAG	BA0204-50HF-330R-2%
R853	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R854	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R856 to R858	24321/418	RESISTOR 56R 1% 100mW100V 100ppm 0805	VTM	503-0-56R-1%-100ppm
R859	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R860 to R861	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R862	24321/428	RESISTOR 150R 1% 100mW100V 100ppm 0805	VTM	503-0-150R-1%-100ppm
R863	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R864 to R866	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R867	24811/227	RESISTOR 182K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182K-1%-50ppm
R868	24321/757	RESISTOR 220R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2210-FT
R869	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R870	24811/125	RESISTOR 10R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10R-1%-50ppm
R871	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R872 to R874	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R875	24811/129	RESISTOR 15R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15R-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
R876	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R877	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R878	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R879 to R882	24321/416	RESISTOR 47R 1% 100mW100V 100ppm 0805	VTM	503-0-47R-1%-100ppm
R883	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R884 to R887	24321/416	RESISTOR 47R 1% 100mW100V 100ppm 0805	VTM	503-0-47R-1%-100ppm
R888	24811/191	RESISTOR 5K62 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-5K62-1%-50ppm
R889	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R890	24811/146	RESISTOR 75R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-75R0-1%-50ppm
R891	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R892	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R893	24764/707	RESISTOR 220R 2% 400mW200V 50ppm LO-IND AXIAL	BEYSCHLAG	MBA0204-50HF-220R-2%
R894	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R895	24811/145	RESISTOR 68R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68R1-1%-50ppm
R896	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R897	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R899	24811/167	RESISTOR 562R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-562R-1%-50ppm
R8100 to R8101	24321/757	RESISTOR 220R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-2210-FT
R8102	24811/153	RESISTOR 150R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-150R-1%-50ppm
R8103	24811/129	RESISTOR 15R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15R-1%-50ppm
R8104	24811/153	RESISTOR 150R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-150R-1%-50ppm
R8106	24321/416	RESISTOR 47R 1% 100mW100V 100ppm 0805	VTM	503-0-47R-1%-100ppm
R8108	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R8109	24811/125	RESISTOR 10R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10R-1%-50ppm
R8110	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R8111	24811/125	RESISTOR 10R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10R-1%-50ppm
RLA	23486/195	RELAY MAGNETIC DPCO 12V1K028 PCB-MTG DIL-10	MATSUSHITA	TN2-12V
T601 to T602	43590/141	WOUND TRANSFORMER BALUN, RING CORE 5:5 TURNS, TW	AMETHYST DESIGNS LTD	AD5161
TR101	28487/809	TRANSISTOR NPN BFR93A..12V 5GHz MKD-R2 SOT-23	PHILIPS	BFR93A
TR102	28457/867	TRANSISTOR NPN 42086..12V 6GHz CASE-AV-86	HEWLETT-PACKARD	AT-42086
TR201 to TR203	28487/809	TRANSISTOR NPN BFR93A..12V 5GHz MKD-R2 SOT-23	PHILIPS	BFR93A
TR204	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR205	28457/850	TRANSISTOR NPN FMMT2369.40V 600MHz MKD-*1J SOT23	MOTOROLA	MMBT2369LT1
TR301 to TR303	28457/850	TRANSISTOR NPN FMMT2369.40V 600MHz MKD-*1J SOT23	MOTOROLA	MMBT2369LT1
TR304	28457/858	TRANSISTOR PNP BSR12..15V 1.5GHz MKD-B5 SOT-23	PHILIPS	BSR12
TR305	28457/867	TRANSISTOR NPN 42086..12V 6GHz CASE-AV-86	HEWLETT-PACKARD	AT-42086
TR401	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR402	28459/084	TRANSISTOR N-ENH MOSFETBST82.. 80V MKD-02 SOT23	PHILIPS	BST82(TAPE & REEL)
TR406 to TR408	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR409	28459/084	TRANSISTOR N-ENH MOSFETBST82.. 80V MKD-02 SOT23	PHILIPS	BST82(TAPE & REEL)
TR501 to TR502	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1 RF board (contd.)</b>				
TR503 to TR505	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR506	28457/867	TRANSISTOR NPN 42086..12V 6GHz CASE-AV-86	HEWLETT-PACKARD	AT-42086
TR507	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR508	28457/867	TRANSISTOR NPN 42086..12V 6GHz CASE-AV-86	HEWLETT-PACKARD	AT-42086
TR509	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR510	28457/862	TRANSISTOR NPN MMBR951L.10V 8GHz MKD-7Z SOT-23	MOTOROLA	MMBR951L.T1
TR601 to TR602	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR603	28487/809	TRANSISTOR NPN BFR93A..12V 5GHz MKD-R2 SOT-23	PHILIPS	BFR93A
TR604	28457/857	TRANSISTOR NPN BFR93AR..12V 5GHz MKD-R5 SOT-23	PHILIPS	BFR93AR
TR605 to TR606	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR701 to TR707	28457/852	TRANSISTOR PNP BSR15..40V MKD-CH/T7p SOT-23	PHILIPS	BSR15 or BSR16
TR708	28457/850	TRANSISTOR NPN FMMT2369.40V 600MHz MKD-*1J SOT23	MOTOROLA	MMBT2369LT1
TR801 to TR805	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR806 to TR807	28457/867	TRANSISTOR NPN 42086..12V 6GHz CASE-AV-86	HEWLETT-PACKARD	AT-42086
TR808	28487/823	TRANSISTOR NPN AT-64020.20V 4GHz CASE-AV-200	HEWLETT-PACKARD	AT-64020
TR809	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR810 to TR811	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR812	28457/850	TRANSISTOR NPN FMMT2369.40V 600MHz MKD-*1J SOT23	MOTOROLA	MMBT2369LT1
TR813	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR814	28457/862	TRANSISTOR NPN MMBR951L.10V 8GHz MKD-7Z SOT-23	MOTOROLA	MMBR951L.T1
TR815 to TR822	28457/850	TRANSISTOR NPN FMMT2369.40V 600MHz MKD-*1J SOT23	MOTOROLA	MMBT2369LT1
TR823 to TR824	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA1/1 RF board</b>				
Components are the same as for AA1, with the following exceptions.				
When ordering, prefix circuit reference with AA1/1.				
	<b>44830/249</b>	<b>Complete unit</b>		
C601	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
IC102	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
IC401	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
L601	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R113	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R117	24811/196	RESISTOR 9K09 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-9K09-1%-50ppm
R127	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R208 to R209	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R210	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R216 to R217	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R218 to R219	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R464	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R465	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
	44830/001	PCB-ASSY SURFACE MOUNT 2023/3002, AA1, RF BOARD		

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2 Attenuator board</b>				
When ordering, prefix circuit reference with AA2.				
<b>Note:</b> there are two numbers for this board, indicating slightly different build standards in the factory. The parts list below is applicable however to both boards. When ordering a replacement AA2 attenuator board, simply quote the 44830/xxx number of the board you have removed.				
	<b>44830/002</b>	<b>Complete unit</b>		
	<b>44830/231</b>	<b>Complete unit</b>		
C1 to C4	26386/830	CAPACITOR CERAMIC 330pF+/-5% 50V 0805	AVX	0805-5A-331-JAT-1A o
C5	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C6 to C9	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C11	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C12	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C13 to C24	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C25	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C26 to C30	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C31	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
D1	28383/943	DIODE HSMP-3830.. PIN200V MKD-K0L SOT-23	HEWLETT-PACKARD	HSMP-3830-TR1
D2 to D6	28383/941	DIODE BA682.. BAND SWTCH35V MKD-RED SOD-80	PHILIPS	BA682
D7	28383/943	DIODE HSMP-3830.. PIN200V MKD-K0L SOT-23	HEWLETT-PACKARD	HSMP-3830-TR1
D8	28383/909	DIODE HSMS-2822.. SMALLSIG DUAL MKD-C2L SOT-23	HEWLETT-PACKARD	HSMS-2822-TR1
D9	28373/273	DIODE BZX84-C22.. ZENER22V MKD-Y8 SOT-23	PHILIPS	BZX84-C22
D10 to D15	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
IC1	28461/613	IC-ANALOG COMPARATORLM393.. DUAL SO-8	PHILIPS	LM393D
IC2	28461/774	IC-ANALOG VOLTAGE-REG78L05AC.. SO-8	NATIONAL SEMI	LM78L05ACM
L1 to L3	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L4	23642/701	INDUCTOR 2.2uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L5	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L6	23642/701	INDUCTOR 2.2uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L7	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L8	23642/701	INDUCTOR 2.2uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L9 to L14	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L15 to L16	23642/533	INDUCTOR 10uH 5%MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L17	23642/730	INDUCTOR 470uH 10% MOULDED 5.6x5mm	TDK	NLC565050T-471K
R1 to R2	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R3	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R4	24811/909	RESISTOR 51R1 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-51R1
R5	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R6	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R7	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R8	24811/909	RESISTOR 51R1 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-51R1
R9	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2 Attenuator board (contd.)</b>				
R10 to R11	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R12 to R13	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R14 to R15	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R16	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R17	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R18	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R19	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R20	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R21 to R22	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R23 to R24	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R25 to R26	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R27	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R28	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R29	24321/740	RESISTOR 43R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-43R2-FT
R30	24321/739	RESISTOR 39R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-39R2-FT
R31 to R32	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R33	24321/739	RESISTOR 39R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-39R2-FT
R34	24321/740	RESISTOR 43R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-43R2-FT
R35	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R36	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R37 to R38	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R39 to R40	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R41 to R42	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R43	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R44	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R45	24321/742	RESISTOR 51R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-51R1-FT
R46	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R47 to R48	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R49	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R50	24811/169	RESISTOR 681R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-681R-1%-50ppm
R51	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R52	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R53	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R54 to R55	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R56	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R57 to R58	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R59	24811/909	RESISTOR 51R1 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-51R1
R60	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2 Attenuator board (contd.)</b>				
R61 to R62	24811/909	RESISTOR 51R1 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-51R1
R63	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
RLA	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLB	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLC	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLD	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLE	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLF	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLG	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLH	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLJ	23486/156	RELAY MAGNETIC DPCO 5V100R PCB-MTG TO-5 8-PIN	TELEDYNE	732-5
RLK	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLL	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLM	23486/171	RELAY REED SP N/O 5V360R PCB-MTG FLATPACK	PICKERING	102F-1-A-5/928
TR1	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR2	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/1 High power attenuator board</b>				
When ordering, prefix circuit reference with AA2/1.				
<b>Note:</b> there are two numbers for this board, indicating slightly different build standards in the factory. The parts list below is applicable however to both boards. When ordering a replacement AA2/1 attenuator board, simply quote the 44830/xxx number of the board you have removed.				
	<b>44830/006</b>	<b>Complete unit</b>		
	<b>44830/232</b>	<b>Complete unit</b>		
C1 to C4	26386/830	CAPACITOR CERAMIC 330pF+/-5% 50V 0805	AVX	0805-5A-331-JAT-1A o
C6 to C18	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C19	26386/998	CAPACITOR CERAMIC 1uF-20/+80% 25V 1206	MURATA	GRM42-6-Y5V105Z-25PT
C20	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C21	26386/602	CAPACITOR CERAMIC 1uF+/-10% 25V 1210	PHILIPS	1210-2R-105-K8-BBC
C23	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C25	26451/006	CAPACITOR ALUM 22uF+/-20% 16V 5.3mmSQ	RUBYCON	16-REV-22
C26	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C27	26386/602	CAPACITOR CERAMIC 1uF+/-10% 25V 1210	PHILIPS	1210-2R-105-K8-BBC
C29	26386/808	CAPACITOR CERAMIC 4.7pF+/-0.5pF 50V 0805	AVX	0805-5A-4R7-DAT-1A o
C31	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C32	26451/006	CAPACITOR ALUM 22uF+/-20% 16V 5.3mmSQ	RUBYCON	16-REV-22
C33	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C34	26386/602	CAPACITOR CERAMIC 1uF+/-10% 25V 1210	PHILIPS	1210-2R-105-K8-BBC
C36	26386/817	CAPACITOR CERAMIC 27pF+/-5% 50V 0805	AVX	0805-5A-270-JAT-1A o
C37	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C38	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C39	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C40	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C41	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C42	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C43 to C45	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C46	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C47	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C48	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C49	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C50	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C51 to C54	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C55	26386/602	CAPACITOR CERAMIC 1uF+/-10% 25V 1210	PHILIPS	1210-2R-105-K8-BBC
C56 to C57	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C58	26386/602	CAPACITOR CERAMIC 1uF+/-10% 25V 1210	PHILIPS	1210-2R-105-K8-BBC
D1	28383/943	DIODE HSMP-3830.. PIN200V MKD-K0L SOT-23	HEWLETT-PACKARD	HSMP-3830-TR1
D2 to D6	28383/941	DIODE BA682.. BAND SWTCH35V MKD-RED SOD-80	PHILIPS	BA682
D7	28383/943	DIODE HSMP-3830.. PIN200V MKD-K0L SOT-23	HEWLETT-PACKARD	HSMP-3830-TR1
D8 to D17	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D18	28349/029	DIODE HSMS-2810.. SMALLSIG SCHTKY MK-B0L SOT-23	HEWLETT-PACKARD	HSMS-2810-TR1



## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/1 Fast pulse modulator board (contd.)</b>				
D19	28383/909	DIODE HSMS-2822.. SMALLSIG DUAL MKD-C2L SOT-23	HEWLETT-PACKARD	HSMS-2822-TR1
D20	28373/273	DIODE BZX84-C22.. ZENER22V MKD-Y8 SOT-23	PHILIPS	BZX84-C22
D21	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D22	28349/029	DIODE HSMS-2810.. SMALLSIG SCHTKY MK-B0L SOT-23	HEWLETT-PACKARD	HSMS-2810-TR1
D23	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
IC1	28461/613	IC-ANALOG COMPARATORLM393.. DUAL SO-8	PHILIPS	LM393D
IC2	28461/412	IC-ANALOG OP AMPTL072.. DUAL SO-8	MOTOROLA	TL072CD
IC3	28461/774	IC-ANALOG VOLTAGE-REG78L05AC.. SO-8	NATIONAL SEMI	LM78L05ACM
L1 to L3	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L4	23642/701	INDUCTOR 2.2uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L5	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L6	23642/701	INDUCTOR 2.2uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L7	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L8	23642/701	INDUCTOR 2.2uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L9 to L14	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L15	23642/730	INDUCTOR 470uH 10% MOULDED 5.6x5mm	TDK	NLC565050T-471K
L16	23642/701	INDUCTOR 2.2uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L17	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L18	23642/064	INDUCTOR 1mH 10%UNSCRNED AIR-CORE RADIAL	TOKO	494HYF0140K
L19	23642/091	INDUCTOR 10uH 20%SCREENED 7.3mmSQ	TOKO	646CY-100M-P
L20	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L21 to L22	23642/533	INDUCTOR 10uH 5%MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L23	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L24 to L25	23642/730	INDUCTOR 470uH 10% MOULDED 5.6x5mm	TDK	NLC565050T-471K
R1 to R2	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R3	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R4	24811/909	RESISTOR 51R1 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-51R1
R5	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R6	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R7	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R8	24811/909	RESISTOR 51R1 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-51R1
R9	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R10 to R11	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R12 to R13	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R14 to R15	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R16	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R17	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R18	24321/739	RESISTOR 39R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-39R2-FT
R19	24321/740	RESISTOR 43R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-43R2-FT
R20 to R21	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R22	24321/740	RESISTOR 43R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-43R2-FT

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/1 Fast pulse modulator board (contd.)</b>				
R23	24321/739	RESISTOR 39R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-39R2-FT
R24	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R25	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R26 to R27	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R28 to R29	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R30 to R31	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R32	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R33	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R34	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R35	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R36	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R37 to R38	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R39 to R40	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R41 to R42	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R43	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R44	24811/155	RESISTOR 182R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182R-1%-50ppm
R45	24811/903	RESISTOR 18R2 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-18R2
R46	24811/155	RESISTOR 182R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182R-1%-50ppm
R47 to R50	24811/905	RESISTOR 33R2 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-33R2
R51	25683/406	THERMISTOR NEG-TC DISC12K @ 25 DEG.C RADIAL	PHILIPS	2322-640-90004
R52	24811/177	RESISTOR 1K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K5-1%-50ppm
R53	24811/196	RESISTOR 9K09 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-9K09-1%-50ppm
R54	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R55	24772/057	RESISTOR 220R 2% 125mW150V 100ppm AXIAL	VTM	GP/490-0/221R-F-T2
R56	24811/129	RESISTOR 15R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15R-1%-50ppm
R57	24811/127	RESISTOR 12R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12R1-1%-50ppm
R58	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R59	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R60	24811/915	RESISTOR 150R 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-150R
R61	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R62	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm
R63	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R64	24772/060	RESISTOR 300R 2% 125mW150V 100ppm AXIAL	VTM	GP/490-0/301R-F-T2
R65	24681/086	RESISTOR 8R2 5% 1W100V 350ppm 2512	VISHAY	CRCW-2512-8R2-J-RT2
R66	24811/904	RESISTOR 24R3 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-24R
R67	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R68	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R69	24811/904	RESISTOR 24R3 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-24R
R70	24811/925	RESISTOR 274R 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-274R
R71	24811/912	RESISTOR 100R 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-100R
R72	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R73	24321/742	RESISTOR 51R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-51R1-FT
R74	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/1 Fast pulse modulator board (contd.)</b>				
R75 to R76	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R77 to R78	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R79 to R80	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R81	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R82 to R84	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R85	24811/211	RESISTOR 39K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-39K2-1%-50ppm
R86	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R87	24811/193	RESISTOR 6K81 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-6K81-1%-50ppm
R88	24811/169	RESISTOR 681R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-681R-1%-50ppm
R89	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R90 to R91	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R92	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R93	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R94	24811/905	RESISTOR 33R2 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-33R2
R95 to R96	24811/231	RESISTOR 274K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274K-1%-50ppm
R97	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R98	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R99	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R100	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R101	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R102	24811/909	RESISTOR 51R1 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-51R1
R103	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R104 to R105	24811/909	RESISTOR 51R1 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-51R1
R106 to R107	24811/904	RESISTOR 24R3 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-24R
RLA	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLB	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLC	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLD	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLE	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLF	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLG	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLH	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLJ	23486/156	RELAY MAGNETIC DPCO 5V100R PCB-MTG TO-5 8-PIN	TELEDYNE	732-5
RLK	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLL	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLM	23486/171	RELAY REED SP N/O 5V360R PCB-MTG FLATPACK	PICKERING	102F-1-A-5/928
RLN	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLP	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
TR1	28487/823	TRANSISTOR NPN AT-64020.20V 4GHz CASE-AV-200	HEWLETT-PACKARD	AT-64020
TR2	28487/821	TRANSISTOR NPN LTE21015R20V 2.1GHz CASE-FO-41B		
TR3 to TR4	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B

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Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/1 Fast pulse modulator board (contd.)</b>				
TR5 to TR6	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR7	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR8	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR9	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B

**AA2/2 Signal output board**

When ordering, prefix circuit reference with AA2/2.

**44830/007 Complete unit**

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/5 Fast pulse modulator board</b>				
When ordering, prefix circuit reference with AA2/5.				
	<b>44830/199</b>	<b>Complete unit</b>		
C2	26386/603	CAPACITOR CERAMIC 470nF+/-10% 16V 1206	PHILIPS	1206-2R-474-K7-BB
C3	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C4	26386/603	CAPACITOR CERAMIC 470nF+/-10% 16V 1206	PHILIPS	1206-2R-474-K7-BB
C5	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C6	26386/603	CAPACITOR CERAMIC 470nF+/-10% 16V 1206	PHILIPS	1206-2R-474-K7-BB
to C7				
C8	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
to C9				
C10	26386/603	CAPACITOR CERAMIC 470nF+/-10% 16V 1206	PHILIPS	1206-2R-474-K7-BB
C11	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C12	26386/908	CAPACITOR CERAMIC 1.5uF-20/+80% 16V 1206	KEMET	C1206C-155Z-4VAC-T/R
C13	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C14				
C16	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
to C24				
C26	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C30				
C32	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
to C35				
D1	28371/443	DIODE BZX84-C5V6.. ZENER5.6V MKD-Z3 SOT-23	PHILIPS	BZX84-C5V6
to D2				
D3	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D8	28383/909	DIODE HSMS-2822.. SMALLSIG DUAL MKD-C2L SOT-23	HEWLETT-PACKARD	HSMS-2822-TR1
D9	28373/273	DIODE BZX84-C22.. ZENER22V MKD-Y8 SOT-23	PHILIPS	BZX84-C22
D11	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
to D15				
IC1	28461/613	IC-ANALOG COMPARATORLM393.. DUAL SO-8	PHILIPS	LM393D
IC2	28461/774	IC-ANALOG VOLTAGE-REG78L05AC.. SO-8	NATIONAL SEMI	LM78L05ACM
IC4	28461/080	IC-ANALOG SWITCHP35-0702R.. SO-8	GEC-MARCONI MATERIAL	P35-0702R
to IC7				
IC8	28469/655	IC-DIGITAL DRIVERSWD-109.. SO-8	M/A COM	SWD-109-PIN
to IC9				
L4	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L5	23642/533	INDUCTOR 10uH 5%MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L6	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L7	23642/821	FILTER RFI-SUPPRESS 100V DC 5A SURFACE MTG PI-FI	AMP (GB) LTD	1112530-6
to L8				
L10	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
to L14				
L15	23642/533	INDUCTOR 10uH 5%MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
to L16				
L17	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
to L18				
R1	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R2	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R3	24811/131	RESISTOR 18R2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18R2-1%-50ppm
R4	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R5	24811/125	RESISTOR 10R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10R-1%-50ppm
R8	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/5 Fast pulse modulator board (contd.)</b>				
R9	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R10 to R11	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R12 to R13	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R14 to R15	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R16	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R17	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R18	24321/740	RESISTOR 43R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-43R2-FT
R19	24321/739	RESISTOR 39R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-39R2-FT
R20 to R21	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R22	24321/739	RESISTOR 39R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-39R2-FT
R23	24321/740	RESISTOR 43R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-43R2-FT
R24	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R25	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R26 to R27	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R28 to R29	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R30 to R31	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R32	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R33	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R34	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R35	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R36	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R37 to R38	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R39 to R40	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R41 to R42	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R43	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R44	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R45	24321/742	RESISTOR 51R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-51R1-FT
R46	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R47 to R48	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R49	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R50	24811/169	RESISTOR 681R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-681R-1%-50ppm
R51	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R52	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R53	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R54 to R55	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R56	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R57 to R58	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R60	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/5 Fast pulse modulator board (contd.)</b>				
R63	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R64	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R65 to R66	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R67 to R68	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R69 to R70	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R71 to R72	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R73 to R76	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R77	24321/742	RESISTOR 51R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-51R1-FT
R78	24811/145	RESISTOR 68R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68R1-1%-50ppm
R81	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R82	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R83 to R84	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R85	24321/428	RESISTOR 150R 1% 100mW100V 100ppm 0805	VTM	503-0-150R-1%-100ppm
R86	24811/123	RESISTOR 8R25 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-8R25-1%-50ppm
R87 to R88	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R89	24811/135	RESISTOR 27R4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27R4-1%-50ppm
R90	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
RLA	23486/187	RELAY MAGNETIC DPCO 5V61R PCB-MTG 10-PIN	TELEDYNE	RF170-5
RLB	23486/187	RELAY MAGNETIC DPCO 5V61R PCB-MTG 10-PIN	TELEDYNE	RF170-5
RLC	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLD	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLE	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLF	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLG	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLH	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLJ	23486/156	RELAY MAGNETIC DPCO 5V100R PCB-MTG TO-5 8-PIN	TELEDYNE	732-5
RLK	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLL	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLM	23486/171	RELAY REED SP N/O 5V360R PCB-MTG FLATPACK	PICKERING	102F-1-A-5/928
TR1	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR2 to TR3	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR4	28459/214	TRANSISTOR GaAs FETCLY2 .. MKD-Y2 6-PIN MW6	SIEMENS	CLY2

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/7 Fast pulse and high power board</b>				
When ordering, prefix circuit reference with AA2/7.				
	<b>44830/238</b>	<b>Complete unit</b>		
C10 to C17	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C20	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C21	26386/601	CAPACITOR CERAMIC 470nF+/-10% 25V 1210	PHILIPS	1210-2R-474-K8-BBC
C23	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C25	26451/006	CAPACITOR ALUM 22uF+/-20% 16V 5.3mmSQ	RUBYCON	16-REV-22
C26	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C27	26386/601	CAPACITOR CERAMIC 470nF+/-10% 25V 1210	PHILIPS	1210-2R-474-K8-BBC
C29	26386/808	CAPACITOR CERAMIC 4.7pF+/-0.5pF 50V 0805	AVX	0805-5A-4R7-DAT-1A o
C31	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C32	26451/006	CAPACITOR ALUM 22uF+/-20% 16V 5.3mmSQ	RUBYCON	16-REV-22
C33	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C34	26386/601	CAPACITOR CERAMIC 470nF+/-10% 25V 1210	PHILIPS	1210-2R-474-K8-BBC
C36	26386/817	CAPACITOR CERAMIC 27pF+/-5% 50V 0805	AVX	0805-5A-270-JAT-1A o
C37	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C38	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C39	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C40	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C41	26386/824	CAPACITOR CERAMIC 100pF+/-5% 50V 0805	AVX	0805-5A-101-JAT-1A o
C42	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C43 to C45	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C46	26451/007	CAPACITOR ALUM 22uF+/-20% 35V 6.6mmSQ	RUBYCON	35-REV-22
C47	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C48	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C49	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C51 to C54	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C55	26386/601	CAPACITOR CERAMIC 470nF+/-10% 25V 1210	PHILIPS	1210-2R-474-K8-BBC
C56 to C57	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C58	26386/601	CAPACITOR CERAMIC 470nF+/-10% 25V 1210	PHILIPS	1210-2R-474-K8-BBC
C202	26386/603	CAPACITOR CERAMIC 470nF+/-10% 16V 1206	PHILIPS	1206-2R-474-K7-BB
C204	26386/603	CAPACITOR CERAMIC 470nF+/-10% 16V 1206	PHILIPS	1206-2R-474-K7-BB
C206	26386/777	CAPACITOR CERAMIC 47nF+/-20% 63V 1206	PHILIPS	1206-2R-473-K9-BBC
C207	26386/603	CAPACITOR CERAMIC 470nF+/-10% 16V 1206	PHILIPS	1206-2R-474-K7-BB
C210	26386/603	CAPACITOR CERAMIC 470nF+/-10% 16V 1206	PHILIPS	1206-2R-474-K7-BB
C213 to C214	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C232 to C235	26386/863	CAPACITOR CERAMIC 1nF+/-10% 50V 0805	AVX	0805-5C-102-KAT-1A o
C236	26343/758	CAPACITOR CERAMIC 3.9pF+/-0.5pF 50V 0805	AVX	0805-5A-3R9-DAT-1A o
D9 to D17	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D18	28349/029	DIODE HSMS-2810.. SMALLSIG SCHTKY MK-B0L SOT-23	HEWLETT-PACKARD	HSMS-2810-TR1
D19	28383/909	DIODE HSMS-2822.. SMALLSIG DUAL MKD-C2L SOT-23	HEWLETT-PACKARD	HSMS-2822-TR1
D20	28373/273	DIODE BZX84-C22.. ZENER22V MKD-Y8 SOT-23	PHILIPS	BZX84-C22



## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/7 Fast pulse and high power board (contd.)</b>				
D21	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D22	28349/029	DIODE HSMS-2810.. SMALLSIG SCHTKY MK-B0L SOT-23	HEWLETT-PACKARD	HSMS-2810-TR1
D23	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D201 to D202	28371/443	DIODE BZX84-C5V6.. ZENER5.6V MKD-Z3 SOT-23	PHILIPS	BZX84-C5V6
D203	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
IC1	28461/613	IC-ANALOG COMPARATORLM393.. DUAL SO-8	PHILIPS	LM393D
IC2	28461/412	IC-ANALOG OP AMPTL072.. DUAL SO-8	MOTOROLA	TL072CD
IC3	28461/774	IC-ANALOG VOLTAGE-REG78L05AC.. SO-8	NATIONAL SEMI	LM78L05ACM
IC204 to IC207	28461/064	IC-ANALOG SWITCH SW-239.. SO-8	ALPHA INDUSTRIES	AS002R2-12
IC208 to IC209	28469/655	IC-DIGITAL DRIVERSWD-109.. SO-8	M/A COM	SWD-109-PIN
L10 to L14	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L15	23642/730	INDUCTOR 470uH 10% MOULDED 5.6x5mm	TDK	NLC565050T-471K
L16	23642/701	INDUCTOR 2.2uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-2R2-J
L17	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L18	23642/064	INDUCTOR 1mH 10%UNSCRNED AIR-CORE RADIAL	TOKO	494HYF0140K
L19	23642/091	INDUCTOR 10uH 20%SCREENED 7.3mmSQ	TOKO	646CY-100M-P
L20	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L21 to L22	23642/533	INDUCTOR 10uH 5%MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L23	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L24	23642/730	INDUCTOR 470uH 10% MOULDED 5.6x5mm	TDK	NLC565050T-471K
L204	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L205	23642/533	INDUCTOR 10uH 5%MOULDED 3.2x2.5mm	MEGGITT	612-T-100-J
L206	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
L207 to L208	23642/821	FILTER RFI-SUPPRESS 100V DC 5A SURFACE MTG PI-FI	AMP (GB) LTD	1112530-6
L217 to L218	23642/535	INDUCTOR 1uH 5%MOULDED 3.2x2.5mm	MEGGITT	3612-T-1R0-J
R9	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R10 to R11	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R12 to R13	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R14 to R15	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R16	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R17	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R18	24321/739	RESISTOR 39R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-39R2-FT
R19	24321/740	RESISTOR 43R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-43R2-FT
R20 to R21	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R22	24321/740	RESISTOR 43R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-43R2-FT
R23	24321/739	RESISTOR 39R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-39R2-FT
R24	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R25	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R26 to R27	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/7 Fast pulse and high power board (contd.)</b>				
R28 to R29	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R30 to R31	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R32	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R33	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R34	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R35	24321/632	RESISTOR 90R9 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W90R9E
R36	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R37 to R38	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R39 to R40	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R41 to R42	24321/631	RESISTOR 82R5 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W82R5E
R43	24321/630	RESISTOR 68R1 1% 250mW200V 200ppm 1206	BOURNS	CR1206-F-W68R1E
R44	24811/155	RESISTOR 182R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182R-1%-50ppm
R45	24811/903	RESISTOR 18R2 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-18R2
R46	24811/155	RESISTOR 182R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-182R-1%-50ppm
R47 to R50	24811/905	RESISTOR 33R2 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-33R2
R51	25683/406	THERMISTOR NEG-TC DISC12K @ 25 DEG.C RADIAL	PHILIPS	2322-640-90004
R52	24811/177	RESISTOR 1K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K5-1%-50ppm
R53	24811/196	RESISTOR 9K09 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-9K09-1%-50ppm
R54	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R55	24772/057	RESISTOR 220R 2% 125mW150V 100ppm AXIAL	VTM	GP/490-0/221R-F-T2
R56	24811/129	RESISTOR 15R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15R-1%-50ppm
R57	24811/127	RESISTOR 12R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12R1-1%-50ppm
R58	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R59	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R60	24811/915	RESISTOR 150R 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-150R
R61	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R62	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm
R63	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R64	24772/060	RESISTOR 300R 2% 125mW150V 100ppm AXIAL	VTM	GP/490-0/301R-F-T2
R65	24681/086	RESISTOR 8R2 5% 1W100V 350ppm 2512	VISHAY	CRCW-2512-8R2-J-RT2
R66	24811/904	RESISTOR 24R3 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-24R
R67	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R68	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R69	24811/904	RESISTOR 24R3 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-24R
R70	24811/925	RESISTOR 274R 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-274R
R71	24811/912	RESISTOR 100R 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-100R
R72	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R73	24321/742	RESISTOR 51R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-51R1-FT
R74	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R75 to R76	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R77 to R78	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/7 Fast pulse and high power board (contd.)</b>				
R79 to R80	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R81	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R82 to R84	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R85	24811/211	RESISTOR 39K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-39K2-1%-50ppm
R86	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R87	24811/193	RESISTOR 6K81 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-6K81-1%-50ppm
R88	24811/169	RESISTOR 681R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-681R-1%-50ppm
R89	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R90 to R91	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R92	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R93	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R94	24811/905	RESISTOR 33R2 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-33R2
R95 to R96	24811/231	RESISTOR 274K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274K-1%-50ppm
R97	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R98	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R99	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R100	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R101	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R103	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R106 to R107	24811/904	RESISTOR 24R3 1% 250mW200V 50ppm L-I MINI-MELF	BEYSCHLAG	MMA0204-50HF-1%-24R
R178	24811/145	RESISTOR 68R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68R1-1%-50ppm
R201	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R202	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R203	24811/131	RESISTOR 18R2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18R2-1%-50ppm
R204	24811/159	RESISTOR 274R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274R-1%-50ppm
R205	24811/125	RESISTOR 10R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10R-1%-50ppm
R208	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R264	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R265 to R266	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R267 to R268	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
R269 to R270	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R271 to R272	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R273 to R276	24811/185	RESISTOR 3K32 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-3K32-1%-50ppm
R277	24321/742	RESISTOR 51R 2% 125mW200V 200ppm 1206	VISHAY	CRCW-1206-51R1-FT
R278	24811/145	RESISTOR 68R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68R1-1%-50ppm
R281	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R282	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R283 to R284	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R285	24321/430	RESISTOR 180R 1% 100mW100V 100ppm 0805	VTM	503-0-180R-1%-100ppm
R286	24811/123	RESISTOR 8R25 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-8R25-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AA2/7 Fast pulse and high power board (contd.)</b>				
R287 to R288	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R289	24811/133	RESISTOR 22R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22R-1%-50ppm
R290	24321/417	RESISTOR 51R 1% 100mW100V 100ppm 0805	VTM	503-0-51R-1%-100ppm
RLA	23486/187	RELAY MAGNETIC DPCO 5V61R PCB-MTG 10-PIN	TELEDYNE	RF170-5
RLB	23486/187	RELAY MAGNETIC DPCO 5V61R PCB-MTG 10-PIN	TELEDYNE	RF170-5
RLC	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLD	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLE	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLF	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLG	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLH	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLJ	23486/156	RELAY MAGNETIC DPCO 5V100R PCB-MTG TO-5 8-PIN	TELEDYNE	732-5
RLK	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLL	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLM	23486/171	RELAY REED SP N/O 5V360R PCB-MTG FLATPACK	PICKERING	102F-1-A-5/928
RLN	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
RLP	23486/205	RELAY MAGNETIC DPCO 5V50R PCB-MTG 8-LEAD	TELEDYNE	RF100-5
TR1	28487/823	TRANSISTOR NPN AT-64020.20V 4GHz CASE-AV-200	HEWLETT-PACKARD	AT-64020
TR2	28487/821	TRANSISTOR NPN LTE21015R20V 2.1GHz CASE-FO-41B		
TR3 to TR4	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR5 to TR6	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR7	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR8	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR9	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR203	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR204	28459/214	TRANSISTOR GaAs FETCLY2 .. MKD-Y2 6-PIN MW6	SIEMENS	CLY2

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board</b>				
When ordering, prefix circuit reference with AB1.				
	<b>44830/003TC</b>	<b>Complete unit with OCXO fitted</b>		
	<b>44830/003TT</b>	<b>Complete unit with TCXO fitted</b>		
C1	26386/982	CAPACITOR CERAMIC 2.2uF+/-80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C2	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C3				
C4	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C5	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C6	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C7	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C8	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C9	26386/932	CAPACITOR CERAMIC 1nF+/-1% 50V 1206	AVX	1206-5A-102-FAT-1A
C10	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C11	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C12	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C13	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C14	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C15	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C16				
C17	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C18	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
to C20				
C21	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C22				
C23	26585/003	CAPACITOR POLYESTR 470nF+/-10% 25V 7.3x9mm	PHILIPS	394-28474
C24	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C25	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C26	26386/760	CAPACITOR CERAMIC 220nF+/-10% 50V 1210	PHILIPS	1210-2R-224-K9-BBC
C27	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
to C28				
C29	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C30	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C31	26386/982	CAPACITOR CERAMIC 2.2uF+/-80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C32	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
C33	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C34	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C35	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C36	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
to C37				
C38	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C39				
C40	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
to C42				
C43	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C46				
C47	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
to C53				
C54	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C83				
C84	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
C85 to C100	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C101	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C102 to C111	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C112	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C113	26451/001	CAPACITOR ALUM 1uF+/-20% 50V 4.3mmSQ	RUBYCON	0-REV-1-M-0450
C114 to C118	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C119 to C121	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C122	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C123	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C124	26585/003	CAPACITOR POLYESTR 470nF+/-10% 25V 7.3x9mm	PHILIPS	394-28474
C125 to C130	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C131	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C202	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C203	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C204	26451/013	CAPACITOR ALUM 100uF+/-20% 35V 10.3mmSQ	RUBYCON	35-REV-100-M-(10mm)
C205	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C206	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C207	26451/013	CAPACITOR ALUM 100uF+/-20% 35V 10.3mmSQ	RUBYCON	35-REV-100-M-(10mm)
C208	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C209	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C210	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C211	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C212	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C213	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C214	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C215	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C216	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C217 to C218	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C219	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C220	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C221	26451/013	CAPACITOR ALUM 100uF+/-20% 35V 10.3mmSQ	RUBYCON	35-REV-100-M-(10mm)
C222	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C223	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C224	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C225 to C226	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C227	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C228	26451/013	CAPACITOR ALUM 100uF+/-20% 35V 10.3mmSQ	RUBYCON	35-REV-100-M-(10mm)
C229	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
C230 to C231	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C232	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
C233	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C234	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
C235	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
C236	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C237	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C238	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C239	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C240	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C241 to C242	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C250 to C252	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C255 to C262	26386/783	CAPACITOR CERAMIC 330pF+/-1% 50V 0805	AVX	0805-5A-331-FAT-1A
C263 to C264	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C265	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
D3	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D5	28357/030	DIODE 4004.. RECTIFIER400V S/M MELF	GENERAL SEMI	GL41G-46
D6 to D7	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D8	28357/030	DIODE 4004.. RECTIFIER400V S/M MELF	GENERAL SEMI	GL41G-46
D11 to D17	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D206	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D207	28372/471	DIODE BZX84-C15.. ZENER15V MKD-Y4 SOT-23	PHILIPS	BZX84-C15
IC1	28469/552	IC-DIGITAL BFR/LINE-DRVR74HC541.. OCT SO-20	PHILIPS	74HC541D
IC2	28467/133	IC-MICRO PROCESSOR80C188.. PLCC-68	AMD	N80C188-12
IC3 to IC4	28462/439	IC-DIGITAL LATCH74AC573.. OCT SO-20	HARRIS	D74AC573M
IC6	28467/117	IC-MICRO STATIC-RAMHM628128.. 128Kx8 SO-32	HITACHI	HM628128LFP-10SL
IC7	28471/051	IC-MICRO EEPROM28C256.. 32Kx8 PLCC-32	ATMEL	AT28C256-20JC
IC8	28466/385	IC-DIGITAL NAND-GATE74HCT00.. QUAD SO-14	PHILIPS	74HCT00D
IC9	28466/120	IC-DIGITAL OR-GATE74HC32.. QUAD SO-14	HARRIS	D74HC32M
IC10	28462/151	IC-DIGITAL FLIP-FLOP-D74HC374.. OCTAL SO-20	HARRIS	D74HC374M
IC11	28462/638	IC-DIGITAL FLIP-FLOP-D74HC74.. DUAL SO-14	PHILIPS	74HC74D
IC12	28467/108	IC-MICRO DIGIT/SGNL PROCADSP2105.. PLCC-68	ANALOG	ADSP2105KP-55
IC13	28461/038	IC-ANALOG D/A-CONVERTERAD1856.. SO-16	ANALOG	AD1856R
IC15	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC16	28466/120	IC-DIGITAL OR-GATE74HC32.. QUAD SO-14	HARRIS	D74HC32M
IC17	28462/157	IC-DIGITAL FLIP-FLOP-D74HC377.. OCTAL SO-20	PHILIPS	74HC377D
IC18	28461/618	IC-DIGITAL COMPARATOR74HC688.. SO-20	PHILIPS	4HC688D
IC19	28469/552	IC-DIGITAL BFR/LINE-DRVR74HC541.. OCT SO-20	PHILIPS	74HC541D
IC20	28465/055	IC-DIGITAL DECDR/DEMPLEX74HC138.. SO-16	PHILIPS	74HC138D
IC21	28467/552	IC-DIGITAL SHIFT-REGISTR74HC165.. SO-16	PHILIPS	74HC165D
IC22	28462/157	IC-DIGITAL FLIP-FLOP-D74HC377.. OCTAL SO-20	PHILIPS	74HC377D
IC23	28467/552	IC-DIGITAL SHIFT-REGISTR74HC165.. SO-16	PHILIPS	74HC165D
IC24	28466/393	IC-DIGITAL NAND-GATE74HC132.. QUAD SO-14	HARRIS	D74HC132M
IC25 to IC26	28462/157	IC-DIGITAL FLIP-FLOP-D74HC377.. OCTAL SO-20	PHILIPS	74HC377D
IC27	28469/550	IC-DIGITAL TRANSCEIVER74HC245.. OCT SO-20	PHILIPS	74HC245D
IC28	28469/063	IC-DIGITAL BFR/LINE-DRVR74HC125.. QUAD SO-14	PHILIPS	74HC125D

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
IC29	28469/786	IC-ANALOG MULTIPLEXER74HC4053.. TRIPLE SO-16	PHILIPS	74HC4053D
IC30	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC31 to IC32	28469/756	IC-ANALOG MULTIPLEXER74HC4051.. SO-16	PHILIPS	74HC4051D
IC33	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC34	28461/849	IC-ANALOG D/A-CONVERTERD8840.. OCTAL SO-24	ANALOG	DAC-8840FS
IC35	28461/037	IC-ANALOG D/A-CONVERTERAD7537.. DUAL PLCC-28	ANALOG	AD7537JP
IC36	28469/786	IC-ANALOG MULTIPLEXER74HC4053.. TRIPLE SO-16	PHILIPS	74HC4053D
IC37 to IC38	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC39	28461/780	IC-ANALOG VOLTAGE-REG79L05AC.. SO-8	ST MICRO	L79L05ACZ
IC40	28466/393	IC-DIGITAL NAND-GATE74HC132.. QUAD SO-14	HARRIS	D74HC132M
IC41	28469/543	IC-DIGITAL COUNTER74HC390.. DUAL SO-16	PHILIPS	74HC390D
IC42	28469/768	IC-DIGITAL MULTIPLEXER74AC153.. DUAL SO-16	FAIRCHILD	74AC153SC
IC43	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
IC44	28462/638	IC-DIGITAL FLIP-FLOP-D74HC74.. DUAL SO-14	PHILIPS	74HC74D
IC45	28469/056	IC-DIGITAL INVERTER74AC14.. HEX SO-14	FAIRCHILD	4AC14SC
IC46	28466/414	IC-DIGITAL EXCLUSIVE-OR74HC86.. QUAD SO-14	PHILIPS	74HC86D
IC47	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC48	28461/458	IC-ANALOG OP AMPOP37.. SO-8	ANALOG	OP37GS
IC49	28461/507	IC-ANALOG OP AMPMC33076.. DUAL DIL-8	MOTOROLA	MC33076P1
IC50	28466/120	IC-DIGITAL OR-GATE74HC32.. QUAD SO-14	HARRIS	D74HC32M
IC51	28462/638	IC-DIGITAL FLIP-FLOP-D74HC74.. DUAL SO-14	PHILIPS	74HC74D
IC52	28469/617	IC-DIGITAL BFR/LINE-DRVR75C185.. SO-20	TEXAS	SN75C185DW
IC53	28467/123	IC-MICRO PERIPHERAL16C452.. PLCC-68	TEXAS	TL16C452FN
IC54	28466/600	IC-DIGITAL NAND-GATE74HC30.. SO-14	PHILIPS	74HC30D
IC55	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
IC56	28467/176	IC-MICRO CONTROLLER7210.. DIL-40	IOTECH	IOT7210P-(IN TUBES)
IC57	28469/616	IC-DIGITAL TRANSCEIVER75160.. OCT SO-20	TEXAS	SN75160BDW
IC58	28469/615	IC-DIGITAL TRANSCEIVER75161.. OCT SO-20	TEXAS	SN75161BDW
IC59 to IC60	28461/774	IC-ANALOG VOLTAGE-REG78L05AC.. SO-8	NATIONAL SEMI	LM78L05ACM
IC61	28469/543	IC-DIGITAL COUNTER74HC390.. DUAL SO-16	PHILIPS	74HC390D
IC62	28469/063	IC-DIGITAL BFR/LINE-DRVR74HC125.. QUAD SO-14	PHILIPS	74HC125D
IC63	28469/056	IC-DIGITAL INVERTER74AC14.. HEX SO-14	FAIRCHILD	4AC14SC
IC201	28461/776	IC-ANALOG VOLTAGE-REGLT1086.. 3-PIN TO-220	LINEAR TECH	LT1086CT
IC202	28461/613	IC-ANALOG COMPARATORLM393.. DUAL SO-8	PHILIPS	LM393D
IC203	28461/776	IC-ANALOG VOLTAGE-REGLT1086.. 3-PIN TO-220	LINEAR TECH	LT1086CT
IC204	28461/757	IC-ANALOG VOLTAGE-REFAD586.. DIL-8	ANALOG	AD586JN
IC205	28461/507	IC-ANALOG OP AMPMC33076.. DUAL DIL-8	MOTOROLA	MC33076P1
IC206	28469/027	IC-DIGITAL INVERTER74HCT14.. HEX SO-14	PHILIPS	74HCT14D
IC207	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
L1	23642/091	INDUCTOR 10uH 20%SCREENED 7.3mmSQ	TOKO	646CY-100M-P
L2 to L6	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L201 to L202	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L203 to L205	23642/091	INDUCTOR 10uH 20%SCREENED 7.3mmSQ	TOKO	646CY-100M-P



## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
L206 to L207	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L208	23642/091	INDUCTOR 10uH 20%SCREENED 7.3mmSQ	TOKO	646CY-100M-P
PLD	23437/046	CONNECTOR PCB-HEADER26-WAY STRT 2-ROW	FCI	75869-305
PLG	23445/501	CONNECTOR-RF MMCX JACK50-OHM SURFACE MTG	HUBER & SUHNER	82MMCX-S50-0-51
PLH	23437/048	CONNECTOR PCB-HEADER40-WAY STRT 2-ROW	FCI	75869-307
PLK	23437/073	CONNECTOR PCB-HEADER3-WAY STRT SURFACE MTG	SAMTEC	T M-103-01-S-SV-P
PLL	23437/073	CONNECTOR PCB-HEADER3-WAY STRT SURFACE MTG	SAMTEC	T M-103-01-S-SV-P
PLM	23437/073	CONNECTOR PCB-HEADER3-WAY STRT SURFACE MTG	SAMTEC	T M-103-01-S-SV-P
PLN	23437/074	CONNECTOR PCB-HEADER16-WAY STRT SURFACE MTG	SAMTEC	T M-108-01-S-DV-P
R1	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R2 to R3	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R4	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R5 to R6	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R7 to R8	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R9	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R10	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R11 to R14	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R15	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R16	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R17 to R18	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R35	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R36 to R40	24811/160	RESISTOR 301R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-301R-1%-50ppm
R41	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R42	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R43	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R44	24811/190	RESISTOR 5K11 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-5K11-1%-50ppm
R45	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R46	24811/209	RESISTOR 33K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-33K2-1%-50ppm
R47	24811/145	RESISTOR 68R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68R1-1%-50ppm
R48	24811/172	RESISTOR 909R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-909R-1%-50ppm
R49	24811/203	RESISTOR 18K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18K2-1%-50ppm
R50	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R51 to R52	24811/234	RESISTOR 365K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-365K-1%-50ppm
R53	24811/233	RESISTOR 332K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-332K-1%-50ppm
R54	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R55 to R56	24811/234	RESISTOR 365K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-365K-1%-50ppm
R57	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R58	24811/195	RESISTOR 8K25 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-8K25-1%-50ppm
R59	24811/194	RESISTOR 7K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-7K5-1%-50ppm
R60 to R61	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R62	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
R64	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R65	24811/237	RESISTOR 475K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475K-1%-50ppm
R66	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R67	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R68	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R69	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R70	24811/160	RESISTOR 301R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-301R-1%-50ppm
R71	24811/212	RESISTOR 43K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-43K2-1%-50ppm
R72	24811/231	RESISTOR 274K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274K-1%-50ppm
R73	24811/207	RESISTOR 27K4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27K4-1%-50ppm
R74	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R75	24811/203	RESISTOR 18K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18K2-1%-50ppm
R76	24811/193	RESISTOR 6K81 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-6K81-1%-50ppm
R77	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R78	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R79	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R80	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R81	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R82	24811/203	RESISTOR 18K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18K2-1%-50ppm
R84	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R85	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R86	24811/163	RESISTOR 392R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-392R-1%-50ppm
R87	24811/145	RESISTOR 68R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68R1-1%-50ppm
R88 to R89	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R90	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R91	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R92	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R93	24811/218	RESISTOR 75K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-75K0-1%-50ppm
R94	24811/153	RESISTOR 150R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-150R-1%-50ppm
R95	24811/209	RESISTOR 33K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-33K2-1%-50ppm
R96 to R97	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R98	24811/193	RESISTOR 6K81 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-6K81-1%-50ppm
R99	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R100 to R101	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R102	24811/209	RESISTOR 33K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-33K2-1%-50ppm
R103	24811/195	RESISTOR 8K25 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-8K25-1%-50ppm
R104	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R105 to R106	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R107	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R108	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R109 to R110	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R111 to R112	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R113	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R114	24811/215	RESISTOR 56K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-56K2-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
R115	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R116	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R117	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R118 to R119	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R120	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R121 to R122	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R123 to R124	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R125	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R126	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R127	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R128	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R129	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R130	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R131	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R132	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R133 to R134	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R135 to R136	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R137	24811/170	RESISTOR 750R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-750R-1%-50ppm
R138	24811/172	RESISTOR 909R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-909R-1%-50ppm
R139	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R140	24811/203	RESISTOR 18K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18K2-1%-50ppm
R141	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R142 to R145	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R146 to R147	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R148 to R149	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R150	24811/170	RESISTOR 750R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-750R-1%-50ppm
R151	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R152 to R153	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R154	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R157	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R158	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R159	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R160	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R161	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R162	24811/218	RESISTOR 75K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-75K0-1%-50ppm
R163	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R165	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R166	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R167	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R168 to R169	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R170	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
R171 to R173	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R175	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R176	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R177	24811/160	RESISTOR 301R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-301R-1%-50ppm
R178	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R179	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R180	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R181	24811/207	RESISTOR 27K4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27K4-1%-50ppm
R182 to R184	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R185 to R192	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R193 to R199	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R200	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R201	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R202	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R203	24811/208	RESISTOR 30K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-30K1-1%-50ppm
R204	24811/219	RESISTOR 82K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-82K5-1%-50ppm
R205	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R206	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R207	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R208	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R209 to R210	24338/009	RESISTOR 390R 5% 1W100V 350ppm 2512	VTM	509-0-390R-5%-V5
R211	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R212	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R213	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R214 to R215	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R216 to R217	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R218	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R219	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R220	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R221	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R222	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R223	24811/234	RESISTOR 365K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-365K-1%-50ppm
R224	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R225	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R226	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R227	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R228	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm
R229	24811/170	RESISTOR 750R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-750R-1%-50ppm
R231	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R232	24811/172	RESISTOR 909R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-909R-1%-50ppm
R233	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R234	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R235	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
R236 to R237	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R238	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R240 to R241	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R270	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R271	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R272	24811/153	RESISTOR 150R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-150R-1%-50ppm
R273	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R280	24811/194	RESISTOR 7K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-7K5-1%-50ppm
R281	24811/174	RESISTOR 1K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K1-1%-50ppm
R282	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R283	24811/200	RESISTOR 13K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-13K-1%-50ppm
R284	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R285	24811/211	RESISTOR 39K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-39K2-1%-50ppm
R286 to R287	24811/200	RESISTOR 13K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-13K-1%-50ppm
R288	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R289	24811/200	RESISTOR 13K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-13K-1%-50ppm
R290 to R291	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R292	24811/194	RESISTOR 7K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-7K5-1%-50ppm
R293	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R294 to R295	24811/198	RESISTOR 11K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-11K-1%-50ppm
R296	24811/200	RESISTOR 13K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-13K-1%-50ppm
R297	24811/198	RESISTOR 11K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-11K-1%-50ppm
R298 to R299	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R300 to R301	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R302 to R305	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R306	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R307	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
RLA	23486/231	RELAY MAGNETIC DPCO 12V1K028 SURFACE-MTG SO-8	OMRON	G6S-2G12VDC
RLB	23486/231	RELAY MAGNETIC DPCO 12V1K028 SURFACE-MTG SO-8	OMRON	G6S-2G12VDC
SKA	23443/855	CONNECTOR-RF BNC RECEPT50-OHM ELBOW PCB-MTG	AMPHENOL	31-5640-2010
SKC	23443/855	CONNECTOR-RF BNC RECEPT50-OHM ELBOW PCB-MTG	AMPHENOL	31-5640-2010
SKF	23443/855	CONNECTOR-RF BNC RECEPT50-OHM ELBOW PCB-MTG	AMPHENOL	31-5640-2010
SKP	23435/608	CONNECTOR TYPE-57 SKT24-WAY RT-ANG PCB-MTG	DDK	57LE-20240-7700-D35G
SKR	23437/076	CONNECTOR D-TYPE PLUG9-WAY RT-ANG PCB MTG	CINCH	DEB-9P1AENT2
TR1	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR2	28459/097	TRANSISTOR N-DEP JFETMMBFJ310.. MKD-6T SOT23	MOTOROLA	MMBFJ310LT1
TR3	28457/850	TRANSISTOR NPN FMMT2369.40V 600MHz MKD-*1J SOT23	MOTOROLA	MMBT2369LT1
TR4 to TR5	28461/864	TRANSISTOR NPN 3046...ARRAY 20V SO-14	HARRIS	A3046M
TR6	28459/097	TRANSISTOR N-DEP JFETMMBFJ310.. MKD-6T SOT23	MOTOROLA	MMBFJ310LT1
TR7	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR8	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B

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Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1 Control board (contd.)</b>				
TR9	28457/851	TRANSISTOR NPN BFS17..15V 1.3GHz MKD-E1 SOT-23	PHILIPS	BFS17
TR10	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR201	28454/818	TRANSISTOR NPN TIP41..40V 3MHz TO-220	MOTOROLA	TIP41
TR202	28434/951	TRANSISTOR PNP TIP42..40V 3MHz TO-220	MOTOROLA	TIP42

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board</b>				
When ordering, prefix circuit reference with AB1/1.				
	<b>44830/253TC</b>	<b>Complete unit with OCXO fitted</b>		
	<b>44830/253TT</b>	<b>Complete unit with TCXO fitted</b>		
C1	26386/982	CAPACITOR CERAMIC 2.2uF+/-80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C2	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C3				
C4	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C5	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C6	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C7	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C8	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C9	26386/932	CAPACITOR CERAMIC 1nF+/-1% 50V 1206	AVX	1206-5A-102-FAT-1A
C10	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C11	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C12	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C13	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C14	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C15	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C16				
C17	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C18	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
to C20				
C21	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C22				
C23	26585/003	CAPACITOR POLYESTR 470nF+/-10% 25V 7.3x9mm	PHILIPS	394-28474
C24	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C25	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C26	26386/760	CAPACITOR CERAMIC 220nF+/-10% 50V 1210	PHILIPS	1210-2R-224-K9-BBC
C27	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
to C28				
C29	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C30	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C31	26386/982	CAPACITOR CERAMIC 2.2uF+/-80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C32	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
C33	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C34	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C35	26386/816	CAPACITOR CERAMIC 22pF+/-5% 50V 0805	AVX	0805-5A-220-JAT-1A o
C36	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
to C37				
C38	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C39				
C40	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
to C42				
C43	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C45	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
to C53				
C54	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
to C57				
C58	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
C59 to C61	26386/601	CAPACITOR CERAMIC 470nF+/-10% 25V 1210	PHILIPS	1210-2R-474-K8-BBC
C62 to C64	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C65	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C66 to C68	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C70 to C83	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C84	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C85 to C99	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C100	26386/760	CAPACITOR CERAMIC 220nF+/-10% 50V 1210	PHILIPS	1210-2R-224-K9-BBC
C101	26451/010	CAPACITOR ALUM 100uF+/-20% 6.3V 6.6mmSQ	RUBYCON	6.3-REV-100
C102 to C111	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C112	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C113	26451/001	CAPACITOR ALUM 1uF+/-20% 50V 4.3mmSQ	RUBYCON	0-REV-1-M-0450
C114 to C118	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C119 to C121	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C122	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C123	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C124	26585/003	CAPACITOR POLYESTR 470nF+/-10% 25V 7.3x9mm	PHILIPS	394-28474
C125 to C130	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C131	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C202	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C203	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C204	26451/013	CAPACITOR ALUM 100uF+/-20% 35V 10.3mmSQ	RUBYCON	35-REV-100-M-(10mm)
C205	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C206	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C207	26451/013	CAPACITOR ALUM 100uF+/-20% 35V 10.3mmSQ	RUBYCON	35-REV-100-M-(10mm)
C208	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C209	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C210	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C211	26451/009	CAPACITOR ALUM 47uF+/-20% 16V 6.6mmSQ	RUBYCON	16-REV-47
C212	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C213	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C214	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C215	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C216	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C217 to C218	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C219	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C220	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C221	26451/013	CAPACITOR ALUM 100uF+/-20% 35V 10.3mmSQ	RUBYCON	35-REV-100-M-(10mm)
C222	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C223	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C224	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R



## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
C225 to C226	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C227	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C228	26451/013	CAPACITOR ALUM 100uF+/-20% 35V 10.3mmSQ	RUBYCON	35-REV-100-M-(10mm)
C229	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
C230 to C231	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C232	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
C233	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C234	26386/899	CAPACITOR CERAMIC 100nF+/-10% 50V 1206	AVX	1206-5C-104-KAT-1A o
C235	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
C236	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C237	26451/014	CAPACITOR ALUM 220uF+/-20% 16V 10.3mmSQ	RUBYCON	25-REV-220-M-(10mm)
C238	26451/004	CAPACITOR ALUM 10uF+/-20% 35V 5.3mmSQ	RUBYCON	35-REV-10
C239	26585/001	CAPACITOR POLYESTR 1uF+/-10% 63V 7.3x10mm	WIMA	SMD7.3-1uF10%-63V-TR
C240	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C241 to C242	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
C250 to C252	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C255 to C262	26386/783	CAPACITOR CERAMIC 330pF+/-1% 50V 0805	AVX	0805-5A-331-FAT-1A
C263 to C264	26386/875	CAPACITOR CERAMIC 10nF+/-10% 50V 0805	AVX	0805-5C-103-KAT-1A o
C265	26386/818	CAPACITOR CERAMIC 33pF+/-5% 50V 0805	AVX	0805-5A-330-JAT-1A o
D3	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D5	28357/030	DIODE 4004.. RECTIFIER400V S/M MELF	GENERAL SEMI	GL41G-46
D6 to D7	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D8	28357/030	DIODE 4004.. RECTIFIER400V S/M MELF	GENERAL SEMI	GL41G-46
D11 to D21	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D22	28373/273	DIODE BZX84-C22.. ZENER22V MKD-Y8 SOT-23	PHILIPS	BZX84-C22
D206	28383/934	DIODE LL4148.. SMALL-SIG50V MINI-MELF	GENERAL SEMI	LL4148
D207	28372/471	DIODE BZX84-C15.. ZENER15V MKD-Y4 SOT-23	PHILIPS	BZX84-C15
IC2	28467/133	IC-MICRO PROCESSOR80C188.. PLCC-68	AMD	N80C188-12
IC3 to IC4	28462/439	IC-DIGITAL LATCH74AC573.. OCT SO-20	HARRIS	D74AC573M
IC6	28467/117	IC-MICRO STATIC-RAMHM628128.. 128Kx8 SO-32	HITACHI	HM628128LFP-10SL
IC7	28471/051	IC-MICRO EEPROM28C256.. 32Kx8 PLCC-32	ATMEL	AT28C256-20JC
IC8	28466/385	IC-DIGITAL NAND-GATE74HCT00.. QUAD SO-14	PHILIPS	74HCT00D
IC12	28467/108	IC-MICRO DIGIT/SGNL PROCADSP2105.. PLCC-68	ANALOG	ADSP2105KP-55
IC13	28461/038	IC-ANALOG D/A-CONVERTERAD1856.. SO-16	ANALOG	AD1856R
IC15	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC20	28465/055	IC-DIGITAL DECDR/DEMPLEX74HC138.. SO-16	PHILIPS	74HC138D
IC21	28462/640	IC-DIGITAL FLIP-FLOP-D74HC175.. QUAD SO-16	HARRIS	D74HC175M
IC22	28466/032	IC-DIGITAL AND-GATE74HC08.. QUAD SO-14	PHILIPS	74HC08D
IC23	28469/660	IC-DIGITAL FP-GATE-ARRAYispLSI1032E.. FLT-PCK-1	LATTICE	ispLSI1032E-70LT
IC24	28466/393	IC-DIGITAL NAND-GATE74HC132.. QUAD SO-14	HARRIS	D74HC132M
IC25 to IC26	28462/157	IC-DIGITAL FLIP-FLOP-D74HC377.. OCTAL SO-20	PHILIPS	74HC377D

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
IC28	28469/063	IC-DIGITAL BFR/LINE-DRVR74HC125.. QUAD SO-14	PHILIPS	74HC125D
IC29	28469/786	IC-ANALOG MULTIPLEXER74HC4053.. TRIPLE SO-16	PHILIPS	74HC4053D
IC30	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC31 to IC32	28469/756	IC-ANALOG MULTIPLEXER74HC4051.. SO-16	PHILIPS	74HC4051D
IC33	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC34	28461/849	IC-ANALOG D/A-CONVERTERDAC-8840.. OCTAL SO-24	ANALOG	DAC-8840FS
IC35	28461/037	IC-ANALOG D/A-CONVERTERAD7537.. DUAL PLCC-28	ANALOG	AD7537JP
IC36	28469/786	IC-ANALOG MULTIPLEXER74HC4053.. TRIPLE SO-16	PHILIPS	74HC4053D
IC37 to IC38	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC39	28461/780	IC-ANALOG VOLTAGE-REG79L05AC.. SO-8	ST MICRO	L79L05ACZ
IC40	28466/393	IC-DIGITAL NAND-GATE74HC132.. QUAD SO-14	HARRIS	D74HC132M
IC41	28469/543	IC-DIGITAL COUNTER74HC390.. DUAL SO-16	PHILIPS	74HC390D
IC42	28469/768	IC-DIGITAL MULTIPLEXER74AC153.. DUAL SO-16	FAIRCHILD	74AC153SC
IC43	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
IC44	28462/638	IC-DIGITAL FLIP-FLOP-D74HC74.. DUAL SO-14	PHILIPS	74HC74D
IC45	28469/056	IC-DIGITAL INVERTER74AC14.. HEX SO-14	FAIRCHILD	4AC14SC
IC46	28466/414	IC-DIGITAL EXCLUSIVE-OR74HC86.. QUAD SO-14	PHILIPS	74HC86D
IC47	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
IC48	28461/458	IC-ANALOG OP AMPOP37.. SO-8	ANALOG	OP37GS
IC49	28461/507	IC-ANALOG OP AMPMC33076.. DUAL DIL-8	MOTOROLA	MC33076P1
IC50	28466/120	IC-DIGITAL OR-GATE74HC32.. QUAD SO-14	HARRIS	D74HC32M
IC51	28469/056	IC-DIGITAL INVERTER74AC14.. HEX SO-14	FAIRCHILD	4AC14SC
IC52	28469/617	IC-DIGITAL BFR/LINE-DRVR75C185.. SO-20	TEXAS	SN75C185DW
IC53	28467/123	IC-MICRO PERIPHERAL16C452.. PLCC-68	TEXAS	TL16C452FN
IC54	28466/600	IC-DIGITAL NAND-GATE74HC30.. SO-14	PHILIPS	74HC30D
IC55	28461/388	IC-ANALOG OP AMPLM324D.. QUAD SO-14	MOTOROLA	LM324D
IC56	28467/176	IC-MICRO CONTROLLER7210.. DIL-40	IOTECH	IOT7210P-(IN TUBES)
IC57	28469/616	IC-DIGITAL TRANSCEIVER75160.. OCT SO-20	TEXAS	SN75160BDW
IC58	28469/615	IC-DIGITAL TRANSCEIVER75161.. OCT SO-20	TEXAS	SN75161BDW
IC59 to IC60	28461/774	IC-ANALOG VOLTAGE-REG78L05AC.. SO-8	NATIONAL SEMI	LM78L05ACM
IC61	28469/543	IC-DIGITAL COUNTER74HC390.. DUAL SO-16	PHILIPS	74HC390D
IC62	28469/063	IC-DIGITAL BFR/LINE-DRVR74HC125.. QUAD SO-14	PHILIPS	74HC125D
IC63	28469/056	IC-DIGITAL INVERTER74AC14.. HEX SO-14	FAIRCHILD	4AC14SC
IC201	28461/776	IC-ANALOG VOLTAGE-REGLT1086.. 3-PIN TO-220	LINEAR TECH	LT1086CT
IC202	28461/613	IC-ANALOG COMPARATORLM393.. DUAL SO-8	PHILIPS	LM393D
IC203	28461/776	IC-ANALOG VOLTAGE-REGLT1086.. 3-PIN TO-220	LINEAR TECH	LT1086CT
IC204	28461/798	IC-ANALOG VOLTAGE-REFAD586.. SO-8	ANALOG	AD586JR
IC205	28461/507	IC-ANALOG OP AMPMC33076.. DUAL DIL-8	MOTOROLA	MC33076P1
IC206	28469/027	IC-DIGITAL INVERTER74HCT14.. HEX SO-14	PHILIPS	74HCT14D
IC207	28461/413	IC-ANALOG OP AMPTL074.. QUAD SO-14	MOTOROLA	TL074CD
L1	23642/091	INDUCTOR 10uH 20%SCREENED 7.3mmSQ	TOKO	646CY-100M-P
L2 to L6	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L201 to L202	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L203 to L205	23642/091	INDUCTOR 10uH 20%SCREENED 7.3mmSQ	TOKO	646CY-100M-P

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
L206 to L207	23642/726	INDUCTOR 100uH 10% MOULDED 3.2x4.5mm	MEGGITT	3613-A-101-K
L208	23642/091	INDUCTOR 10uH 20% SCREENED 7.3mmSQ	TOKO	646CY-100M-P
L209 to L210	24338/009	RESISTOR 390R 5% 1W100V 350ppm 2512	VTM	509-0-390R-5%-V5
PLD	23437/046	CONNECTOR PCB-HEADER26-WAY STRT 2-ROW	FCI	75869-305
PLG	23445/501	CONNECTOR-RF MMCX JACK50-OHM SURFACE MTG	HUBER & SUHNER	82MMCX-S50-0-51
PLH	23437/048	CONNECTOR PCB-HEADER40-WAY STRT 2-ROW	FCI	75869-307
PLK	23437/073	CONNECTOR PCB-HEADER3-WAY STRT SURFACE MTG	SAMTEC	T M-103-01-S-SV-P
PLL	23437/073	CONNECTOR PCB-HEADER3-WAY STRT SURFACE MTG	SAMTEC	T M-103-01-S-SV-P
PLM	23437/073	CONNECTOR PCB-HEADER3-WAY STRT SURFACE MTG	SAMTEC	T M-103-01-S-SV-P
PLN	23437/074	CONNECTOR PCB-HEADER16-WAY STRT SURFACE MTG	SAMTEC	T M-108-01-S-DV-P
PLS	23437/089	CONNECTOR PCB-HEADEER8-WAY STRT SURFACE MTG	SAMTEC	TSM-108-01-S-SV-P
R1	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R2 to R3	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R4	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R5 to R6	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R7 to R8	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R9	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R11 to R14	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R15	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R16	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R17 to R18	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R35	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R36 to R40	24811/160	RESISTOR 301R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-301R-1%-50ppm
R41	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R42	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R43	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R44	24811/190	RESISTOR 5K11 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-5K11-1%-50ppm
R45	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R46	24811/209	RESISTOR 33K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-33K2-1%-50ppm
R47	24811/145	RESISTOR 68R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68R1-1%-50ppm
R48	24811/172	RESISTOR 909R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-909R-1%-50ppm
R49	24811/203	RESISTOR 18K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18K2-1%-50ppm
R50	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R51 to R52	24811/234	RESISTOR 365K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-365K-1%-50ppm
R53	24811/233	RESISTOR 332K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-332K-1%-50ppm
R54	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R55 to R56	24811/234	RESISTOR 365K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-365K-1%-50ppm
R57	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R58	24811/195	RESISTOR 8K25 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-8K25-1%-50ppm
R59	24811/194	RESISTOR 7K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-7K5-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
R60 to R61	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R62	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R64	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R65	24811/237	RESISTOR 475K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475K-1%-50ppm
R66	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R67	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R68	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R69	24811/205	RESISTOR 22K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-22K1-1%-50ppm
R70	24811/160	RESISTOR 301R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-301R-1%-50ppm
R71	24811/212	RESISTOR 43K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-43K2-1%-50ppm
R72	24811/231	RESISTOR 274K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-274K-1%-50ppm
R73	24811/207	RESISTOR 27K4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27K4-1%-50ppm
R74	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R75	24811/203	RESISTOR 18K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18K2-1%-50ppm
R76	24811/193	RESISTOR 6K81 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-6K81-1%-50ppm
R77	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R78	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R79	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R80	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R81	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R82	24811/203	RESISTOR 18K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-18K2-1%-50ppm
R84	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R85	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R86	24811/163	RESISTOR 392R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-392R-1%-50ppm
R87	24811/145	RESISTOR 68R1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-68R1-1%-50ppm
R88 to R89	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R90	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R91	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R92	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R93	24811/218	RESISTOR 75K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-75K0-1%-50ppm
R94	24811/153	RESISTOR 150R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-150R-1%-50ppm
R95	24811/209	RESISTOR 33K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-33K2-1%-50ppm
R96 to R97	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R98	24811/193	RESISTOR 6K81 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-6K81-1%-50ppm
R99	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R100 to R101	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R102	24811/209	RESISTOR 33K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-33K2-1%-50ppm
R103	24811/195	RESISTOR 8K25 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-8K25-1%-50ppm
R104	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R105 to R106	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R107	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R108	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R109 to R110	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
R111 to R112	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R113	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R114	24811/215	RESISTOR 56K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-56K2-1%-50ppm
R115	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R116	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R117	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R118 to R119	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R120	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R121 to R122	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R123 to R124	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R125	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R126	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R127	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R128	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R129	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R130	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R131	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R132	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R133 to R134	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R135 to R136	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R137	24811/170	RESISTOR 750R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-750R-1%-50ppm
R138	24811/172	RESISTOR 909R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-909R-1%-50ppm
R139	24811/207	RESISTOR 27K4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27K4-1%-50ppm
R141	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R142 to R145	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R146 to R147	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R148	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R149	24811/196	RESISTOR 9K09 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-9K09-1%-50ppm
R150	24811/170	RESISTOR 750R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-750R-1%-50ppm
R151	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R152	24811/101	RESISTOR 1R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1R0-1%-50ppm
R154	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R157	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R158	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R159	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R160	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R161	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R162	24811/218	RESISTOR 75K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-75K0-1%-50ppm
R163	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R165	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R166	24811/213	RESISTOR 47K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47K5-1%-50ppm
R167	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
R168	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R169	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R170	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R171 to R173	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R175	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R176	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R177	24811/160	RESISTOR 301R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-301R-1%-50ppm
R178	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R179	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R180	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R181	24811/207	RESISTOR 27K4 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-27K4-1%-50ppm
R182 to R184	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R185 to R192	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R193 to R199	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R200	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R201	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R202	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R203	24811/208	RESISTOR 30K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-30K1-1%-50ppm
R204	24811/219	RESISTOR 82K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-82K5-1%-50ppm
R205	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R206	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R207	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R208	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R211	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R212	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R213	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R214 to R215	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R216 to R217	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R218	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R219	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R220	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R221	24811/201	RESISTOR 15K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-15K-1%-50ppm
R222	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R223	24811/234	RESISTOR 365K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-365K-1%-50ppm
R224	24811/189	RESISTOR 4K75 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-4K75-1%-50ppm
R225	24811/245	RESISTOR 1M 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1M0-1%-50ppm
R226	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R227	24811/175	RESISTOR 1K21 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K21-1%-50ppm
R228	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm
R229	24811/170	RESISTOR 750R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-750R-1%-50ppm
R231	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R232	24811/172	RESISTOR 909R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-909R-1%-50ppm
R233	24811/151	RESISTOR 121R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-121R-1%-50ppm
R234	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm

## REPLACEABLE PARTS

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
R235	24811/179	RESISTOR 1K82 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K82-1%-50ppm
R236 to R237	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R238	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R240 to R241	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
R270	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R271	24811/182	RESISTOR 2K43 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K43-1%-50ppm
R272	24811/153	RESISTOR 150R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-150R-1%-50ppm
R273	24811/141	RESISTOR 47R5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-47R5-1%-50ppm
R280	24811/194	RESISTOR 7K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-7K5-1%-50ppm
R281	24811/174	RESISTOR 1K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K1-1%-50ppm
R282	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R283	24811/200	RESISTOR 13K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-13K-1%-50ppm
R284	24811/173	RESISTOR 1K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-1K0-1%-50ppm
R285	24811/211	RESISTOR 39K2 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-39K2-1%-50ppm
R286 to R287	24811/200	RESISTOR 13K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-13K-1%-50ppm
R288	24811/183	RESISTOR 2K74 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-2K74-1%-50ppm
R289	24811/200	RESISTOR 13K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-13K-1%-50ppm
R290 to R291	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R292	24811/194	RESISTOR 7K5 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-7K5-1%-50ppm
R293	24811/199	RESISTOR 12K1 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-12K1-1%-50ppm
R294 to R295	24811/198	RESISTOR 11K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-11K-1%-50ppm
R296	24811/200	RESISTOR 13K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-13K-1%-50ppm
R297	24811/198	RESISTOR 11K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-11K-1%-50ppm
R298 to R299	24811/197	RESISTOR 10K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-10K-1%-50ppm
R300 to R301	24811/149	RESISTOR 100R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100R-1%-50ppm
R302 to R305	24811/221	RESISTOR 100K 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-100K-1%-50ppm
R306 to R307	24811/165	RESISTOR 475R 1% 250mW200V 50ppm MINI-MELF	VTM	501-0-475R-1%-50ppm
RLA	23486/231	RELAY MAGNETIC DPCO 12V1K028 SURFACE-MTG SO-8	OMRON	G6S-2G12VDC
RLB	23486/231	RELAY MAGNETIC DPCO 12V1K028 SURFACE-MTG SO-8	OMRON	G6S-2G12VDC
SKA	23443/855	CONNECTOR-RF BNC RECEPT50-OHM ELBOW PCB-MTG	AMPHENOL	31-5640-2010
SKC	23443/855	CONNECTOR-RF BNC RECEPT50-OHM ELBOW PCB-MTG	AMPHENOL	31-5640-2010
SKF	23443/855	CONNECTOR-RF BNC RECEPT50-OHM ELBOW PCB-MTG	AMPHENOL	31-5640-2010
SKP	23435/608	CONNECTOR TYPE-57 SKT24-WAY RT-ANG PCB-MTG	DDK	57LE-20240-7700-D35G
SKR	23437/076	CONNECTOR D-TYPE PLUG9-WAY RT-ANG PCB-MTG	CINCH	DEB-9P1AENT2
SKT	23437/541	CONNECTOR SKT 20-WAYSTRT 2-ROW PCB-MTG	HARWIN	M20-9831022
T1	43590/245	WOUND TRANSFORMER RINGCORE 2:11 TURNS		
TR1	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR2	28459/097	TRANSISTOR N-DEP JFETMMBFJ310.. MKD-6T SOT23	MOTOROLA	MMBFJ310LT1
TR3	28457/850	TRANSISTOR NPN FMMT2369.40V 600MHz MKD-*1J SOT23	MOTOROLA	MMBT2369LT1
TR4 to TR5	28461/864	TRANSISTOR NPN 3046...ARRAY 20V SO-14	HARRIS	A3046M
TR6	28459/097	TRANSISTOR N-DEP JFETMMBFJ310.. MKD-6T SOT23	MOTOROLA	MMBFJ310LT1

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Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
<b>AB1/1 Control board (contd.)</b>				
TR7	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR8	28433/828	TRANSISTOR PNP BC858B..30V 150MHz MKD-3K SOT-23	PHILIPS	BC858B
TR9	28457/851	TRANSISTOR NPN BFS17..15V 1.3GHz MKD-E1 SOT-23	PHILIPS	BFS17
TR10	28453/829	TRANSISTOR NPN BC848B..30V 200MHz MKD-1K SOT-23	PHILIPS	BC848B
TR11	28435/229	TRANSISTOR PNP BCX51..45V 50MHz SOT-89	PHILIPS	BCX51
TR201	28454/818	TRANSISTOR NPN TIP41..40V 3MHz TO-220	MOTOROLA	TIP41
TR202	28434/951	TRANSISTOR PNP TIP42..40V 3MHz TO-220	MOTOROLA	TIP42



## REPLACEABLE PARTS

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Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
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### AB2 SINAD board

**44830/248** Complete unit

**Note:** there is no component parts list or circuit diagram for this board as it may only be replaced as a complete unit.

### AC1 Backlight inverter board

When ordering, prefix circuit reference with AC1.

**44830/004** Complete unit

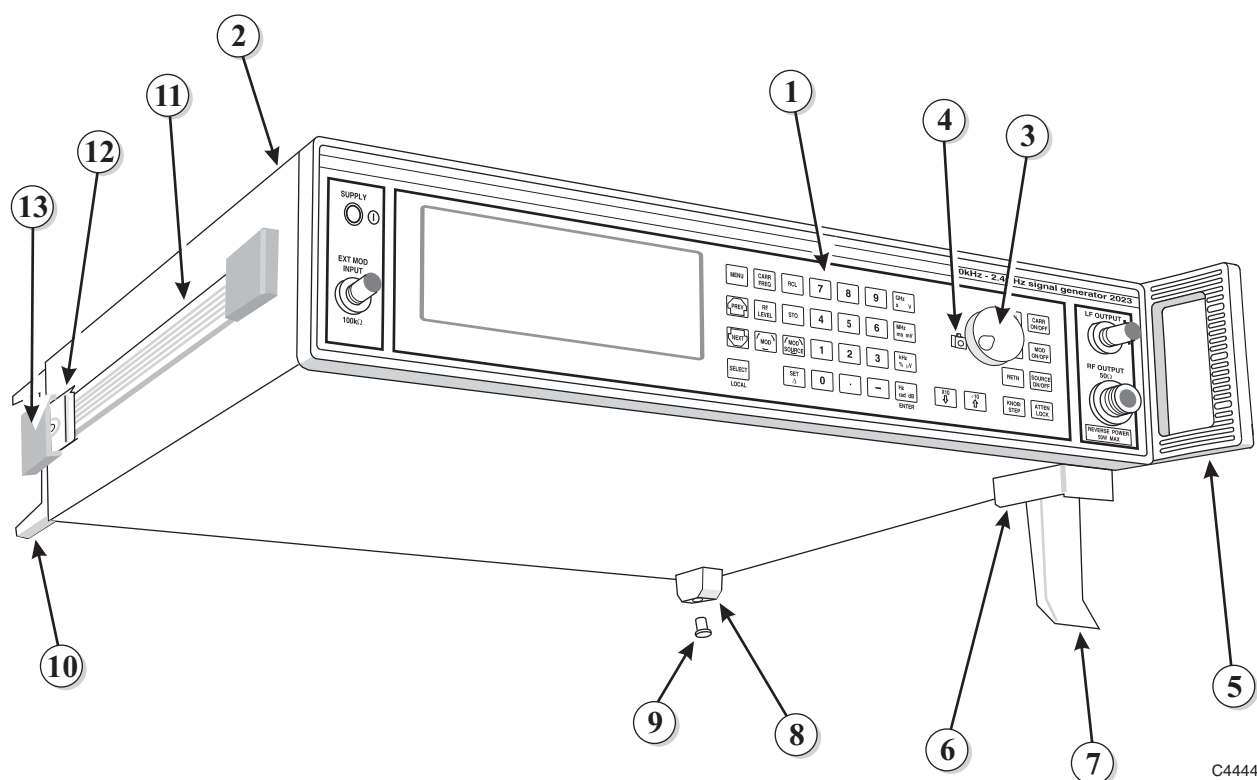
C1	26386/982	CAPACITOR CERAMIC 2.2uF-20/+80% 16V 1206	TDK	CC1206C-Y5V-225Z-T&R
C2 to C6	26451/015	CAPACITOR ALUM 470uF+/-20% 10V 10.3mmSQ	RUBYCON	10-REV-470-M-(10mm)
L1	23642/091	INDUCTOR 10uH 20%SCREENED 7.3mmSQ	TOKO	646CY-100M-P
L2 to L3	23642/064	INDUCTOR 1mH 10%UNSCRND AIR-CORE RADIAL	TOKO	494HYF0140K
PLCA	23437/073	CONNECTOR PCB-HEADER3-WAY STRT SURFACE MTG	SAMTEC T	M-103-01-S-SV-P
PLCB	23437/067	CONNECTOR PCB-HEADER4-WAY RT-ANG	JST	B4PS-VH
PLCC	23437/073	CONNECTOR PCB-HEADER3-WAY STRT SURFACE MTG	SAMTEC T	M-103-01-S-SV-P
X1	28469/054	POWER-SUPPLY INVERTERDC/AC CXA-L10A.. 5-PIN	TDK	CXA-L10A

Cir. Ref.	IFR part number	Description	Manufacturer	Manufacturer's part number
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## Miscellaneous mechanical parts

Order without prefix. Item numbers as show in Fig. 6-3.

Item no.	Description	Part no.
1	Front panel marked (standard instrument)	46662/544
	Front panel marked (Option 7 and Option 11 instrument)	46662/618
2	Instrument cover	41590/289
3	Knob, control	37591/605
4	Collet	37591/452
5	Front panel handle, 1 of 2	37591/674
6	Front foot, 1 of 2	37591/643
7	Tilt foot, 1 of 2	37591/439
8	Rear foot, 1 of 2	37591/460
9	Stud, 1 of 2	37591/461
10	Rear panel stand-off 1 of 2	37591/580
11	Side handle	41700/756
12	End cap, 1 of 2	22315/584
13	Cover 1 of 2	37591/668
[The marked rear panel is part of the main chassis.]		
	Grommet, open	23184/131



C4444

Fig. 6-3 Miscellaneous mechanical parts

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# Chapter 7

## SERVICING DIAGRAMS

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Circuit notes .....	7-1
Component values.....	7-1
Symbols .....	7-1
PCB layouts .....	7-1

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## Circuit notes

### Component values

Resistors :	R = ohms,	k = kilohms,	M = megohms.
Capacitor :	$\mu$ = microfarads,	n = nanofarads,	p = picofarads.
Inductors :	$\mu$ = microhenries,	m = millihenries.	
SIC :	= value selected during test, nominal value shown.		

### Symbols

Symbols are to IEC617 (BS 3939) with the following additions :



Static sensitive component



Test point

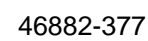


Unit identification

### PCB layouts

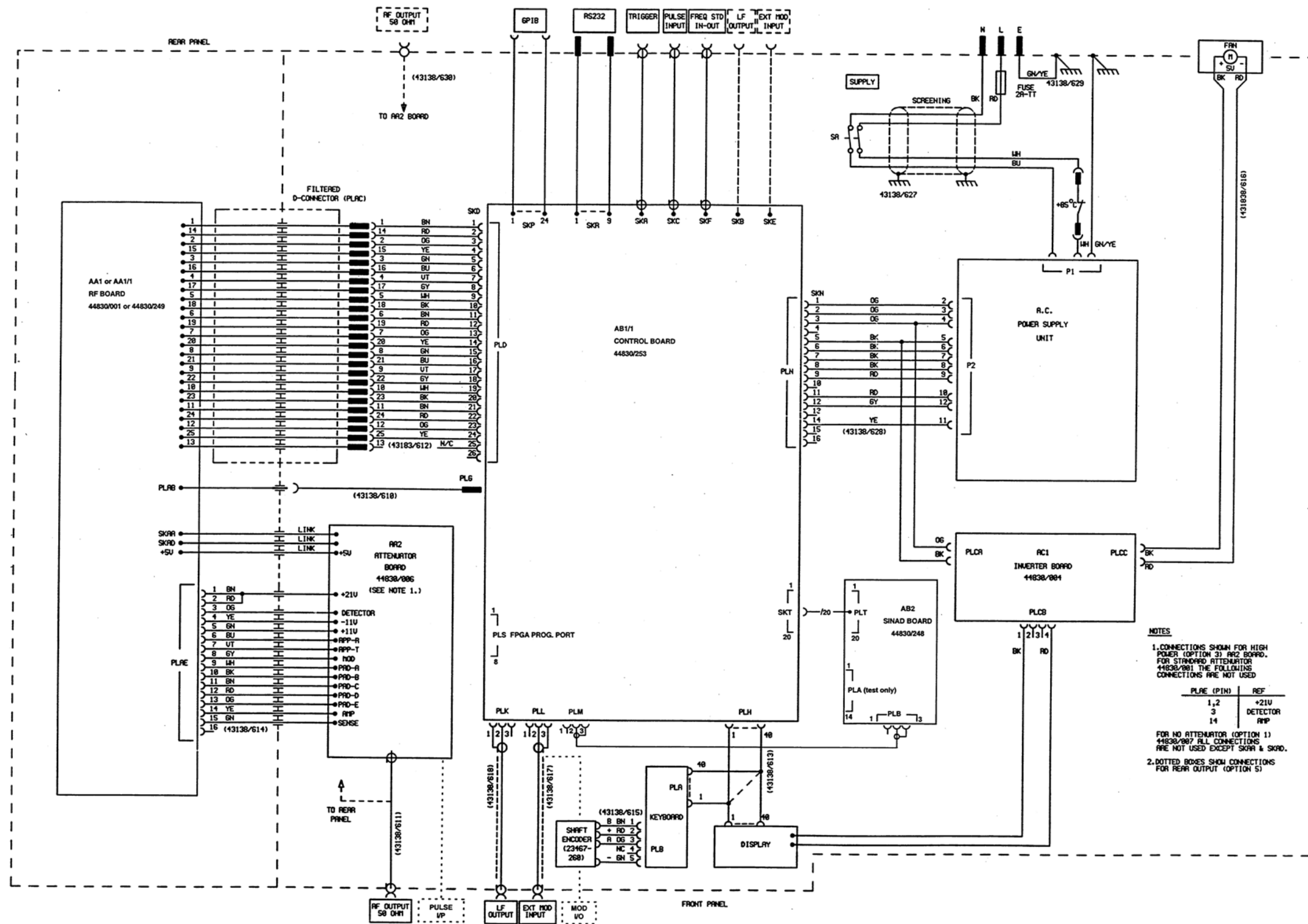
Unless otherwise stated, PCB layouts are shown as viewed from the component side.

Fig. 7-1 A0 Interconnections for 2023 and 2024

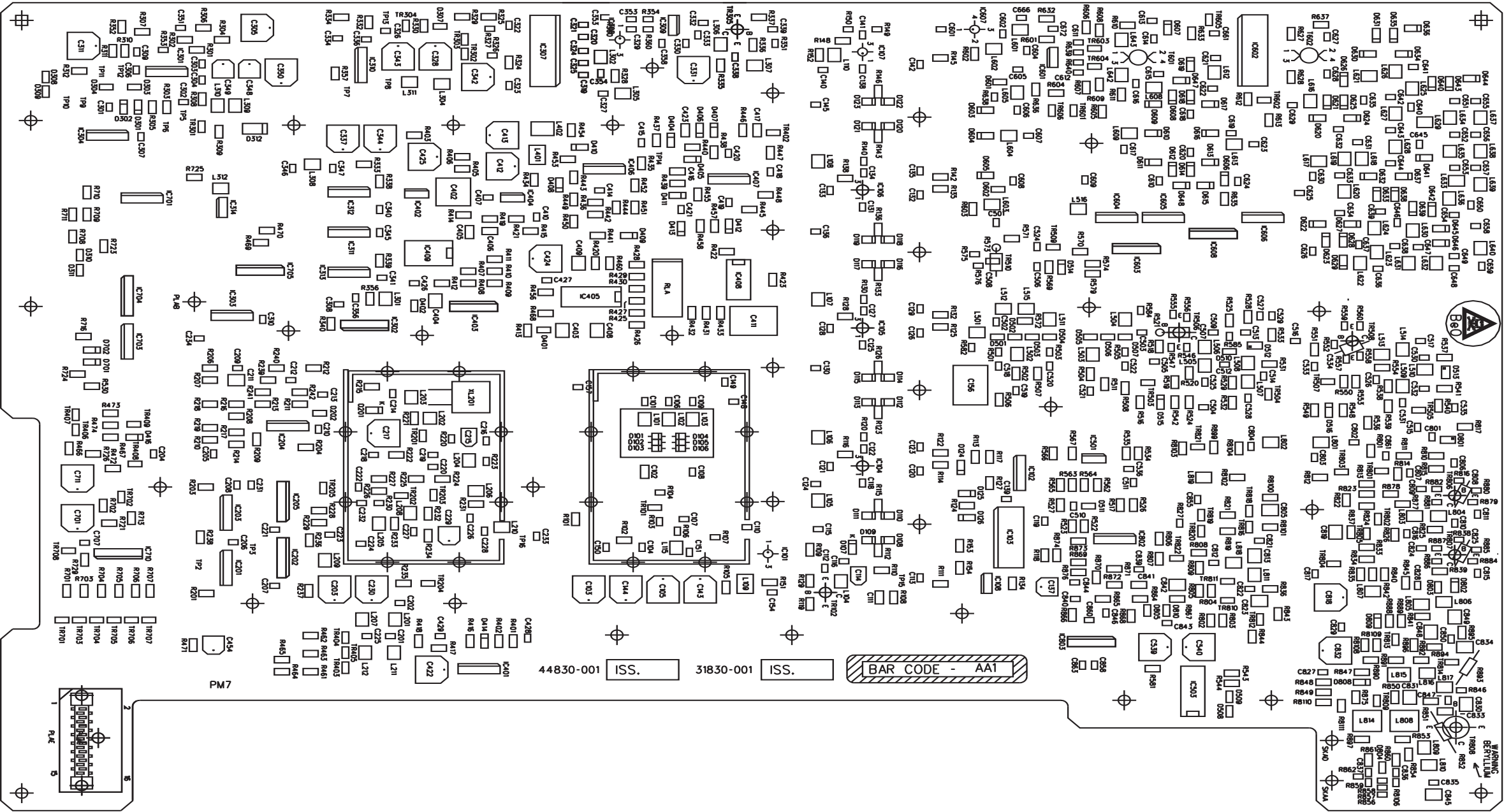


Interconnections **A0** (2023, 2024)

# Interconnections **A0** (2023A, 2023B, 2025)

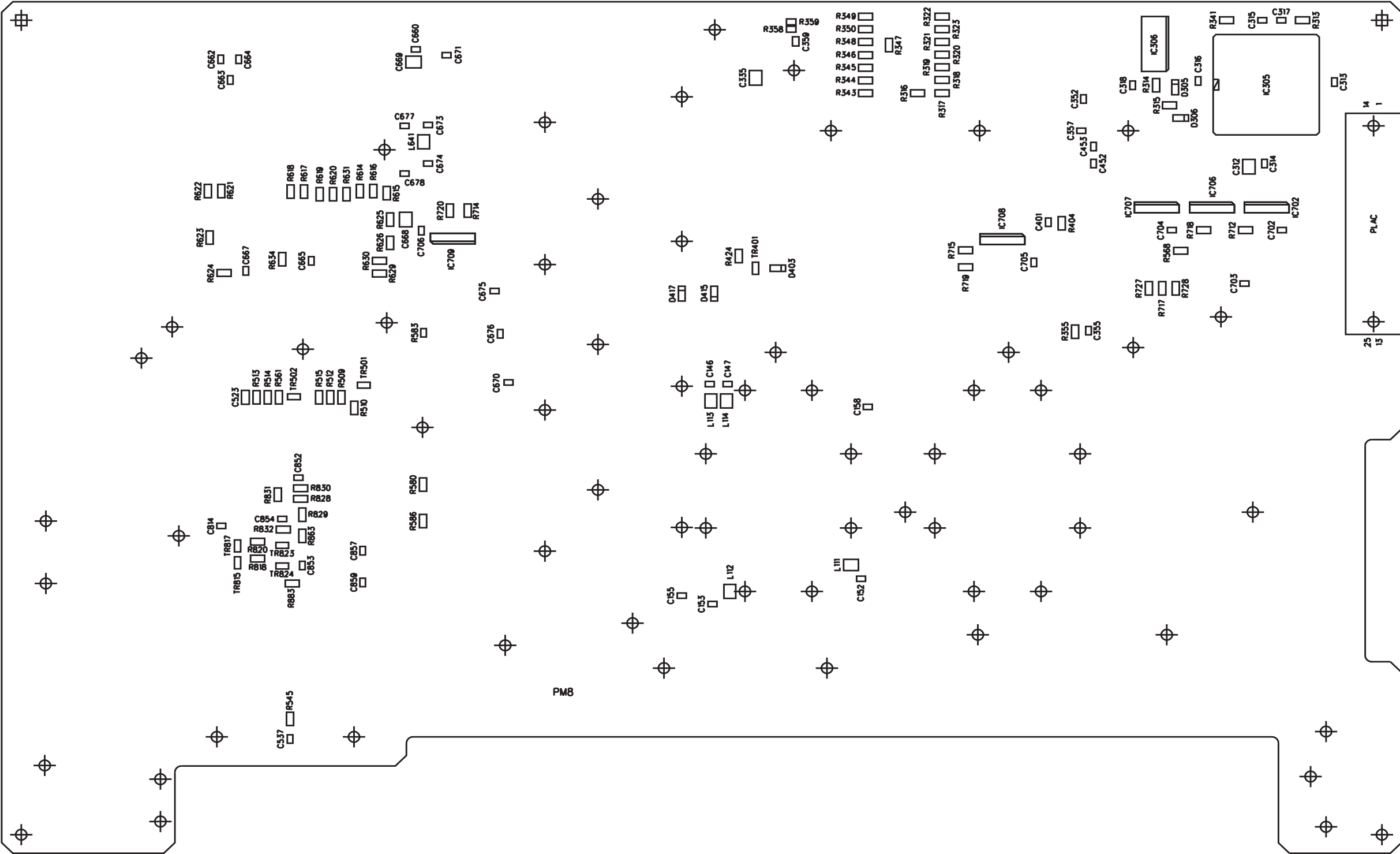


RF board component layout **AA1**



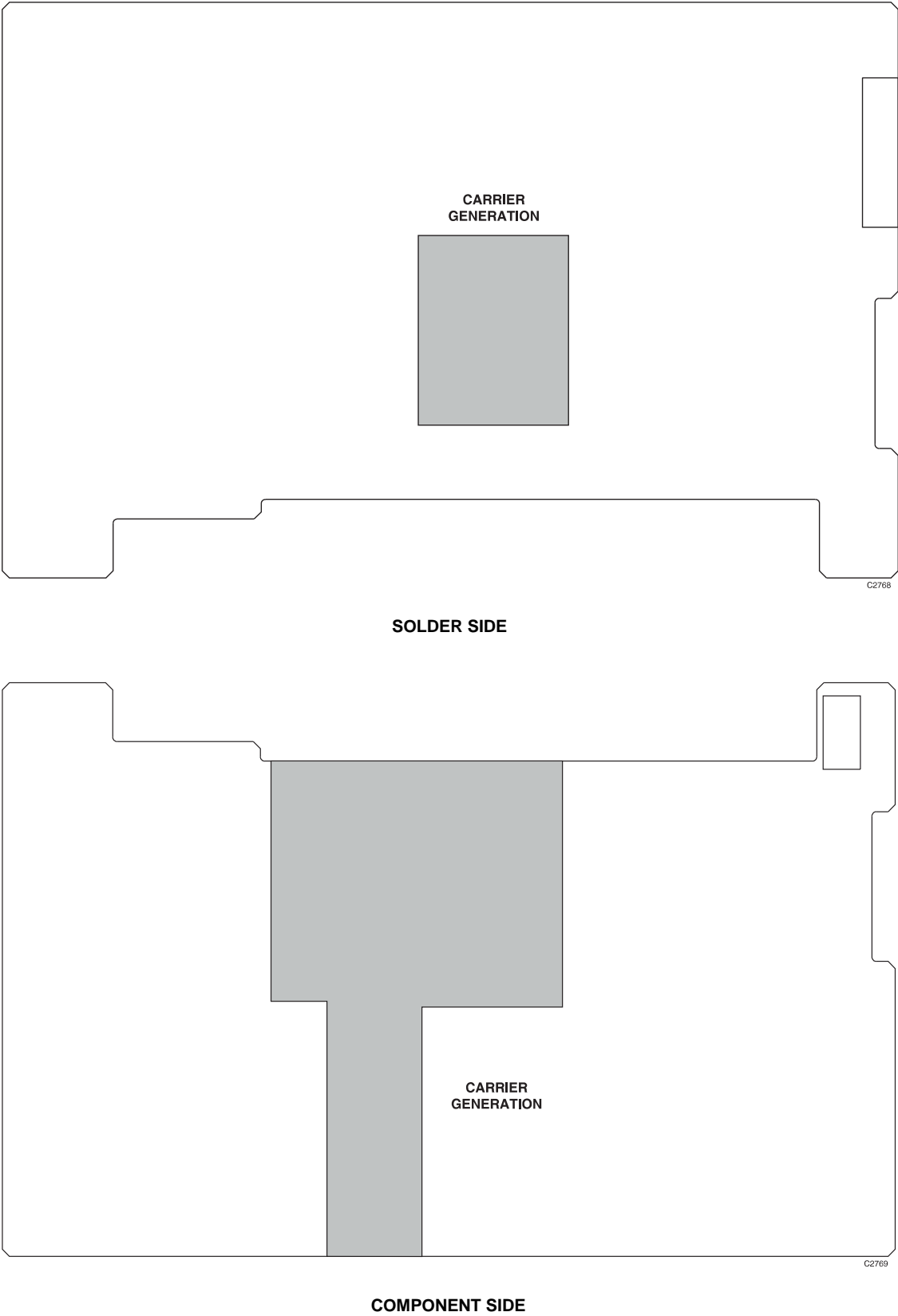
**Interconnections A0** (2023A, 2023B, 2025)

RF board component layout **AA1**



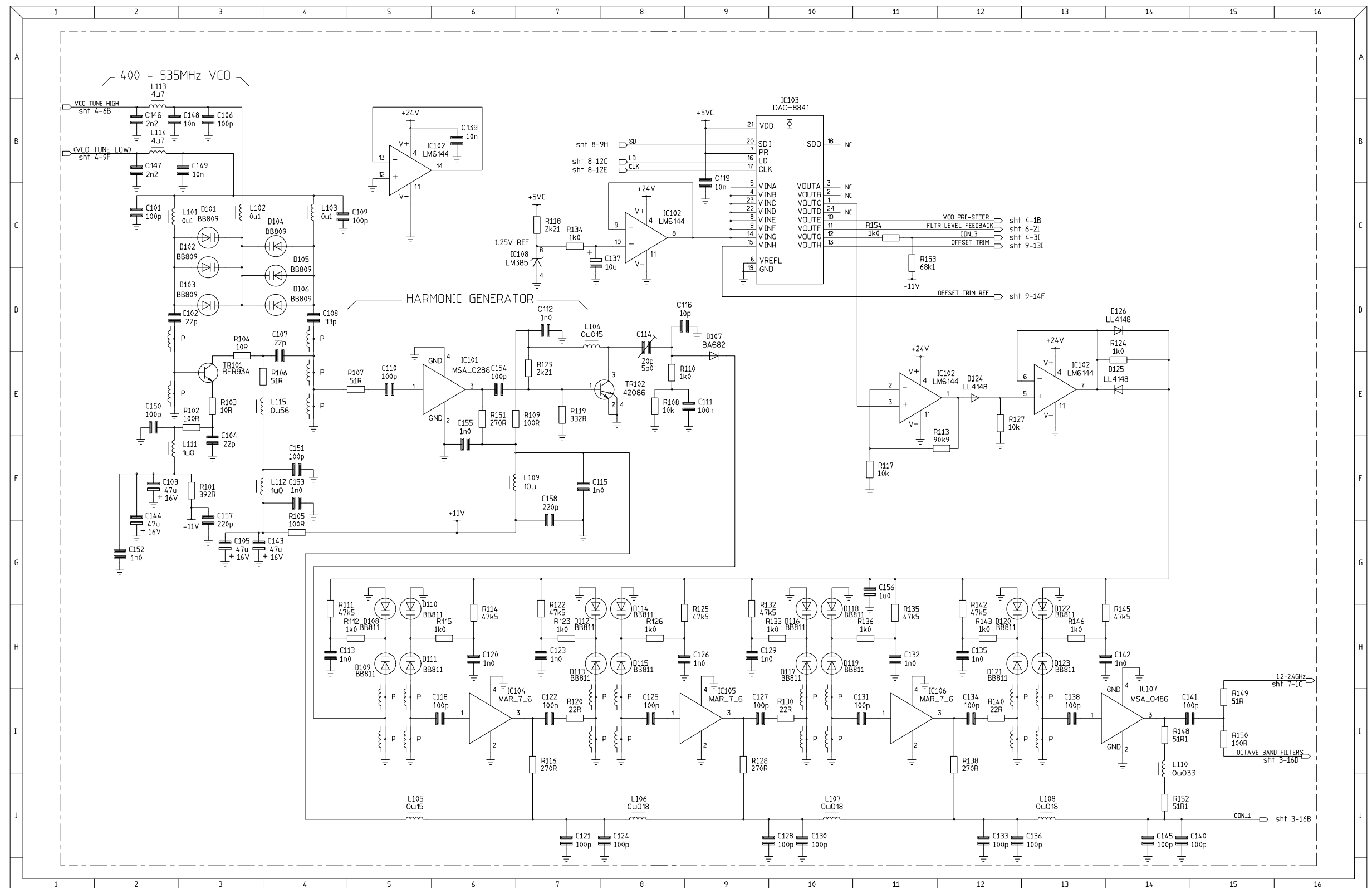


Sheet 1 component locations **AA1**

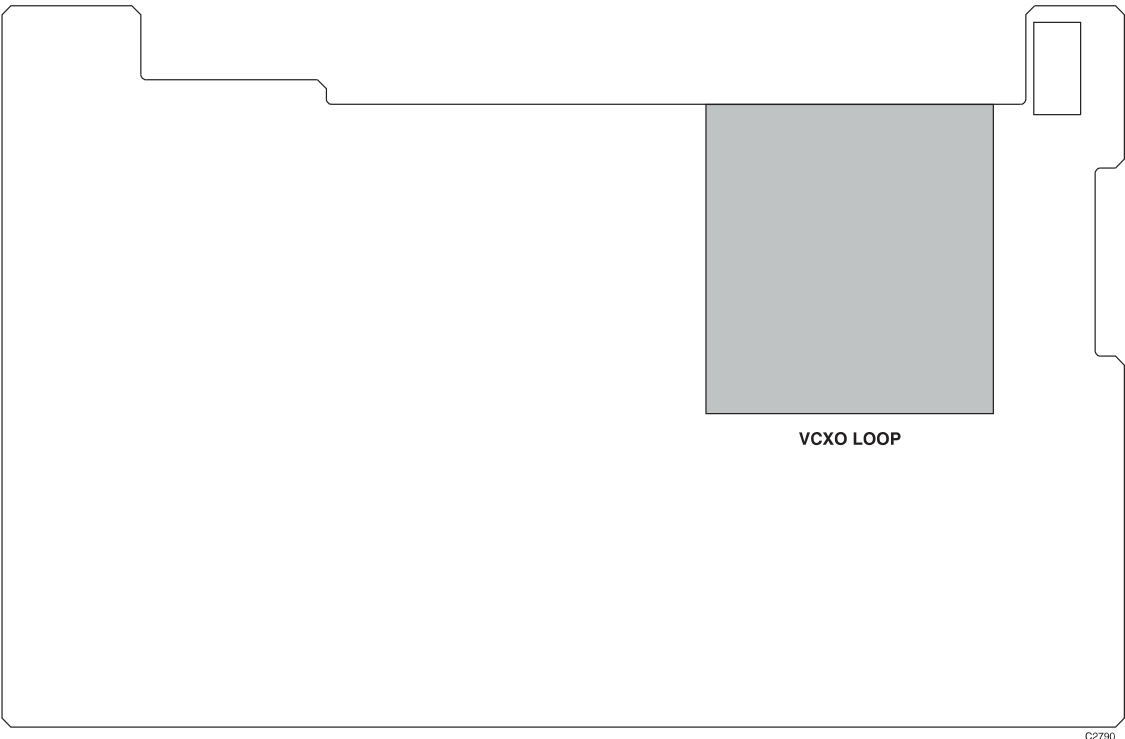


RF board component layout **AA1**

Fig. 7-5 AA1 RF board: Sheet 1 component locations

Carrier generation **AA1**

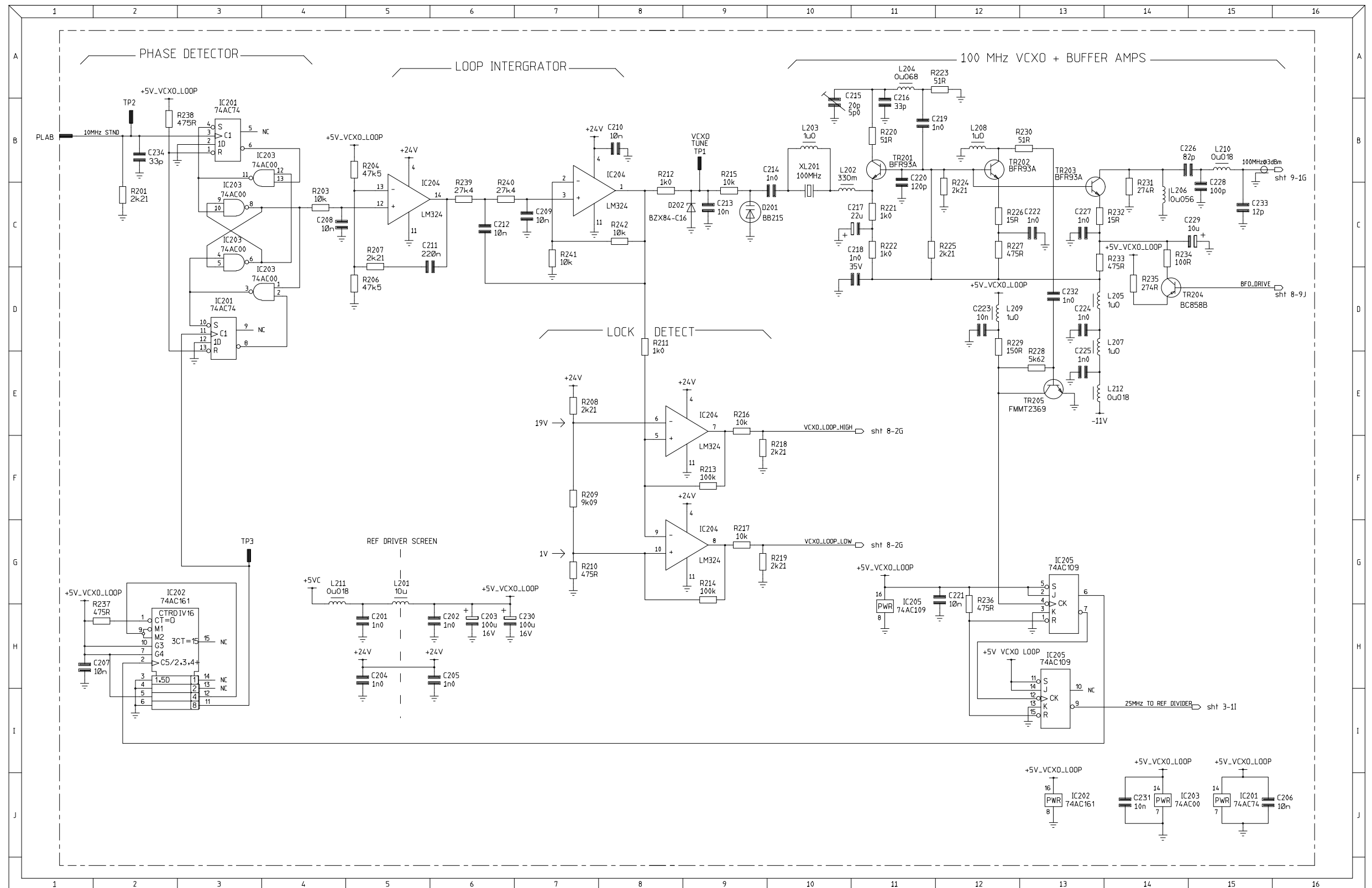
Sheet 2 component locations **AA1**



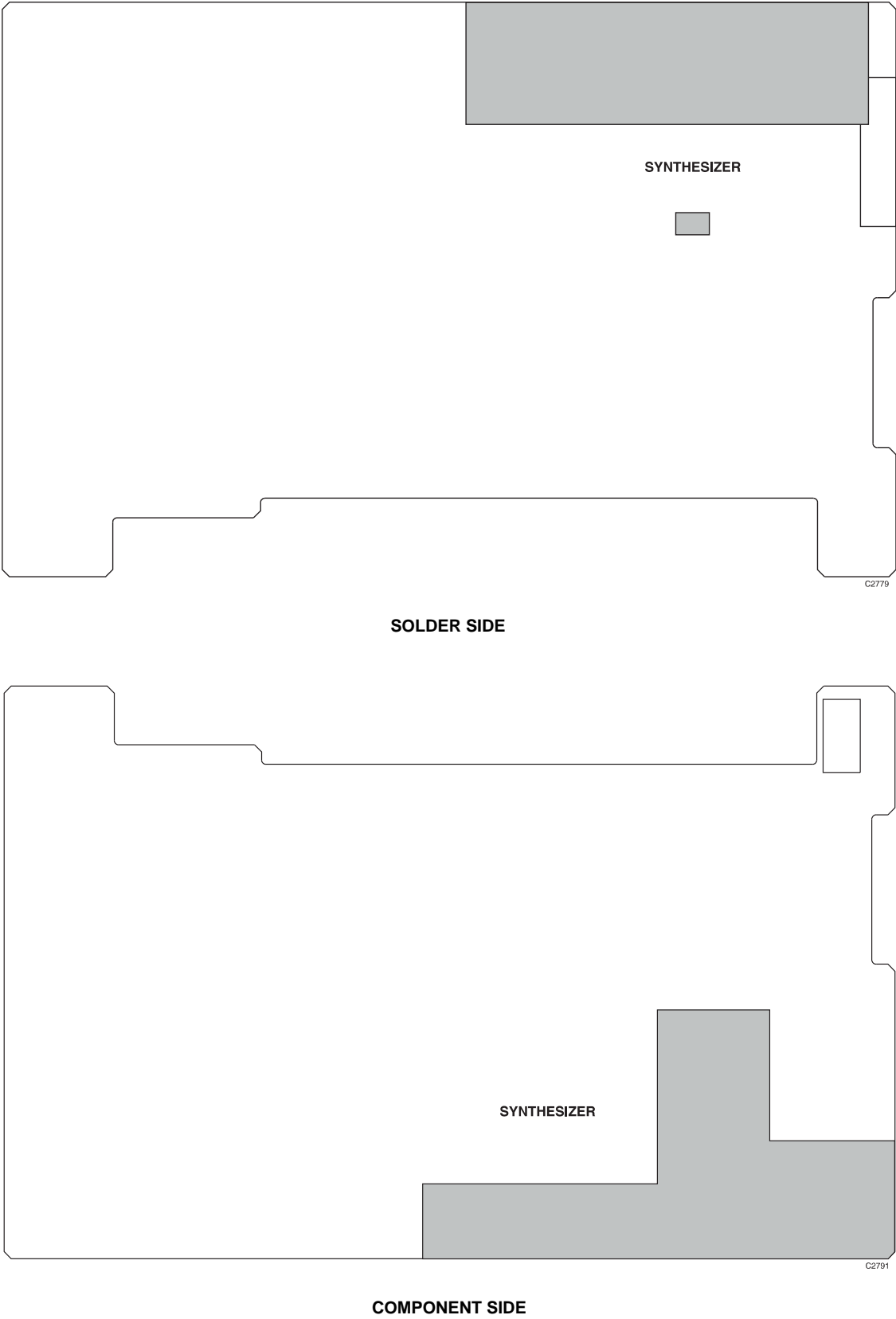
COMPONENT SIDE

Carrier generation **AA1**

Fig. 7-7 AA1 RF board: Sheet 2 component locations

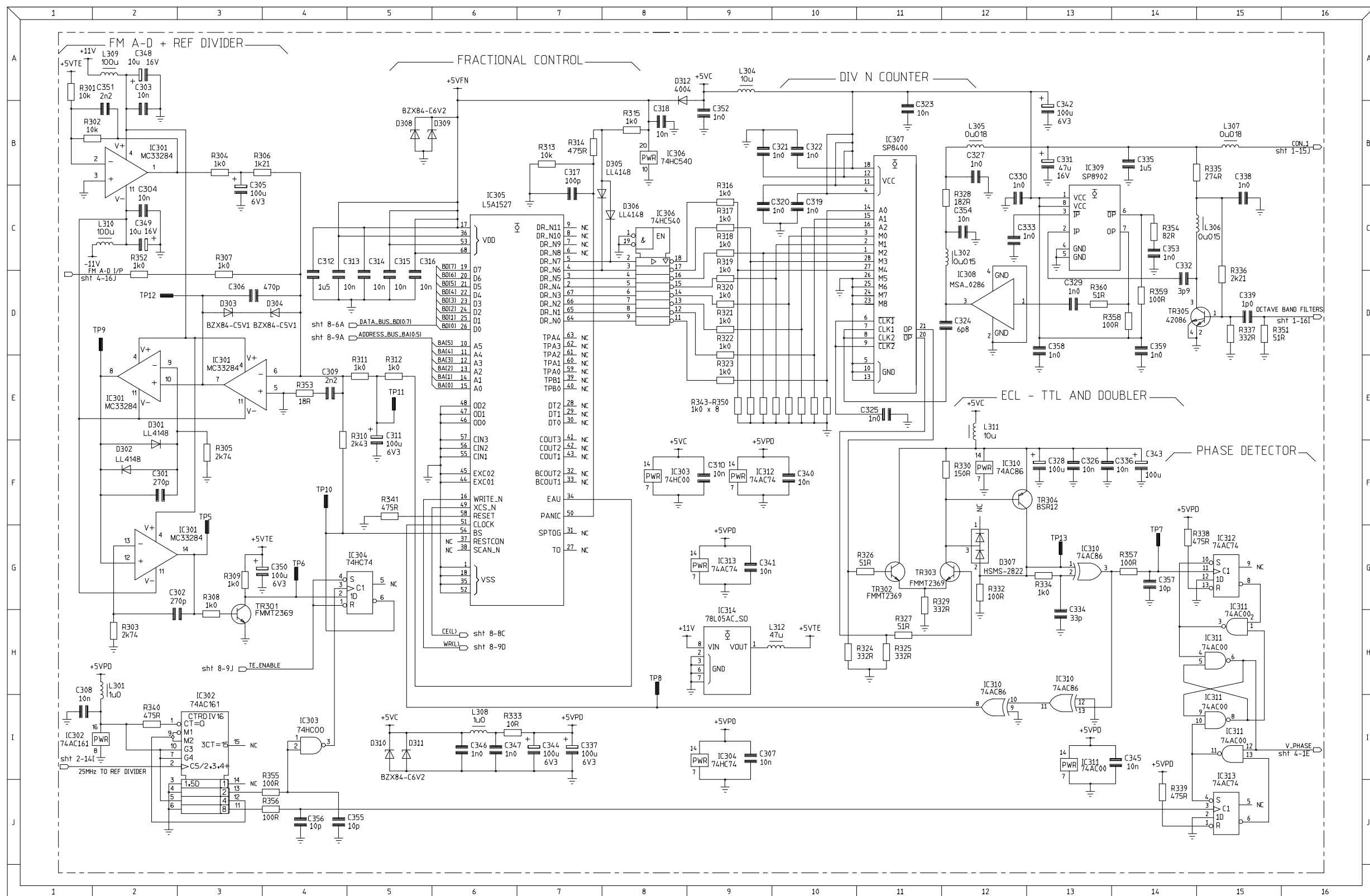
VCXO loop **AA1**

Sheet 3 component locations **AA1**

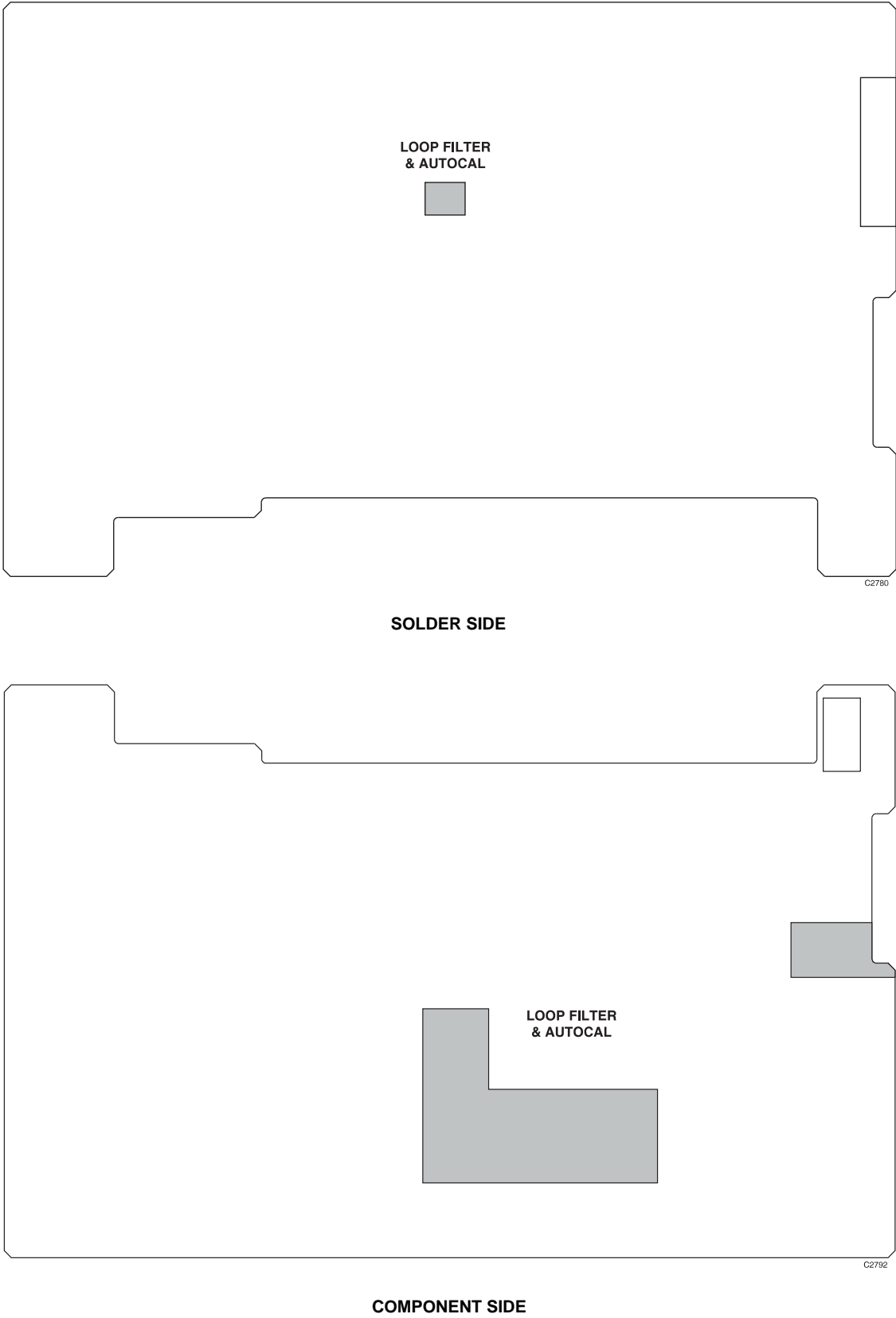


**VCXO loop AA1**

Fig. 7-9 AA1 RF board: Sheet 3 component locations

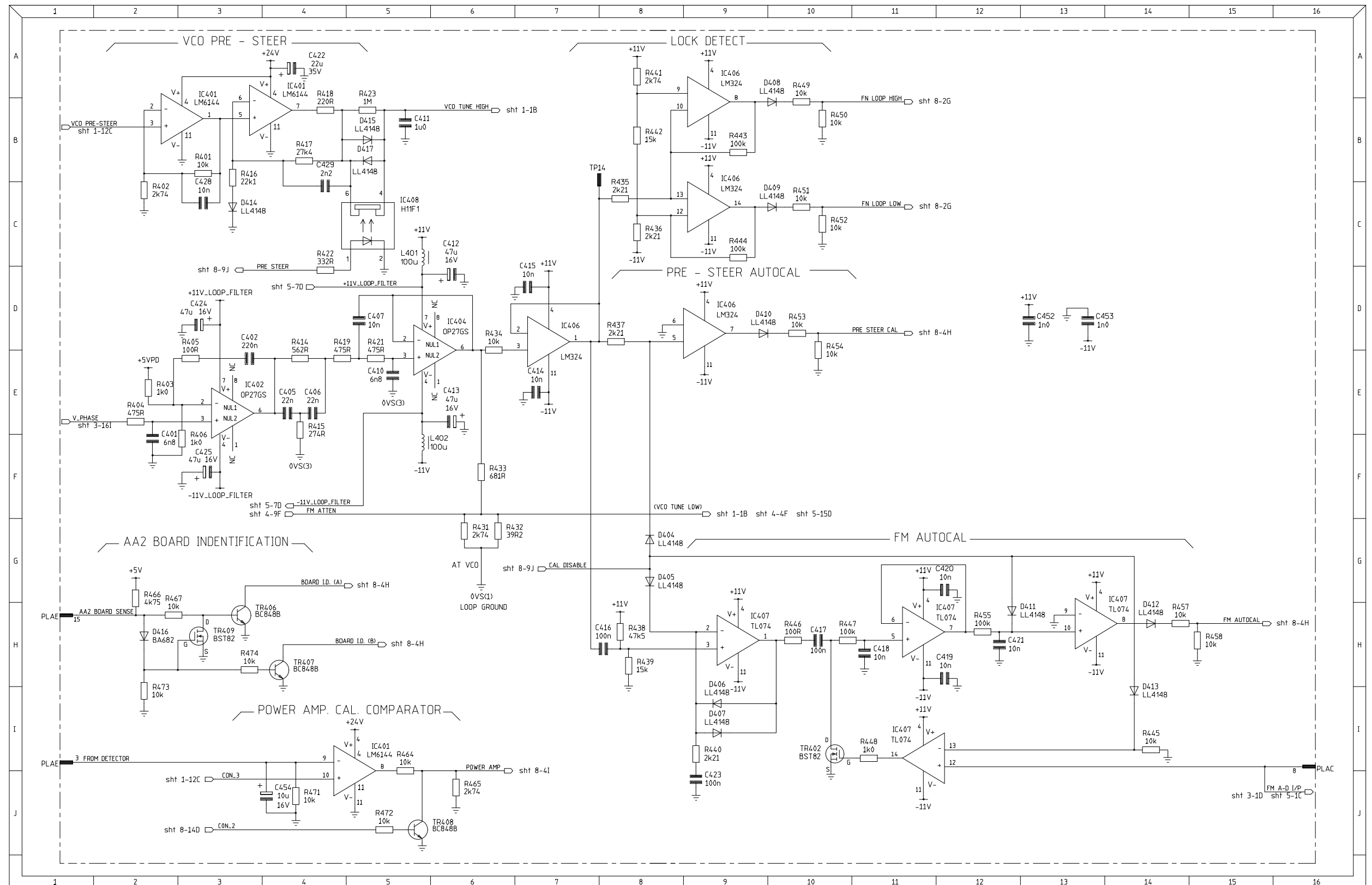
Synthesizer **AA1**

Sheet 4 component locations **AA1**



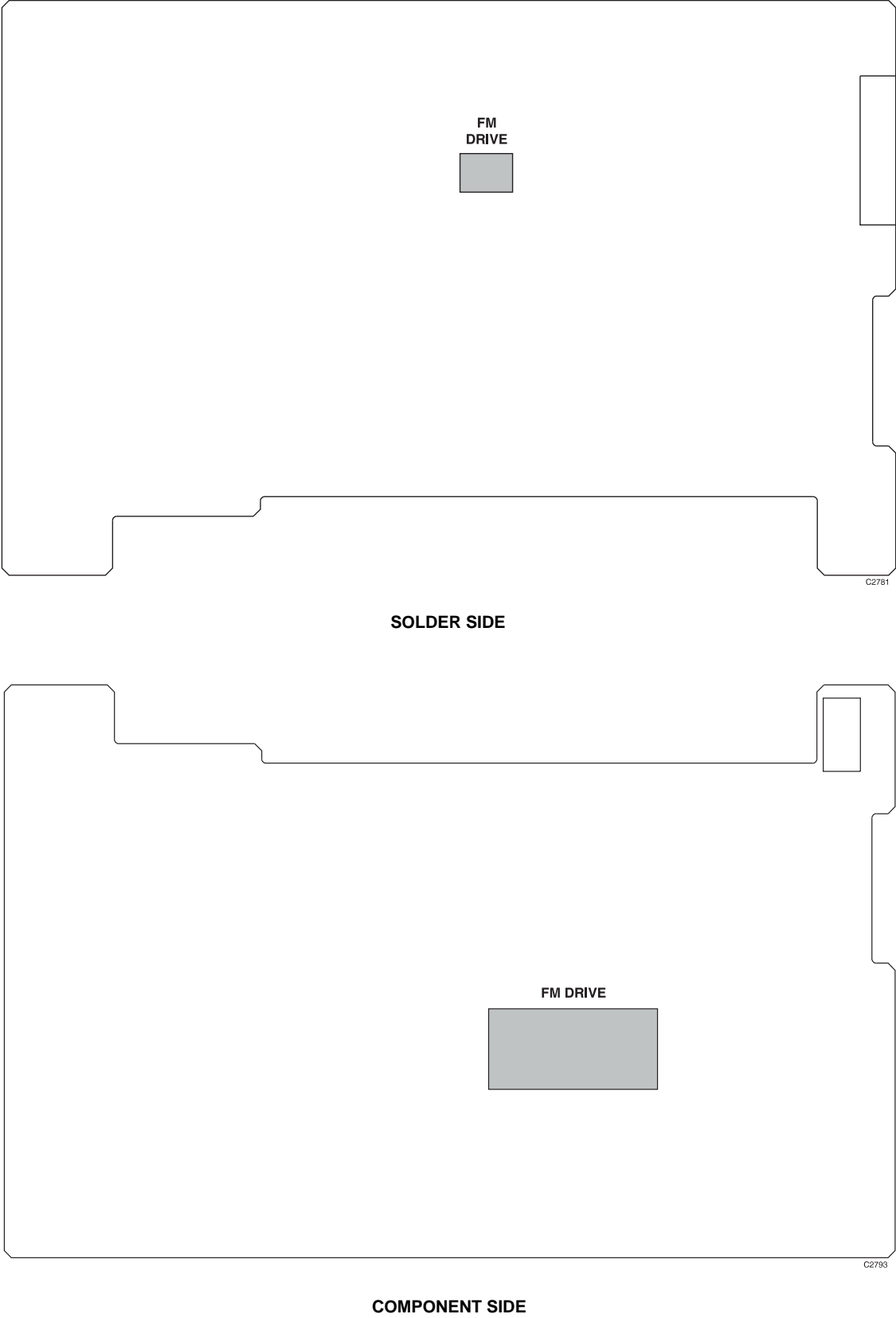
**Synthesizer AA1**

Fig. 7-11 AA1 RF board: Sheet 4 component locations

Loop filter and autocal **AA1**

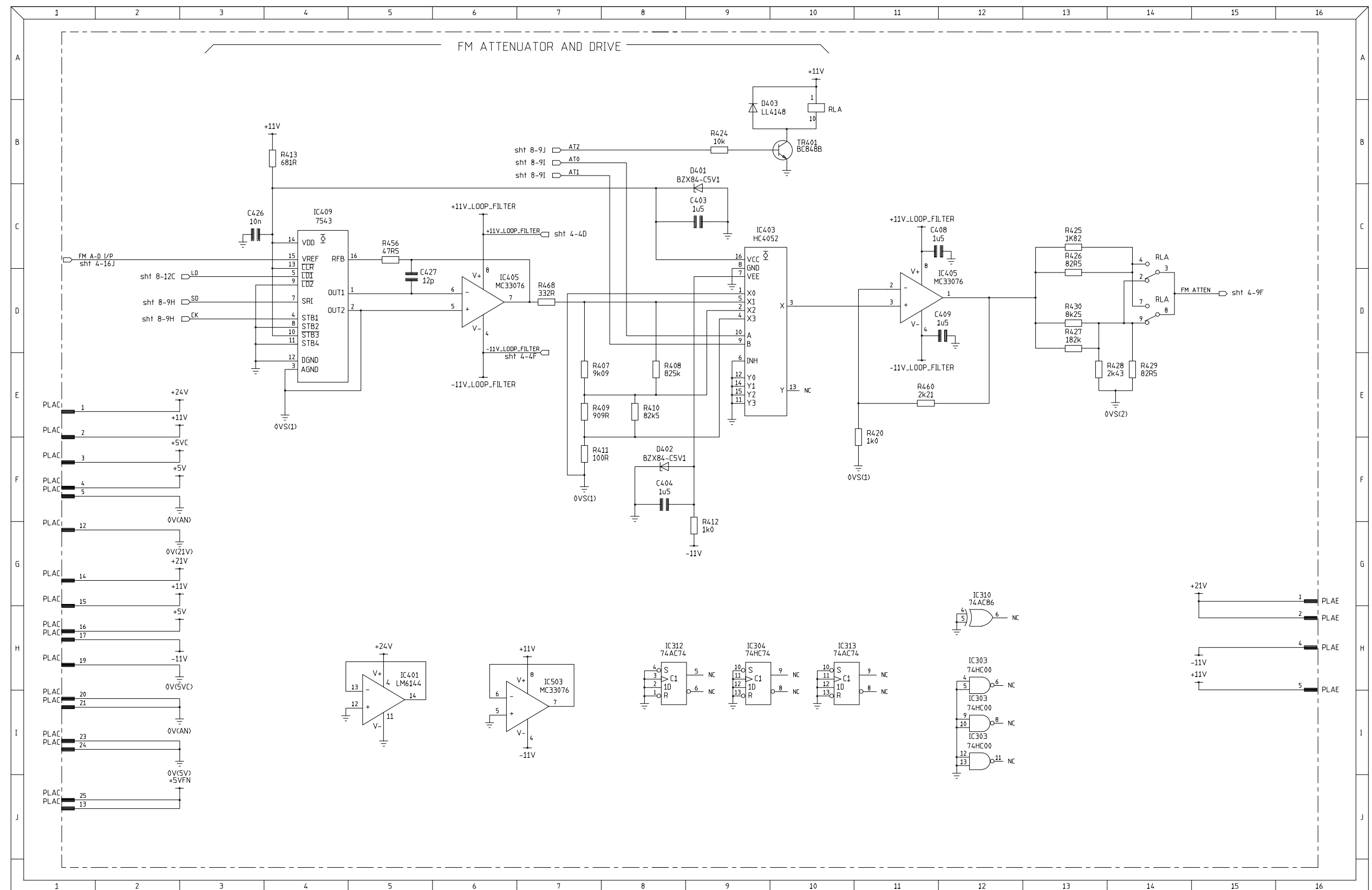


Sheet 5 component locations **AA1**

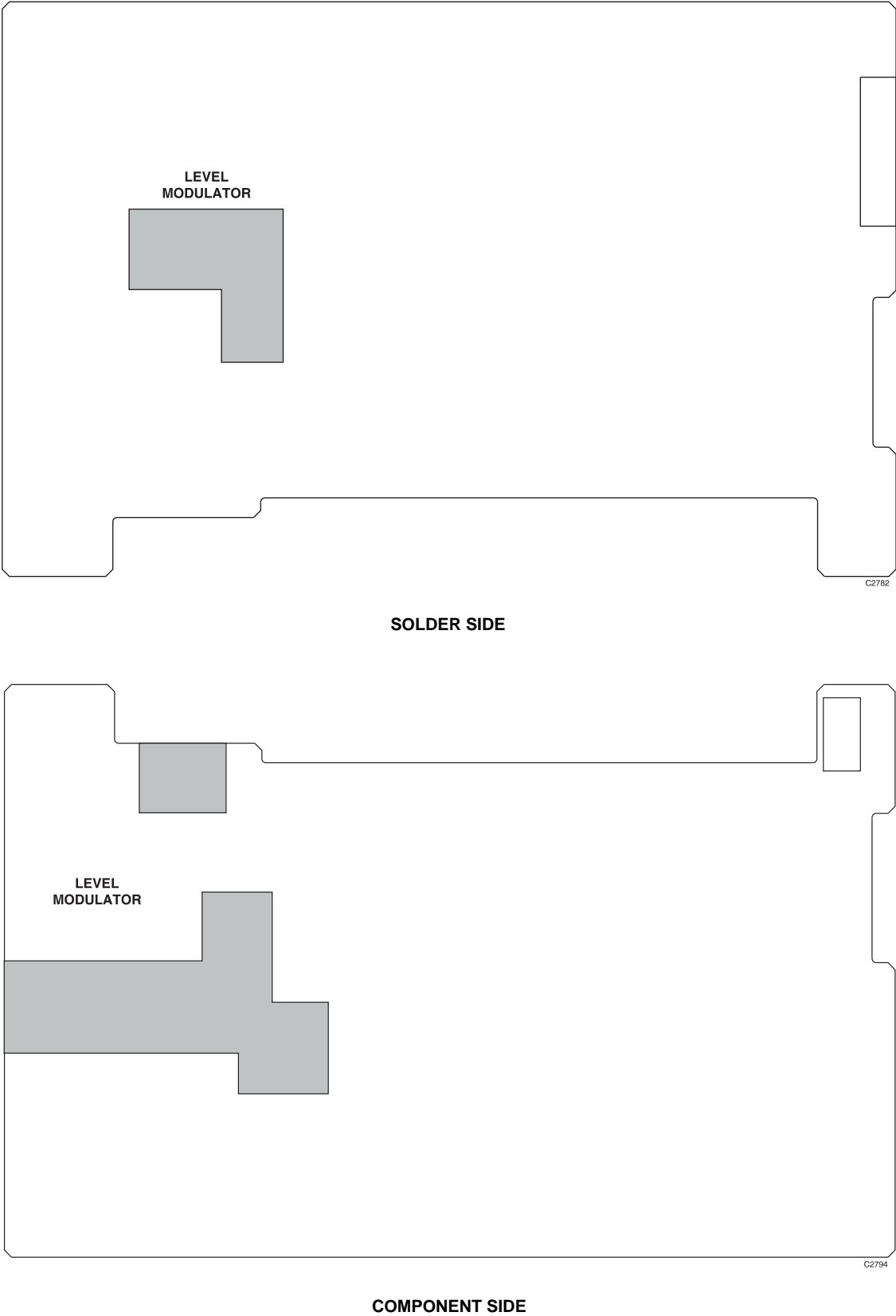


Loop filter and autocal **AA1**

Fig. 7-13 AA1 RF board: Sheet 5 component locations

FM drive **AA1**

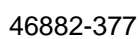
Sheet 6 component locations **AA1**



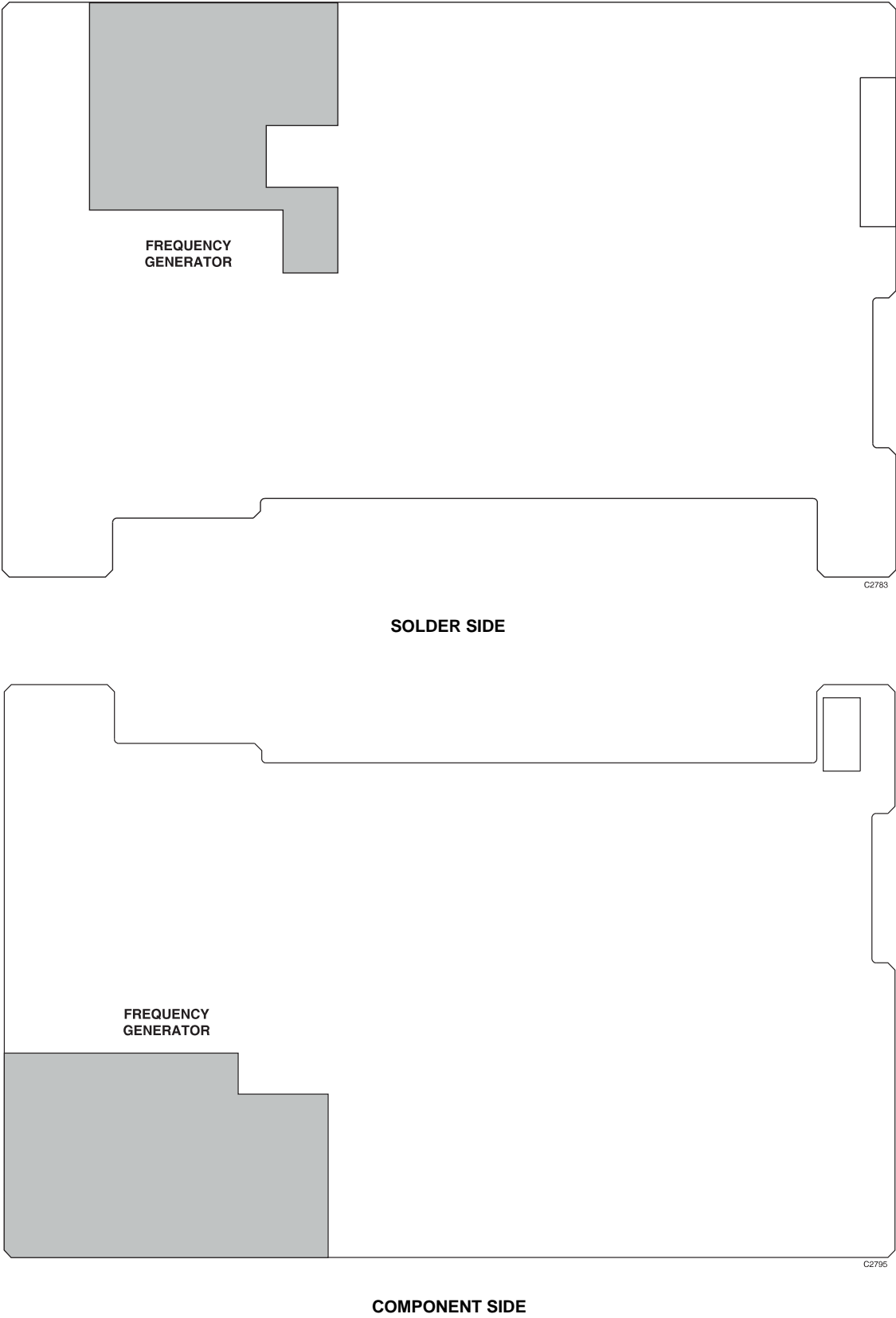
**FM drive AA1**

Fig. 7-15 AA1 RF board: Sheet 6 component locations

Fig. 7-16 AA1 RF board: Level modulator circuit

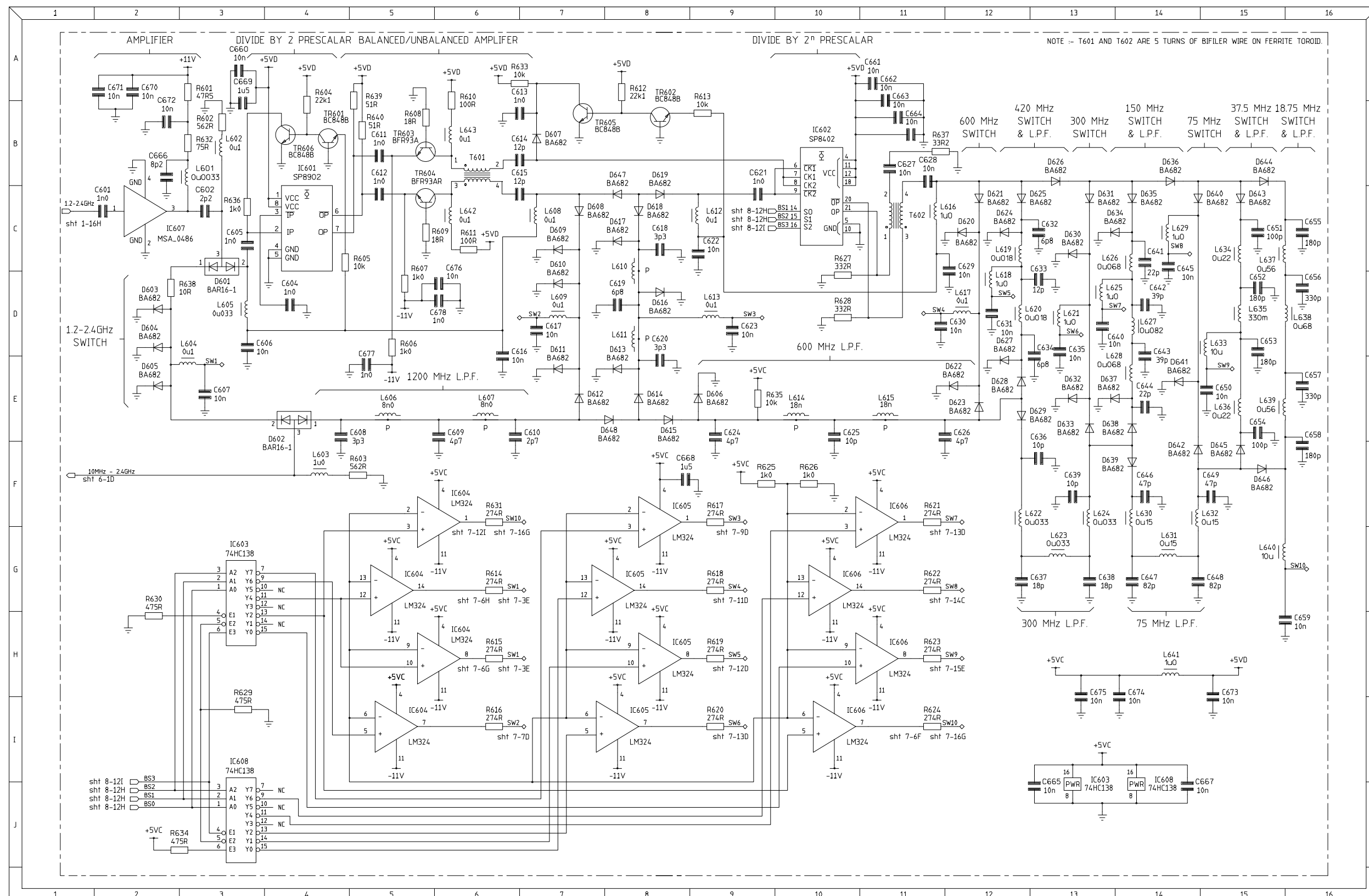


Sheet 7 component locations **AA1**

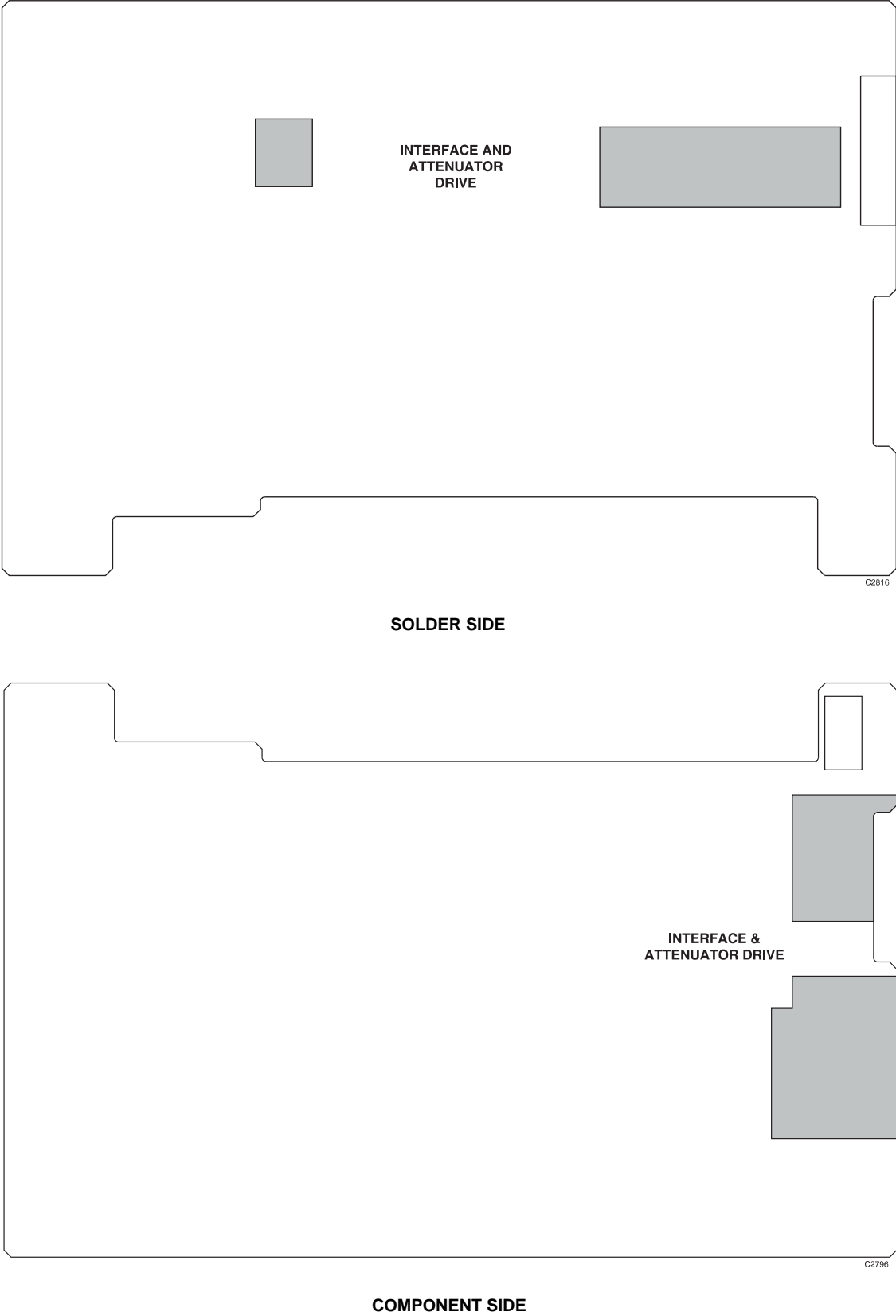


Level modulator **AA1**

Fig. 7-17 AA1 RF board: Sheet 7 component locations

Frequency generator **AA1**

Sheet 8 component locations **AA1**



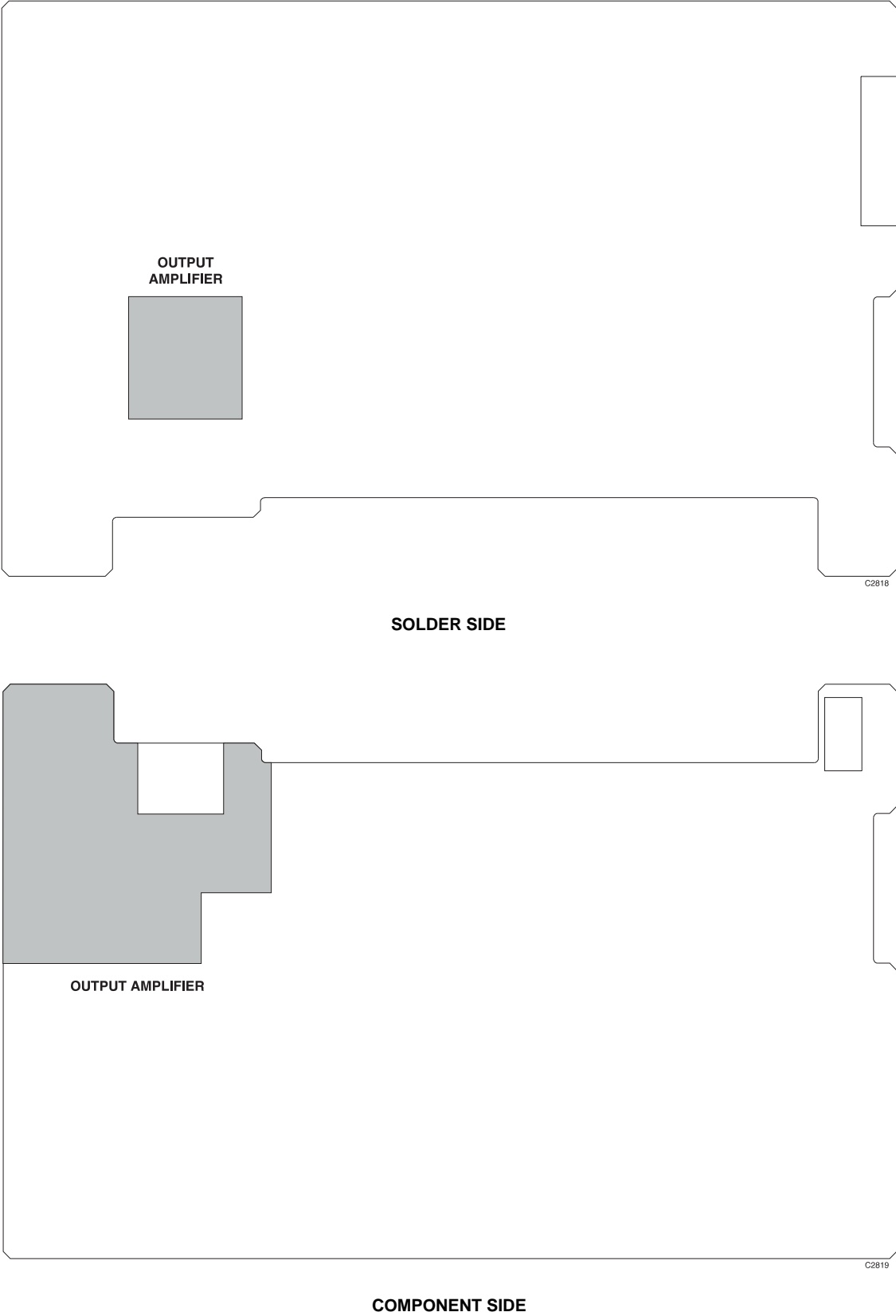
Frequency generator **AA1**

Fig. 7-19 AA1 RF board: Sheet 8 component locations



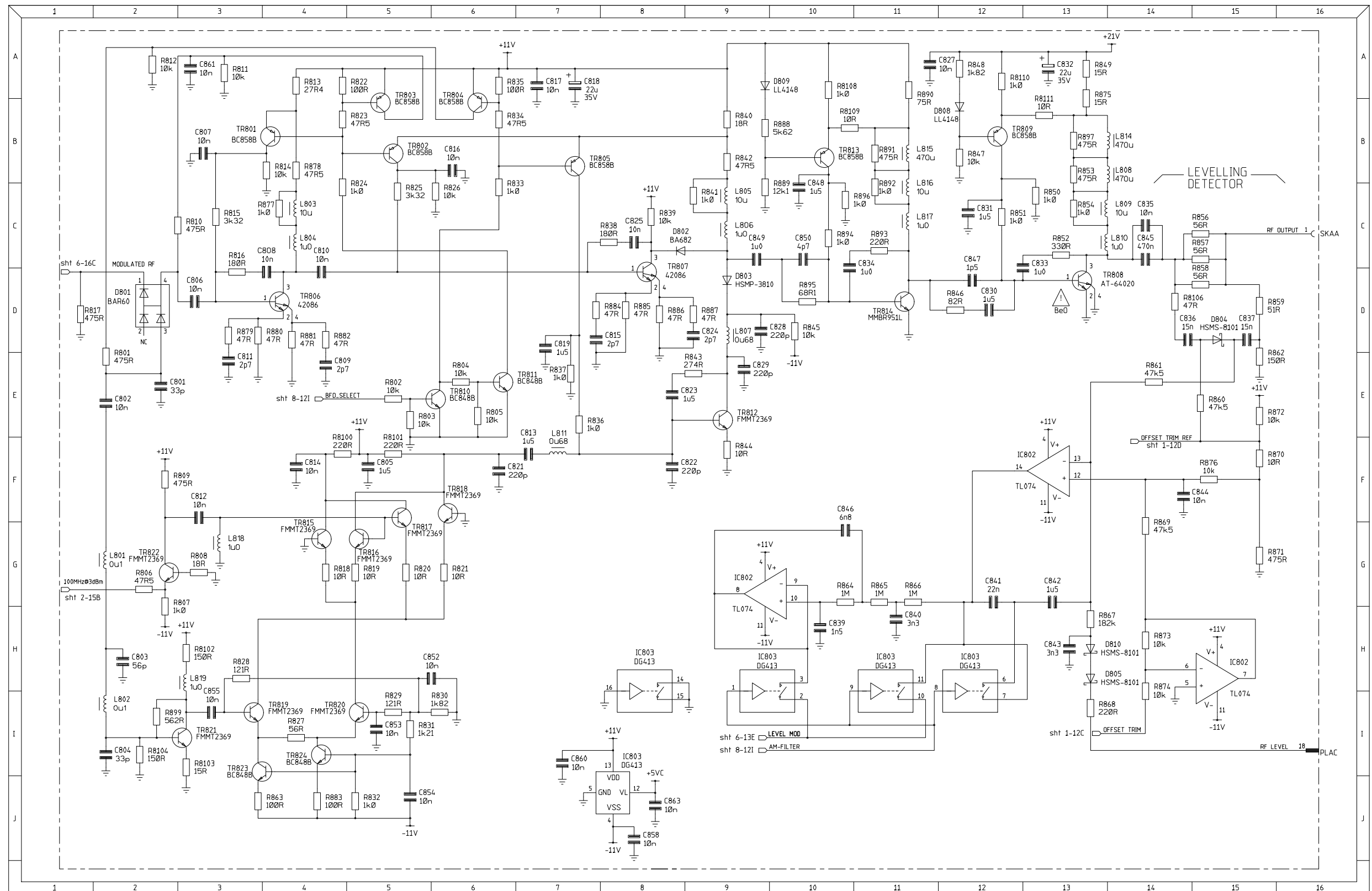


Sheet 9 component locations **AA1**

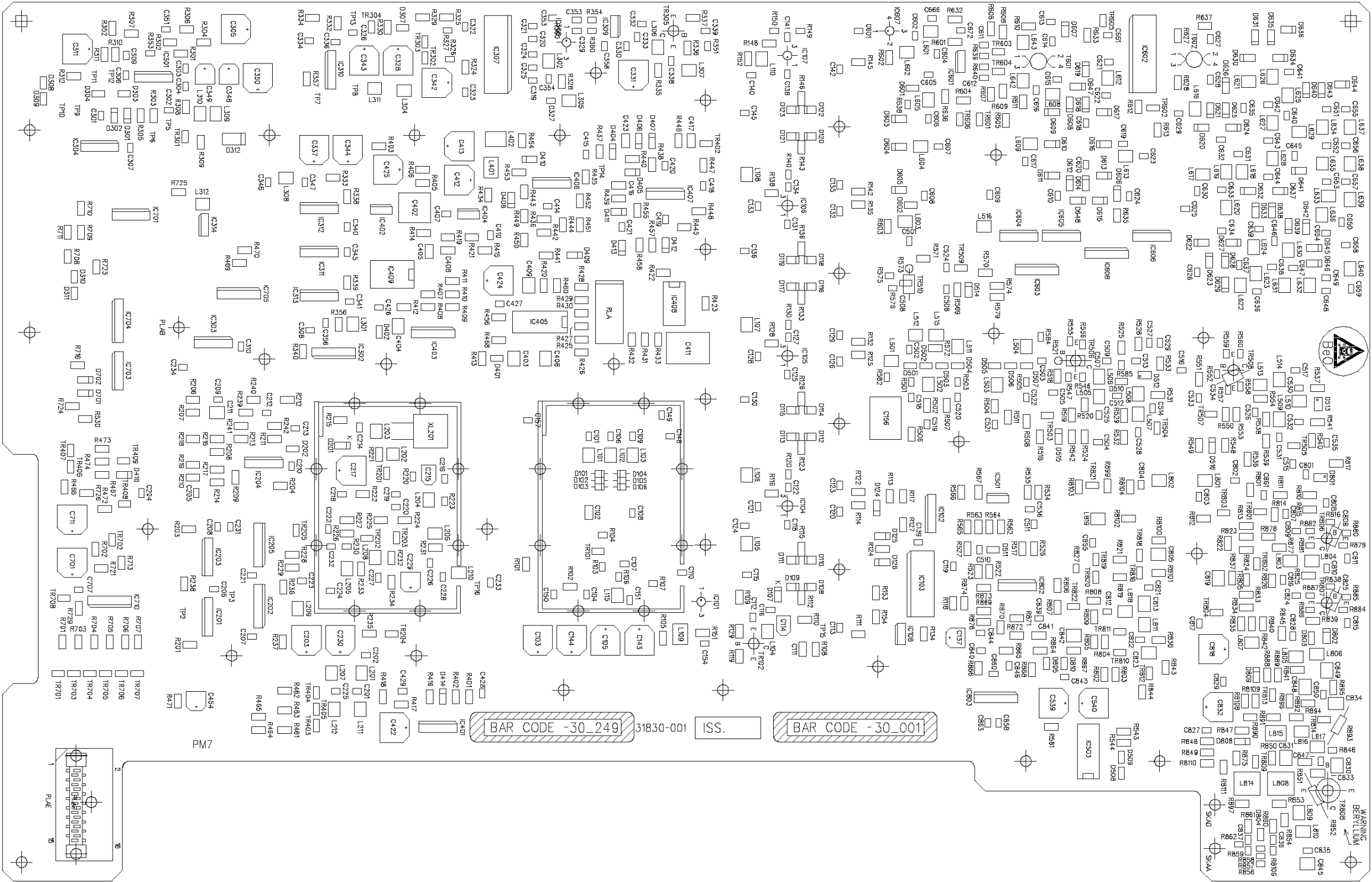


Interface and attenuator drive **AA1**

Fig. 7-21 AA1 RF board: Sheet 9 component locations

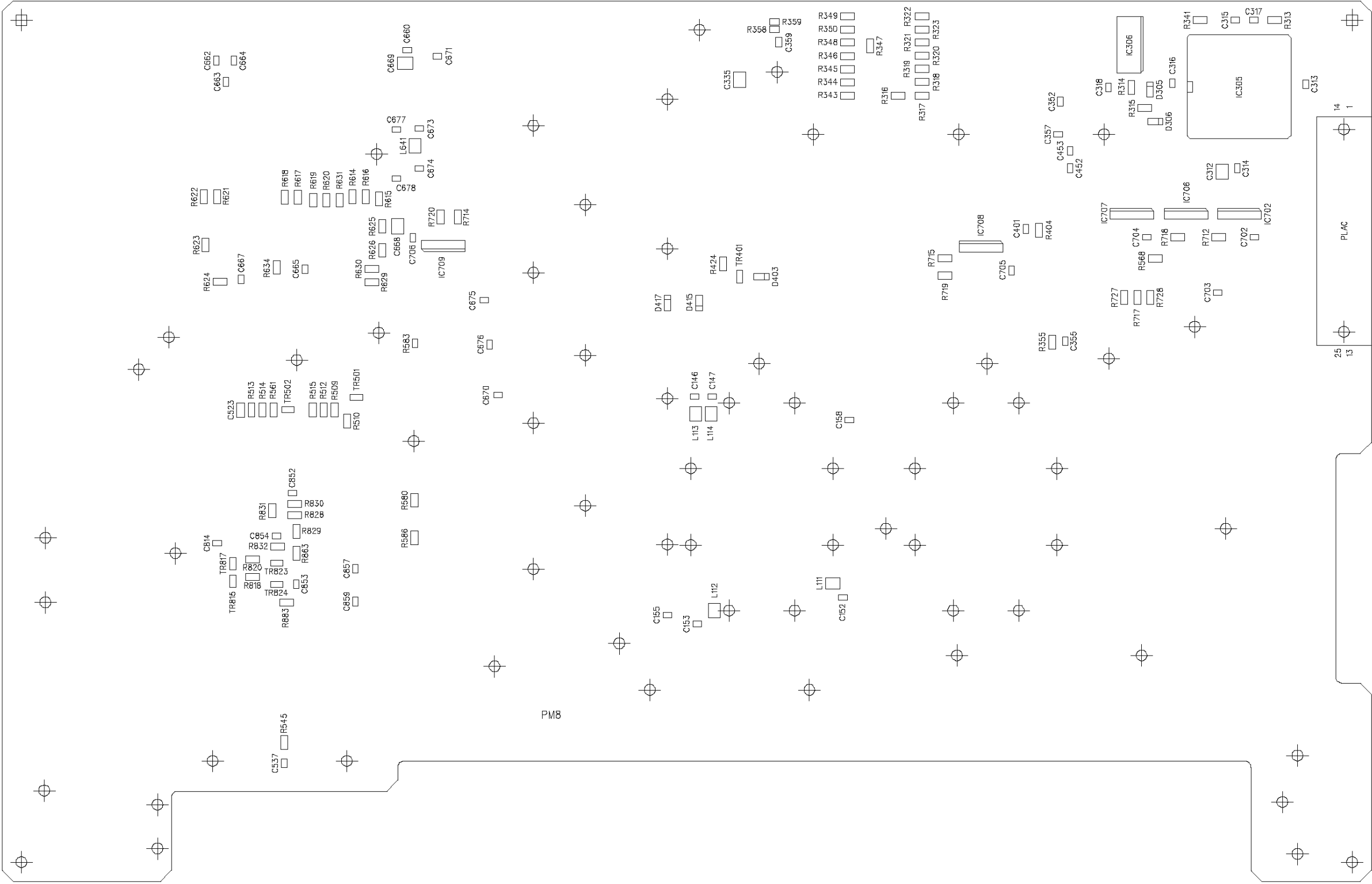
Output amplifier **AA1**

RF board component layout **AA1/1**

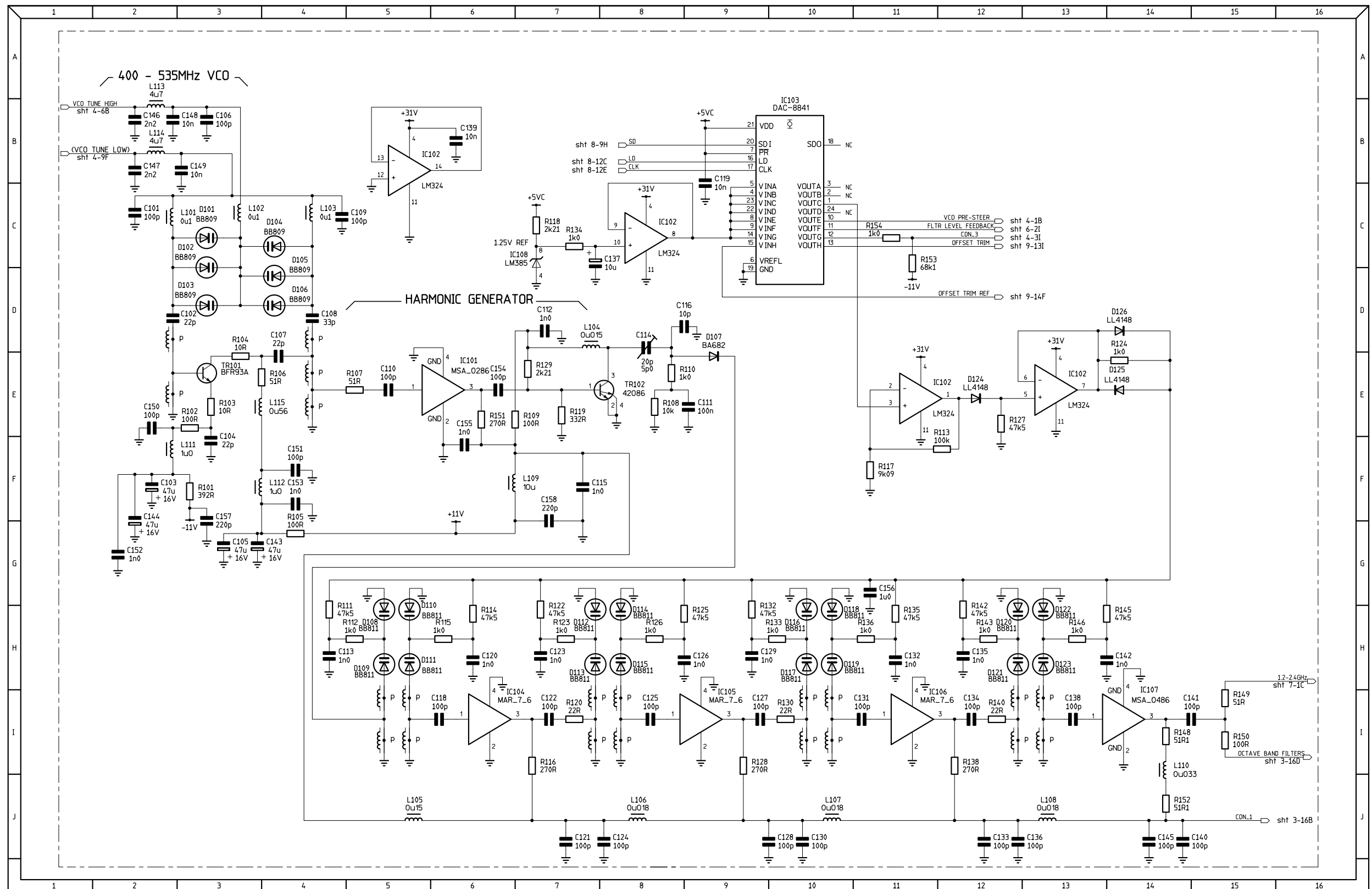


**Output amplifier AA1**

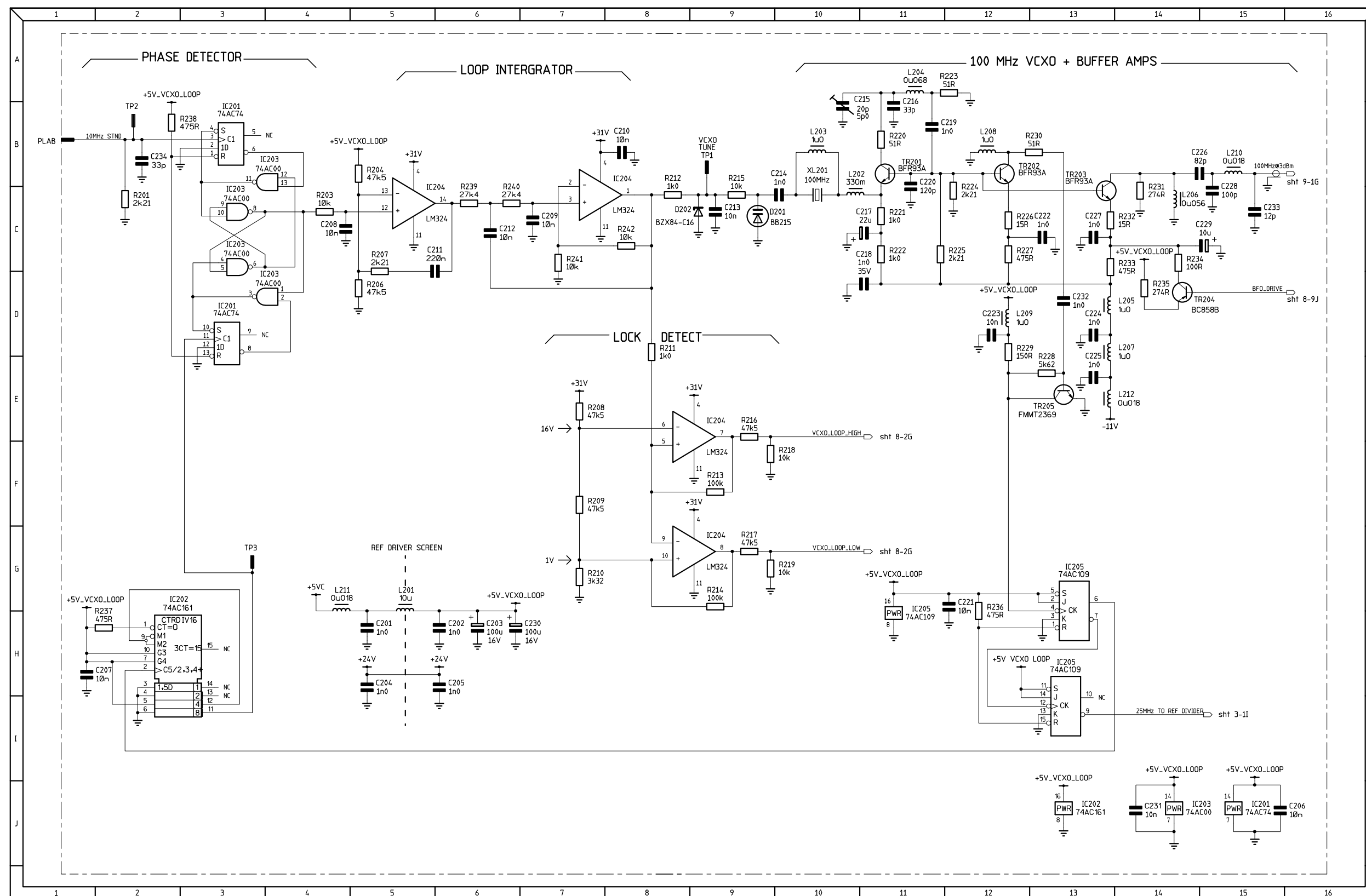
RF board component layout **AA1/1**



RF board component layout **AA1/1**

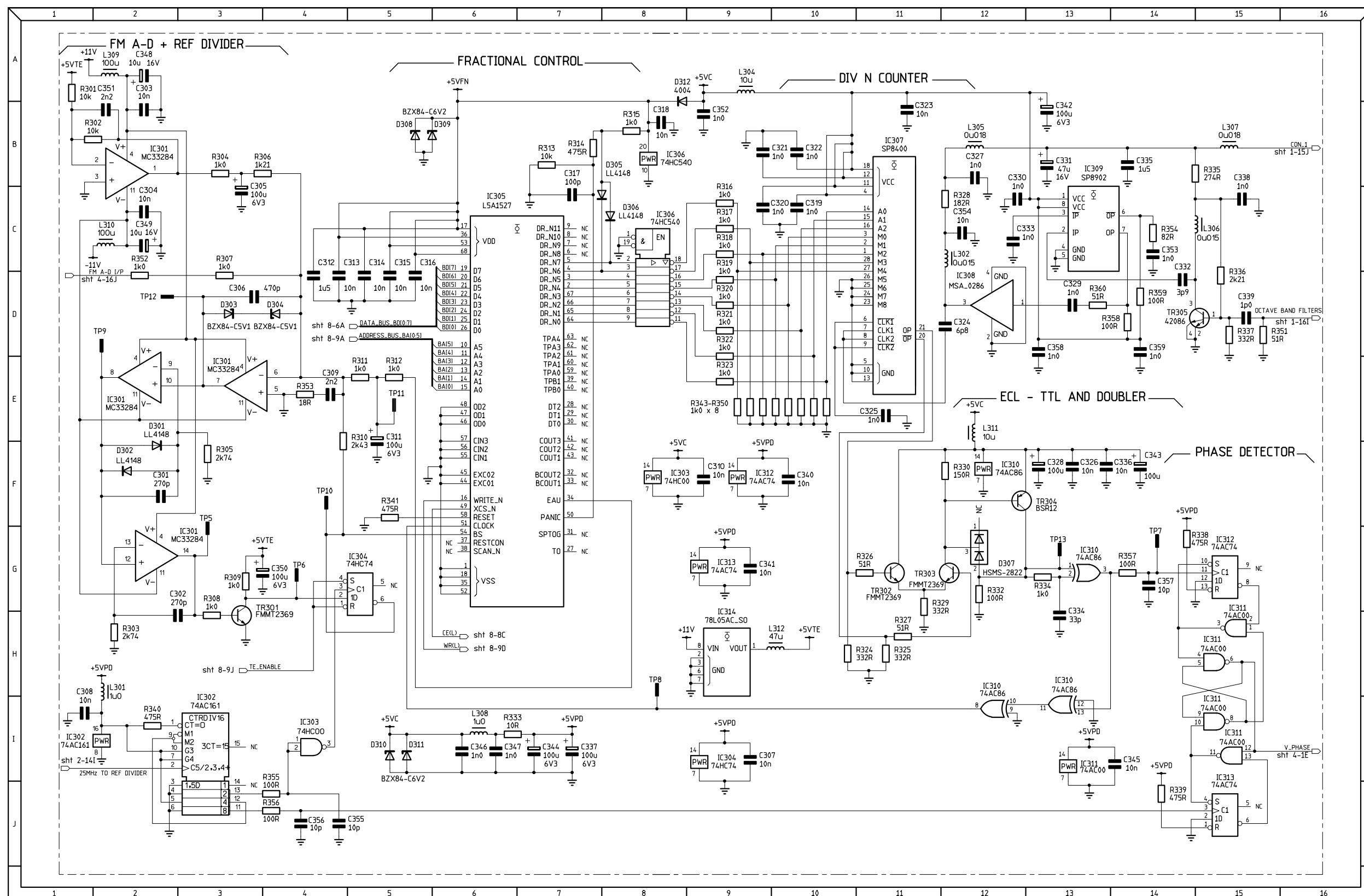
Carrier generation **AA1/1**

Carrier generation AA1/1

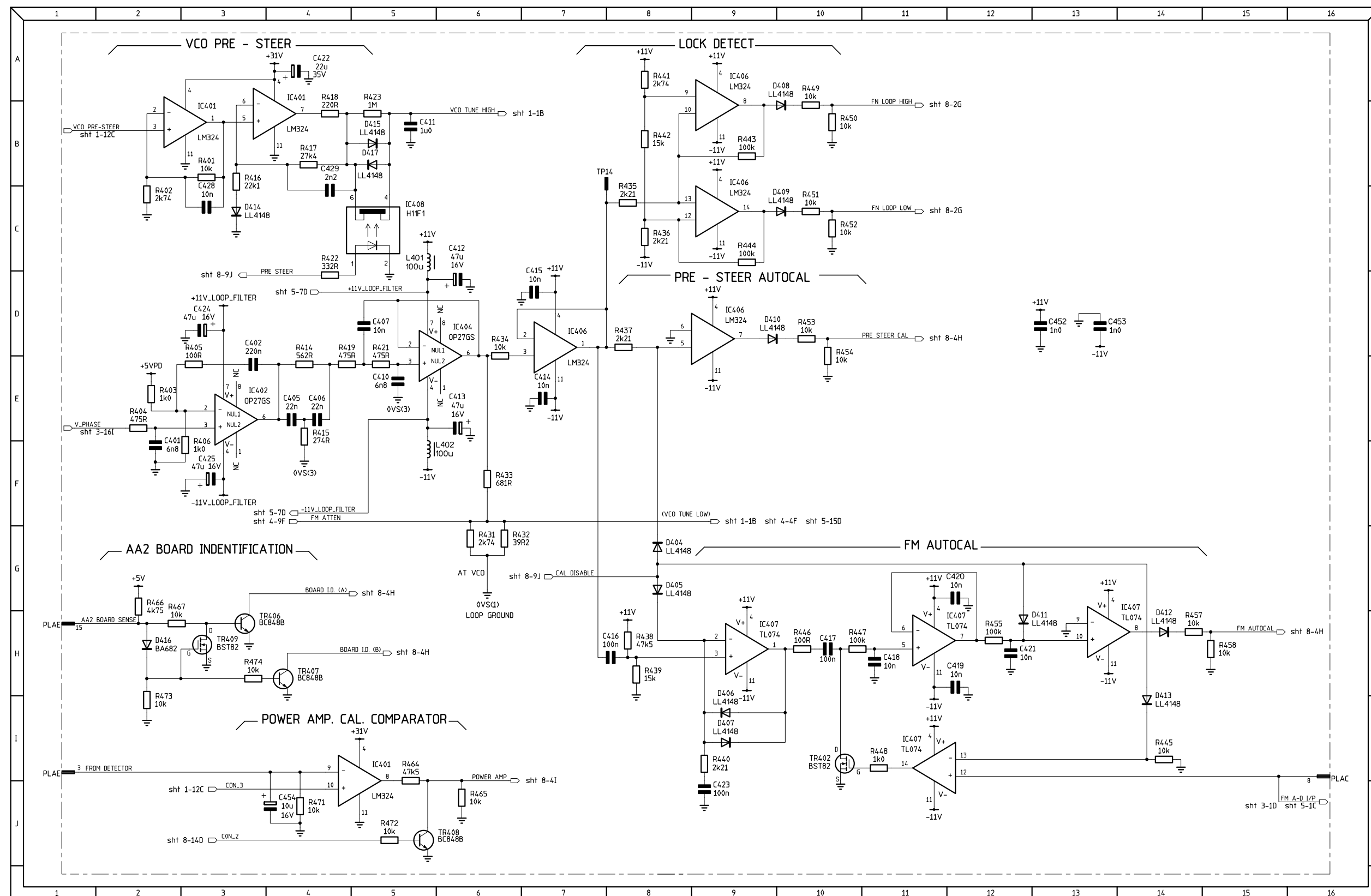
VCXO loop **AA1/1**



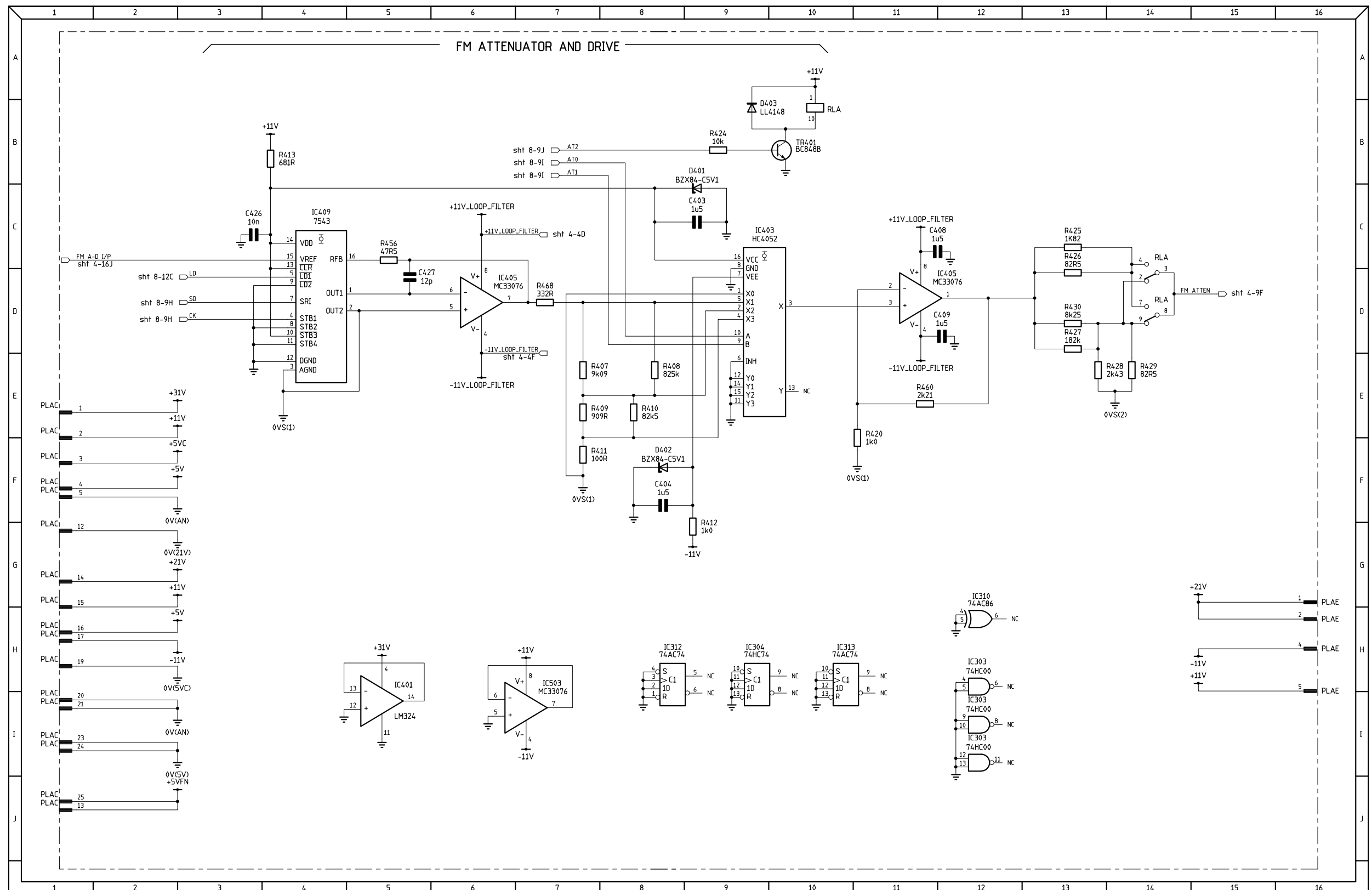
VCXO loop AA1/1

Synthesizer **AA1/1**

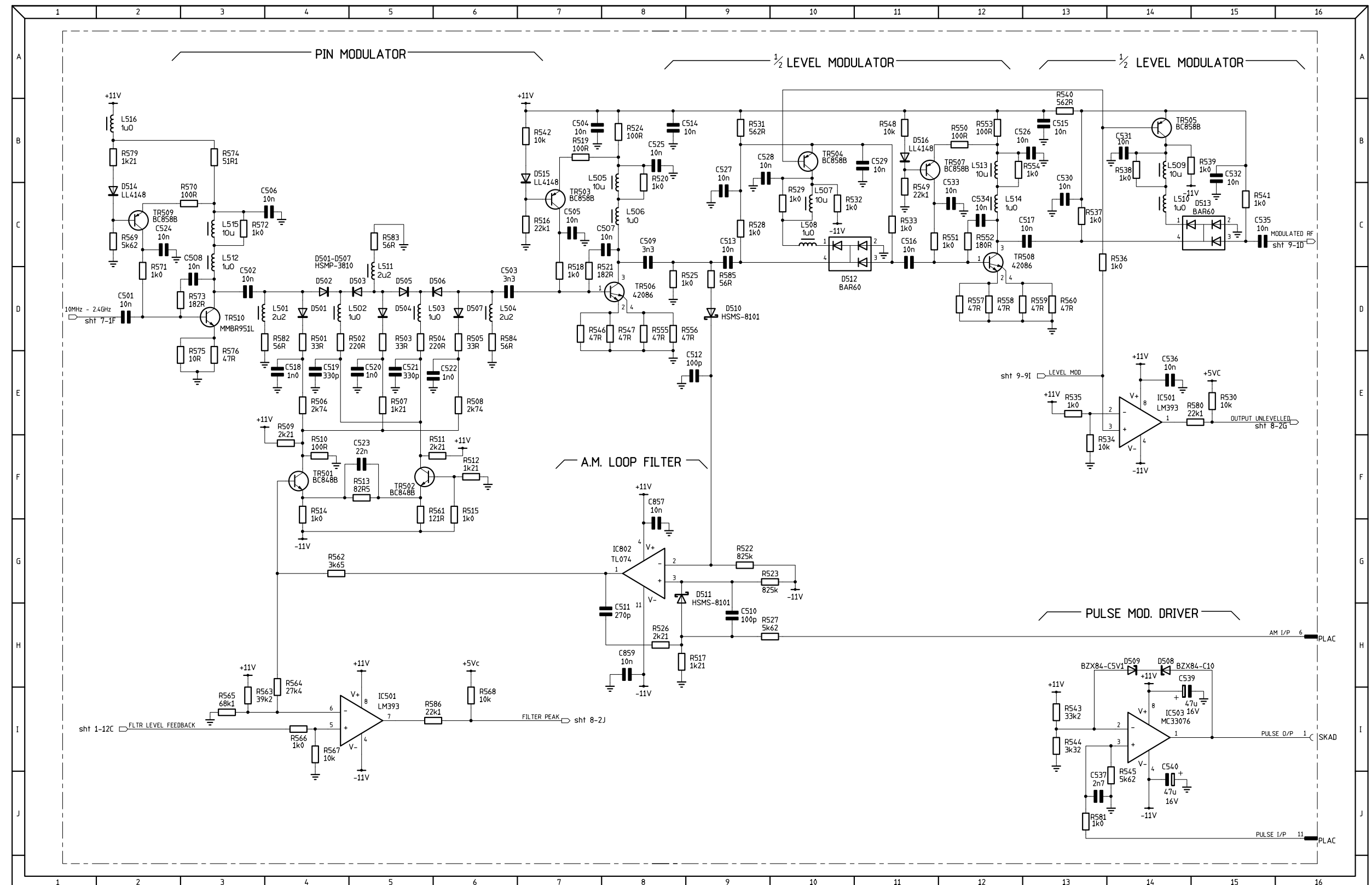


Loop filter and autocal **AA1/1**

Loop filter and autocal **AA1/1**

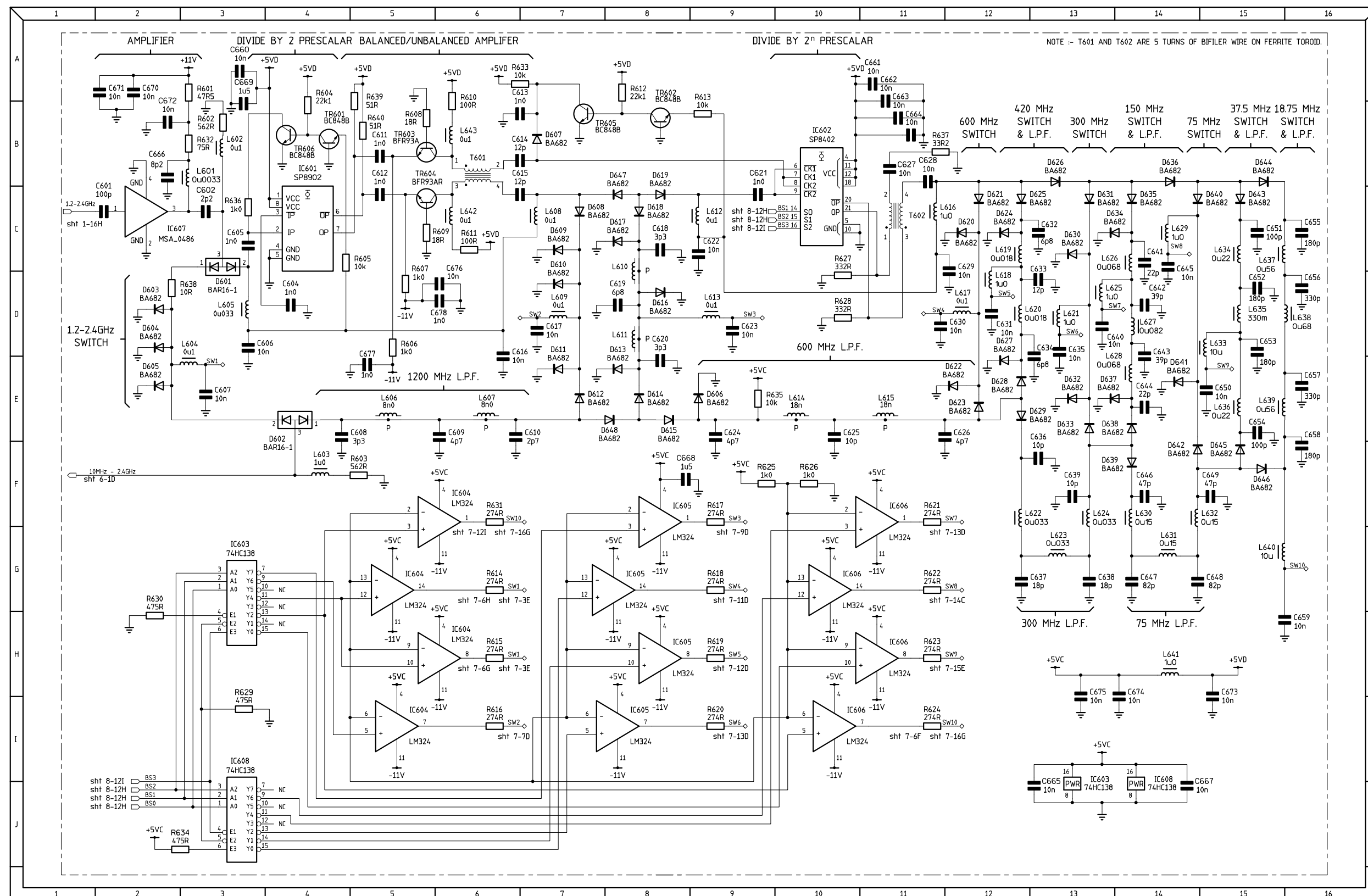
FM drive **AA1/1**



Level modulator **AA1/1**



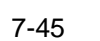
Level modulator **AA1/1**

Frequency generator **AA1/1**

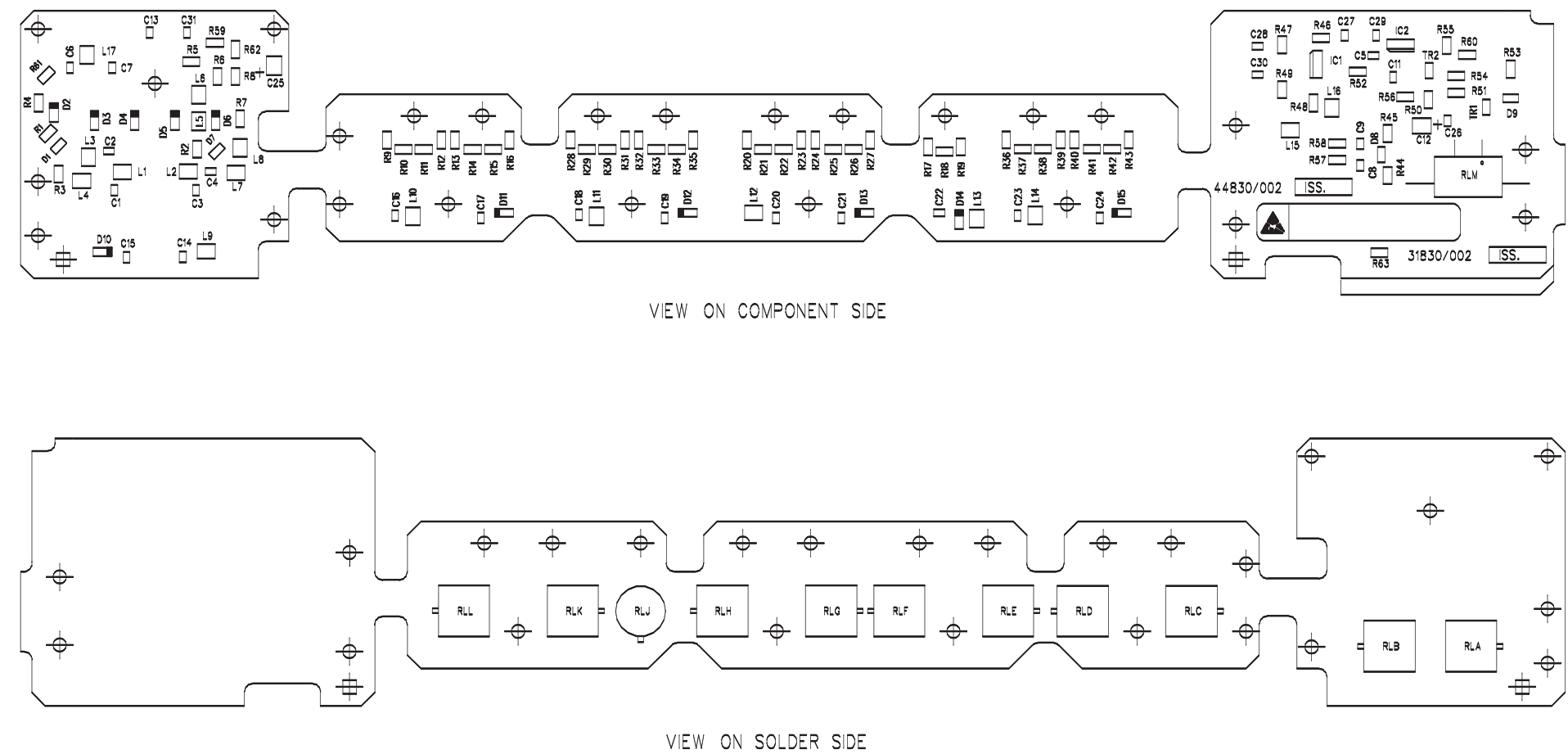
Frequency generator AA1/1



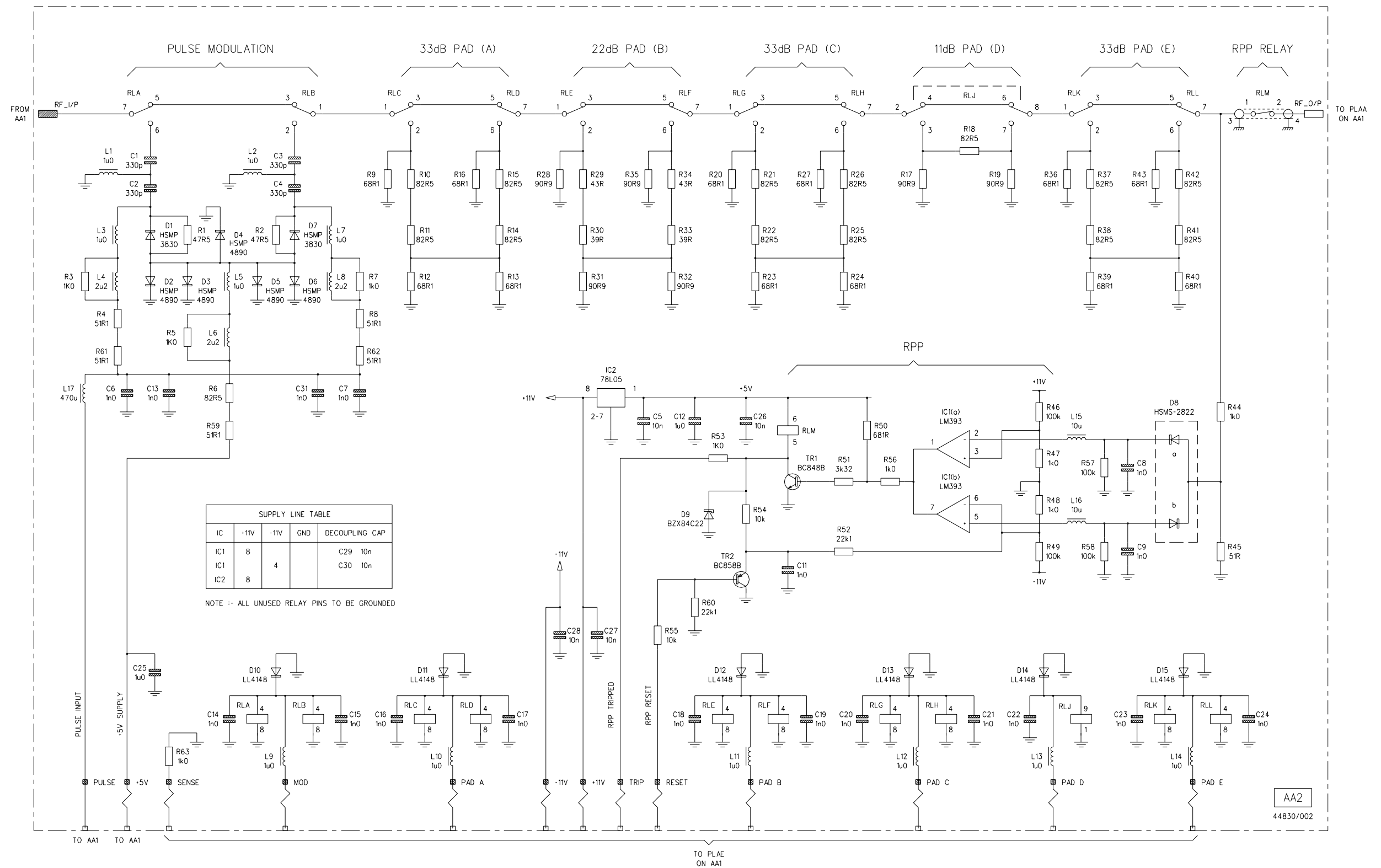
Interface and attenuator drive **AA1/1**



Component layout **AA2**

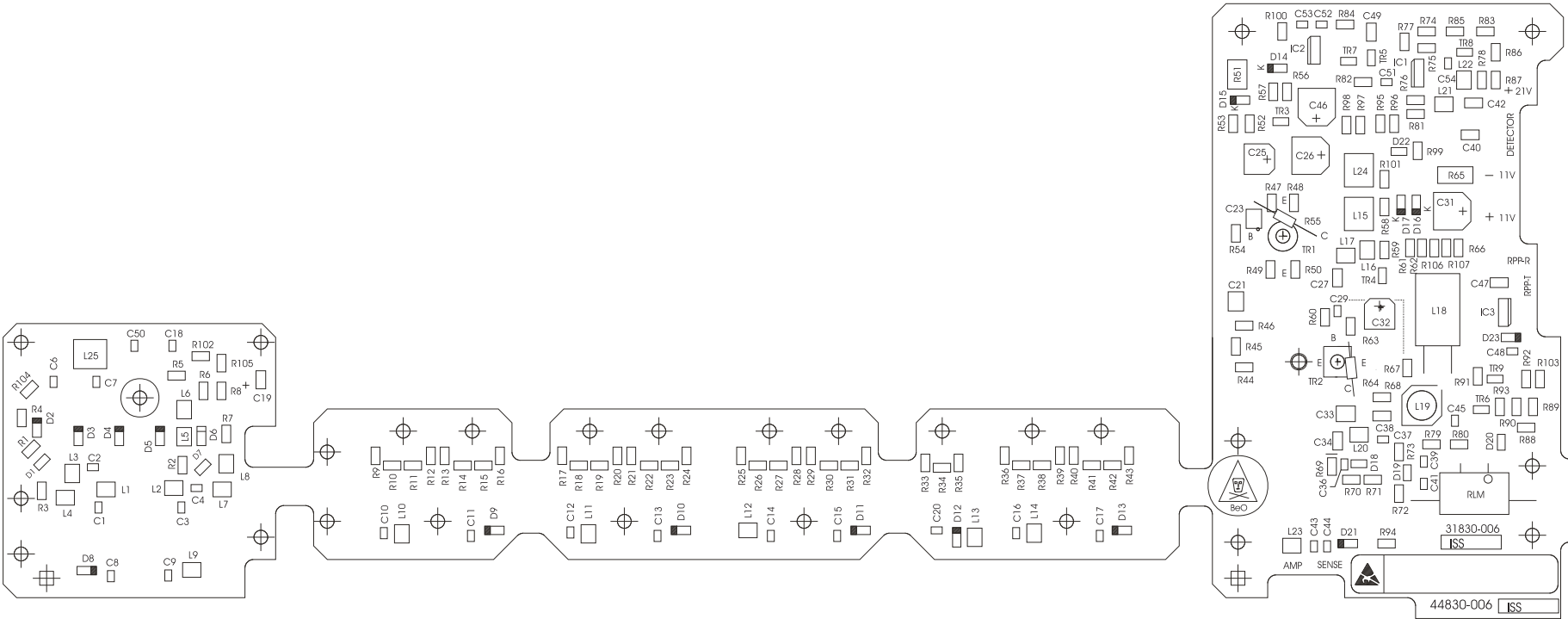


Output amplifier **AA1/1**

Attenuator board **AA2**

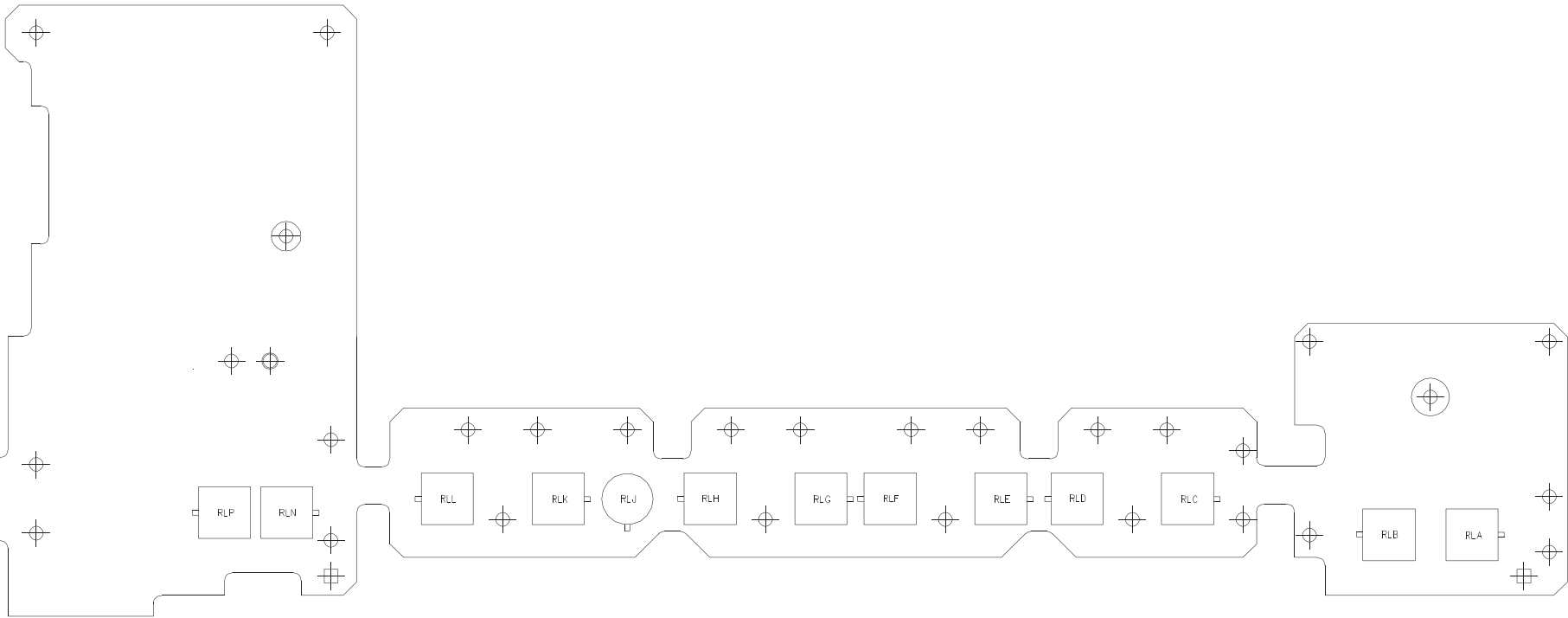


Component layout **AA2/1**



COMPONENT SIDE

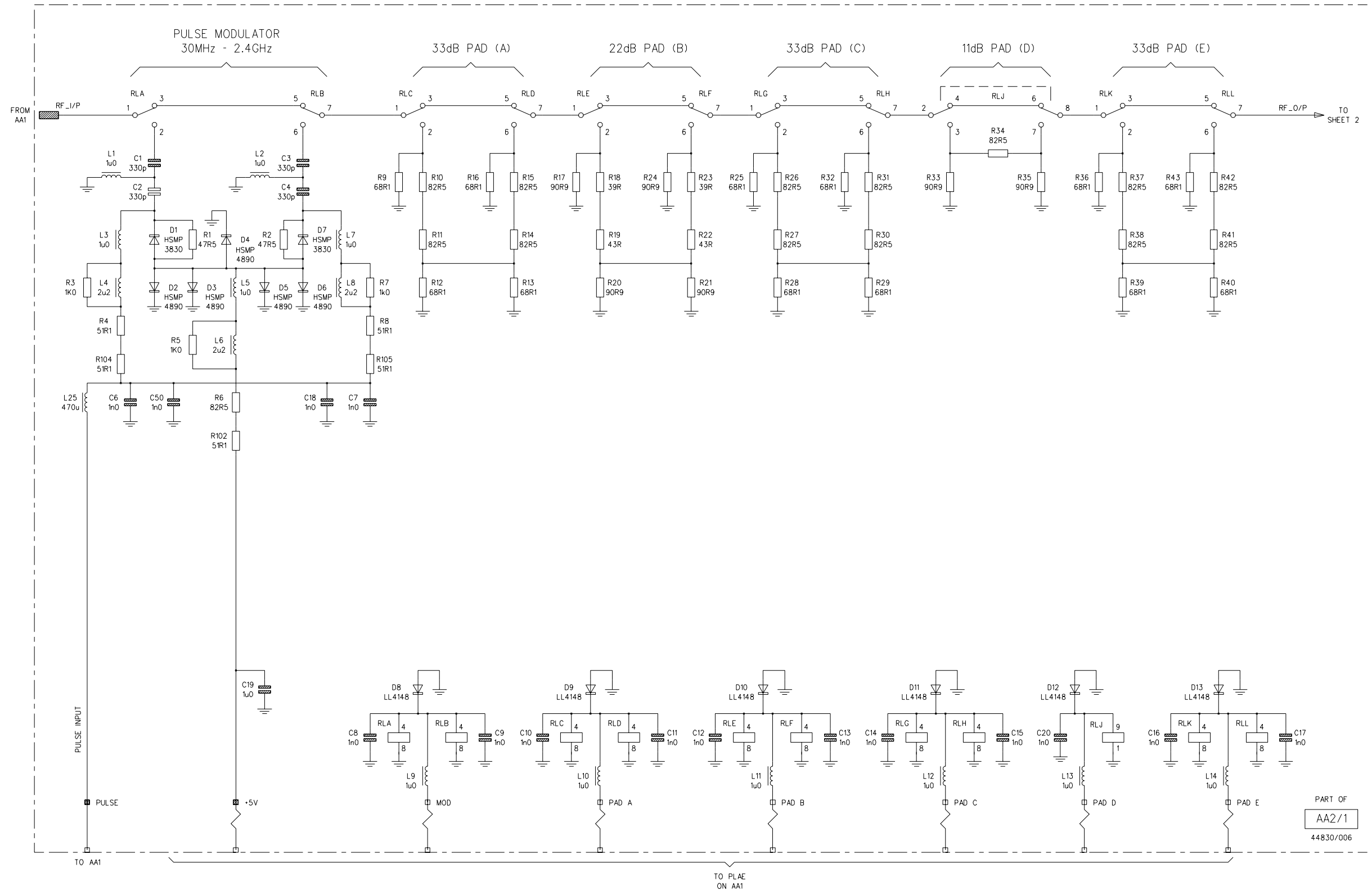
Drg. No. A44830/006 Sheet 1 of 2 (Issue 5)



Attenuator board **AA2**

Drg. No. A44830/006 Sheet 2 of 2 (Issue 5)

Fig. 7-36 AA2/1 High power attenuator board: Component layouts

Pulse mod and attenuator **AA2/1**

Pulse mod and attenuator **AA2/1**

Power amp and RPP **AA2/1**

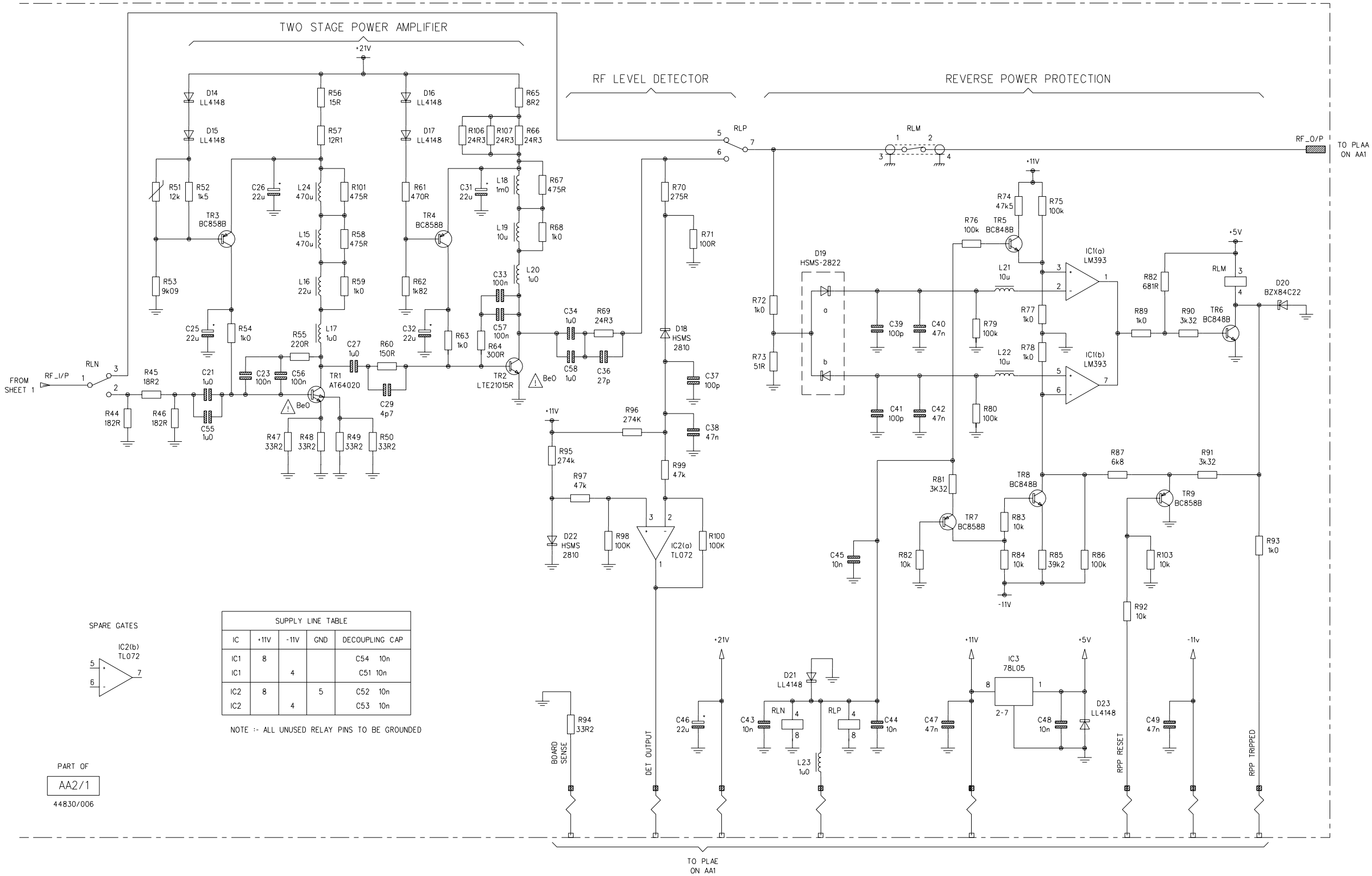
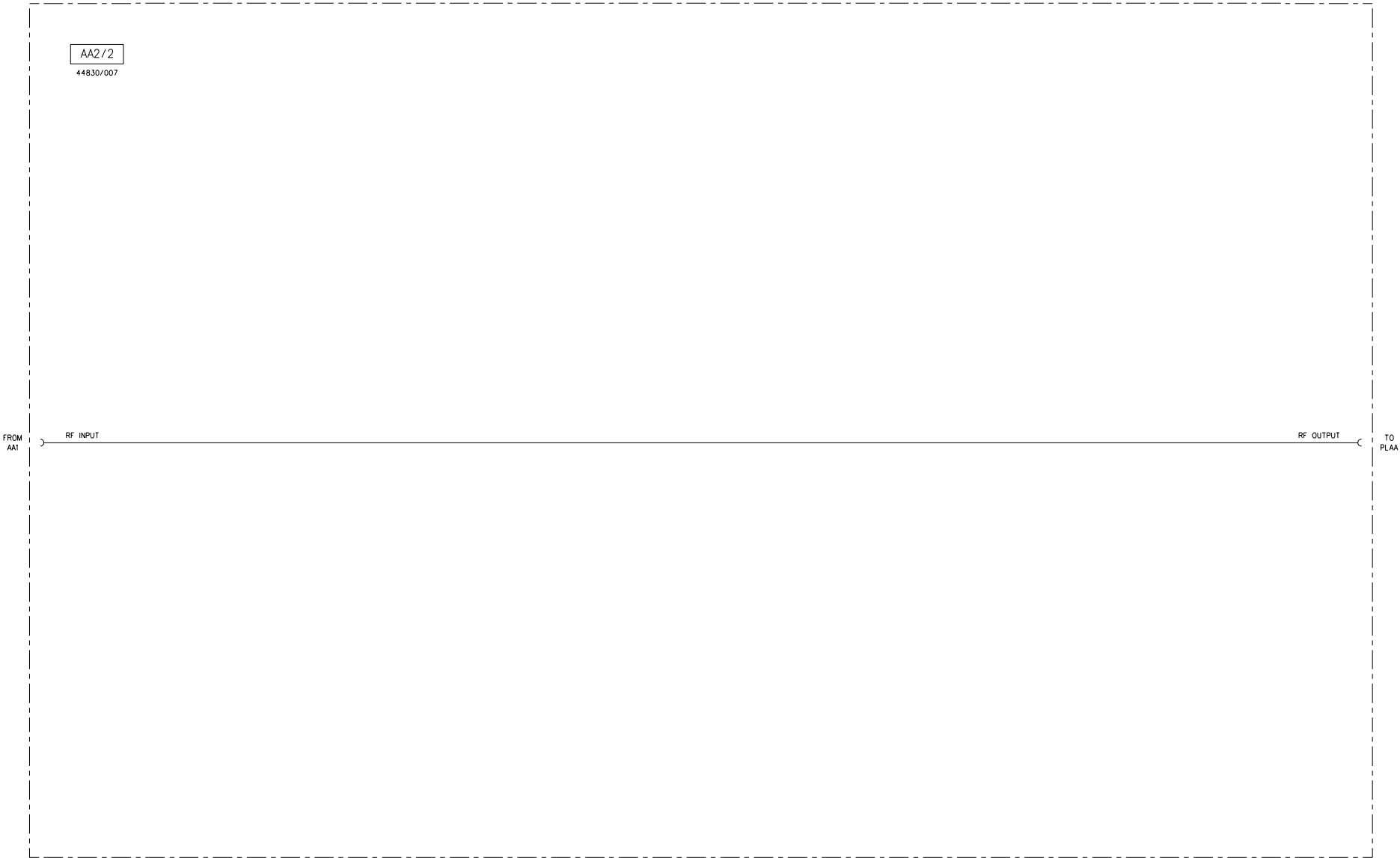


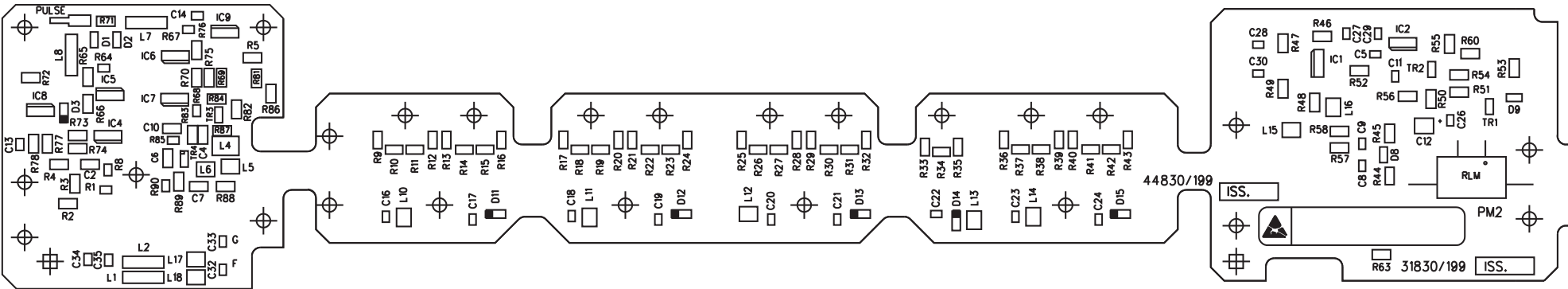
Fig. 7-38 AA2/1 High power attenuator board: Power amp and RPP circuit

Power amp and RPP **AA2/1**

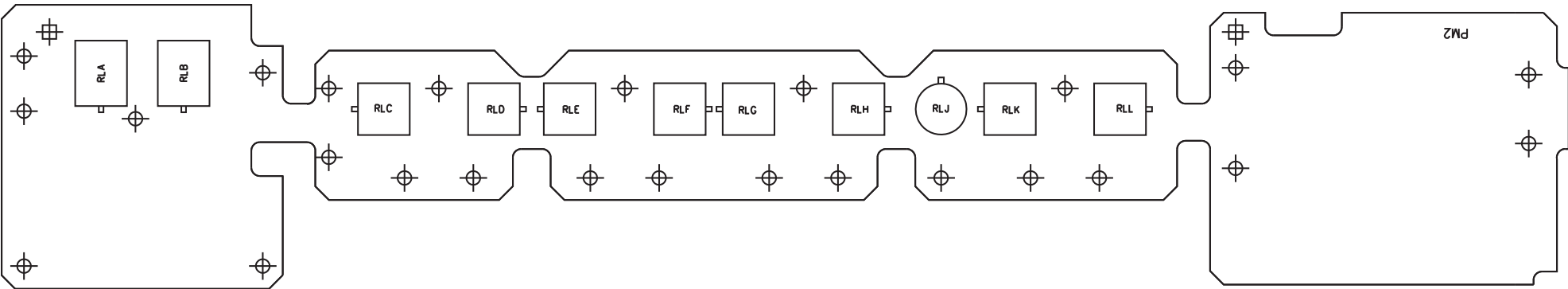
Signal output **AA2/2**



Component layout **AA2/5**



COMPONENT SIDE

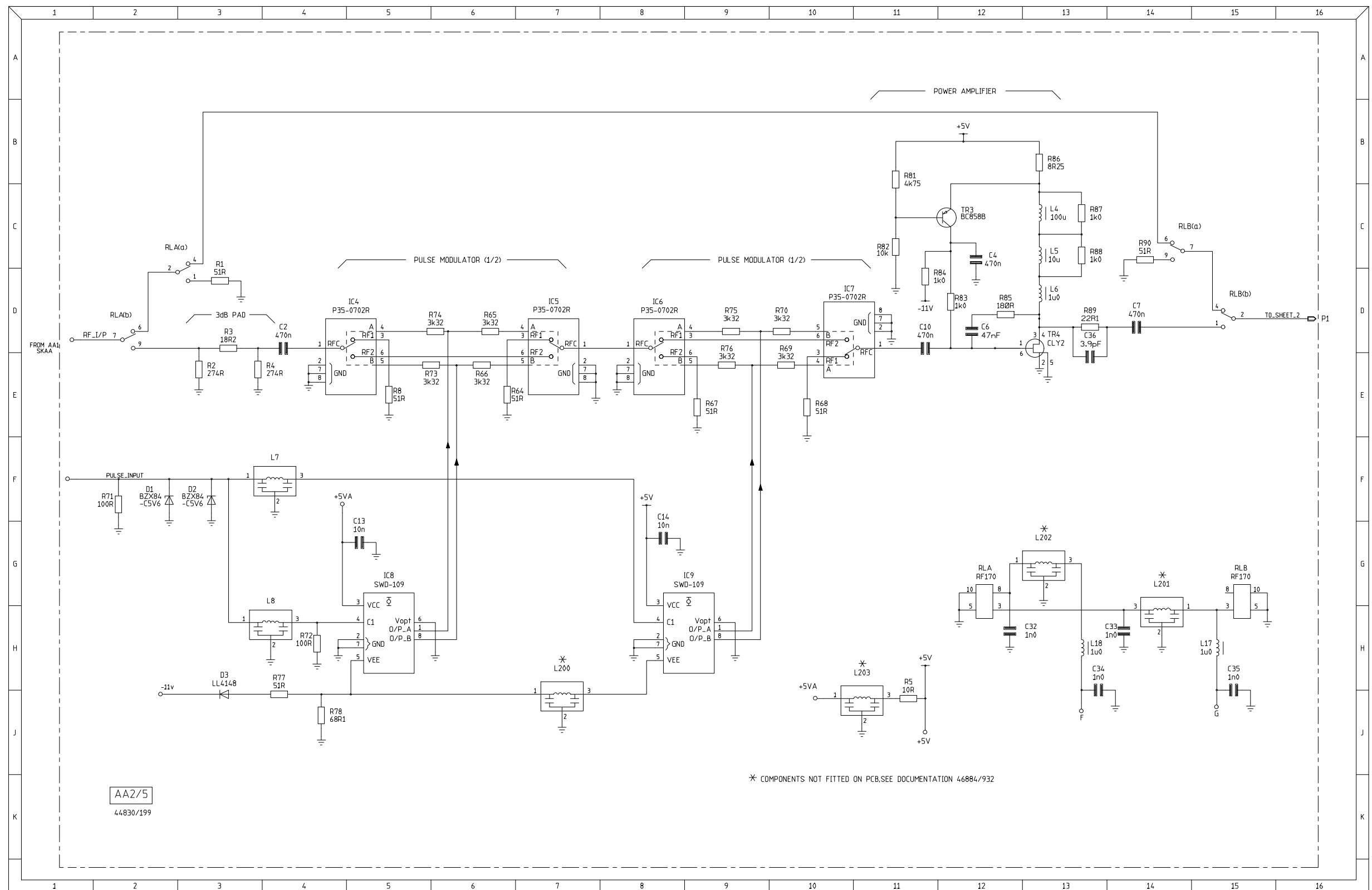


SOLDER SIDE

Signal output **AA2/2**

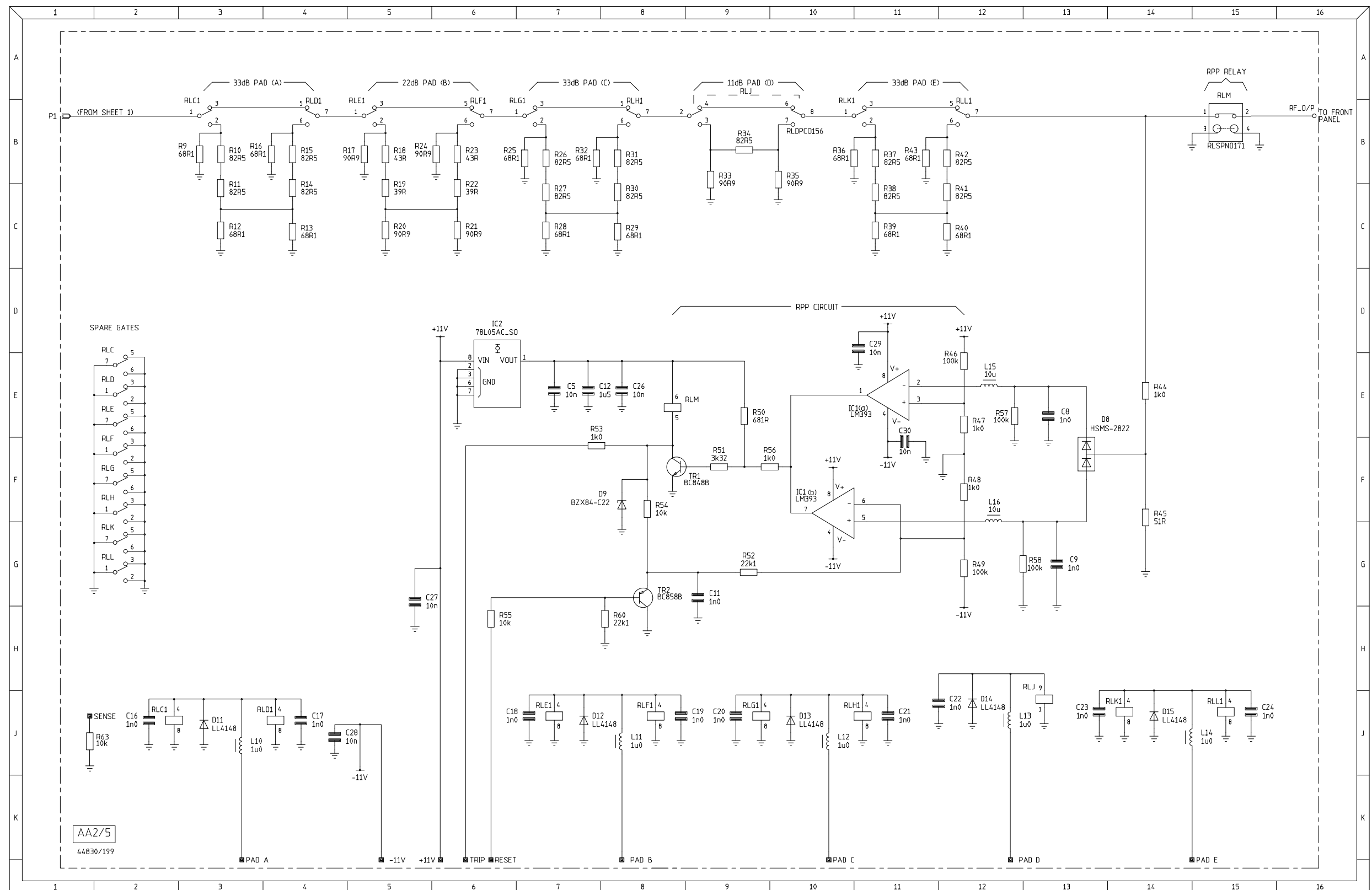
Drg. No. A44830/199 Sheet 1 of 1 (Issue 3)

Fig. 7-40 AA2/5 Fast pulse modulator board: Component layouts

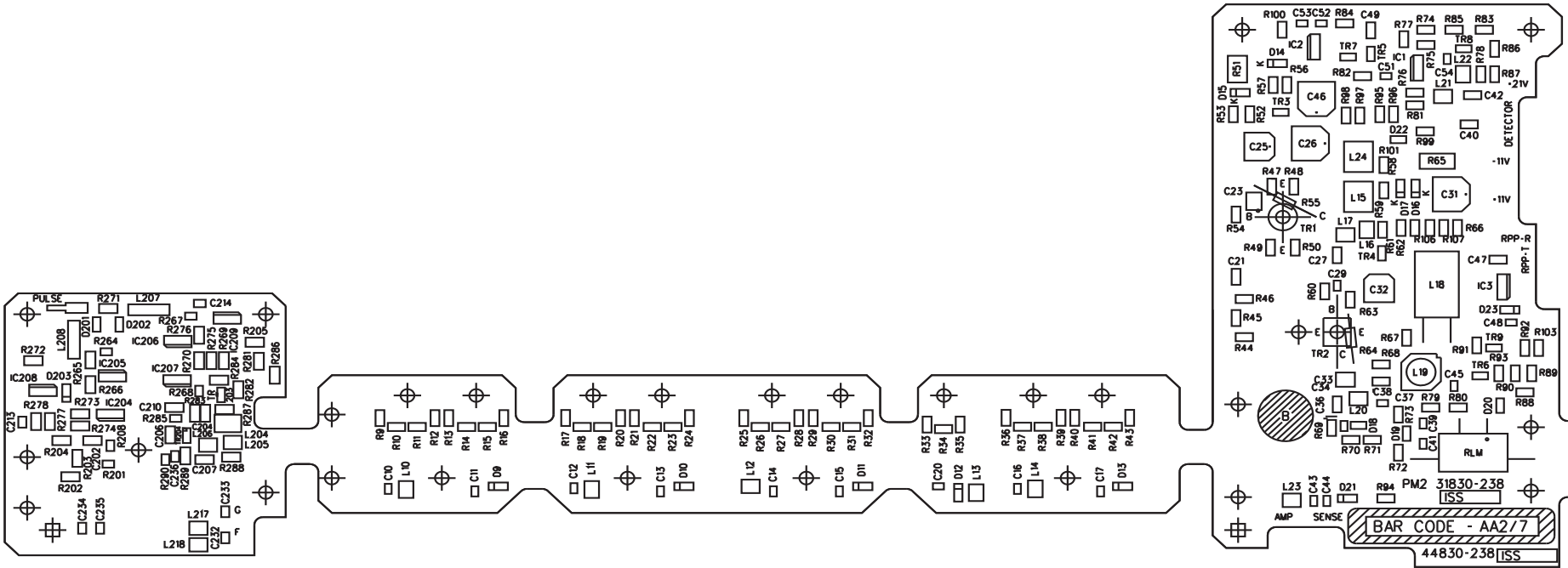
Pulse mod **AA2/5**



Pulse mod **AA2/5**

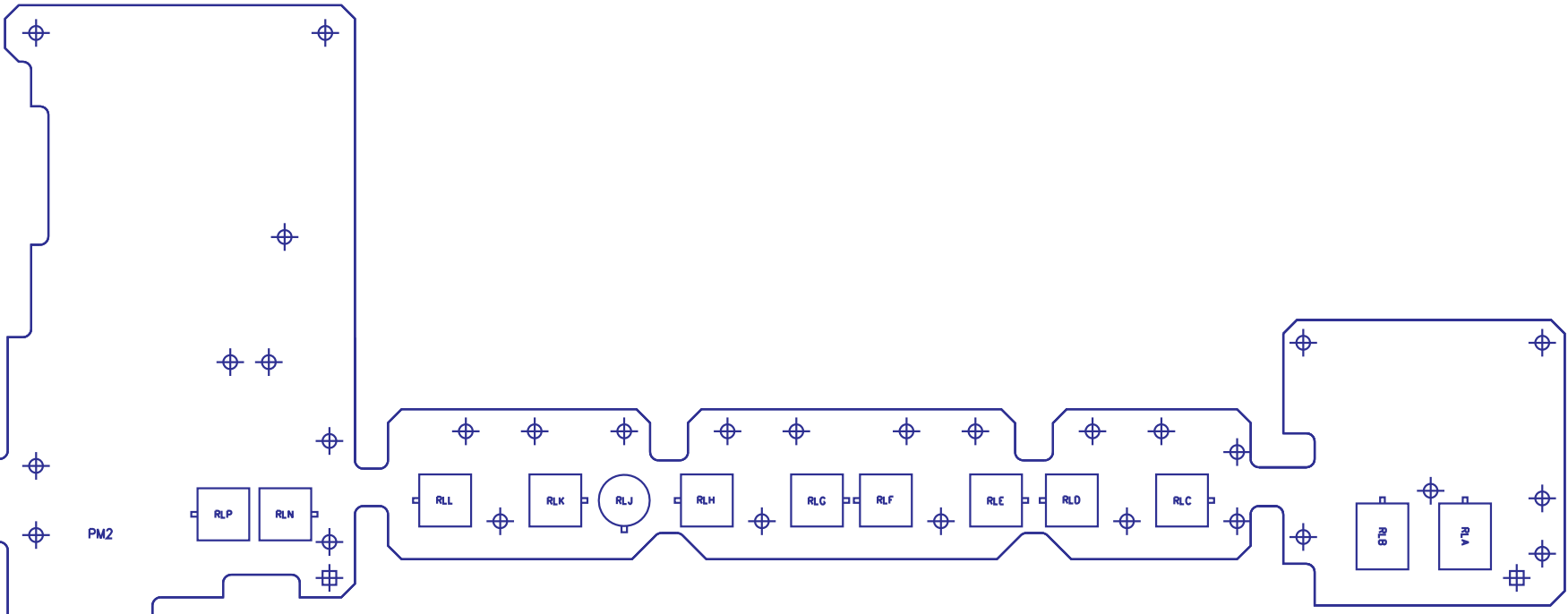
RPP and atten **AA2/5**

Component layout **AA2/7**



COMPONENT SIDE

Drg. No. A44830/238 Sheet 1 of 2 (Issue 5)

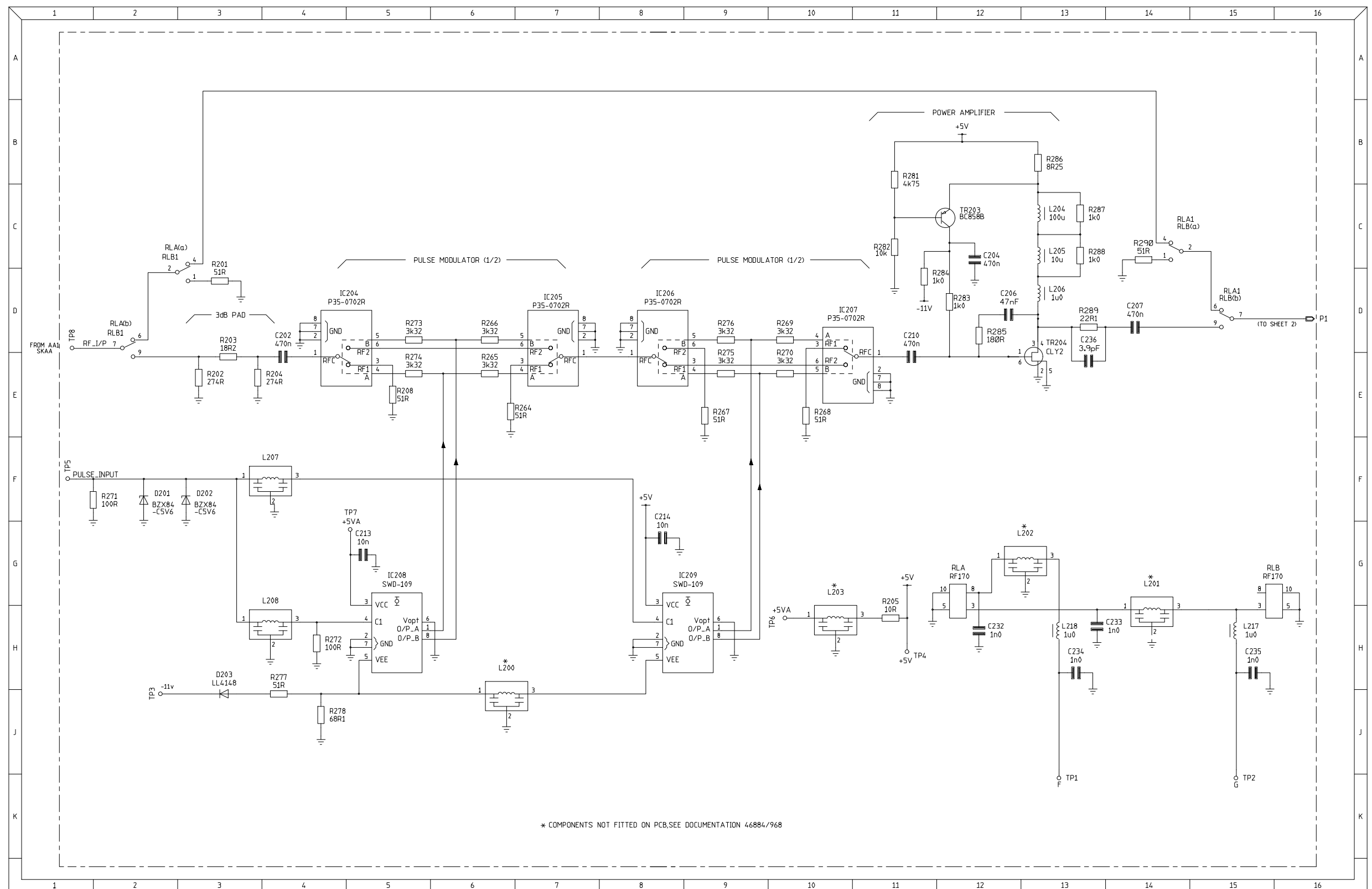


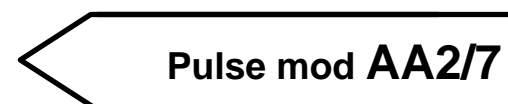
SOLDER SIDE

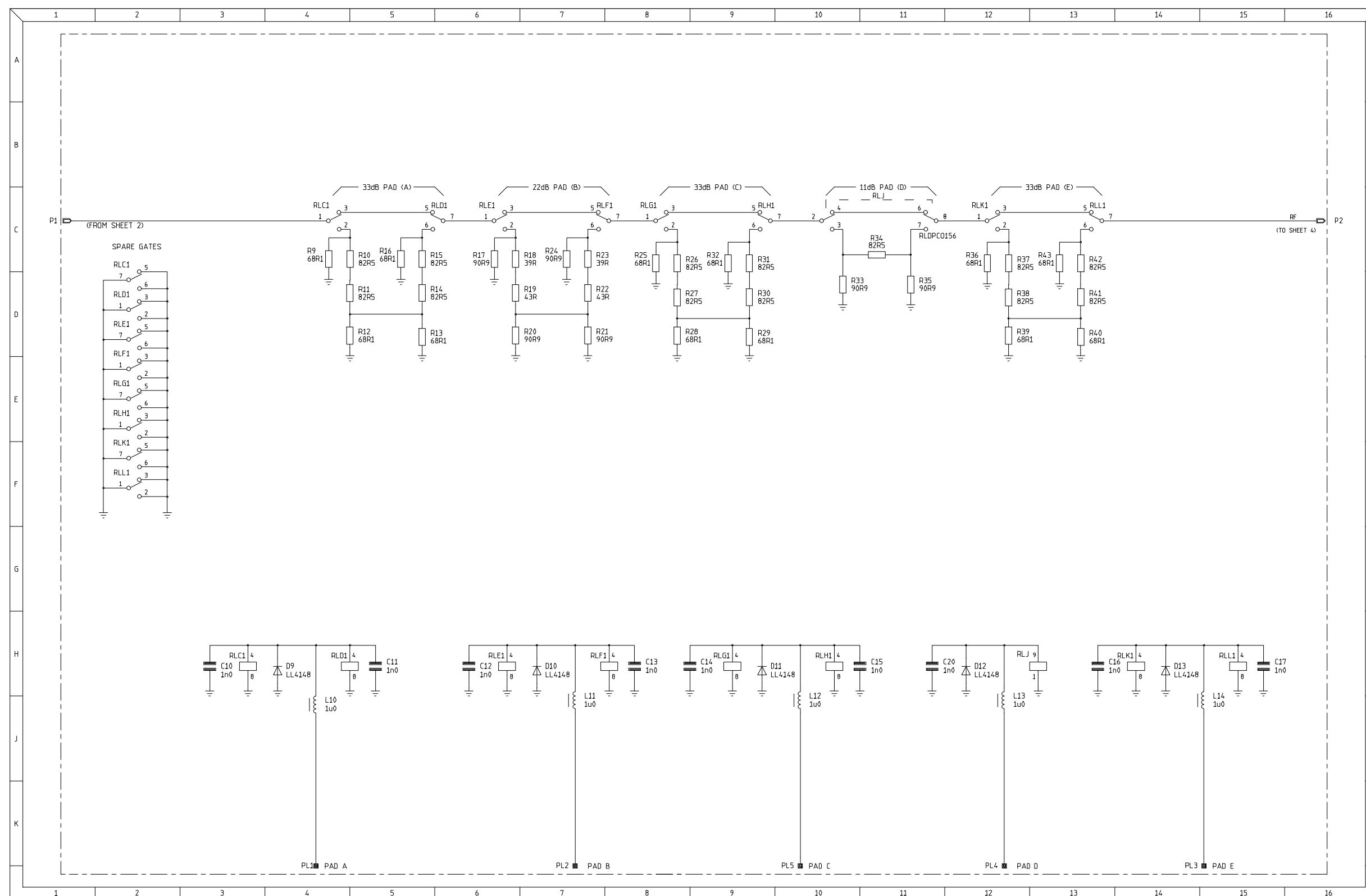
RPP and atten **AA2/5**

Drg. No. A44830/238 Sheet 2 of 2 (Issue 5)

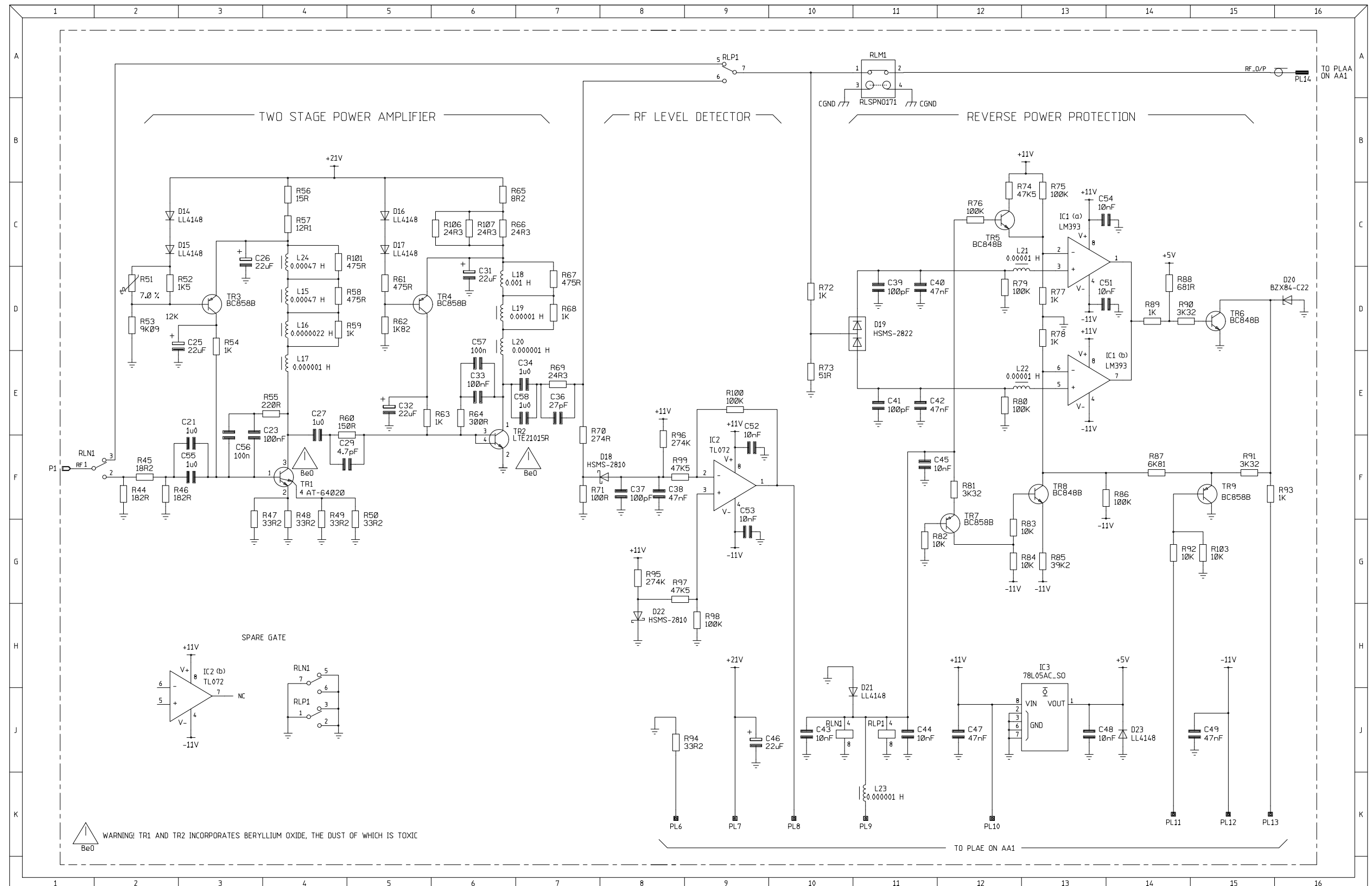
Fig. 7-43 AA2/7 Fast pulse and high power board: Component layouts

Pulse mod **AA2/7**



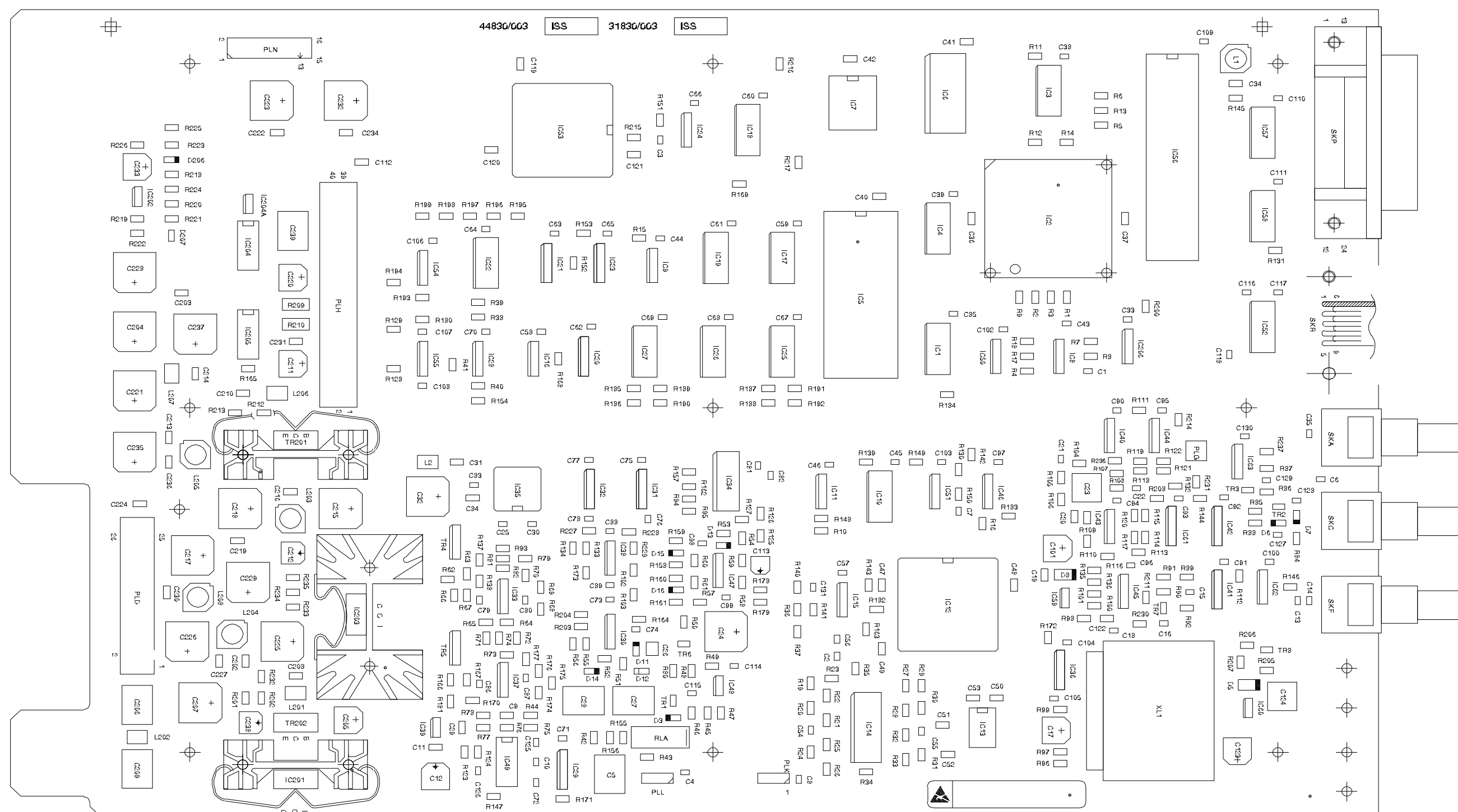
Attenuator **AA2/7**

Attenuator **AA2/7**

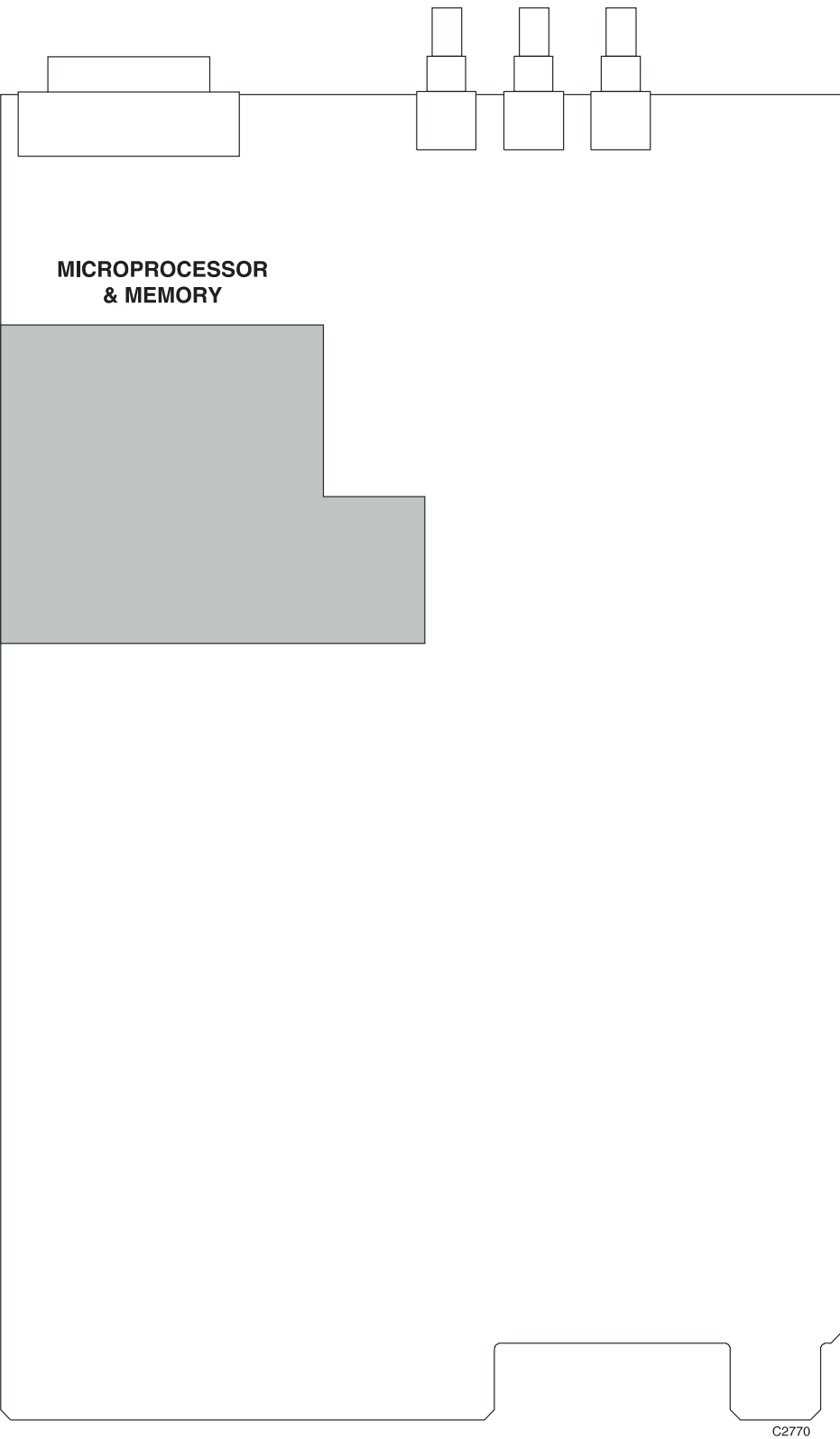
Power amp and RPP **AA2/7**



Power amp and RPP **AA2/7**

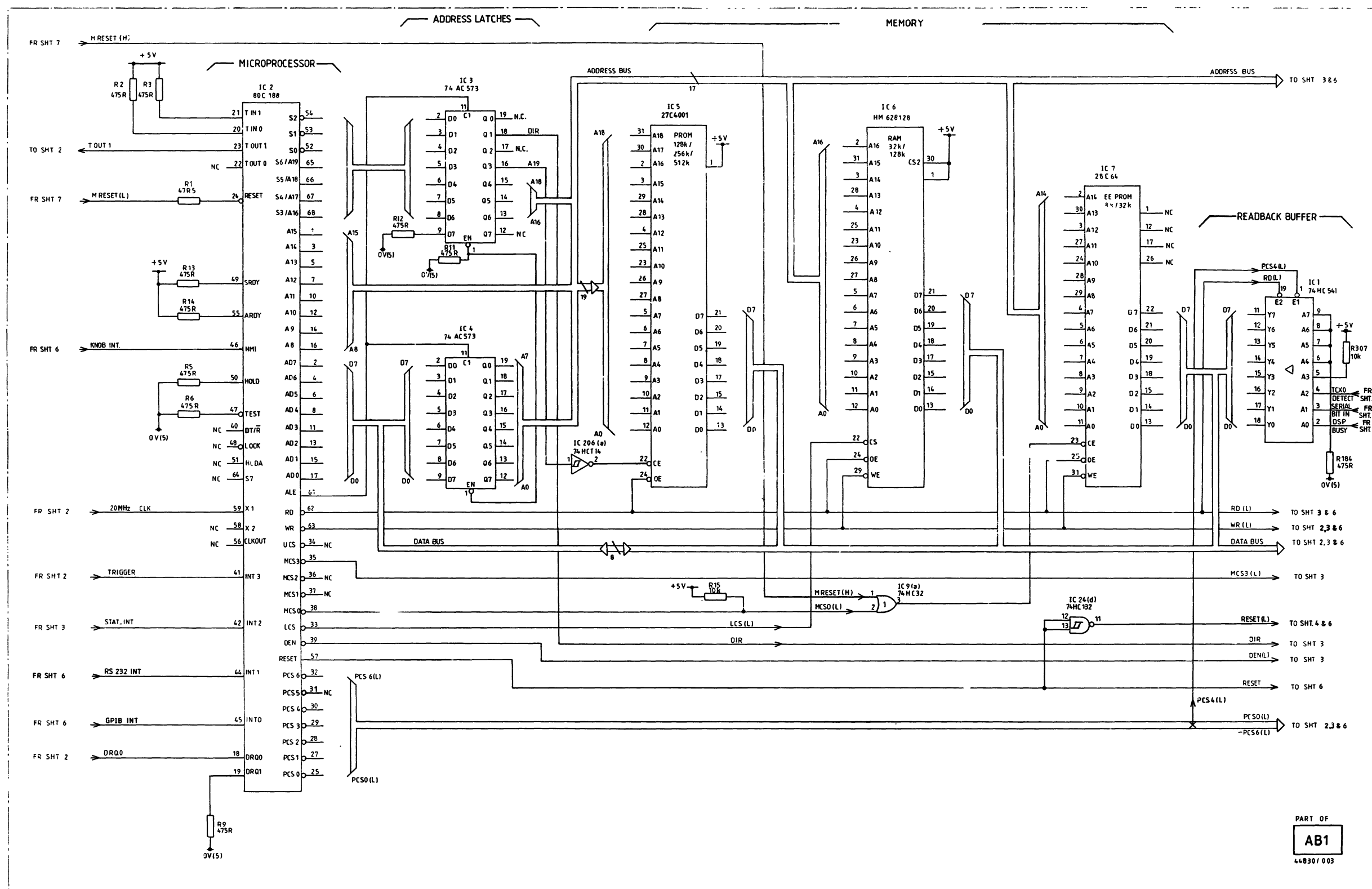
Component layout **AB1**

Sheet 1 component locations **AB1**



Component layout **AB1**

Fig. 7-48 AB1 Control board: Sheet 1 component locations

Microprocessor and memory **AB1**

Sheet 2 component locations **AB1**

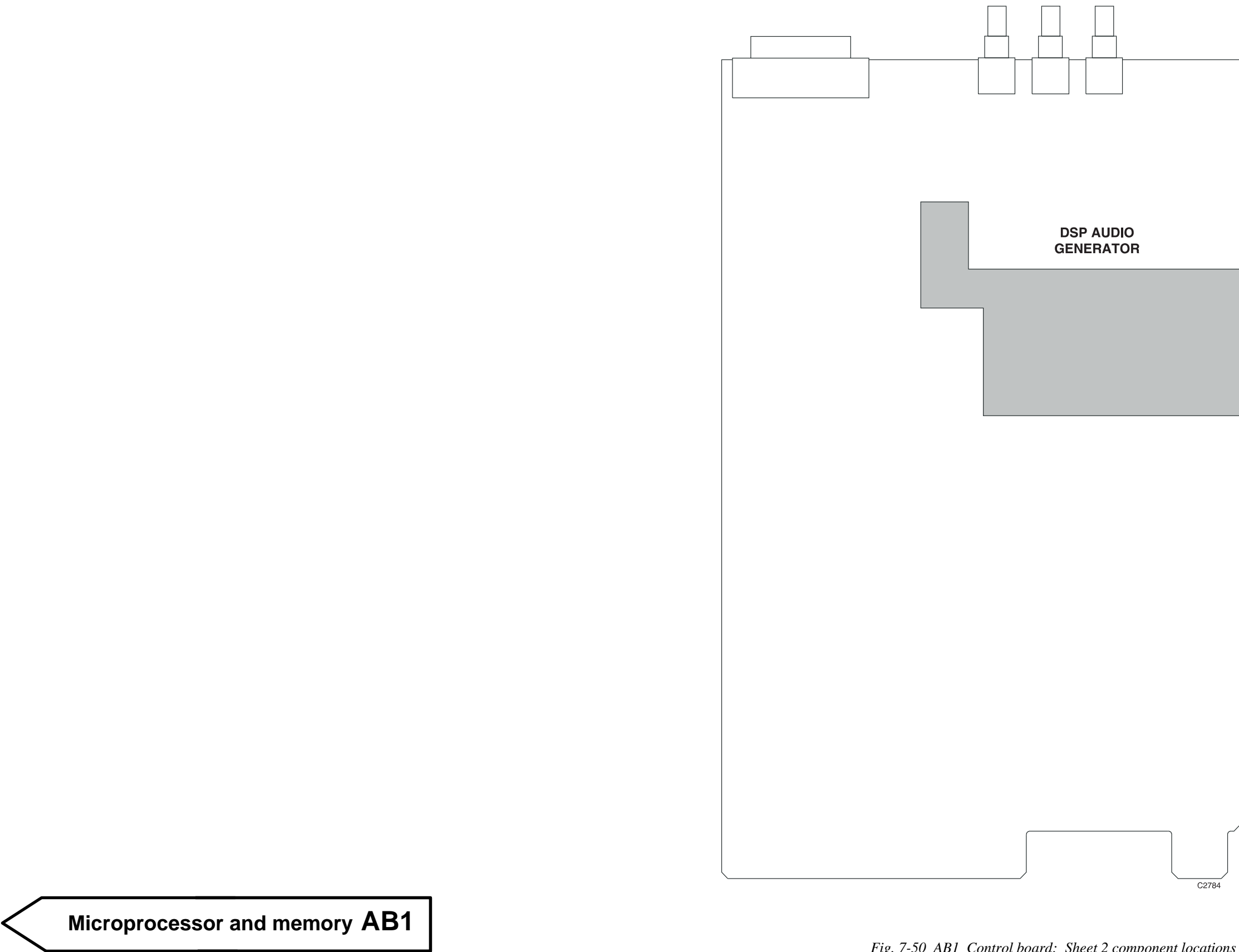


Fig. 7-50 AB1 Control board: Sheet 2 component locations



Sheet 3 component locations **AB1**

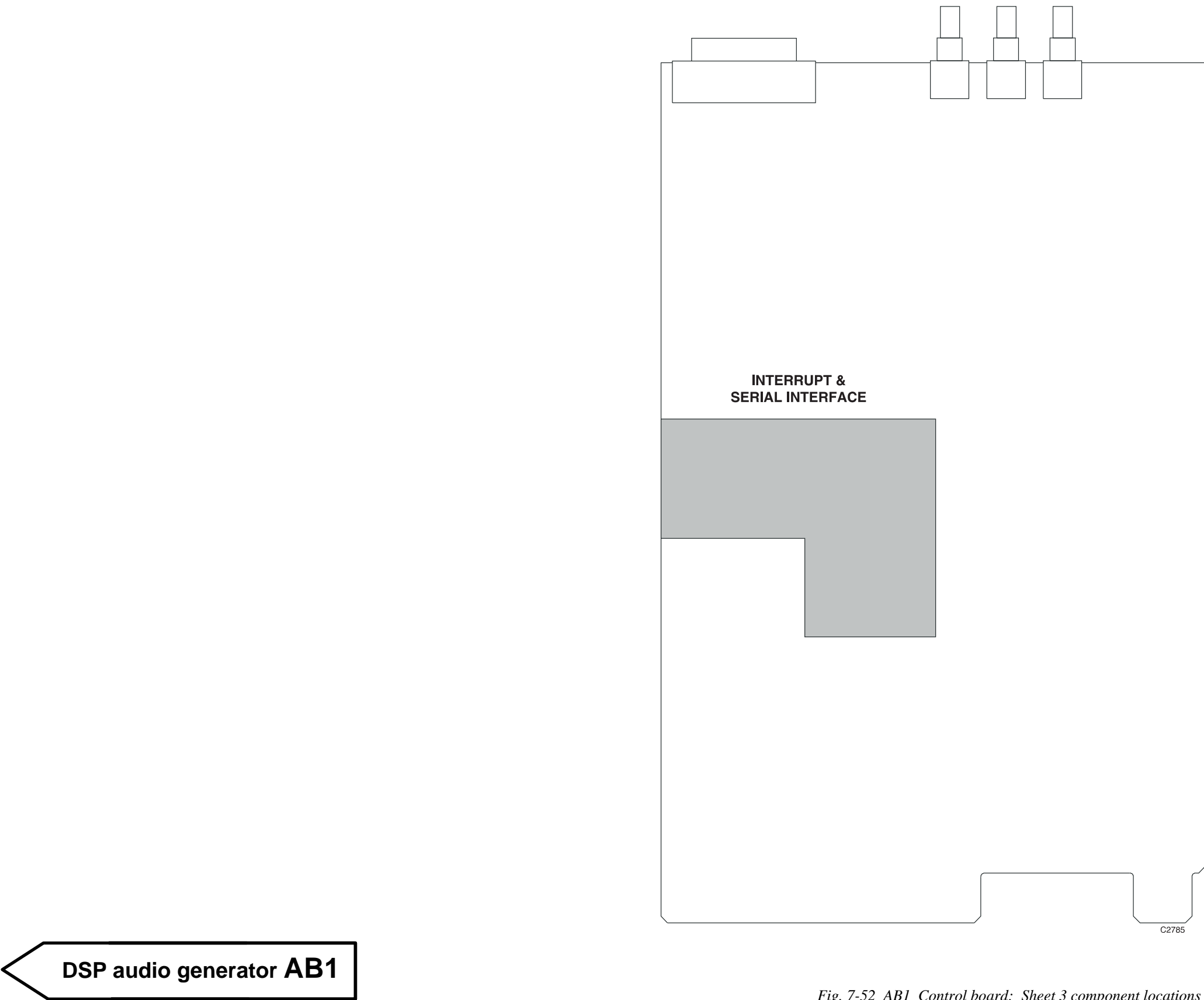
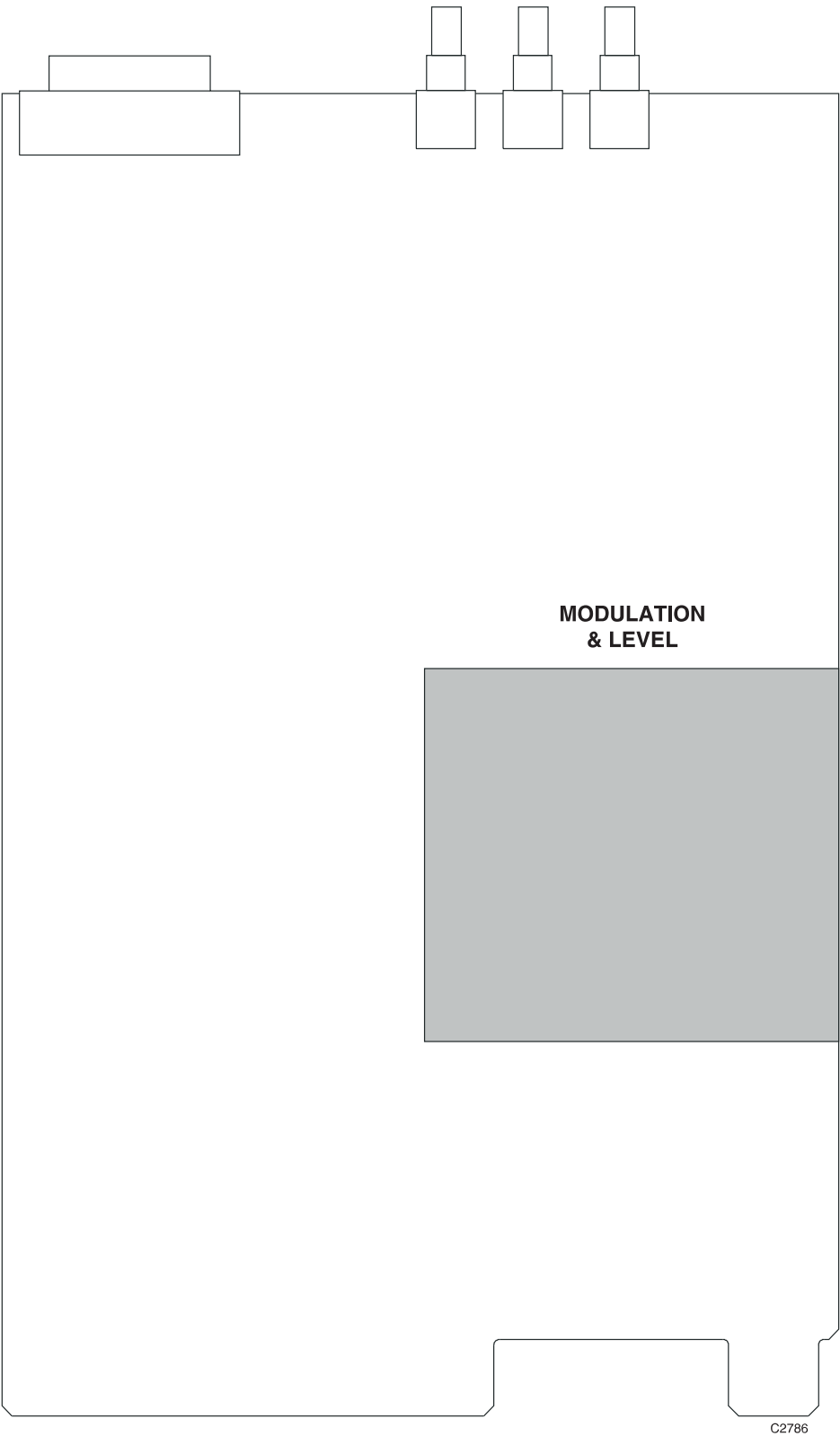


Fig. 7-52 AB1 Control board: Sheet 3 component locations



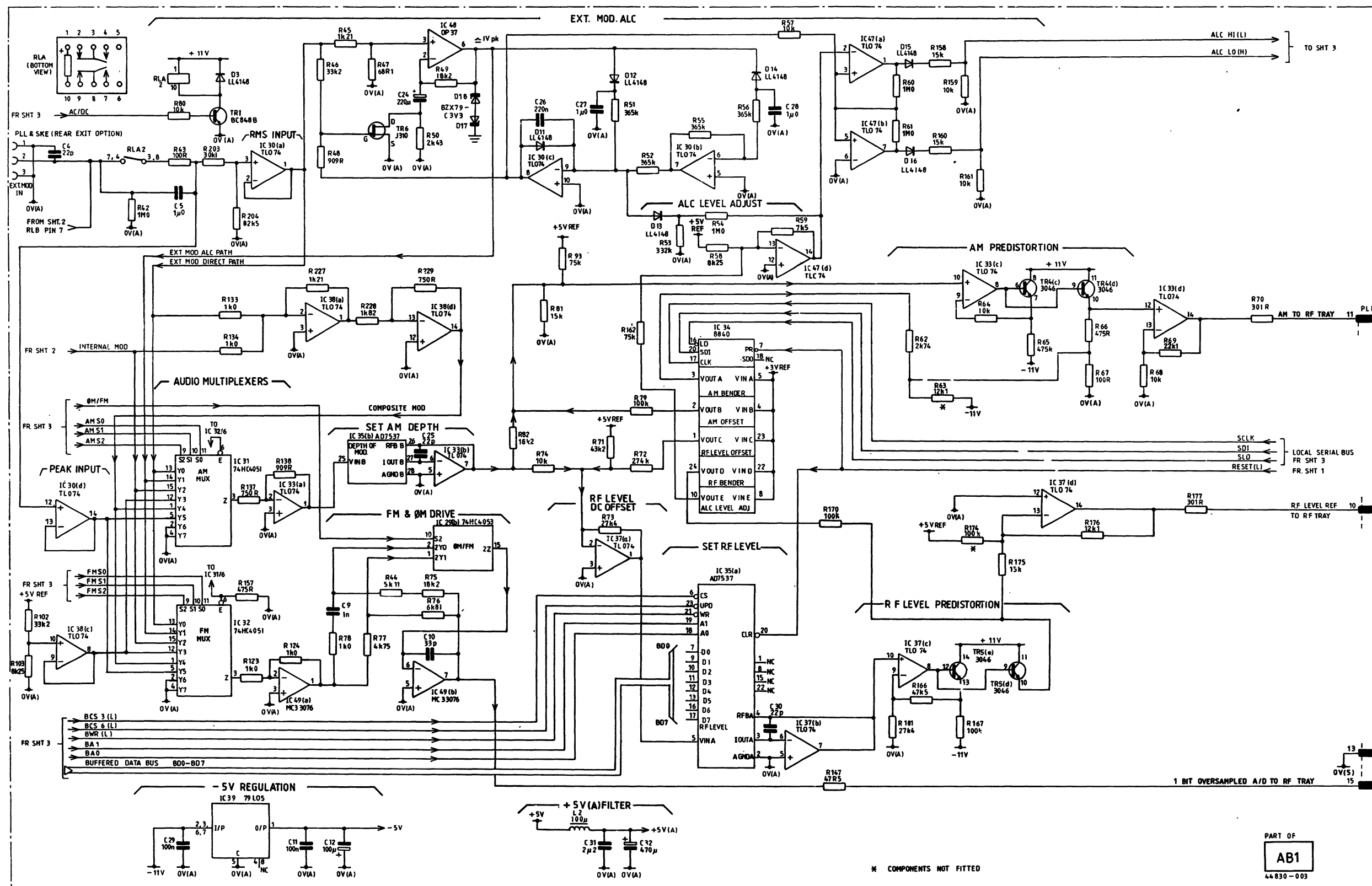


Sheet 4 component locations **AB1**

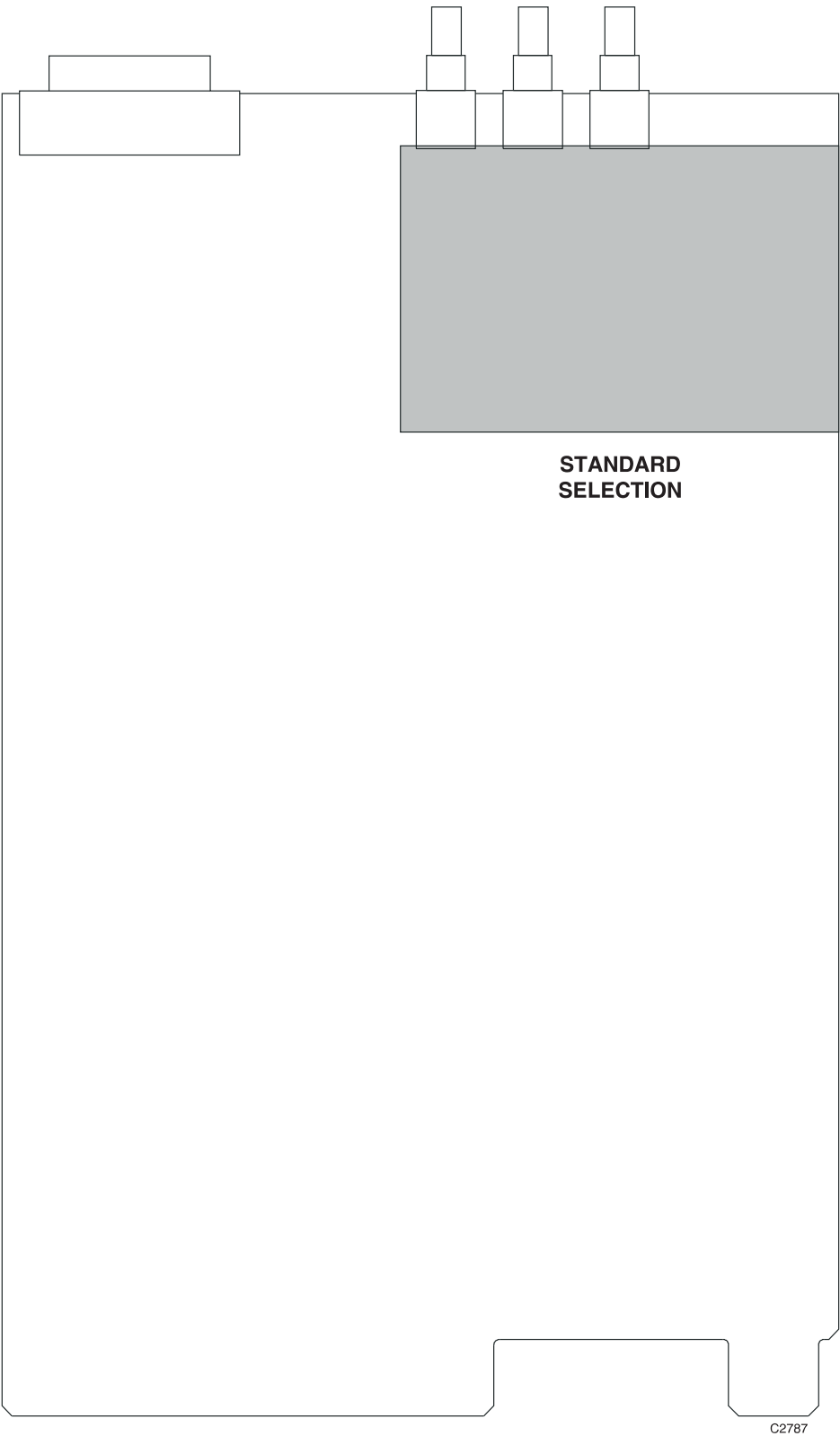


Interrupts and serial interface **AB1**

Fig. 7-54 AB1 Control board: Sheet 4 component locations

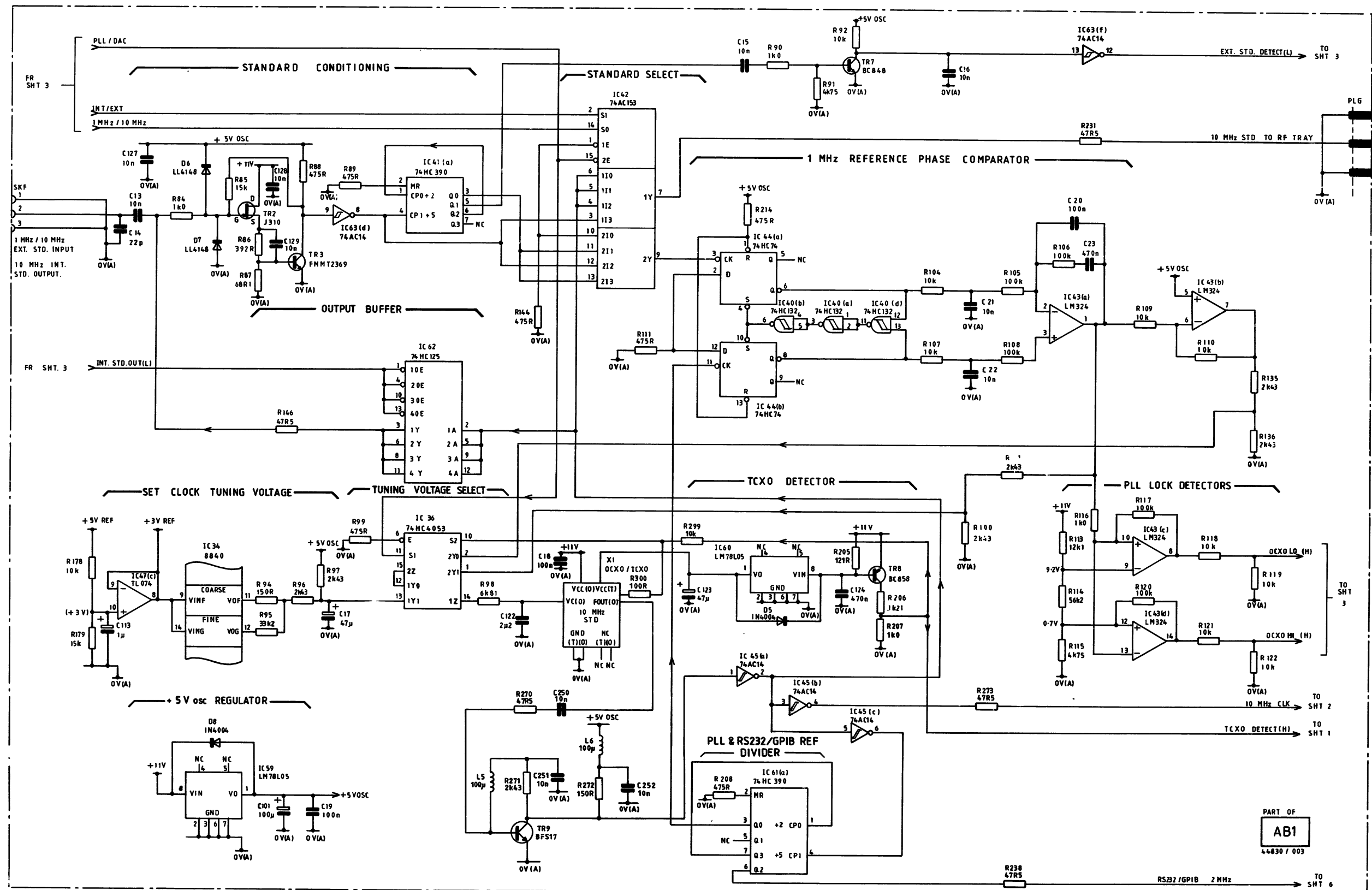
Modulation and level **AB1**

Sheet 5 component locations **AB1**

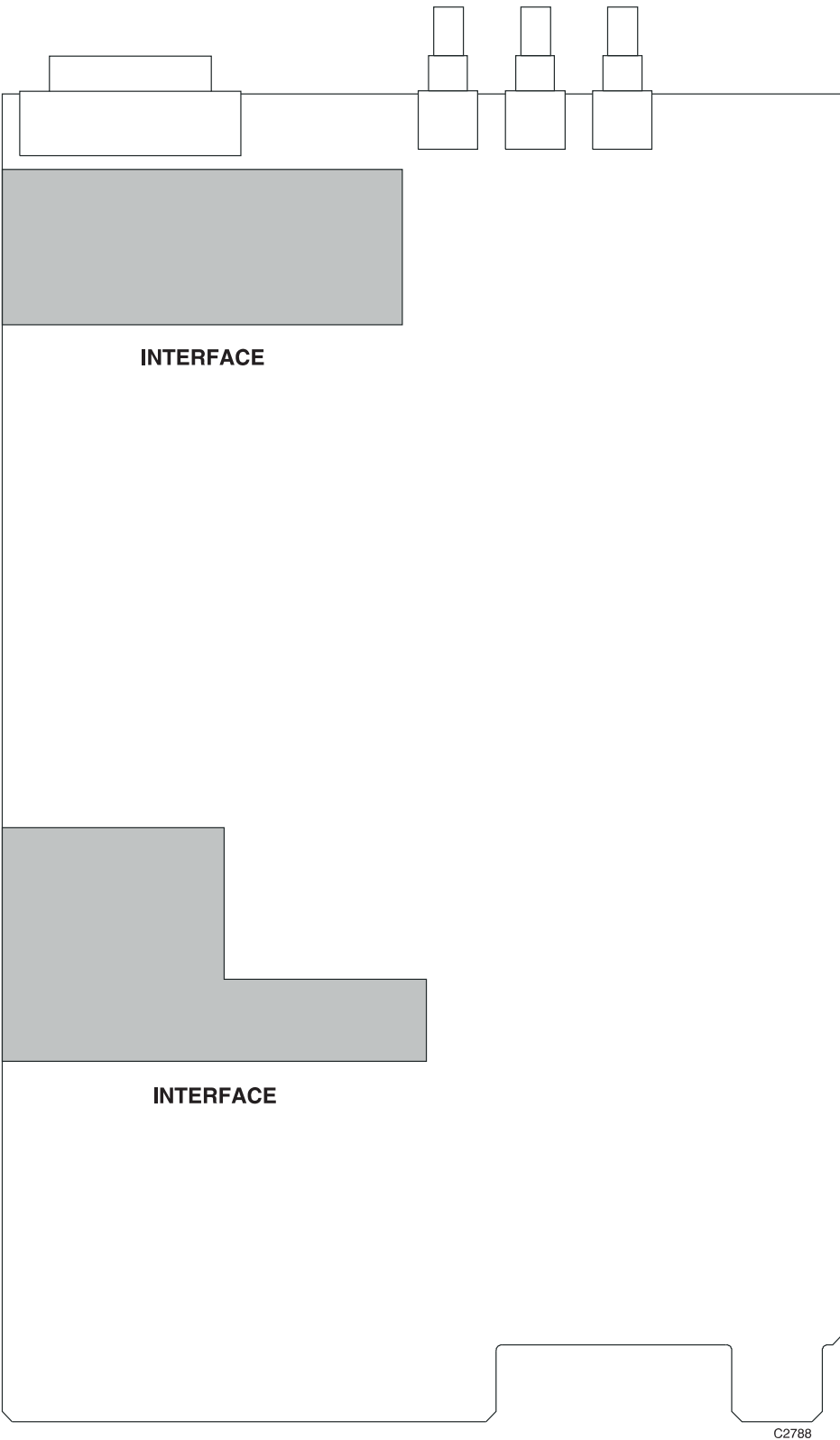


Modulation and level **AB1**

Fig. 7-56 AB1 Control board: Sheet 5 component locations

Standard selection **AB1**

Sheet 6 component locations **AB1**



Standard selection **AB1**

Fig. 7-58 AB1 Control board: Sheet 6 component locations



Sheet 7 component locations **AB1**

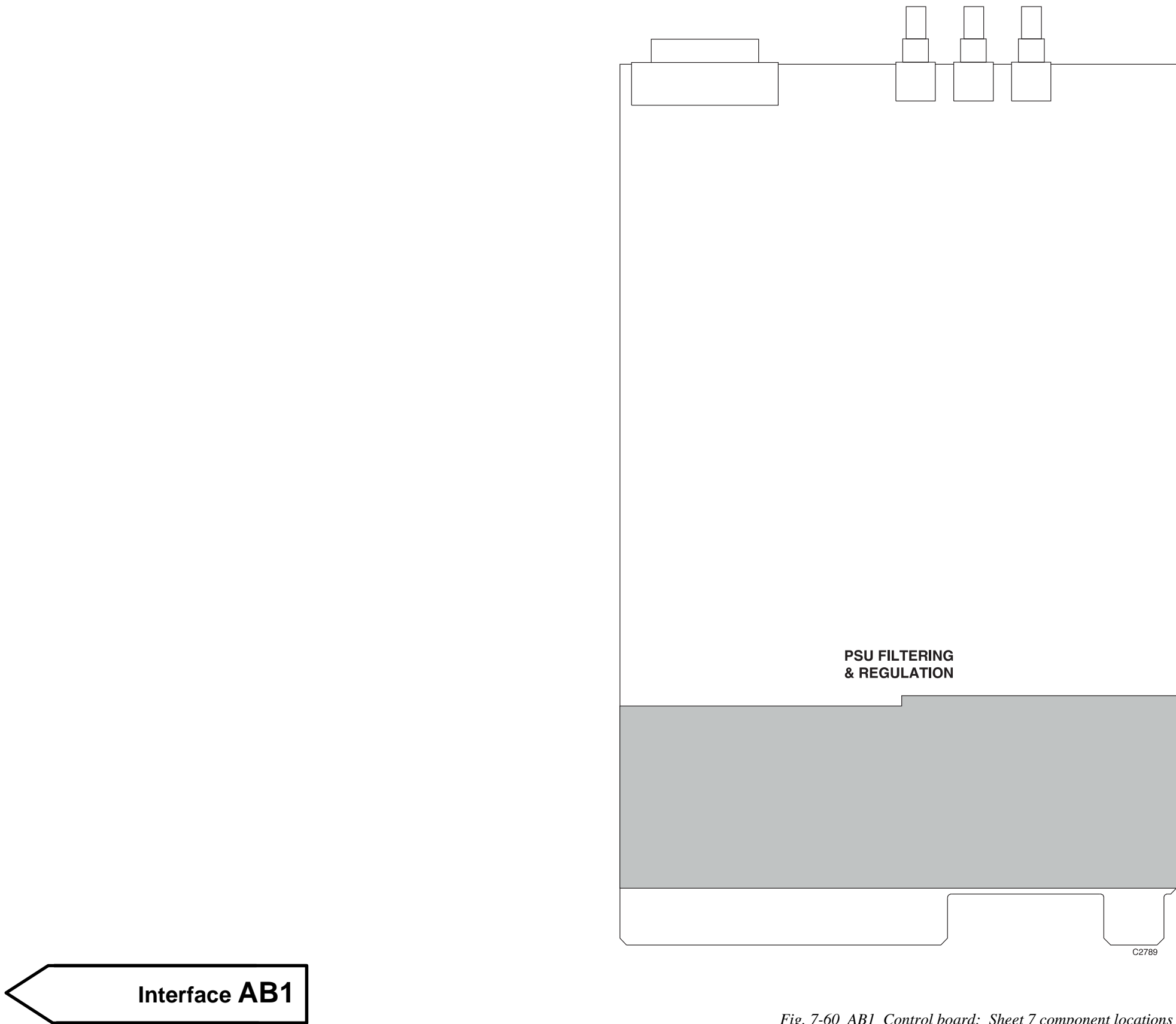
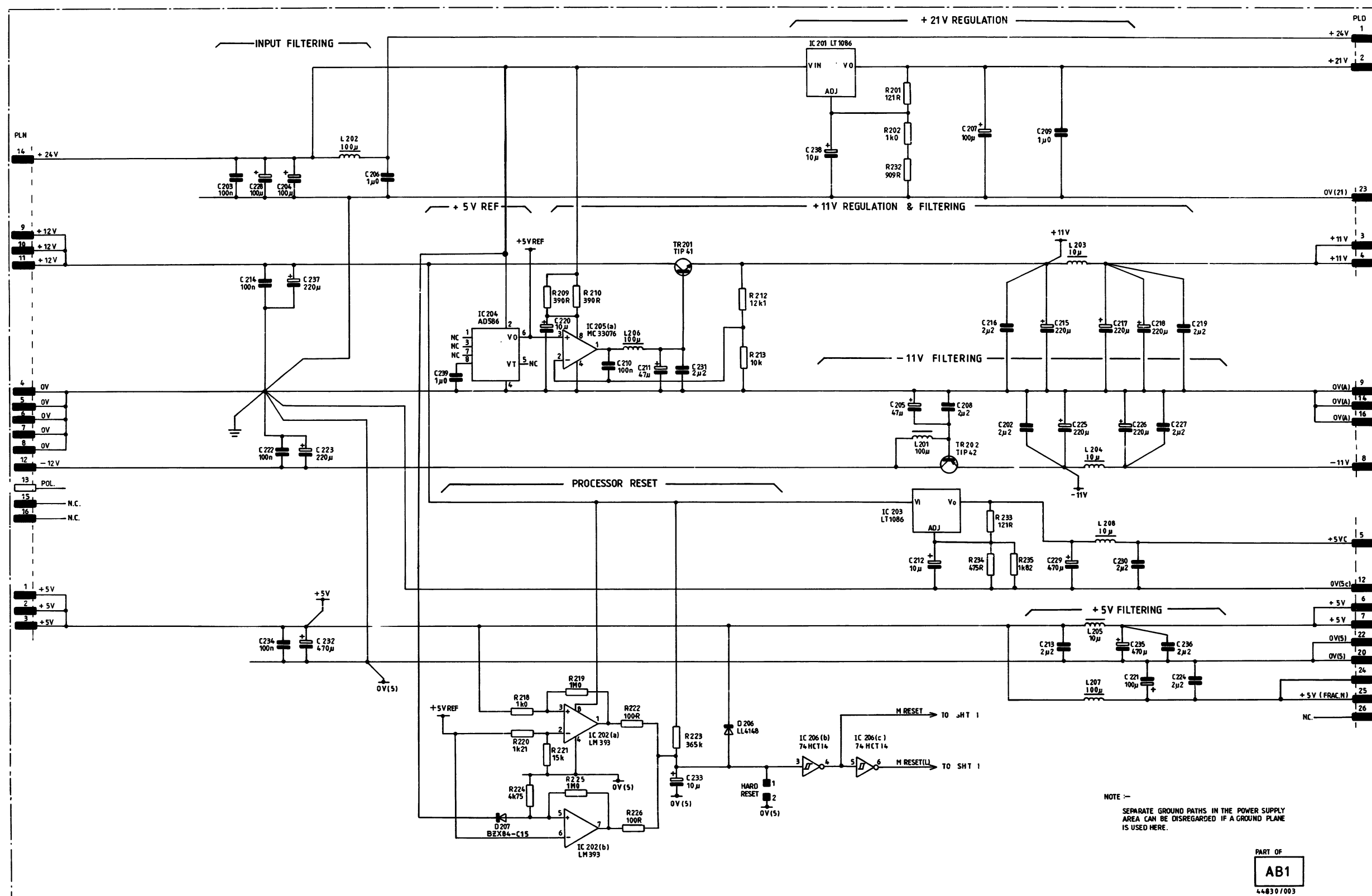
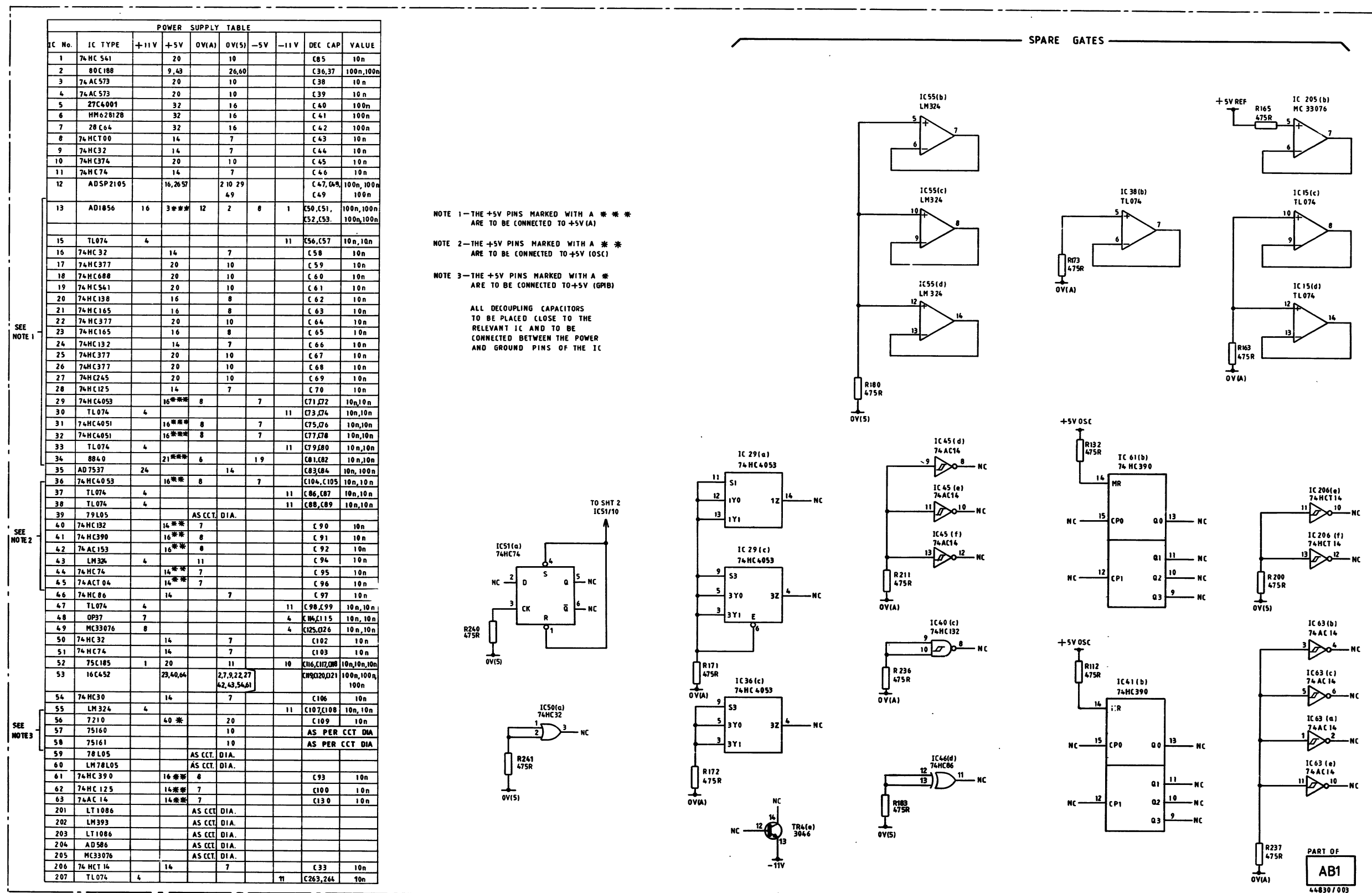


Fig. 7-60 AB1 Control board: Sheet 7 component locations

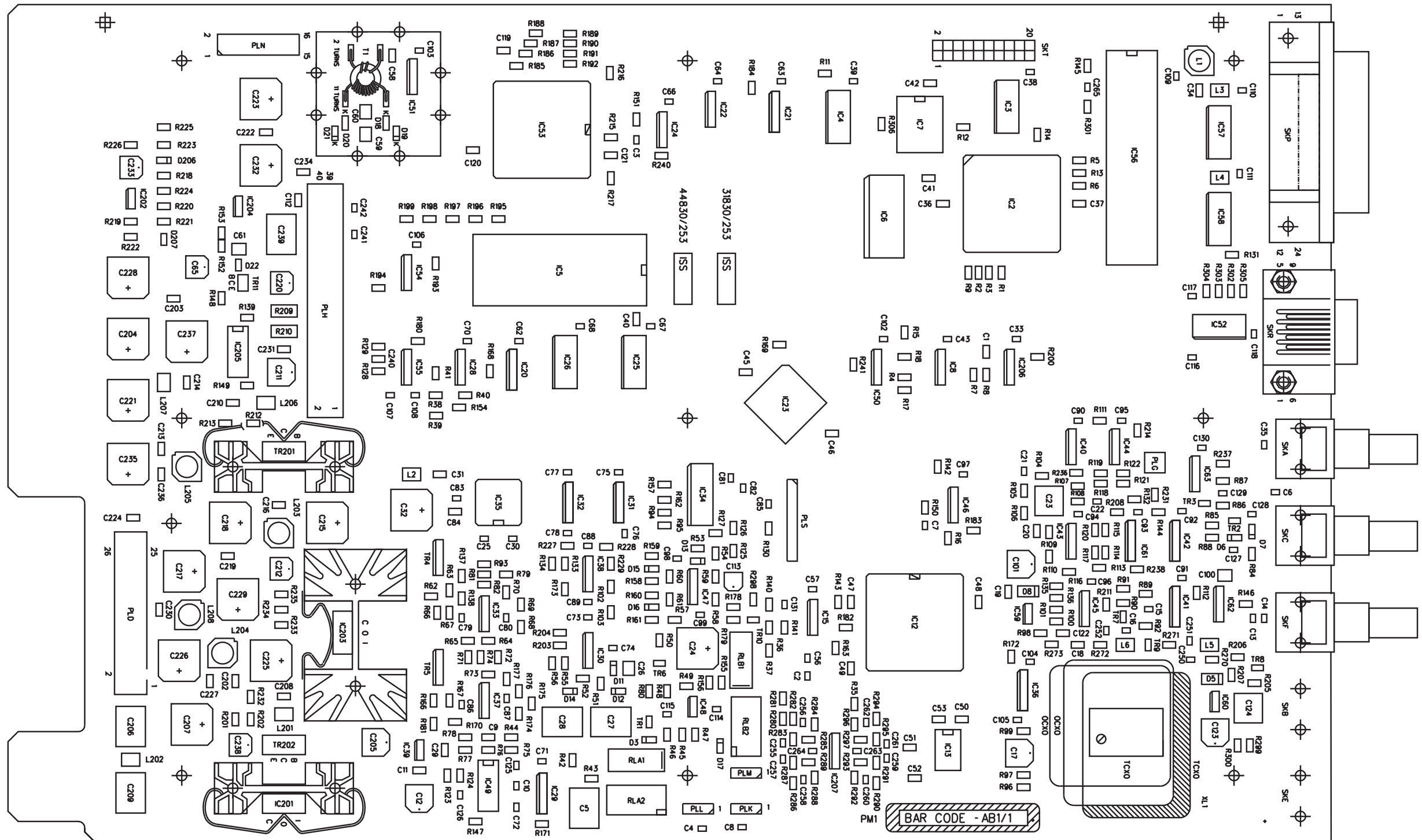
PSU filtering and regulation **AB1**



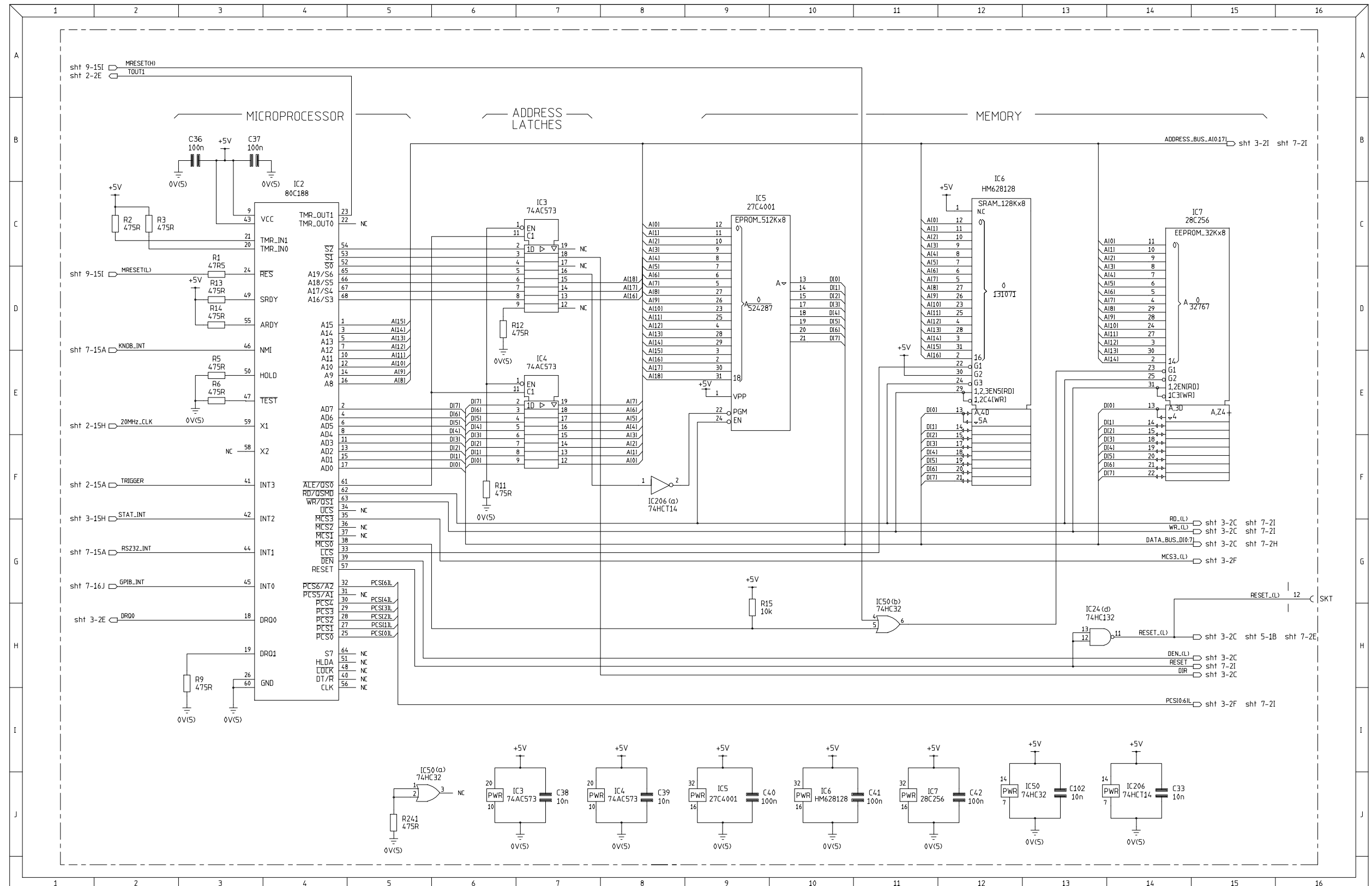
PSU filtering and regulation **AB1**

Power supplies **AB1**

Power supplies **AB1**

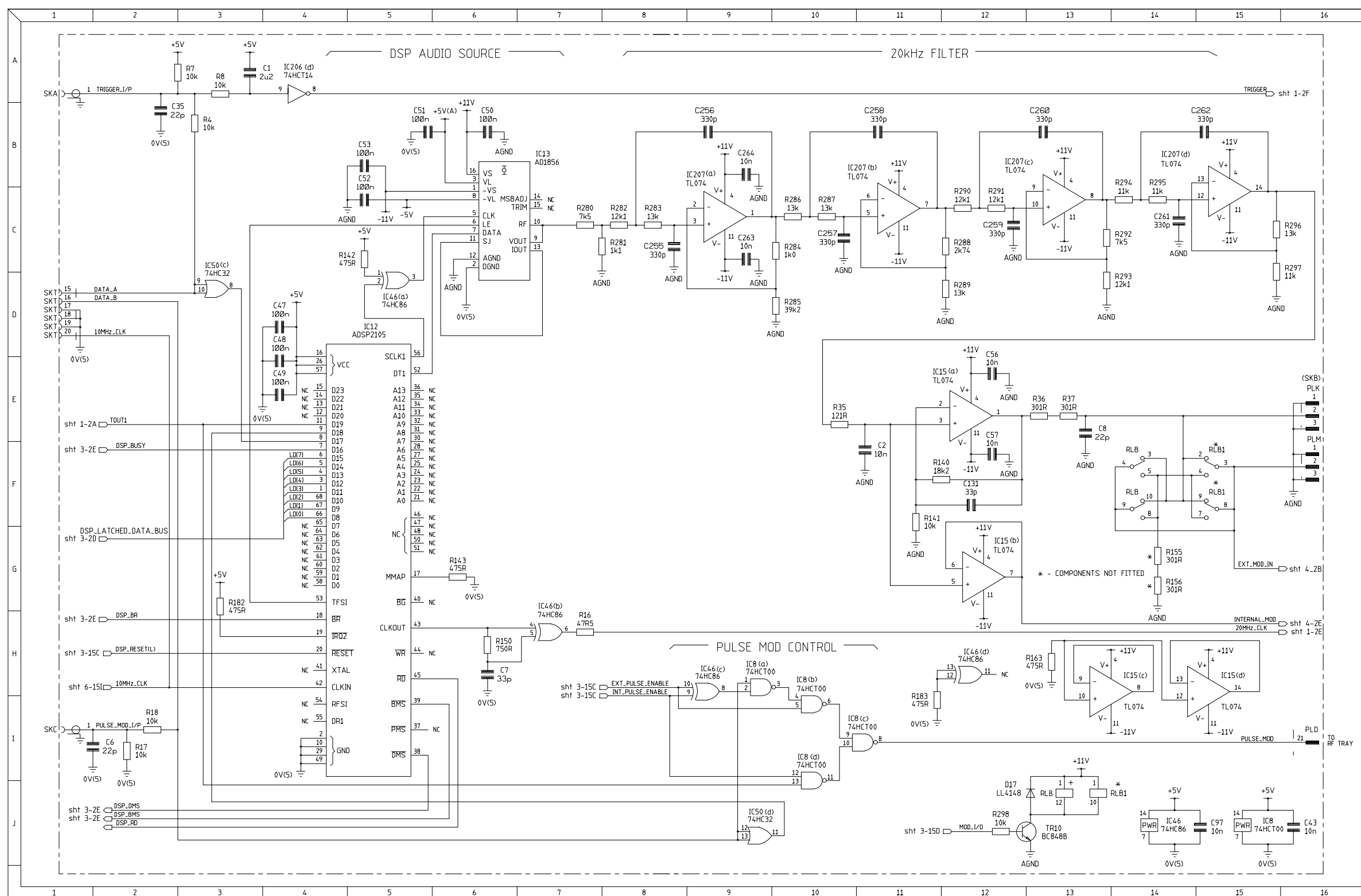
Component layout **AB1/1 and AB1/3**

Component layout **AB1/1**

Microprocessor and memory **AB1/1**

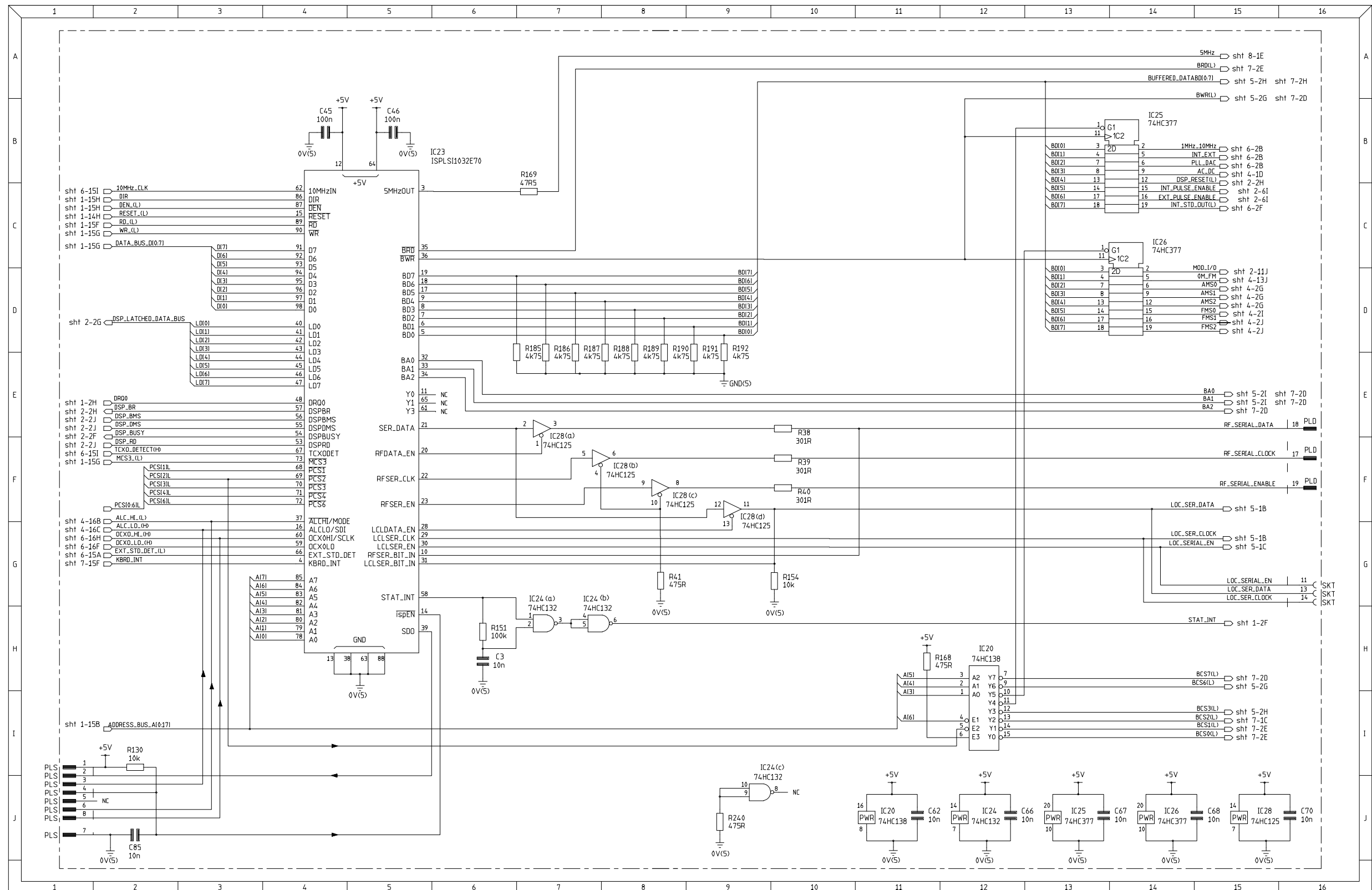
Microprocessor and memory **AB1/1**

# DSP audio generator AB1/1

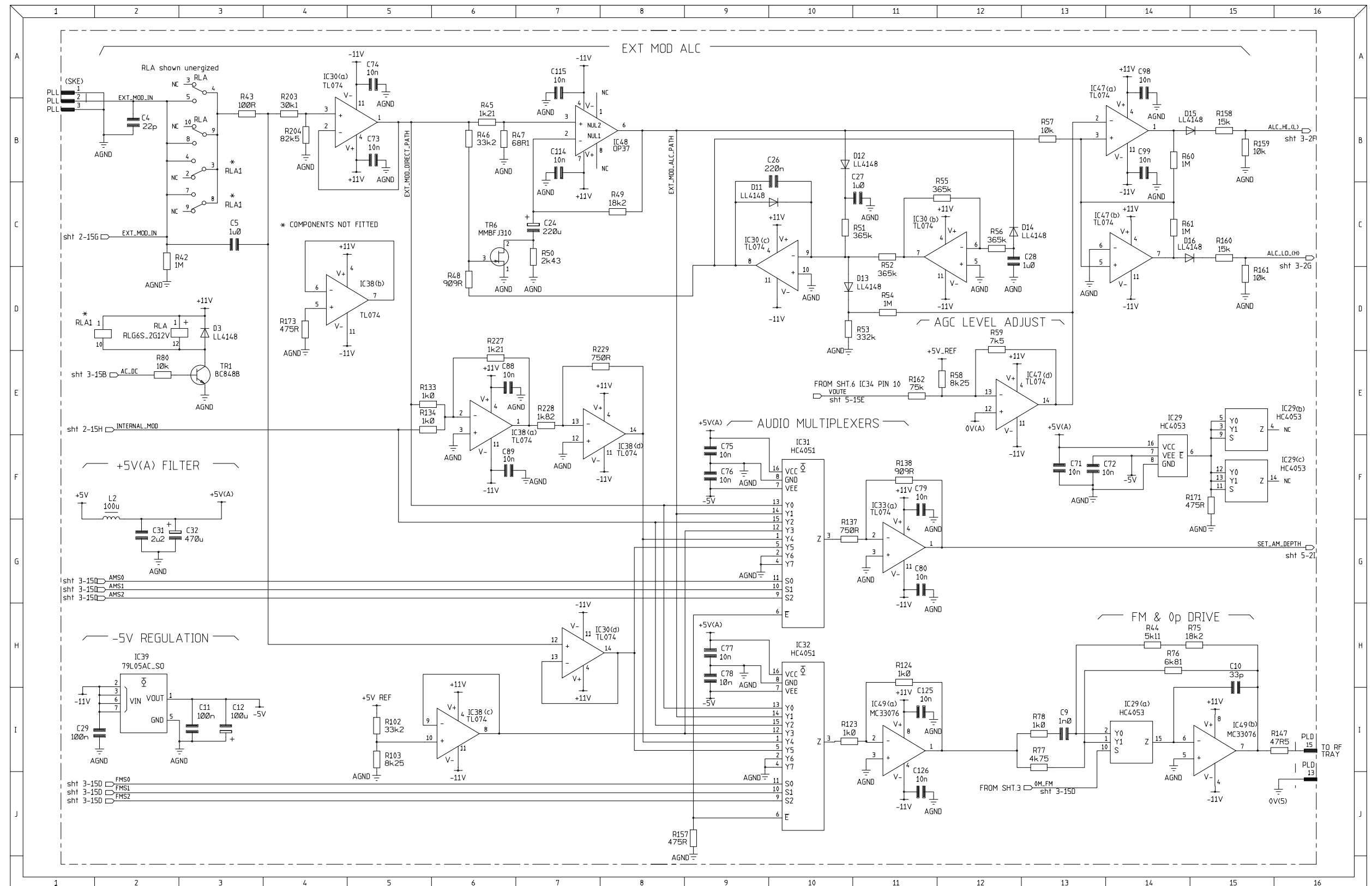


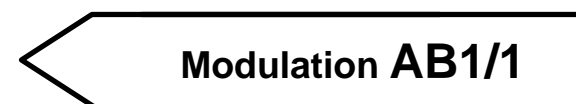


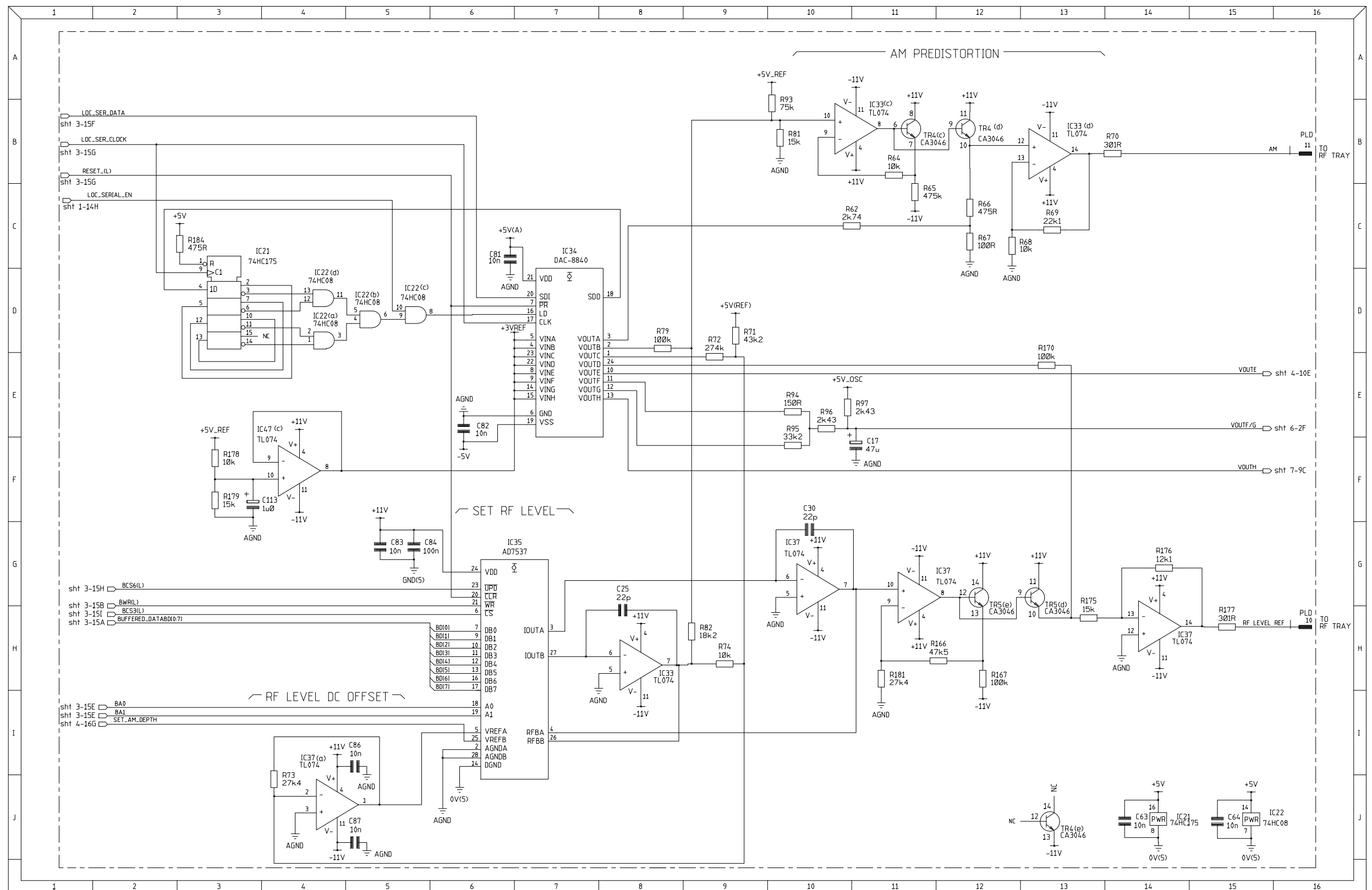
DSP audio generator **AB1/1**

Interrupts and serial interface **AB1/1**

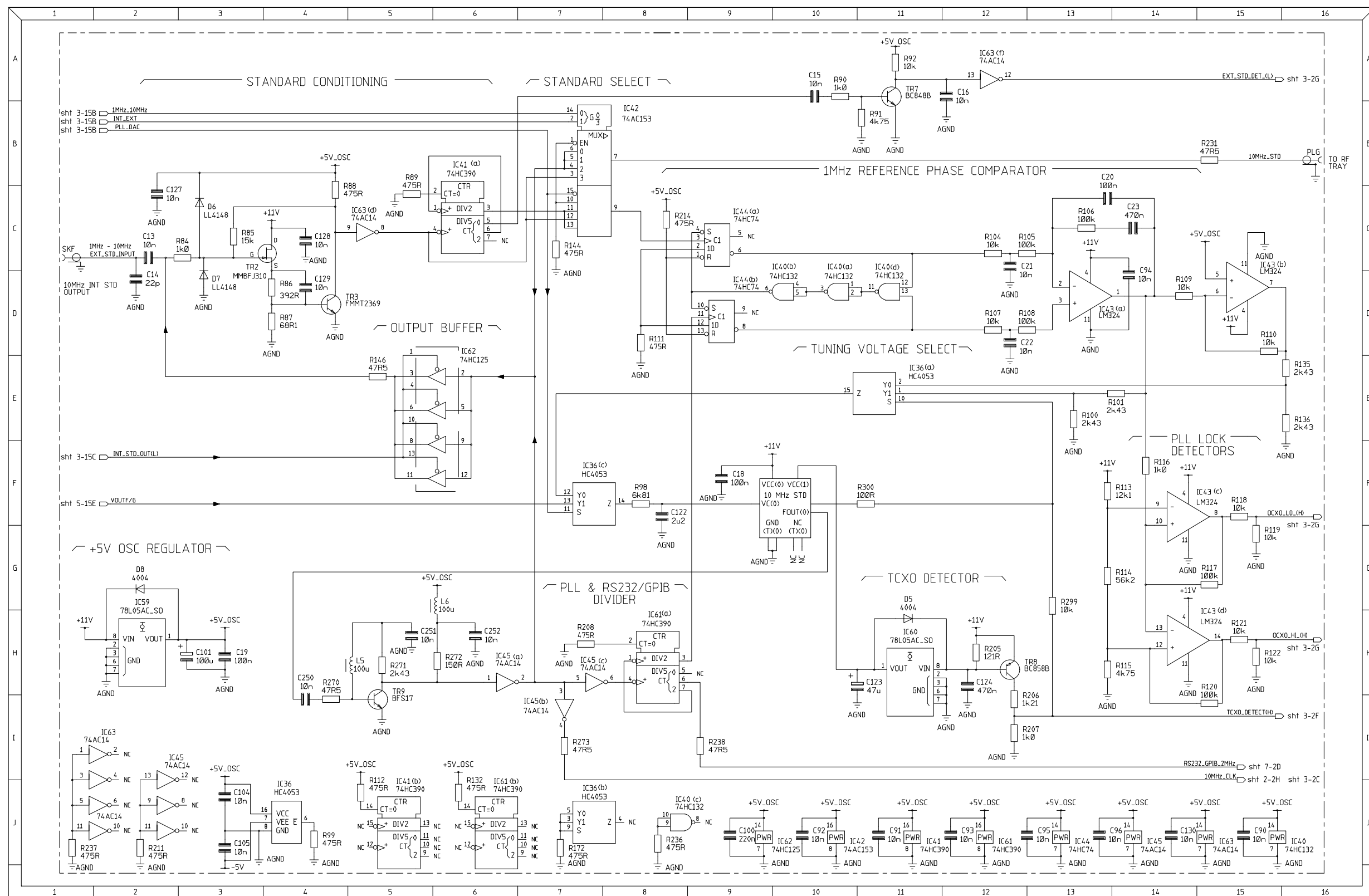
Interrupts and serial interface **AB1/1**

Modulation **AB1/1**



Level **AB1/1**

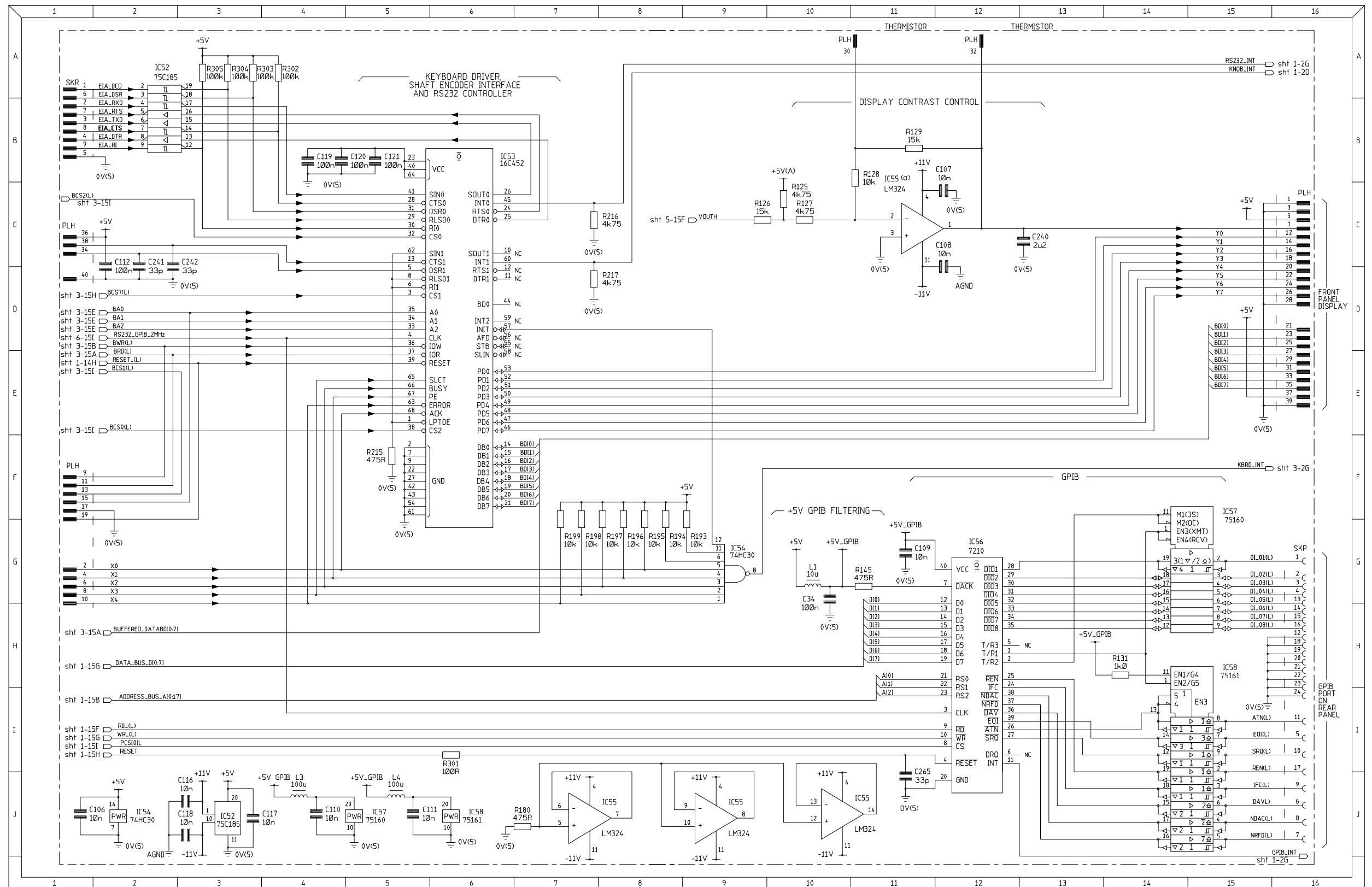


Standard selection **AB1/1**

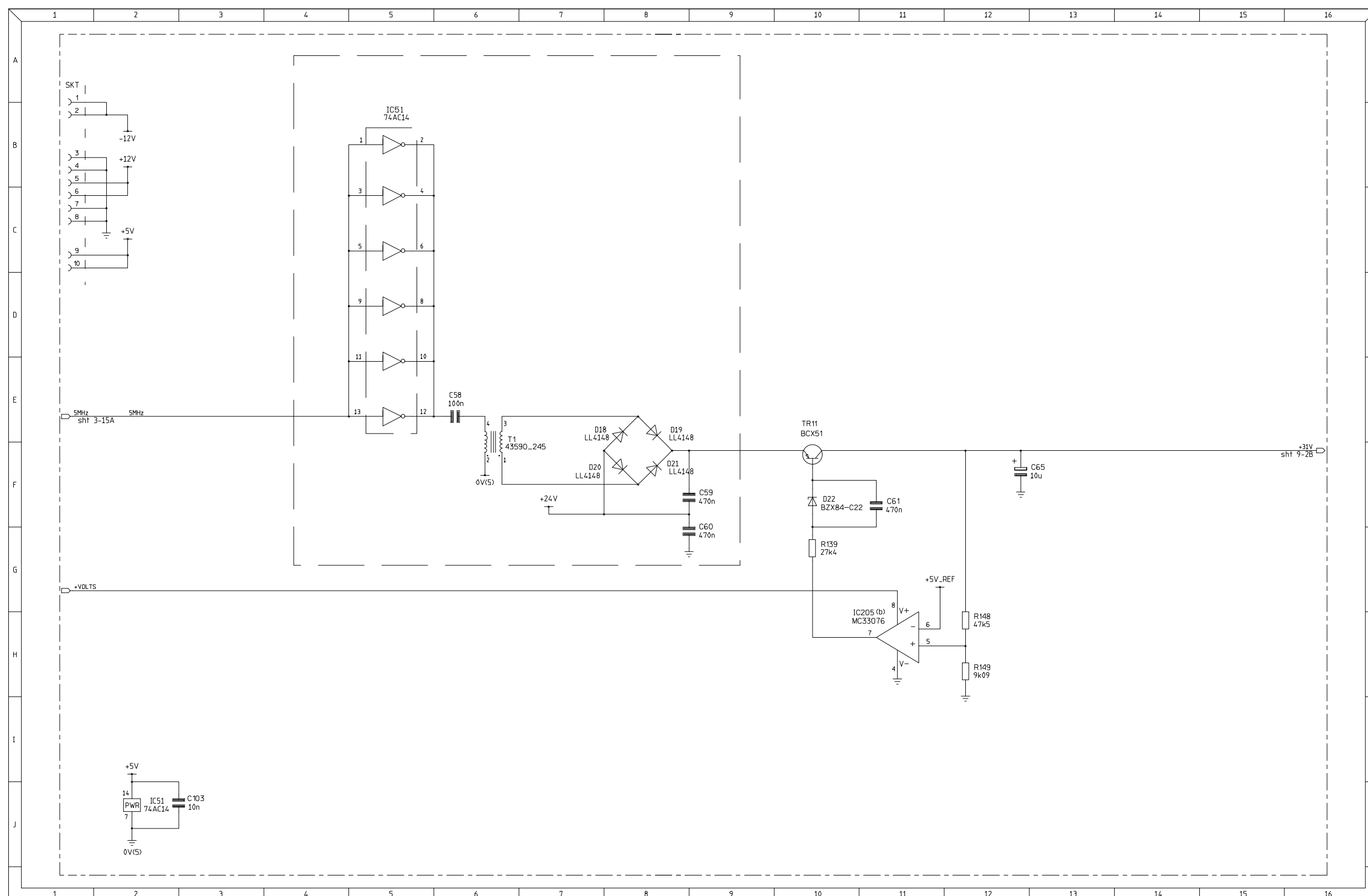


Standard selection **AB1/1**

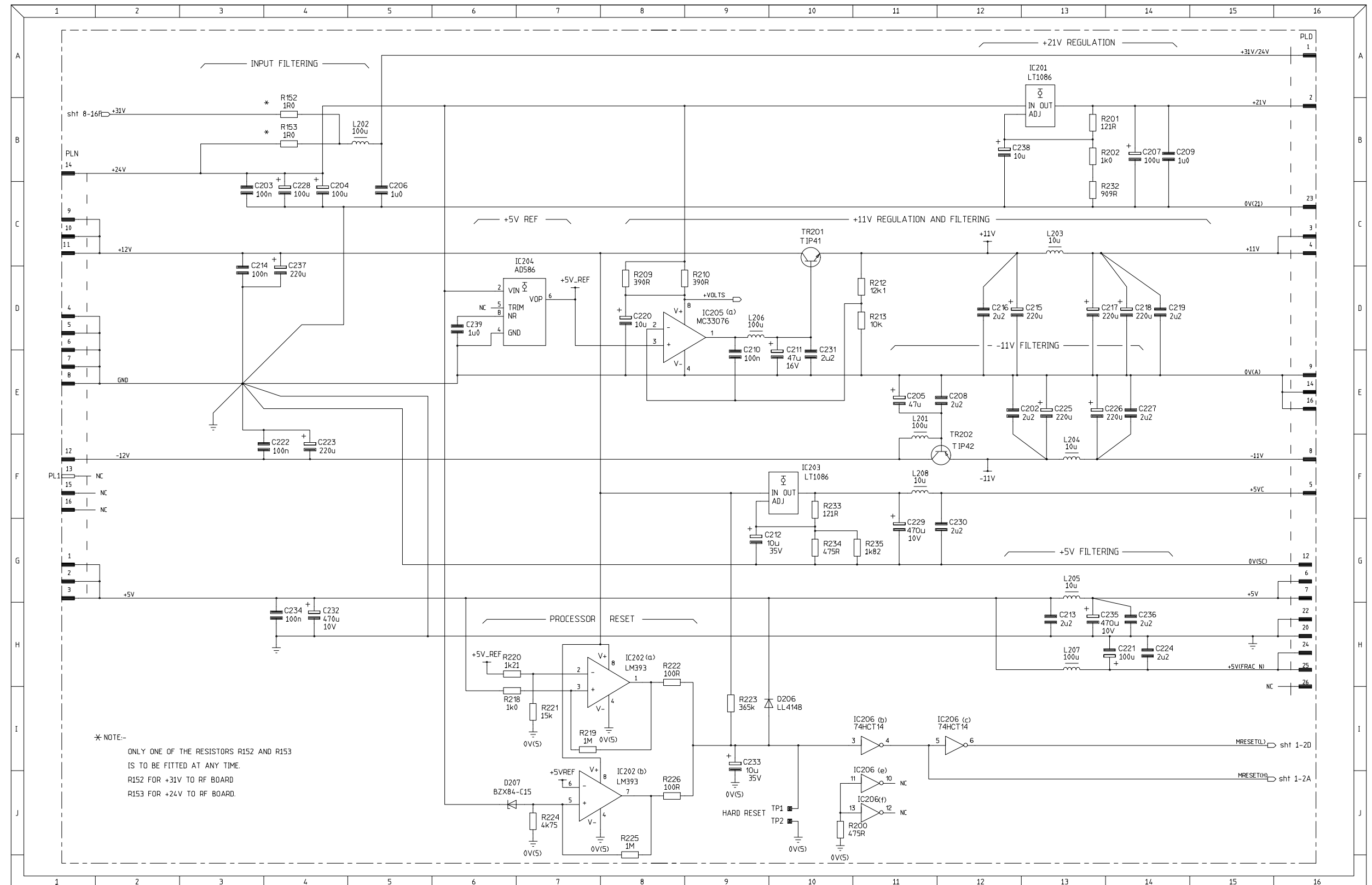
# Interface AB1/1



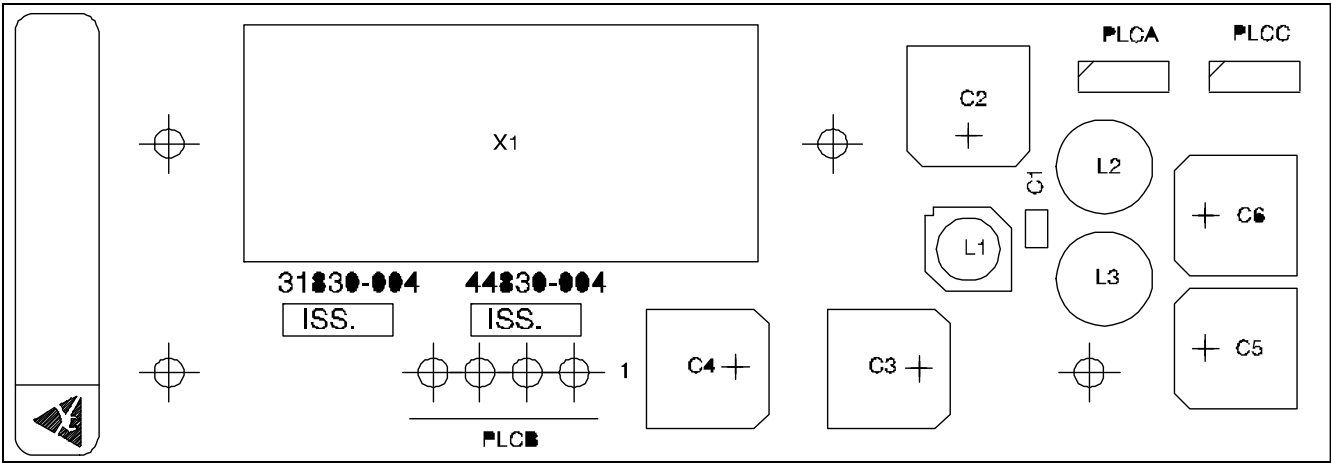


31 V DC supply **AB1/1**

31 V DC supply **AB1/1**

PSU filtering and regulation **AB1/1**

Component layout **AC1**

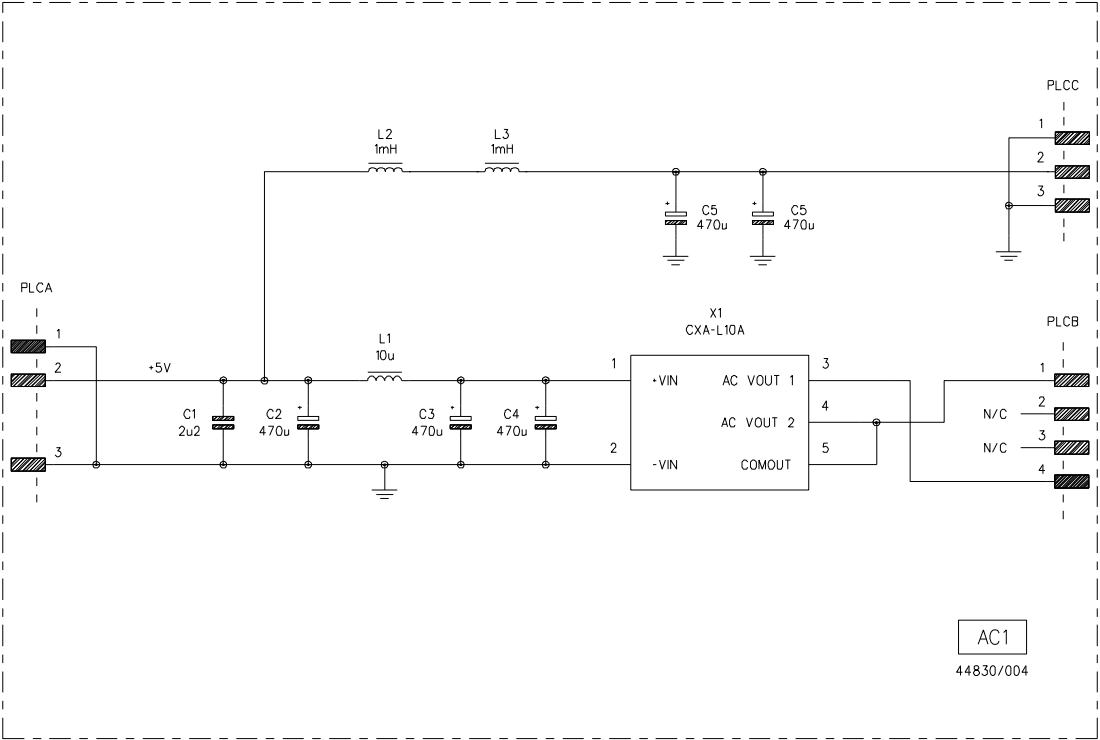


PSU filtering and regulation **AB1/1**

Drg. No. A44830/004 Sheet 1 of 1 (Issue 1)

Fig. 7-73 AC1 Backlight inverter board component layout

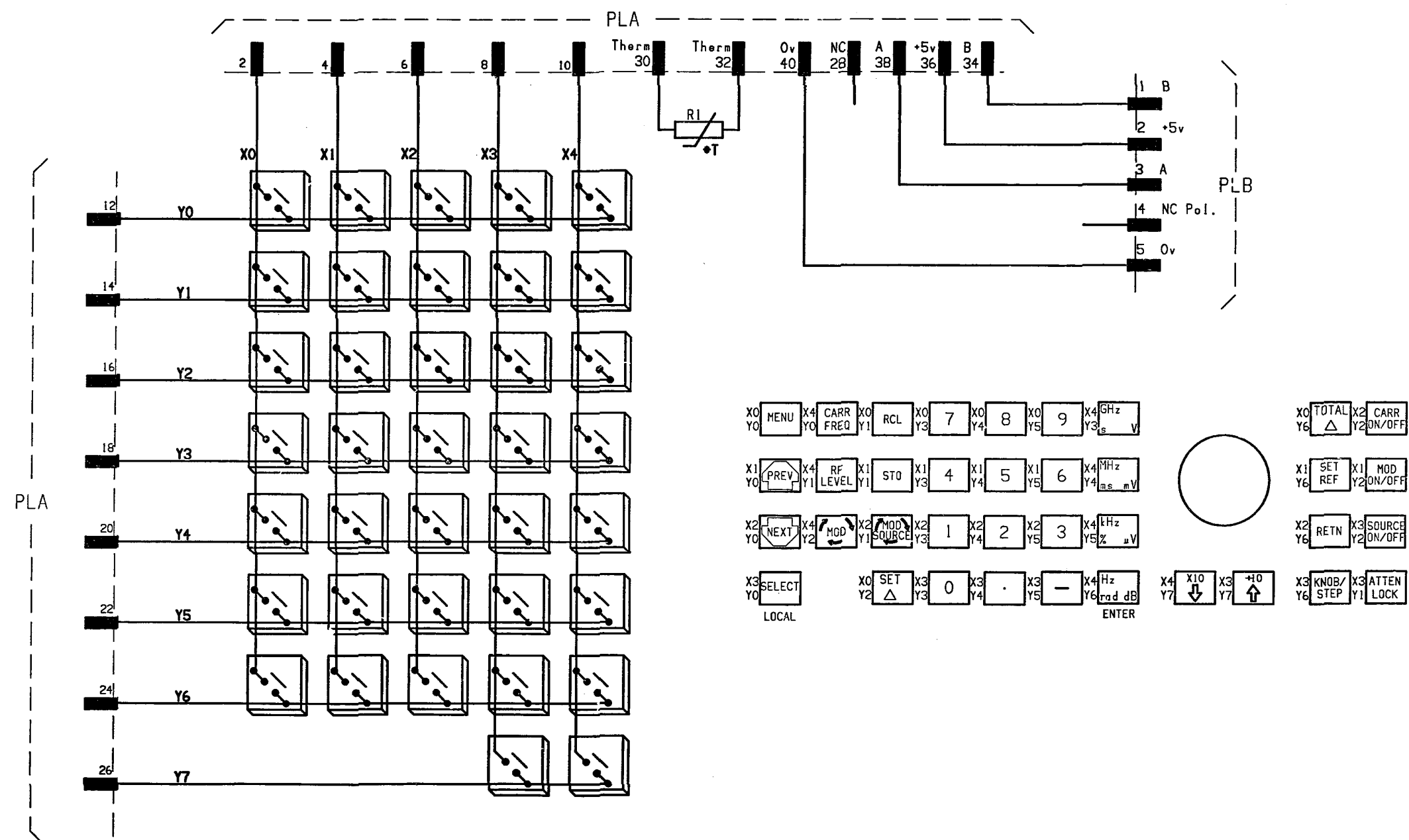
Backlight inverter board **AC1**



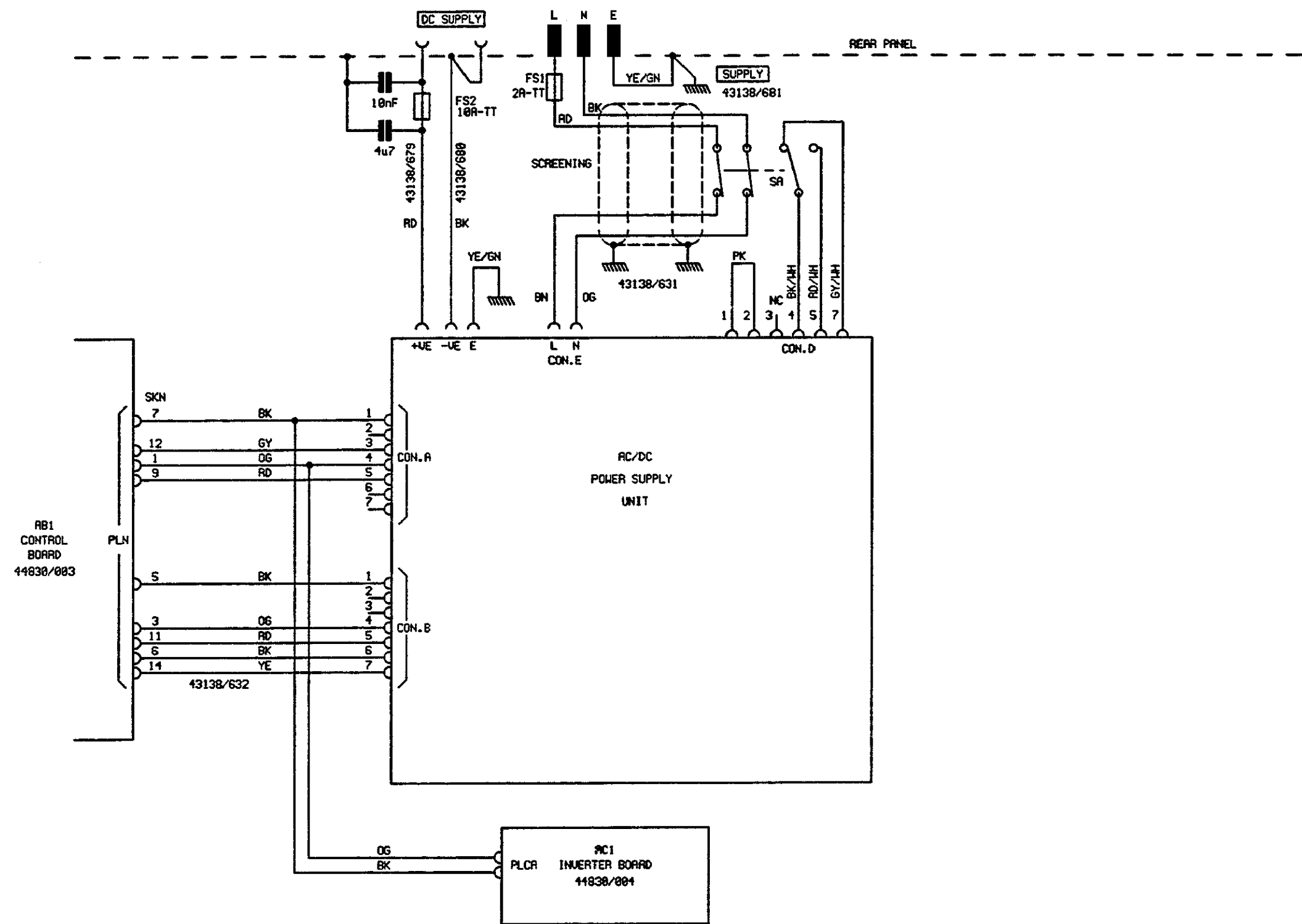


Backlight inverter board **AC1**

# Keyboard AF1



AC/DC power supply interconnections



Keyboard AF1

Fig. 7-76 AC/DC power supply interconnections