# Fluke 93/95/97
# Philips PM93/95/97
## SCOPEMETER

Service Manual

Fluke: 915970
Philips: 4822 872 05349
920121

**Warning:** **These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are fully qualified to do so.**

PHILIPS

FLUKE®

## IMPORTANT

In correspondence concerning this instrument please give the model number and serial number as located on the type number plate on the instrument.

All modifications up to production data 21 january 1992 are incorperated in this manual.

For your reference:

| | | |
|---|---|---|
| Model number: | PMxx | Fluke xx |
| Code number : | 9444 yyy yyyyy | 9444 yyy yyyyy |
| Serial number: | DM nn mmmm | DM nn mmmm |

*Note: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*



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# TABLE OF CONTENTS

# 1 SAFETY INSTRUCTIONS

Read this chapter carefully before installation and use of the instrument.

## 1.1 INTRODUCTION

The following sections contain information, cautions and warnings which must be followed to ensure safe operation and to keep the instrument in a safe condition.

WARNING: **Servicing described in this manual is to be done only by qualified service personnel. To avoid electrical shock, do not service the instrument unless you are qualified to do so.**

## 1.2 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the instrument.

## 1.3 CAUTION AND WARNING STATEMENTS

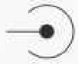
CAUTION: **Is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.**

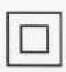
WARNING: **Calls attention to a potential danger that requires correct procedures or practices in order to prevent personal injury.**

## 1.4 SYMBOLS


Caution (refer to accompanying documents)


Common input symbol, equipotentiality.


High BNC input symbol.


Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION


Ground symbol


Recycling symbol


Static sensitive components (black/yellow)

## 1.5 IMPAIRED SAFETY

Whenever it is likely that safety has been impaired, the instrument must be turned off and disconnected from all external voltage sources, and the batteries must be removed. The matter should then be referred to qualified technicians. Safety is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

## 1.6 GENERAL SAFETY INFORMATION

**WARNING: Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to life.**

The instrument must be disconnected from all voltage sources and batteries must be removed before it is opened.

Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources and batteries are removed. Components which are important for the safety of the instrument may only be replaced by components obtained through your local FLUKE/PHILIPS organization. These components are indicated by an asterisk (*) in the parts list section (chapter 9).

# 2 CHARACTERISTICS

**A. Performance Characteristics**

- PHILIPS and FLUKE guarantee the properties expressed in numerical values with stated tolerance. Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.
- For definitions of terms, reference is made to IEC Publication 351-1.
- The accuracy of all measurements is within ± {(% of reading) ±(one least-significant digit)} from 18C to 28C.
  Add 0.1 x (specified accuracy)/C for < 18C or > 28C ambient.

**B. Safety Characteristics**

The instrument has been designed and tested in accordance with IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains information and warnings that must be followed by the user to ensure safe operation and to keep the instrument in a safe condition.

## 2.1 DISPLAY

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Type | LCD | |
| * Useful Screen Area | 84 mm x 84 mm | 1 div equals 25 pixels.<br>1 div equals 8.75 mm. |
| Resolution | 240 x 240 pixels | |
| * Contrast Ratio | | Adjustable via LCD Menu. |
| * Backlight (Model 97 only) | Electro Luminescence | |

## 2.2 SIGNAL ACQUISITION

| | | |
|---|---|---|
| * Sampling Type<br>@ 1 μs/div...60s/div<br>@ 10 ns/div...500 ns/div | <br>Real Time<br>Quasi Random | |
| * Maximum Sample Rate | 25 MS/s | Sampling Rate depends on time/div setting. |
| * Maximum Vertical (voltage) Resolution | 8 bits | Over 10 divisions. |
| * Maximum Horizontal (time) Resolution | 25 Samples/div | Per Channel. |
| * Record Length<br>With capture 20 div<br>With capture 10 div | <br>512 Samples<br>256 Samples | <br>Per Channel.<br>Per Channel. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Acquisition Time (for 20.4 div) | | |
| 60s/div...1 μs/div | 20.5 x time/div + 140 ms | Excluding delay time. Delay time is the selected trigger delay. |
| 500 ns/div...10 ns/div | 20.5 x time/div + 120 ms | Excluding delay time. In Quasi-Random Mode, the acquisition time depends on triggers. |
| * Sources | Channel A<br>Channel ± B<br>mV Input | |
| * Acquisition Modes | 1 Channel Only<br>2 Channels | CHAN A, CHAN B<br>Chopped Mode from 60s/div...50 μs/div.<br>Alternating Mode from 20 μs/div...10 ns/div. |

## 2.3 CHANNELS A & B

| | | |
|---|---|---|
| * Signal Inputs | Isolated BNC | **Signal input BNC commons are connected together.** |
| Common Input | Black Safety Banana Jack | Part of External Trigger Input. |
| * Input Impedance | | Frequency dependent, see Figure 2.1. |
| R parallel | 1 MΩ ± 1% | For DC coupled input. For AC coupled input or GND, add 22 nF in series with R and C parallel. |
| C parallel | 25 pF | |

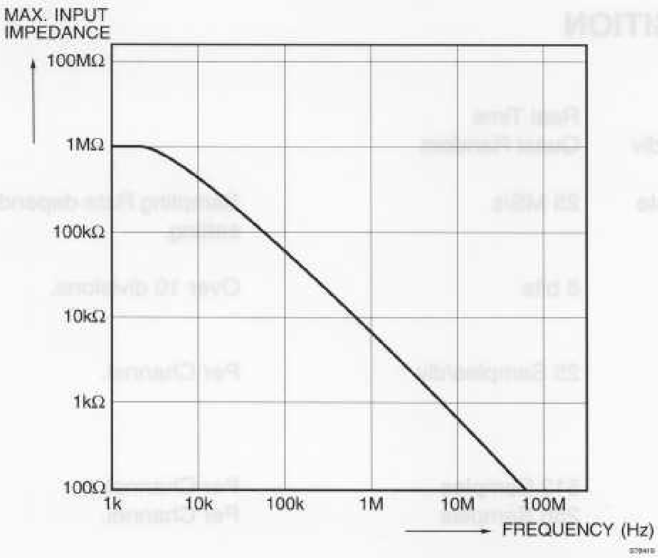



*Figure 2.1 Max. Input Impedance Versus Frequency*

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Input Coupling | AC DC GND | Sequence: ac-dc-GND (pre-charge ac), and back to ac. |
| * Maximum Input Voltage (rms) | 300 V | Frequency dependent see fig. 2.2 **Between BNC inner and outer contact. Outer BNC contacts and Ground (Black) Banana Jack are internally connected together.** |

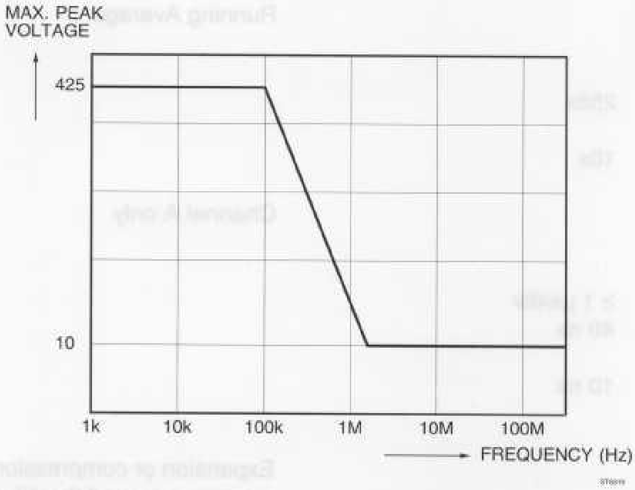



*Figure 2.2 Max Input Voltage Versus Frequency*

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Deflection Coefficient | | |
| Steps | 1 mV/div...2 mV/div (Models 95 and 97 only) | Only for repetitive signals and timebase 60s...1μs. If one of the channels is in this sensitivity, both channels will be switched to Average = 4. |
| Steps | 5 mV/div...100V/div | In a 1-2-5 sequence of 14 positions. |
| Error Limit | | |
| Overall | ± (2% ± 1 digit) | Add 3% for 1 mV and 2 mV |
| Nonlinearity | ± (2% ± 1 digit) | per IEC 351 for frequencies < 1 MHz. |
| * Dynamic Range | 9.5 div<br>4 div | for frequencies < 10 MHz.<br>for frequencies up to 50 MHz. |
| * Position Range (move control) | - 4 div...+ 4 div | |
| * Frequency Response | | Z source = 50Ω. |
| Lower Transition Point of Bandwidth | | |
| DC Input Coupling | DC | |
| AC Input Coupling - 3dB | ≤ 10 Hz | < 1 Hz including 10 MΩ probe. |
| Upper Transition Point of Bandwidth | ≥ 50 MHz (-3 dB) | Subtract 5 MHz for < 18 °C and > 28 °C Ambient. Rise time 7 ns. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Max. Baseline Instability | | |
| Jump | 0.1 div or 1 mV | The baseline is automatically readjusted after switching the attenuator or AC/DC/GND. |
| * Average (Models 95 and 97 only) | | Running Average. |
| Maximum Constant | 256x | |
| Constant in Roll | 10x | |
| * MIN MAX (Models 95 and 97 only) | | Channel A only. |
| Timebase setting | ≥ 1 µs/div | |
| Pulse-width for 100% Probability | 40 ns | |
| Pulse-width for 25% Probability | 10 ns | |
| * ZOOM (Models 95 and 97 only) | | Expansion or compression in 1,2,5 sequence around the 4th division. |
| Range for Delay | < 640 div | |

## 2.4 TIMEBASE

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Modes | Recurrent<br>Single Shot<br>Roll | Automatic selected. |
| * Ranges | | |
| Recurrent | 5s/div...10 ns/div | |
| Dual Channel Chopped | 5s/div...50 µs/div | |
| Dual Channel Alternate | 20 µs/div...10 ns/div | |
| Single Shot | 5s/div...10 ns/div | Every sweep needs a trigger. A sweep first; B sweep arms automatically. For 500 ns, 200 ns, and 100 ns; an automatic interpolation takes place. Chopped. |
| Roll Mode | 60s/div...10s/div | |
| Maximum Timebase Error | ± 0.1% ± 1 LSB | |

## 2.5 TRIGGER

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Sources | | Selected independently. |
| Channel A Signal<br>Channel B Signal<br>External Trigger Input | CHAN A<br>CHAN B<br>EXT | |
| * External Trigger Input **Connector** | Dual Safety Banana Jack | **External Trigger Input common (low) jack is electrically connected to the Channel A and Channel B commons (outer contact of BNC's).** |
| * External Trigger Input Impedance | | |
| R parallel | 1 MΩ ± 1% | If used for mV DC > 1 MΩ. |
| C parallel | 25 pF | Including Banana to BNC adapter. |
| * Trigger Error | | For frequencies < 1 MHz. |
| Voltage Level | ± 1 LSB<br>± 0.5 div | 5s/div...50 µs/div.<br>20 µs/div...10 ns/div. |
| Time Delay | ± 1 LSB ± 5 ns | |
| * Maximum External Trigger Input (rms) | 300 V | Frequency dependent, see fig. 2.2. |
| * Trigger Sensitivity | | For Models 95 and 97, values must be multiplied by 5 in 2 mV/div. and 1 mn/div. |
| Channel A or B<br>@ 100 MHz<br>@ 60 MHz<br>@ 10 MHz | <br>≤ 4 div<br>≤ 1.5 div<br>≤ 0.5 div | |
| External Trigger Input | | TTL logic compatible using 10:1 attenuation Probe. |
| * Trigger Slope Selection | positive going<br>negative going | |
| * Trigger Level Control Range | | |
| Channel A or B<br>Trigger at 50%<br>External Trigger Input | ± 4 div<br>0.5 x peak/peak value<br>Fixed @ TTL:10 | <br>Measured during 20 ms.<br>Switchable to TTL via set-up menu. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
| --- | --- | --- |
| N-cycle mode (Models 95 and 97 only) 5s/div...1 µs/div, N= | 2...255 | For timebase settings from 20 µs/div...1 µs/div acquisition and trigger on Channel A only. |
| Events (5s/div...1 µs/div) | 1...1023 | Start via Ext; count with channel A. |
| * Trigger Delay | | |
| Range | - 20...640 div | |

## 2.6 SIGNAL MEMORY (MODELS 95 AND 97 ONLY)

| | | |
| --- | --- | --- |
| * Signal Memory Size | | |
| Memories | 8 | Memory #1 up to #8. |
| Memory Depth | 512 words | |
| Wordlength | 8 Bit | |
| Functions | Store | Storage of signals. |
| | Save | Contents of Channel A and Channel B are saved in temp memory #1 and #2, and (A ± B) in temp memory #3. |

## 2.7 TRACE DISPLAY

| | | |
| --- | --- | --- |
| * Sources | Channel A<br>Channel B<br>A ± B<br>A vs B | A Maximum of 4 traces plus A vs B can be selected. |
| | Memory #1 up to #8 | (Models 95 and 97 only). |
| * Position range | | |
| Horizontal<br>Vertical | + 4 div...- 16.5 div<br>- 4 div...+ 4 div | From screen center, select per trace. |

## 2.8 SETUP MEMORY (MODEL 95 ONLY)

| | | |
| --- | --- | --- |
| * Memory Size | 8 maximum | Combined with waveform. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|

## 2.9 SETUP MEMORY (MODEL 97 ONLY)

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Memory Size | 10 maximum | Front Panel setups. |
| * Functions | Save | Actual front panel settings are stored in memory, replacing contents of memory location indicated on LCD. |
| | Delete | Contents of memory location indicated on LCD are deleted. |
| | Recall | Actual front panel settings are replaced by contents of memory location indicated on LCD. |
| With soft up/down keys | Next | Actual settings are replaced by contents of the next (+1) memory location indicated on LCD. |
| | Previous | Actual settings are replaced by contents of the previous (-1) memory location indicated on LCD. |
| * Initial setup selection of AUTO SET | only Amplitude<br>only Time<br>Time and Amplitude | |
| trace identification | on/off | |
| trigger identification | on/off | |
| trigger sensitivity external | 0.2V/2V | |
| Clear after Hold/Run | on/off | |
| refresh time @ RECORD in scope mode | infinite<br>2 seconds<br>5 seconds<br>10 seconds<br>60 seconds | |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|

## 2.10 CALCULATION FACILITIES (MODEL 95 ONLY)

| | | |
|---|---|---|
| * Measurement Functions | | Maximum of 5 simultaneous measurement functions. |
| | delta V<br>delta t<br>RMS value<br>Mean (Average) value<br>Peak to Peak value<br>Rise or Fall time<br>Frequency<br>1 ÷ delta t<br>Maximum value<br>Minimum value<br>Phase<br>Trigger time to cursor | of portion between portion. |
| | Ratio | Expression of value in % or absolute on any one of the above values. |

## 2.11 CALCULATION FACILITIES (MODEL 97 ONLY)

| | | |
|---|---|---|
| * Measurement Functions | | Maximum of 5 simultaneous measurement functions. |
| | delta V<br>delta t<br>RMS value<br>Mean (Average) value<br>Peak to Peak value<br>Rise or Fall time<br>Frequency<br>1 ÷ delta t<br>Maximum value<br>Minimum value<br>Phase<br>Trigger time to cursor | of portion between portion. |
| | Ratio | Expression of value in % or absolute on any one of the above values. |
| * Mathematics | Multiplication<br>Add<br>Subtract<br>Filter<br>Invert<br>Integrate | of whole memory or Channel. For timebase settings 20 μs...10 ns, only displayed Channels can be used. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|

## 2.12 CURSORS (MODELS 95 AND 97 ONLY)

| | | |
|---|---|---|
| * Horizontal | | |
| Display Resolution | 25 parts per div | |
| Digital Readout Resolution | 3 digits | |
| Error Limit | ± 0.1% ± 1 LSB | |
| Cursor Range | Visible part of signal | Cursors cannot pass each other. |
| * Vertical | | |
| Display Resolution | 25 parts per div | |
| Digital Readout Resolution | 3 digits | |
| Error Limit | ± 2% | Referred to input at BNC or Probe tip, after Probe recalibration. |

## 2.13 MULTIMETER

The Multimeter uses the Channel A input for VDC & VAC measurements and the Safety Banana Jack Inputs for Resistance, Diode Test, Continuity, and DC mV measurements. An internal reference is used to optimize the accuracy of the Channel A Input and any probes used. The accuracy of all Multimeter measurements is within ± {(% of reading) + (number of least-significant digits)} from 18 °C to 28 °C with relative humidity up to 90% for a period of one year after calibration. Add 0.1 x (specified accuracy)/C for 18 °C or 28 °C Ambient.

- Displayed range include used probe, if calibrated.
- Values listed are without attenuating probe.
- A Vrms AC and V DC dual display mode is optimized for power line (mains) related measurements.

| | | |
|---|---|---|
| * DC Voltage | | |
| Ranges | 300 mV, 3V, 30V & 300V | Manual or automatic ranging on peak voltage. High Voltage x10 Probe extends measurement to 600V. Peak voltage is 2.5x range, except 375V in 300V range. |
| Resolution | 0.1 mV, 1 mV, 0.01V, & 0.1V | Multiply x10 with High Voltage Probe. |
| Accuracy | ± (0.5% + 5) | |
| Digital Display | 3000 counts | Up to 4500 counts, 3500 counts in 300V range. |
| Display update<br>Response Time | < 300 ms<br>< 3.5s | |
| Zeroing | automatic | |
| Series Mode Rejection Ratio | > 50 dB @ 50 Hz or 60 Hz | |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * AC Voltage | | |
| Ranges | 300 mV, 3V, 30V, 250V | Manual or automatic ranging on peak voltage. High Voltage x10 Probe extends measurement to 600V. Peak voltage is 2.5x range and 375V in 250V range. |
| Resolution | 0.1 mV, 1 mV, 0.01V, 0.1V | Multiply x10 with High Voltage Probe. |
| Accuracy (AC Coupled) Using High Voltage 10:1 Probe | | Valid from 5%..100% of range. |
| 50 Hz...60 Hz | ± (1% + 10) | |
| 20 Hz...20 kHz | ± (2% + 15) | |
| 5 Hz...1 MHz | ± (3% + 20) | |
| Accuracy (DC Coupled) Using High Voltage 10:1 Probe | | |
| 50 Hz...60 Hz | ± (1% + 10) | |
| 1 Hz...20 kHz | ± (2% + 15) | |
| Crest Factor | | Meter prevents crest factor errors by autoranging on input waveform peaks. |
| Digital Display | 3000 counts | Up to 4500 counts, at 250V range: 2500. |
| Display Update | < 300 ms | |
| Response Time | | |
| @ Input freq >50 Hz | < 3.5s | |
| SMOOTH | < 10s | |
| FAST | < 1s | |
| DC Common Mode Rejection Ratio | > 100 dB @ dc | |
| | > 100 dB @ 50, 60, or 400 Hz | |
| AC Common Mode Rejection Ratio | > 60 dB @ dc..60 Hz | |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Resistance | | |
| Open Circuit Voltage | < 4V | |
| Full Scale Voltage<br>300Ω...3 MΩ<br>30 MΩ | <br>< 250 mV<br>< 2V | |
| Ranges | 300Ω, 3 kΩ, 30 kΩ,<br>300 kΩ, 3 MΩ, 30 MΩ | Manual or automatic ranging. |
| Resolution | 0.1Ω, 0.001 kΩ, 0.01 kΩ,<br>0.1 kΩ, 0.001 MΩ, 0.01 MΩ | |
| Accuracy | ± (0.5% + 5) | |
| Digital Display | 3000 counts | Up to 4500 counts, at 30 MΩ 3000. |
| Measurement Current | 0.5 mA...70 nA | Decreases as range increases. |
| Display Update | < 300 ms | |
| Response Time<br>SMOOTH<br>FAST | < 3.5s<br>< 10s<br>< 1s | |
| Protection | 600V RMS | |
| Continuity<br>Beeps if resistance is <: | <br>5% of selected | |
| * Diode Test | | OL is indicated if measured voltage is > 2.8V. |
| Maximum Voltage | 4V | |
| Range | 2.800V | |
| Resolution | 0.001V | |
| Accuracy | ± (2% + 5) | |
| Digital Display | 3000 counts | If value > 2800 readout gives OL. |
| Measurement Current | 0.5 mA | |
| Display update | < 300 ms | |
| Response Time<br>SMOOTH<br>FAST | < 3.5s<br>< 10s<br>< 1s | |
| Protection | 600 V RMS | |
| Polarity | + on RED Banana Jack<br>- on BLACK Banana Jack | |
| Continuity (Alert) | Beeps if reading is below 1V | |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * DC mV | Banana Jack Inputs | Used for Accessory (including Temperature) input. |
| Ranges | 300 mV & 3V | Manual or Automatic ranging. |
| Resolution | 0.1 mV & 1 mV | |
| Accuracy | ± (0.5% + 5) | |
| Digital Display | 3000 Counts | Up to 3500 Counts. |
| Display update | < 300 ms | |
| Response Time<br>SMOOTH<br>FAST | < 3.5s<br>< 10s<br>< 1s | |
| Input | + on RED Banana Jack<br>on BLACK Banana Jack | |
| * Multimeter Math (Display) Functions (Models 95 and 97 only) | | |
| Relative | ZERO delta | Displayed Value = Reading Reference Reading. |
| % Change (% Relative) | ZERO % delta | Displayed Value = {(Reading/Reference Reading) -1} x 100. |
| % Scale | | Displayed Value = {(Reading-Set 0% Reading)/(Set 100% Reading-Set 0% Reading)} x 100%. |
| Set 0% Reference | Set 0% | Present, Maximum, Minimum, Average. |
| Set 100% Reference | Set 100% | Present, Maximum, Minimum, Average. |
| Power with respect to 1 mW in selected load resistance | dBm | |
| Select load resistance | 1200, 1000, 900, 800, 600, 500, 300, 250, 150, 135, 125, 110, 93, 75, 60 & 50 | |
| Voltage Ratio in dB with respect to 1V | dBV | |
| Audio power | WATTS or dBW | |
| Select load resistance | 50, 16, 8, 4, 2 & 1Ω | |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Other Multimeter Operating Modes | | |
| Touch Hold | HOLD | Causes the meter to capture the next measured reading (and beep) when a new stable measurement has been detected. When first enabled, the numeric display is frozen (held) until a stable measurement is detected. Stable measurements are defined as within ± 100 display counts for 4 measurements (~1s.); and above a floor of 200 display counts in volts (300 counts in ac, below 4000 counts in Ω and below 2800 counts in diode). Overload is a valid stable condition except in Ω and diode test. |
| MIN MAX recording (Models 95 and 97 only) | RECORD | Simultaneous displays of Maximum, Minimum, Peak to Peak, Average, and Present reading. |
| * Frequency | | |
| Range | 1 Hz...5 MHz | Manual for frequencies < 20 Hz. |
| Accuracy | +/- (0.5% + 2 counts) | |
| Timebase Accuracy | +/- 0.01% | |
| Resolution | 4 digits | |
| Measuring Time<br>SMOOTH<br>FAST | 3.5s<br>< 10s<br>< 1s | gradually degradation from 100 Hz and down.<br>Running average over 32 measurements. |
| Ranging | Automatic | |
| * AUTO RANGE | | Voltage and Time are coupled. |
| Voltage Range_Up | 3500 | Maximum reading in manual range @ 300 mV, 3V, 30V : 4500. @external input: 3500. |
| Voltage Range_Down | 0300 | |
| Time Range_Up<br>5 ms...50 µs | > 8 periods in display | TIME switch selects manual timebase. |
| 20 µs...1 µs | > 4 periods in display | AUTOSET starts timebase ranging. |
| Time Range_Down<br>5 ms...50 µs<br>20 µs...1 µs | <br>< 1.5 periods in display<br>< 0.75 periods in display | |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|

## 2.14 AUTO SETTING

| | | |
|---|---|---|
| * Settling time | 3s | The default values are indicated (Model 97 only). If this can be changed with the aid of the SETUP (auto-set) menu, this is shown. |
| Selectable mode of operation (Model 97 only) | Selected @ initial setup, Complete | |
| * Display functions | | |
| Channel Baseline | mid screen | One channel display. |
| Separate | A = + 1 div<br>B = - 1 div | Dual Channel display. |
| X-position | zero | SETUP: not affected (Model 97 only). |
| Y-posit[ion | zero | SETUP: not affected or separation (Model 97 only). |
| X-expand | x 1 | |
| A vs B | off | SETUP: not affected (Model 97 only). |
| * Cursors | not affected | if cursors are on a not the selected channel, Channel A. SETUP: not affected (Model 97 only). |
| Mathematics | off | SETUP: not affected (Model 97 only). |
| * Text | Not affected | Except for actual setting, that is adapted (Model 97 only). |
| Trace identification | on | SETUP: OFF (Model 97 only). |
| * Vertical Acquisition | | |
| Y deflection source | Every source having a triggerable signal at its input | Channel A if no trigger is found. |
| Input coupling | ac | SETUP: not affected (Model 97 only). |
| Y deflection | | Each channel is independently set. |
| Input voltage > 20 mV | approx. 5 div | |
| Input voltage < 20 mV | Channel at 200 mV/div | Due to trigger uncertainty at freq. > 2 MHz or at duty cycle <> 50% sensitivity can deviate from above, but signal will remain on the screen. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| Average | off | SET-UP: not affected (Model 97 only). |
| * Horizontal Acquisition | Free Run<br>Recurrent | |
| TB Deflection coefficient | | |
| Signal 40 Hz...5 MHz | min. 2, max 6 signal periods over 8 div | |
| Signal 5 MHz...50 MHz | min. 2, max 20 signal periods over 8 div | |
| When no trigger found | 5 ms/div | |
| * Triggering | | |
| Delay ≥ 0 | Off | SETUP: not affected (Model 97 only). |
| Negative delay | Not affected | |
| Triggerable signal @ ext. input | Ext | SETUP: select A or B (Model 97 only). |
| No signal @ ext input, but trig. signal @ channel A or B | channel A or channel B | Channel with lowest input frequency is selected (Channel A when frequencies are equal). |
| No triggerable signal. @ any input | Channel A | |
| Level | 40...60% of peak-to-peak value | After Autoset.<br>SETUP: not affected (Model 97 only). |
| Slope | Positive | SETUP: not affected (Model 97 only). |
| Events (Models 95 and 97 only) | OFF | SET-UP: not affected (Model 97 only). |
| N-Cycle (Models 95 and 97 only) | OFF | SET-UP: not affected (Model 97 only). |
| * Various | | |
| Generator (Model 97 only) | OFF | SETUP: not affected. |
| Record restart timing (Model 97 only) | OFF | SETUP: 2, 5, 10 or 60s or acquisitions, whichever is the shortest. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|

## 2.15 GENERATOR (MODEL 93 AND 95)

| | | |
|---|---|---|
| * Probe Adjust | | A square wave voltage is available via the external trigger input for adjusting probe compensation. |
| Voltage (p-p) | 5V | |
| Frequency | 976 Hz | |
| Source resistance | 400Ω | |
| * DC Calibration | | Including 10:1 attenuation Probe. |
| Voltage | 3V | Inaccuracy is optimized internally. |
| Source resistance | 400Ω | |

## 2.16 GENERATOR (MODEL 97 ONLY)

| | | |
|---|---|---|
| * Probe Adjust | | A square wave voltage is available via the external trigger input for adjusting probe compensation. |
| Voltage (p-p) | 5V | |
| Frequency | 976 Hz | |
| Source resistance | 400Ω | |
| * DC Calibration | | Including 10:1 attenuation Probe. |
| Voltage (p-p) | 3V | Inaccuracy is optimized internally. |
| Source resistance | 400Ω | |
| * LF Sine wave | | |
| Amplitude (p-p) | 1V | |
| Frequency | 976 Hz | |
| Max. Individual Harmonic | 3% | |
| Source resistance | 400Ω | |
| * Square wave | | |
| Amplitude (p-p) | 5V | |
| Frequency | 1.95 kHz<br>976 Hz<br>488 Hz | selectable |
| Source Resistance | 400Ω | |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * DAC Output Current | | Can be used for a component tester. |
| Amplitude | 0 mA...+ 3 mA | In max. 128 amplitude steps. The time for every step can differ. |
| Max. voltage | 2V | |
| * DAC output voltage | | In max. 128 amplitude steps. The time for every step can differ. |
| Amplitude | - 2V...+ 2V | |
| Max. Current | ± 1 mA | |

## 2.17 POWER ADAPTOR /BATTERY CHARGER

| | | |
|---|---|---|
| * Input Connector | 5 mm Power Jack | Per DIN 45323 |
| * Source Voltage dc | | |
| Nominal | 15V dc | |
| Limits of Operation | 8V...20V dc | |
| * Charging Current | | |
| Instrument ON | 60 mA | |
| Instrument OFF | 170 mA | |
| * Allowable Temperature During Charging | 0 °C...45 °C | |
| * Power Consumption | | |
| Instrument ON | 5W | |
| Instrument OFF | 3W | |

## 2.18 POWER SUPPLY

| | | |
|---|---|---|
| * Battery Voltage Range | 4V...6V | The batteries are not charged at delivery. A warning is given if the battery voltage becomes lower than 4.4V. The instrument is switched off if the battery voltage becomes lower than 4 V.<br><br>If the instrument is Battery Powered, it will switch off automatically after 10 minutes of no operator actions, except in RECORD or ROLL mode. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Recommended Batteries | | |
| NiCad Battery Pack | PM 9086/001 | Only this Battery Pack is internally re-chargeable. |
| Recharging time | 16 hours | |
| Life time | | After 500 cycles the capacity will be > 1100 mAh. The nominal capacity is 2200 mAh. |
| Operating time | > 4 hours | After Charging for > 15 hours. |
| Stand Alone Batteries (4x) | | |
| Model | KR27/50<br>K70<br>C-CELL | per IEC.<br>per ANSI. |
| Operating time | > 4 hours | |
| Temperature Rise of Batteries | 20 °C | After instrument has reached a stable operating temperature. |
| Temperature Range of Alkaline Batteries. | | |
| Working | - 20...65 °C | |
| Storage | - 30...65 °C | It is recommended to remove the batteries from the instrument when it is stored longer than 24 hours below - 30 °C or above 60 °C. CAUTION! UNDER NO CIRCUMSTANCES SHOULD BATTERIES BE LEFT IN THE INSTRUMENT @ TEMPERATURES BEYOND THE RATED SPECIFICATIONS OF THE BATTERIES BEING USED! |

## 2.19 MECHANICAL

| | | |
|---|---|---|
| * Height | 262 mm | With holster 281 mm. |
| * Width | 129 mm | With holster 140 mm. |
| * Depth | 60 mm | With holster 62 mm. |
| * Weight | 1.5 kg | With holster ca 1.8 kg. |

## 2.20 ENVIRONMENTAL

The characteristics are valid only if the instrument is checked in accordance with the official checking procedure.

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * Meets Environmental Requirements of: | MIL-T-28800D Type III Class 3, Style C | |
| * Temperature | | Batteries removed from instrument unless batteries meet the required temperature specifications. Maximum Operating Temperature derated 3 °C for each km. (each 3000 feet) above sea level. |
| Operating | 0 °C...50 °C | |
| Non Operating (Storage) | - 20 °C...70 °C | |
| * Maximum Humidity | | |
| Non Operating (Storage) | 95% Relative Humidity | |
| Operating<br>20 °C...30 °C<br>30 °C...50 °C | <br>90%<br>70% | |
| * Maximum Altitude | | Memory backup batteries removed from instrument unless batteries meet maximum altitude specifications. |
| Operating | 3 km (10 000 feet) | |
| Non Operating (Storage) | 12 km (40 000 feet) | |
| * Vibration (Operating) | | |
| Frequency 5...15 Hz | Sweep Time 7 min. | |
| Excursion (pk to pk) | 1.5 mm | |
| Max Acceleration | 7 m/s² (0.7 x g) | @ 15 Hz. |
| Frequency 15...25 Hz | Sweep Time 3 min. | |
| Excursion (pk to pk) | 1.0 mm | |
| Max Acceleration | 13 m/s² (1.3 x g) | @ 25 Hz. |
| Frequency 25...55 Hz | Sweep Time 5 min. | |
| Excursion (pk to pk) | 0.5 mm | |
| Max Acceleration | 30 m/s² (3.0 x g) | @ 55 Hz. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| Resonance Dwell | 10 min. | @ each resonance frequency (or @ 33 Hz if no resonance is found). |
| * Shock (Operating) | | |
| Number of shocks | 18 Total<br>6 Each Axis | (3 in each direction). |
| Shock Wave Form | Half Sine | |
| Duration | 6...9 ms | |
| Peak Acceleration | 400 m/s$^2$ (40 x g) | |
| * Bench Handling<br>Meets requirements of: | MIL-STD-810, Method 516, Procedure V | |
| * Salt Atmosphere<br>Structural parts meet | MIL-STD-810, Method 509, Procedure I with 5 % salt solution | |
| * EMI (Electro Magnetic Interference)<br>Meets requirements of: | MIL-STD-461 Class B | Applicable requirements of Part 7: CE03, CE07, CS01, CS02, CS06, RE02, RS03.(RS02: max 2 div distorsion in 20 mV/div). |
| | VDE 0871 and VDE 0875 Grenzwertklasse B | |
| Packing meets requirements of: | UND 1400 | |
| Transportation meets requirements of: | AN-D628 | |
| Packaged Transportation Drop meets requirements of: | Nat. Safe Transp. Assoc. Procedure 1A-B-2 | |
| Packaged Transportation Vibration meets requirements of: | Nat. Safe Transp. Assoc. Procedure 1A-B-1 | |
| * ESD (ElectroStatic Discharge) meets requirements of: | IEC 801-2 | Test severity level 15 kV. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|

## 2.21 INTERFACE (MODEL 97 ONLY)

| | | |
|---|---|---|
| * Type of interface | RS-232-C | Optical. |
| Plug | 9 pole D-plug male | |
| * Spacing | | |
| "0" | Light | |
| "1" | No light | |
| * Interface function repertoiry for printers | | |
| Baud Rate | 1200, 9600 | Input and Output are the same. |
| Number of STOP bits | 1 | |
| Parity | No | |
| Character length | 8 | |
| Tranmission mode | Asynchronous, full duplex | |
| Handshake | XON/XOFF | Software handshake only. |
| * Interface function repertoiry for interface | | |
| Baud Rate | 75...19K2 | Input and Output are the same.<br>Selectable by controller. |
| Number od STOP bits | 1 | |
| Parity | No, Odd or Even | |
| Character length | 8 | |
| Tranmission mode | Asynchronous, full duplex | |
| Handshake | XON/XOFF or no Handshake | Software handshake only;<br>default: no Handshake. |
| * Print facilities | | |
| Protocol | EPSON FX, LQ compatible<br>HP ThinkJet compatible | |
| Print out | Screen<br>log of readings:<br>single<br>every 2, 5, 10 or 60s<br>selectable waveform | |
| * Front Panel Control | | |
| Modes | Local | Front panel exclusively under manual control. |
| | Remote-locked | Front panel exclusively under RS-232-C control. |
| | Remote-unlocked | Return To Local by User ReQuest |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|
| * CPL Protocol implemented: | | |
| Go to Remote | GR | |
| Go to Local | GL | |
| Local Lockout | LL | |
| Reset Instrument (Master Reset) | RI | |
| Status Query | SQ | |
| IDentification query | ID | Restricted; only 0= 1= 2= . Gives Type number and software version. |
| Auto Setup | AS | |
| Default Setup | DS | Default Scope setting. |
| Program Setup | PS | Has to be done with the string that comes out with QS. |
| Query Setup | QS | |
| Recall Setup | RS | |
| Save Setup | SS | |
| Program Communication parameter | PC | |
| Arm Trigger | AT | |
| Trigger acquisition | TA | |
| Query Waveform | QW | |
| Program Waveform | PW | |
| Query for Measurement data | QM | |

## 2.22 SAFETY

| | | |
|---|---|---|
| * Meets requirements of: | IEC 348 Class II<br>VDE 0411 Class II<br>ANSI/ISA S82<br>UL 1244<br>CSA C22.2 No. 231 | With or without battery charger. |
| * Approvals | VDE 0411 (applied for)<br>UL 1244 (applied for)<br>CSA C22.2 No. 231 (applied for) | With or without battery charger. |

| CHARACTERISTICS | SPECIFICATIONS | ADDITIONAL INFORMATION |
|---|---|---|

## 2.23 ACCESSORIES

| | | |
|---|---|---|
| * Accessories furnished with instrument: | Users Manual<br>Quick Operating Guide | |
| | PM 8918/002 | 2 x 10 MΩ 10:1 Passive Probe, 1.5m. |
| ScopeMeter Accessory set:<br>2 x HF adapter<br>2 x High voltage testpin<br>2 x Earth lead<br>2 x Trim screwdriver<br>4 mm adapter<br>Banana to BNC adapter | PM9081/001 | shrouded. |
| Set Testleads and Testpins:<br>2 x testleads<br>2 x testpins<br>2 x banana adapter | | 1.5m. |
| Holster | PM 9083/001 | |
| Accessory case | C 75 | |
| Power Adaptor/Battery Charger: | | Depends on model: |
| | PM 8907/001 | Universal Europe. |
| | PM 8907/003 | North American. |
| | PM 8907/004 | United Kingdom. |
| | PM 8907/008 | Universal 115V/ 230V. |
| PM9080/001 (Model 97 only) | | RS-232-C Interface |

## 2.24 SERVICE AND MAINTENANCE

| | | |
|---|---|---|
| * Main Time Between Failures (MTBF) | 40 000 hours | Predicted value, calculated through parts counting method, according to MIL HDBK- 217E. |
| * Calibration Interval | 1 year | |
| * Mean Time To Calibrate (MTTC) | 30 minutes | |

# 3 CIRCUIT DESCRIPTIONS

## 3.1 INTRODUCTION TO CIRCUIT DESCRIPTION

### 3.1.1 General

This chapter presents a layered description of the ScopeMeter circuitry. First the ScopeMeter's overall theory of operation is described, referring to the overall block diagram (section 3.2).
The next section gives some information concerning the ScopeMeter's data acquisition.
Then the circuits on both digital (A1) and analog (A2) printed circuit boards (PCB) are described. After a short introduction, a detailed circuit description is given for each circuit part.

The various circuit descriptions refer to the circuit diagrams in chapter 10.

*NOTE: The large digital (A1) and analog (A2) printed circuit board diagrams are provided as separate drawings. Whenever a signal line continues on another drawing, it is indicated by the following comment:*

*"FROM A1"* ----> *coming from the digital (A1) circuit (figure 10.2)*

*"TO A2a"* ----> *the signal continues on the first circuit diagram of the analog A2 PCB (figure 10.5)*

### 3.1.2 Location of electrical parts

The item numbers of C..., R..., V..., N..., D... and K... have been divided into groups. These groups relate to the functional parts on the PCBs:

*Table 3.1 Location of electrical parts.*

| Item number | Functional part | PCB diagram | |
|---|---|---|---|
| 1200-1299 | µP, Digital ASIC and related circuitry | A1 | A1 |
| 1300-1399 | battery sense, RAM power, backlight | A1 | A1 |
| 1400-1499 | LCD and related circuitry | A1 | A1 |
| 1500-1599 | ON/OFF circuit | A1 | A1 |
| 1600-1699 | keypad | A1 | A1 |
| 2100-2199 | attenuator channel B | A2 | A2a |
| 2200-2299 | attenuator channel A | A2 | A2a |
| 2300-2399 | Analog ASIC and ADC | A2 | A2a/b |
| 2500-2599 | battery charger and power supply | A2 | A2c |
| 2700-2799 | EXTernal input-/output circuitry | A2 | A2b |
| 2800-2899 | generator | A2 | A2b |
| 2900-2999 | analog control circuitry | A2 | A2a |

# 3.2 FUNCTIONAL BLOCK DESCRIPTION

## 3.2.1 Introduction

This section contains an overall block diagram of the ScopeMeter. Refer to figure 3.1.

The block diagram can be divided in two parts. The upper part of the diagram shows the components that are situated on the Printed Circuit Board (in the following text: PCB), that is connected to the ScopeMeter's bottom cover. Because this PCB contains mainly analog circuits, it is called the **analog A2 PCB**.

The lower part of the diagram contains the digital circuitry of the ScopeMeter. This circuitry is located on the **digital A1 PCB**, the PCB connected to the ScopeMeter's top cover.

The general layout of the block diagram is the same as the layout of the circuit diagrams in chapter 10. The circuits that can be found on the same circuit diagram (chapter 10) are placed in a dashed box in the *block diagram.*

***Analog A2 PCB***

The signals at the red and gray BNC input connectors are attenuated by the **CHANNEL A ATTENUATOR** section and the **CHANNEL B ATTENUATOR**. These attenuators are set by the Microprocessor (on the digital A1 PCB) via the **ANALOG CONTROL CIRCUIT**. Also input protection circuits are provided here.

The output signals of the attenuator blocks are fed to the **ANALOG ASIC** (ASIC = Application Specific Integrated Circuit). This component is controlled by the ScopeMeter's microprocessor (on the digital A1 PCB). The Analog ASIC incorporates signal amplification and channel selection. It also prepares the signal for sampling by the **Analog to Digital Converter (ADC).**

The red and black banana connectors are connected to the **EXTERNAL (BANANA) INPUT/OUTPUT CIRCUIT**. When the ScopeMeter is set to mV, DIODE or OHM METER mode, the External (banana) input/output circuit outputs its signal into the Channel A Attenuator section. In SCOPE mode, the circuit can act as a trigger input. The trigger signal is fed to the Analog ASIC. In the Analog ASIC "channel A", "channel B" or "External trigger" can be selected as trigger source. The trigger signal is used to generate the DELTA- T voltage (time relation between trigger moment and sampling moment).

The built-in **GENERATOR** uses the External (banana) input/output circuitry as output. It is possible to generate a DC voltage and a square wave voltage. ScopeMeter model 97 also can generate sine wave voltages, a ramp voltage, and a ramp current.

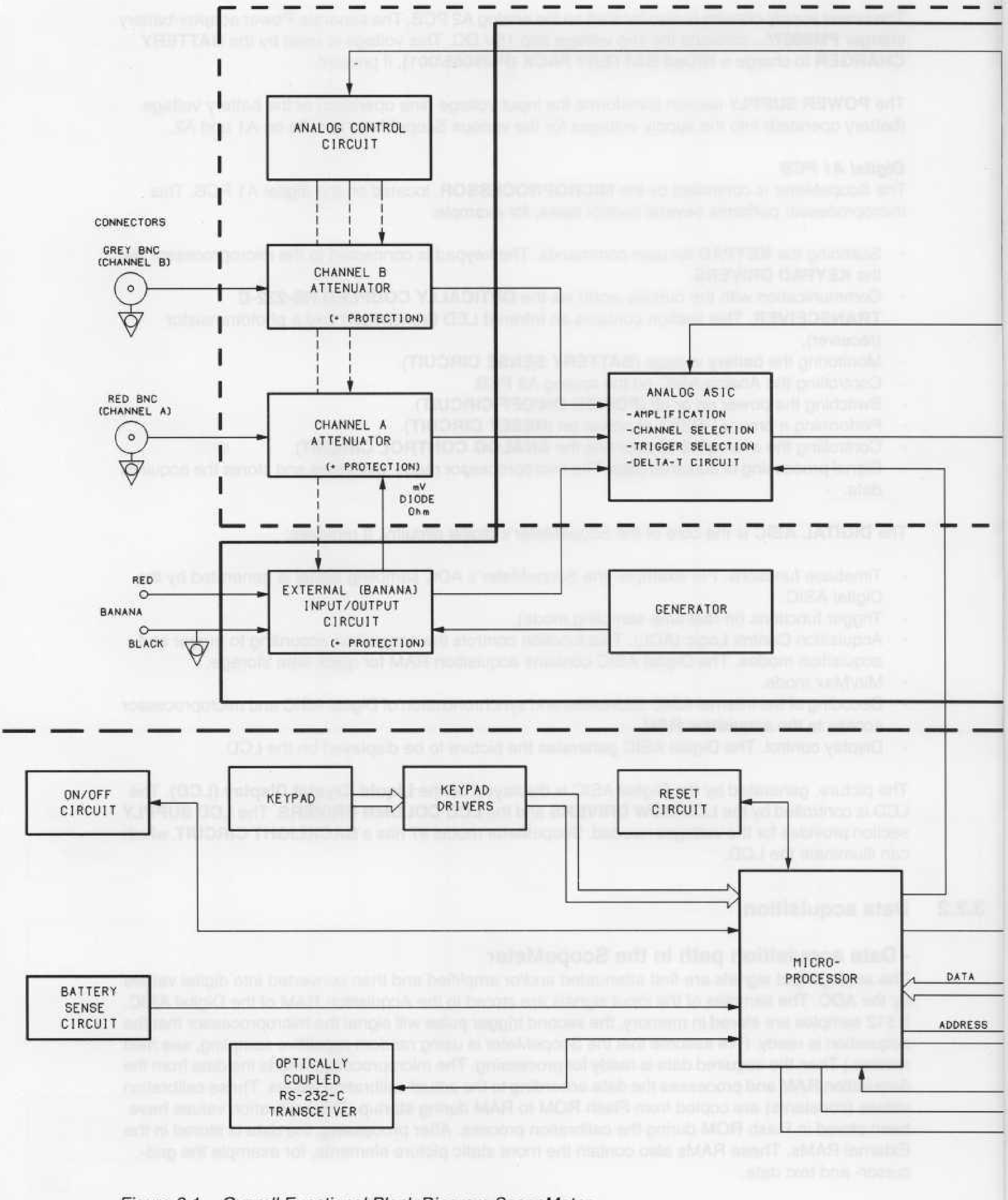
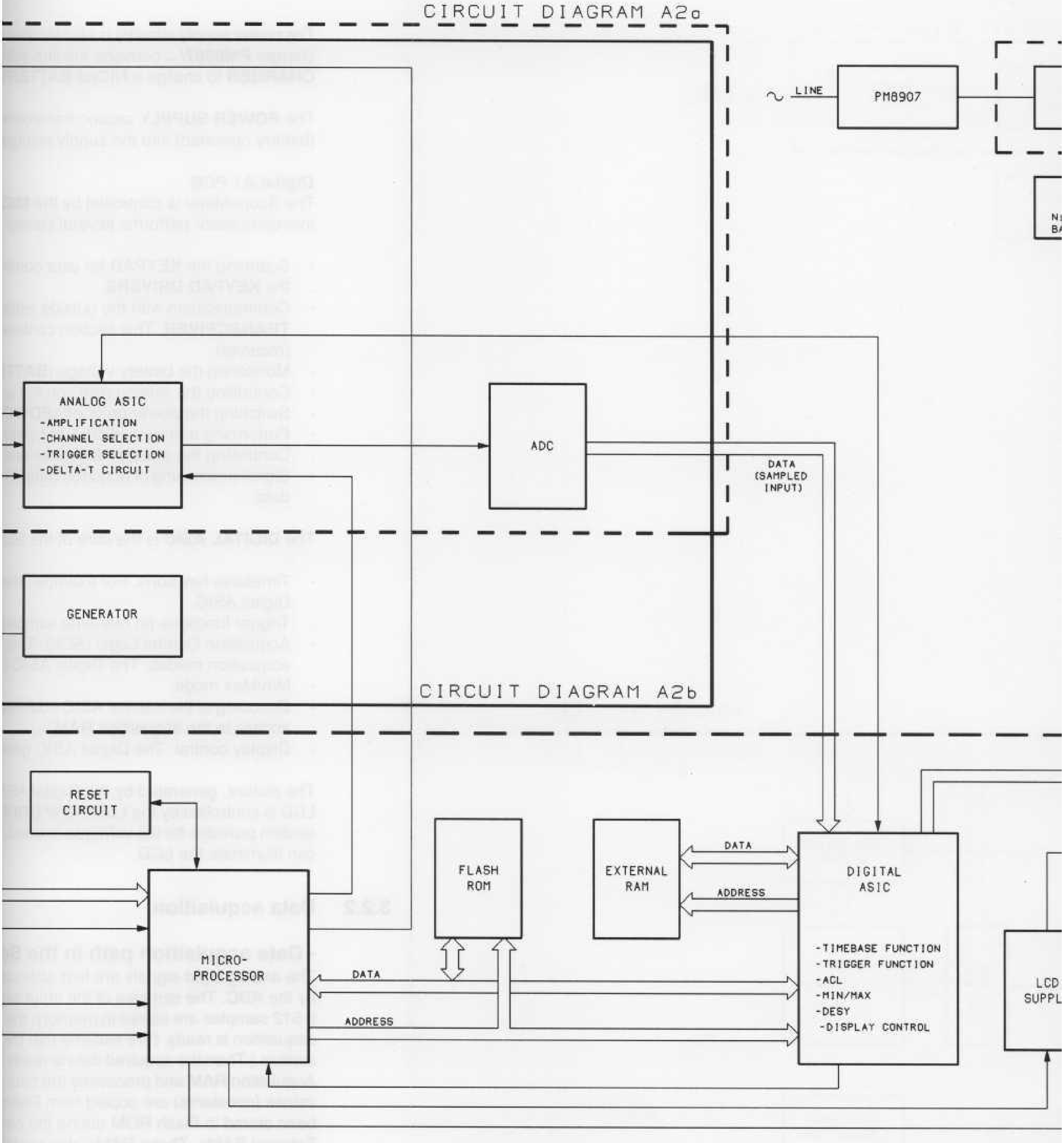
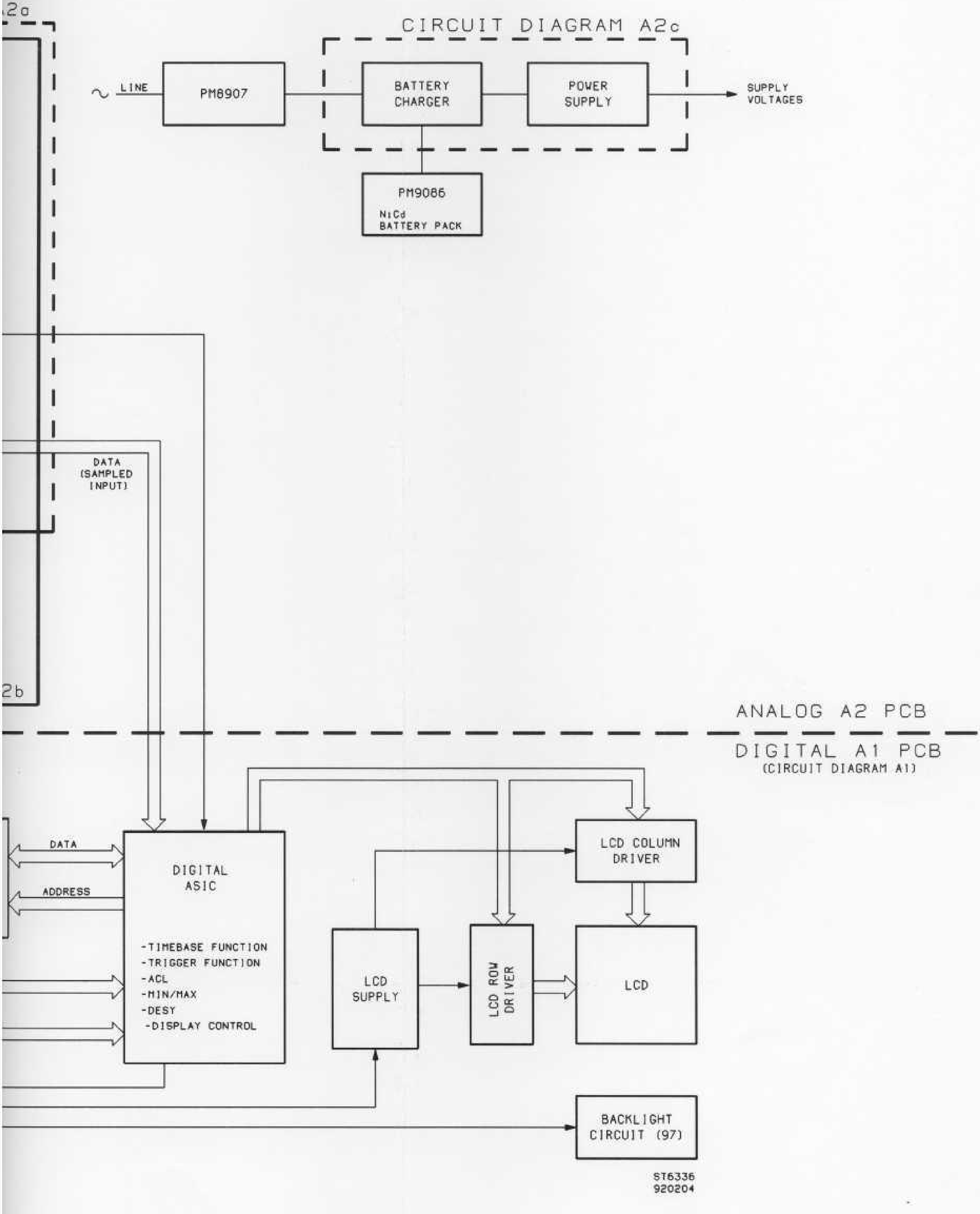



*Figure 3.1 Overall Functional Block Diagram ScopeMeter*


CIRCUIT DIAGRAM A2a
LINE
PM8907
ANALOG ASIC
-AMPLIFICATION
-CHANNEL SELECTION
-TRIGGER SELECTION
-DELTA-T CIRCUIT
ADC
DATA (SAMPLED INPUT)
GENERATOR
CIRCUIT DIAGRAM A2b
RESET CIRCUIT
FLASH ROM
EXTERNAL RAM
DATA
ADDRESS
DIGITAL ASIC
-TIMEBASE FUNCTION
-TRIGGER FUNCTION
-ACL
-MIN/MAX
-DESY
-DISPLAY CONTROL
MICRO-PROCESSOR
DATA
ADDRESS
LCD SUPPL



2a
CIRCUIT DIAGRAM A2c
LINE
PM8907
BATTERY CHARGER
POWER SUPPLY
SUPPLY VOLTAGES
PM9086
NiCd BATTERY PACK
DATA (SAMPLED INPUT)
2b
ANALOG A2 PCB
DIGITAL A1 PCB
(CIRCUIT DIAGRAM A1)
DATA
ADDRESS
DIGITAL ASIC
-TIMEBASE FUNCTION
-TRIGGER FUNCTION
-ACL
-MIN/MAX
-DESY
-DISPLAY CONTROL
LCD COLUMN DRIVER
LCD SUPPLY
LCD ROW DRIVER
LCD
BACKLIGHT CIRCUIT (97)
ST6336
920204

The power supply circuitry is also located on the analog A2 PCB. The separate Power adapter/battery charger **PM8907/...** converts the line voltage into 15V DC. This voltage is used by the **BATTERY CHARGER** to charge a **NiCad BATTERY PACK (PM9086/001)**, if present.

The **POWER SUPPLY** section transforms the input voltage (line operated) or the battery voltage (battery operated) into the supply voltages for the various ScopeMeter circuits on A1 and A2.

***Digital A1 PCB***
The ScopeMeter is controlled by the **MICROPROCESSOR**, located on the digital A1 PCB. This microprocessor performs several control tasks, for example:

- Scanning the **KEYPAD** for user commands. The keypad is connected to the microprocessor via the **KEYPAD DRIVERS**.
- Communication with the outside world via the **OPTICALLY COUPLED RS-232-C TRANSCEIVER**. This section contains an Infrared LED (transmitter) and a phototransistor (receiver).
- Monitoring the battery voltage (**BATTERY SENSE CIRCUIT**).
- Controlling the Analog ASIC on the analog A2 PCB.
- Switching the power on or off (**POWER ON/OFF CIRCUIT**).
- Performing a proper RESET at power on (**RESET CIRCUIT**).
- Controlling the analog A2 circuits (via the **ANALOG CONTROL CIRCUIT**).
- Signal processing of acquired data. The microprocessor reads, calibrates and stores the acquired data.

The **DIGITAL ASIC** is the core of the ScopeMeter's digital circuitry. It provides:

- Timebase functions. For example: the ScopeMeter's ADC sampling signal is generated by the Digital ASIC.
- Trigger functions (in real-time sampling mode).
- Acquisition Control Logic (ACL). This function controls the acquisition according to trigger and acquisition modes. The Digital ASIC contains acquisition RAM for quick data storage.
- Min/Max mode.
- Decoding of the internal ASIC addresses and synchronization of Digital ASIC and microprocessor access to the acquisition RAM.
- Display control. The Digital ASIC generates the picture to be displayed on the LCD.

The picture, generated by the Digital ASIC is displayed on the **Liquid Crystal Display (LCD)**. The LCD is controlled by the **LCD ROW DRIVERS** and the **LCD COLUMN DRIVERS**. The **LCD SUPPLY** section provides for the voltages needed. ScopeMeter model 97 has a **BACKLIGHT CIRCUIT**, which can illuminate the LCD.

## 3.2.2 Data acquisition

### - Data acquisition path in the ScopeMeter

The analog input signals are first attenuated and/or amplified and then converted into digital values by the ADC. The samples of the input signals are stored in the Acquisition RAM of the Digital ASIC. If 512 samples are stored in memory, the second trigger pulse will signal the microprocessor that the acquisition is ready. (We assume that the ScopeMeter is using random repetitive sampling, see next section.) Then the acquired data is ready for processing. The microprocessor reads the data from the Acquisition RAM and processes the data according to the actual calibration values. These calibration values (constants) are copied from Flash ROM to RAM during startup. The calibration values have been stored in Flash ROM during the calibration process. After processing, the data is stored in the External RAMs. These RAMs also contain the more static picture elements, for example the grid-, cursor- and text data.

### - A multitasking kernel for hardware and software scheduling

Processing the acquired data is only one of the tasks of the microprocessor. The ScopeMeter uses a multitasking kernel for hardware and software scheduling, based on internal and external interrupts. The microprocessor contains internal timers, which can be programmed by the software. One of these timers is used to generate interrupts, e.g. to scan the keypad for depressed or released keys.

Except processing (calibrating) the acquired data, the microprocessor also does mathematical computations and controls the hardware. The multitasking kernel takes care that every 20 ms of processing time, a task is interrupted. This task will then be held and rescheduled, unless it requires execution without interruption. In this way a variety of user-requested tasks can be handled quasi-simultaneously, without the user being aware of the heavy loads on the microprocessor. The display of the data on the LCD is done by the Digital ASIC, also taking part in the multitasking scheme.

### - Sampling and Triggering

The ScopeMeter uses two types of sampling, commonly used in many Digital Storage Oscilloscopes: **REAL-TIME SAMPLING** and **RANDOM REPETITIVE SAMPLING**.

In the real-time sampling mode (timebase settings: 60s/div...1 μs/div) the ScopeMeter takes a series of samples from a single period of the input signal. These samples are later used to reconstruct the signal. During the real-time sampling mode, the Digital ASIC calculates the trigger pulses out of the acquired data (for timebase settings between 60s/div...50 μs/div). For timebase settings between 20 μs/div and 1 μs/div, the triggering is done by the Analog ASIC, using analog comparators.

In random repetitive sampling mode, the ScopeMeter takes a sample from successive cycles in a repetitive signal. These samples are stored in memory and combined to reconstruct the original signal.

In this sampling mode, samples are taken from the input signal at intervals determined by the internal ScopeMeter clock. Since there is no time-correlation between the system's clock and the incoming signal, all samples are taken at random points of the signal. The time between the trigger moment and the sampling moment must be tracked to enable reconstruction of the signal from the samples. This time, DELTA T, is generated by the Analog ASIC. See section 3.4.5 and figure 3.12.
During random repetitive sampling mode, the ScopeMeter always uses analog triggering (Analog ASIC).

# 3.3 DIGITAL CIRCUITS (A1)

## 3.3.1 Introduction

The following paragraphs describe the circuits on the digital A1 PCB in detail. Refer to circuit diagram A1 (figure 10.2 in chapter 10).

## 3.3.2 Overview digital circuits

The digital circuitry of the ScopeMeter can be separated into three main parts:

- Microprocessor circuitry
- Digital ASIC (in the following text: D-ASIC) circuitry
- LCD circuitry

A block diagram, which clearly shows the connections between these main parts, is shown in figure 3.2

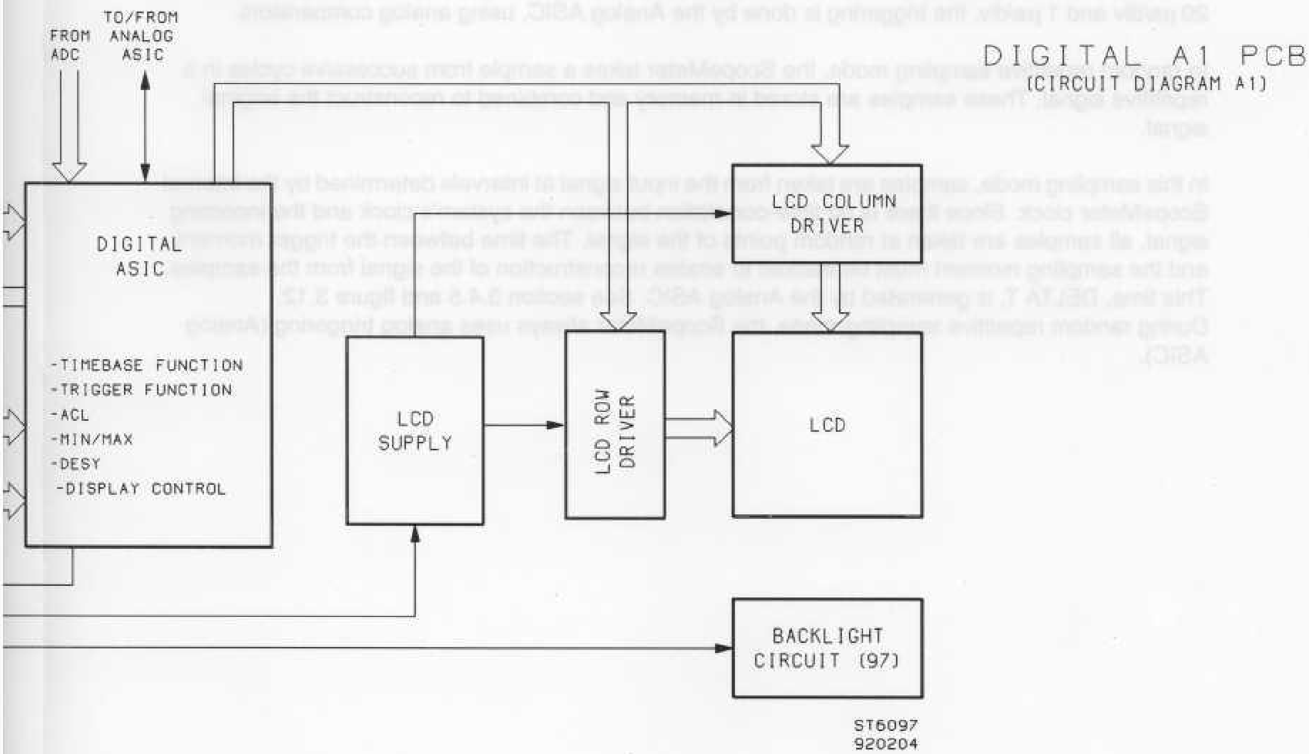



*Figure 3.2 Block diagram main parts digital circuitry*

## 3.3 DIGITA

### 3.3.1 Introduc

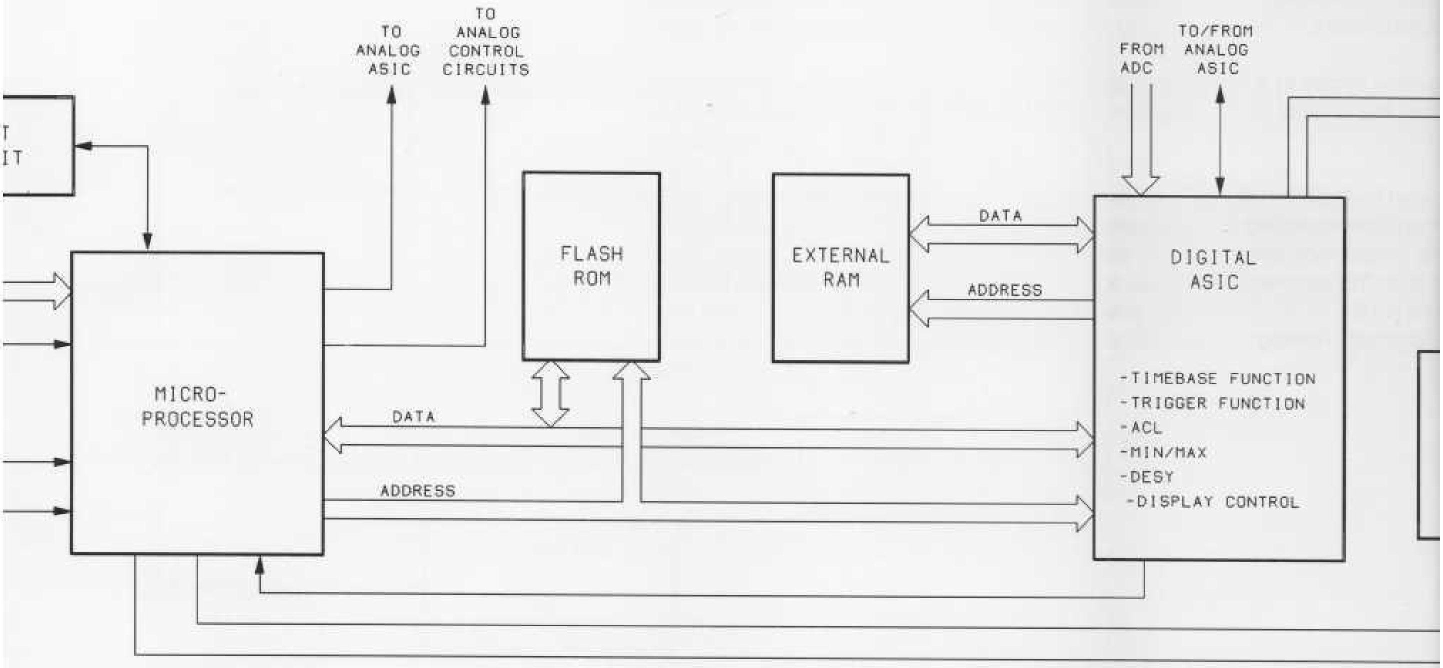
The follow
A1 (figure

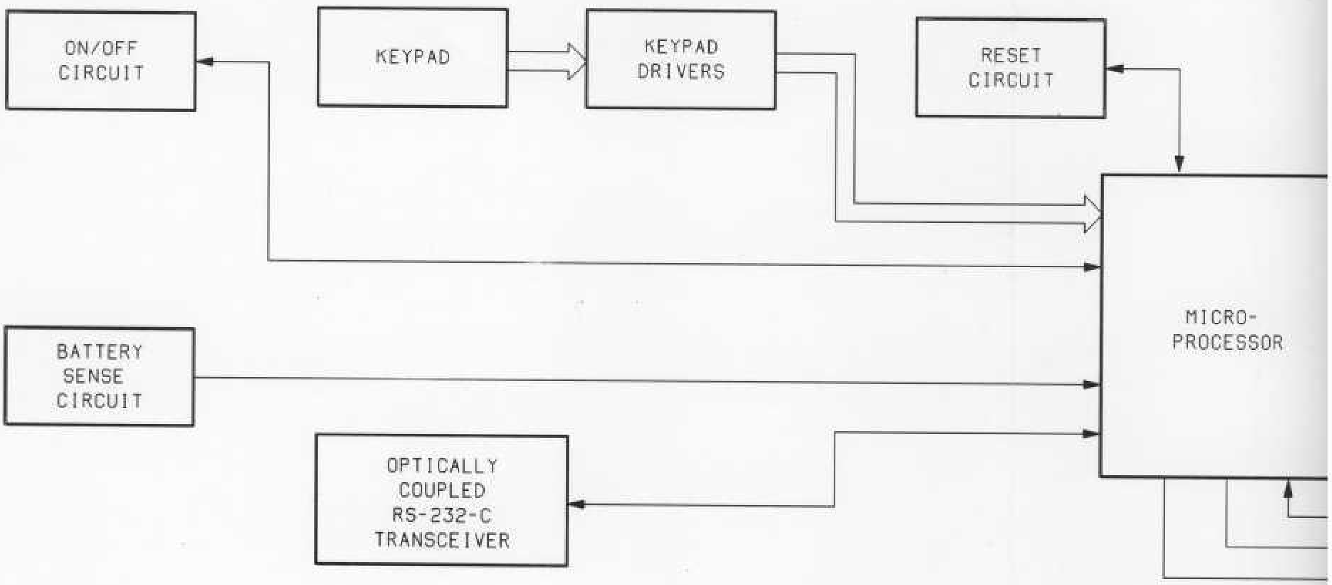
### 3.3.2 Overvie

The digita

- Microp
- Digital
- LCD ci

A block di
figure 3.2




ON/OFF CIRCUIT
KEYPAD
KEYPAD DRIVERS
RESET CIRCUIT
MICRO-PROCESSOR
BATTERY SENSE CIRCUIT
OPTICALLY COUPLED RS-232-C TRANSCEIVER

## 3.3.3 MICROPROCESSOR circuitry (µP)

### - Introduction

The ScopeMeter is controlled by a single chip microcomputer with on-board ROM (called Mask ROM in the following text). This microprocessor controls the total system operation and communication between the ScopeMeter and the outside world (key pad, RS-232-C interface). It also controls the communication between the internal system components.

### - Detailed circuit description

See figure 3.2 and circuit diagram A1 (figure 10.2).

The ScopeMeter uses an Intel 83C196 microprocessor D1201, with on-board Mask-programmed ROM (Mask ROM). This microprocessor has an 8-bit data bus and a 16-bit address bus. The lower 8 address bits A0...A7 are combined with the data bits (multiplexed data bus). ADDRESS LATCH D1210 is used to separate data bits and address bits.

The microprocessor's Mask ROM contains the startup software and a diagnostic kernel test (see chapter 7). It also contains the software necessary to drive the serial interface and to clear and program the Flash ROMs.

The two Flash ROMs (FROMs) D1207 and D1208 contain the system software. The FROMs are directly connected to the microprocessor via the dat and address busses. The microprocessor addresses the RAMs via the D-ASIC (D1203).

The microprocessor contains five 8-bit I/O ports. Port 3 and 4 share their bits with the data and address busses. The other I/O ports 0, 1, 2 are used for various purposes. For example: reading the keypad, operating the RS-232-C interface, battery voltage sense, switching the power on/off, etc.

***Keypad circuitry***

The keypad circuitry consists of five shift registers, D1601...D1606, each of which has eight inputs. These inputs are normally kept "high" by 56 KΩ resistor arrays connected to the +5V supply voltage. Whenever a key on the keypad is pressed, the corresponding line is connected to ground, resulting in a "low" signal. All signals are clocked into the shift registers (with the FRONT_CLOCK and FRONT_LATCH signals). Then they are converted into two signals FRONT_DATA1 (shift registers D1603, D1604, D1606) and FRONT_DATA2 (D1601 and D1602).

***Optically isolated RS-232-C interface***

The serial communications circuitry, which is built into the microprocessor, is used to operate the infrared (IR) RECEIVER and TRANSMITTER of the ScopeMeter. For this purpose a stripped version of the RS-232-C protocol is used.

Only the TXD (transmit data) and RXD (receive data) lines from the RS-232-C standard are used. The IR transmitter LED H1201 is driven directly from the TXD-not pin of the microprocessor. If a "0" is transmitted, the LED lights.

The IR receiver uses operational amplifier N1301 to power the collector of phototransistor H1202. If any IR light is received, the phototransistor will drive V1207 in saturation. This results in a "low" RXD line, interpreted by the microprocessor as a "1".

***Battery sense circuitry***

The battery voltage -VBAT generated on the analog unit is amplified by -2/3 at operational amplifier N1301. The resulting signal BAT_LEVEL is connected to an A/D converter input of the microprocessor. In this way the microprocessor can monitor the battery voltage level. If the battery voltage level drops below 4.4V, the microprocessor generates the BATTERY LOW indication on the LCD.

***Analog ASIC bus***
The Analog ASIC (A-ASIC D2301, see circuit diagram A2a/A2b, figure 10.5/10.6) or A-ASIC, as used in the following text, is controlled by the microprocessor. The microprocessor uses the signals CDAT, CCLK and DTAEa,b,c to set the A-ASIC and the attenuator sections on the analog A2 PCB. These signals together form the CONTROL bus.

***Flash ROM type selection***
The ScopeMeter hardware allows the usage of different types of Flash ROMs. The actual Flash ROM configuration is indicated by resistors R1222 and R1224.

FLASH ROM CONFIGURATION

| Resistor(s) | F512 (1x) | F512 (2x) | F010 (1x) |
|---|---|---|---|
| R1222 | | * | * |
| R1224 | * | | * |

The resulting voltage levels (0 volt, 2.5 volt or 5 volt) are read directly by the microprocessor A/D converter inputs.

***ON/OFF circuit***
The ON/OFF circuit operates almost like a thyristor. When the ON/OFF key is pressed, a current is drawn from the base of V1503, via R1503 and V1501. Transistor V1503 will now start to conduct. This results in a current through R1507, R1504, V1502 and R1506. The signal POWER_ON will now become "high". Also transistor V1506 will conduct, supplying base current to V1503 after the ON/OFF key is released. The POWER-ON signal will latch "high". The ON/OFF signal will go high, turning off V1506 and V1503, the next time the ON/OFF key is depressed. The POWER_ON signal will become "low" and the ScopeMeter power turns off.

***RESET circuit***
The RESET circuit consists of V1203, V1205, V1215, V1201, D1205 and related components. When the ScopeMeter power is switched on, the +5V supply voltage starts to rise. This causes the zener diode V1202 to conduct. After some time transistor V1203 also starts to conduct.
R1204 and C1203 form a time delay (see figure 3.3).

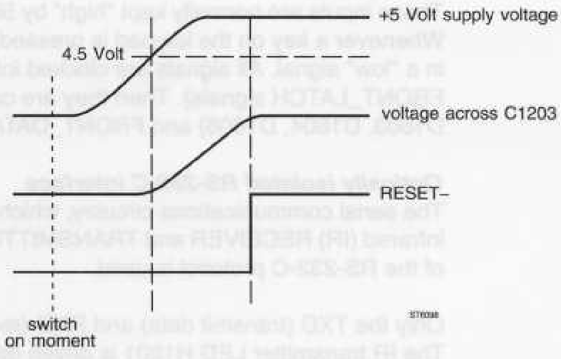



*Figure 3.3 RESET signal timing*

The RESET signal now is buffered by D1205 and connected with the RESET inputs of the microprocessor and the D-ASIC circuitry.
After a reset, the voltage on the EA (External Address) input of the microprocessor (pin 14) is "high". The Microprocessor starts up using the internal Mask ROM software. First the Flash ROMs are checked to see if they contain valid software. If this is true, output pin 6 of flip-flop D1202 is set "low". Now the microprocessor invokes a software reset. Because of the "low" voltage on the EA input of the microprocessor, the microprocessor will "start up" again, using the external Flash ROM software. The reset pulse is blocked by transistor V1201 to prevent the RESET signal from performing a "hard-reset" on the microprocessor again. At this software reset, the microprocessor enables the LCD by means of the signal LCDPWR. Then the buffers that control the LCD contain valid data.

## 3.3.4 DIGITAL ASIC (D-ASIC) cicuitry

### - Introduction

The Digital Application Specific Integrated Circuit (or D-ASIC) D1203 forms the core of the digital circuitry of the ScopeMeter, all located on the digital A1 PCB.
Many functions are incorporated in this complex CMOS integrated circuit (see figure 3.4 on the next page):

- Timebase
- Trigger
- Acquisition Control Logic
- Acquisition RAM
- Min/max
- Display control
- Decoding and synchronization
- Digital-to-analog converters (DACs)

### - Detailed circuit description:

See figure 3.4 and circuit diagram A1 (figure 10.2).

The following gives a short description of the separate parts of the D-ASIC, which perform the functions mentioned above:

***Timebase***

The D-ASIC contains a crystal oscillator, which uses the 25 MHz crystal G1201. An internal programmable divider generates timebase signal TRACK with a frequency from 0.8333 Hz up to 25 MHz (see section 3.4.5). This TRACK signal is used to sample the ScopeMeter input signals.

***Trigger***

The trigger module in the D-ASIC takes care of all trigger related functions:

- pre triggering
- post triggering
- event counting: the time interval corresponding to the trigger delay is increased by a programmed number of "events" (trigger level crossings of the external trigger signal), which must occur before triggering.
- n-cycle mode: trigger level crossings of the input signal are counted, and triggering occurs every $n^{th}$ crossing ($2 < n < 255$). The n-cycle mode can be used as a digital trigger hold-off.

In the real-time sampling mode (< 1 µs/div), the D-ASIC determines the trigger moment with digital comparators. In the quasi-random sampling mode, the A-ASIC determines the trigger moment with analog comparators.

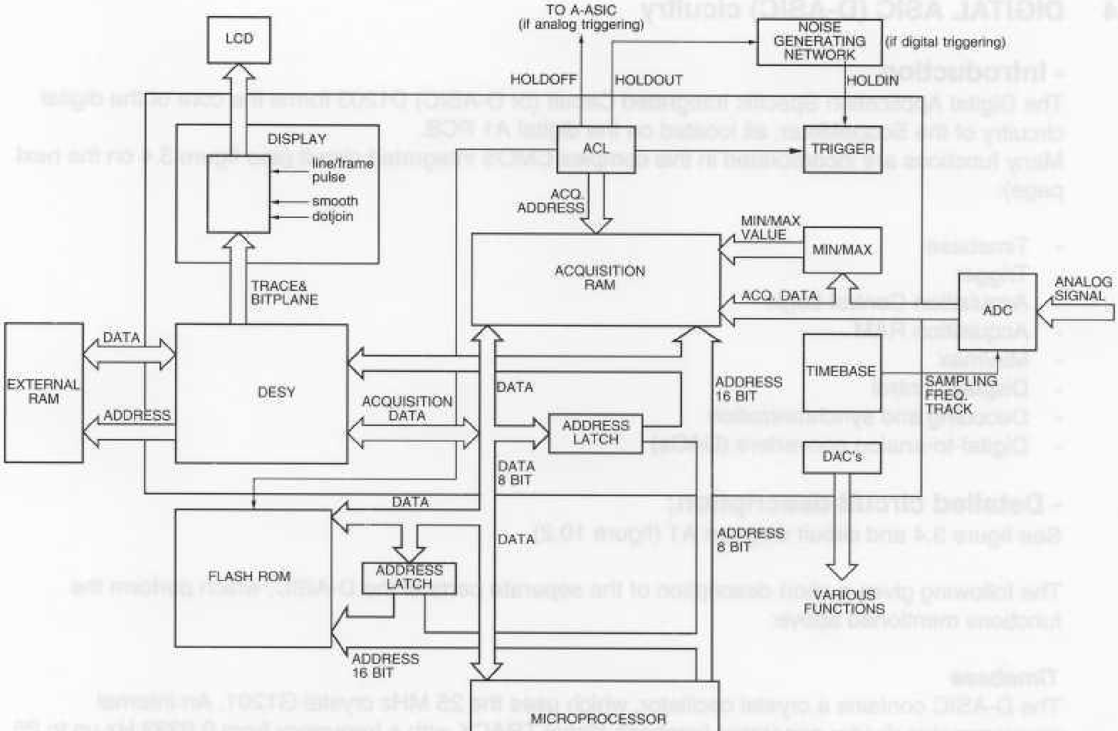



*Figure 3.4 Schematic Diagram D-ASIC D1203*

***Acquisition Control Logic (ACL)***

The ACL controls the analog input circuitry and the ADC (N2302, see circuit diagram A2a/A2b, figure 10.5/10.6). The ACL also writes the digital representations of the input signals to the Acquisition RAM in the D-ASIC, according to the selected trigger and acquisition modes. Before the acquired trace data is displayed, it is first processed by the microprocessor. The microprocessor corrects for offset- and amplification errors, using the calibration values that are stored in Flash ROM.

In fast timebase positions the ACL acquires 1024 values. Then the acquisition is stopped and the microprocessor can read the data out of the Acquisition RAM. In slow timebase positions the ACL uses the Acquisition RAM as a FIFO (First In First Out) memory. The microprocessor can start reading the acquired data immediately after triggering. Now there is synchronization between the ACL and the microprocessor.

If the system uses analog triggering (time base ≥ 1μs), the trigger hold-off signal (HLDOFFN) to the A-ASIC is generated. In digital triggering mode, the D-ASIC generates the HLDOUTN signal. This signal is fed to the HLDIN input of the D-ASIC, via R1211, C1221, R1214 and C1211. These components generate noise on the HOLDOUTN signal, which is needed as a random factor in the Delta- T circuit.

***Min/max***

The Min/max module finds the minimum and maximum value of the input signals between two time base pulses, and writes them into the Acquisition RAM. To detect narrow glitches, the TRACK signal (ADC sample frequency) is always 25 MHz in Min/max mode.

***Display control***

This module reads screen data from the External RAMs (D1204 and D1205) and sends it to the LCD. It also sends line pulses LINECL (17 kHz) and frame pulses FRAME (70 Hz). This screen data, consisting of for example cursor and grid information, is stored in External RAMs as bitplane information. The trace data is stored as a value for every vertical line on the LCD. This data is converted to bitplane data and added to the cursor and grid information. The display control module also makes it possible to change the dotsize of the signal displayed and to use dot joining.

***Decoding and synchronization (DESY)***

The DESY section is the decoder for the D-ASIC's internal addresses. This module also synchronises the microprocessor with the D-ASIC's Display control module, as both access the same Acquisition RAM.

***Digital to analog converters (DACs)***

The DACs module contains 10 one-bit pulse width modulated monotonous DACs, whose resolution ranges from five to ten bits. The DACs are used to control level shifting, analog trigger level, LCD contrast and the generator function (see section 3.4.7).

***External RAMs***

The External RAM section consists of two 32K ⋆ 8 SRAMs (D1204 and D1206). These RAMs contain:

- waveforms (stored with the WAVEFORM key)
- frontsettings (stored with the SETUP key)
- bitplane data for the LCD picture
- text, to be used on the display
- data in RECORD mode
- data in A versus B mode (A= ↑ B= → )
- bitplane data used while making a printout of the screen

***Ram Power circuit***

The External RAMs are powered by the RAM Power circuit. The RAM Power circuit is fed directly by the batteries, independently of the main power supply.
The RAM Power circuit is a simple oscillator, used to generate a stabilised voltage +VRAM out of the battery voltage -VBAT. The basic oscillator circuit is shown in figure 3.5.

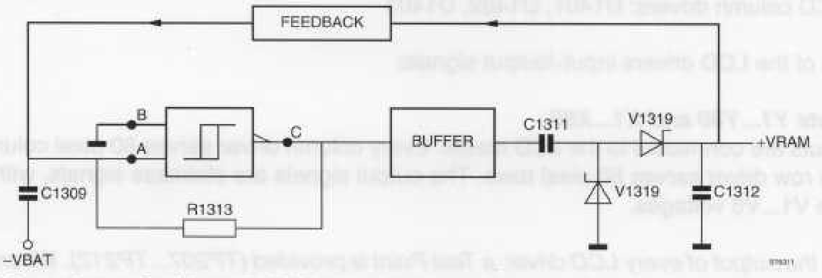



*Figure 3.5 Oscillator RAM Power circuit*

Input B of Schmitt input NAND D1301 is connected to ground. When the voltage on input A is also "low", the output C will become "high". Capacitor C1309 will charge via R1313. After some time input A will become "high", resulting in a "low" output C.

Capacitor C1309 will then discharge via resistor R1313. The generated output pulses are buffered and converted into a DC voltage by C1311, C1312 and V1319. The output voltage +VRAM is fed back to the NAND input A, via several transistors (voltage gap). If the output voltage +VRAM has reached the correct value, the pulse train at NAND output C is stopped via this feedback (see figure 3.6). In this way capacitor C1312 is charged just enough to keep the output voltage +VRAM at a stable value ( 3V DC).

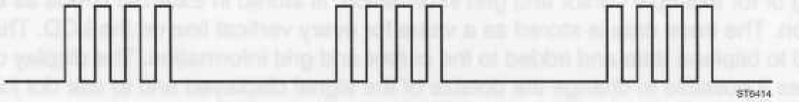


*Figure 3.6 Pulse train signal on input A of Schmitt input NAND (Test Point 223)*

## 3.3.5 LCD circuitry

### - Introduction

The LCD used in the ScopeMeter is controlled by six LCD driver integrated circuits. These drivers get their information (data- and control signals) directly from the D-ASIC. The microprocessor enables the display when valid data is present.

ScopeMeter models 93 and 95 use a reflexive LCD. Model 97 is provided with a transflexive LCD with a backlight, which can be switched on or off by the user.

### - Detailed circuit description

See figure circuit diagram A1 (figure 10.2).

***LCD***

The ScopeMeter uses a Super Twisted Nematic Liquid Crystal Display (LCD H1401, see circuit diagram A1, figure 10.2), with a resolution of 240 * 240 pixels.

The picture on the LCD screen is written column (vertical line) after column, rather than row (horizontal line) after row. The LCD screen is divided horizontally in 3 row-sections, each 80 pixels wide and vertically into 3 column-sections, each 80 pixels wide.

***LCD drivers***

The LCD display is controlled by the D-ASIC, via six LCD drivers:

- three LCD row drivers: D1404, D1406, D1407
- three LCD column drivers: D1401, D1402, D1403

Description of the LCD drivers input-/output signals:

***LCD outputs Y1...Y80 and X1...X80***

These outputs are connected to the LCD matrix. Every column driver serves 80 pixel columns of the LCD. Every row driver serves 80 pixel rows. The output signals are staircase signals, with levels equal to the V1...V6 voltages.

*NOTE: On the output of every LCD driver, a Test Point is provided (TP207...TP212). When the driver is working properly, a staircase voltage can be measured on these test points.*

### - Data inputs D0...D3 (row drivers only!)

The actual display data coming from the D-ASIC is sent via the DRIVERBUS to the LCD drivers D0...D3 inputs.

### - Terminal input voltages V1...V6

Out of these DC signals, with $V_{EE}$ = -20 V, the LCD drivers generate the staircase signals. The input voltages V1...V6 are generated by the LCD supply section.

### - Display control signals LINECL, DATACL, M, FRAME

These signals are used to control the LCD. The LCD picture is constructed from these display control signals and the data signals and sent to the LCD via the LCD outputs.
DATACL is the clock signal, used to clock the data D0...D3 into the driver buffer.
LINECL is a clock signal, used to clock one complete line (column) into the LCD.
The M signal is described furtheron (see M-randomize section).

***LCD supply section***

The pulse modulated signal, CONTRAST, comes from the D-ASIC. CONTRAST is filtered by R1401 and C1401 to get a DC voltage. The value of this DC voltage depends on the duty cycle of the CONTRAST signal. Opamps N1401 convert the DC signal into stabilized DC voltages V1...V6. If the signal, LCDPWR, coming from the D-ASIC, is "high" (+5V), the -20V voltage is generated and the system is active. The -20V supply voltage is temperature corrected to compensate for the temperature dependency of the LCD (-80 mV/C). The LCD supply voltages have to be corrected by the same amount to get a constant (over a temperature range) brightness and contrast of the LCD. This temperature compensation is made by Positive Temperature Coefficient (PTC) R1418. The -20V voltage is made out of the -30V voltage, coming from the analog A2 PCB. Transistors V1404 and V1402 form a protection circuit, that limits the current in case the -20V voltage is short circuited.

***M-randomize section***

The signal M ("LCD backplane modulation") has a time relation with the display control signals LINECL and DATACL. The M-randomize section converts M into M1, which is no longer time related to the other display control signals. The M1 signal is used by the LCD drivers to convert all DC voltages into AC voltages, able to drive the LCD.
Depending on the type (brand) of LCD mounted, integrated circuits D1408, D1409 and D1410 or D1411 are used.

***Backlight circuitry***

The backlight circuitry is based on the Hartley oscillator principle. Components V1307, T1301, and C1302 form the oscillator. Transistor V1304 supplies current to the circuit. This transistor is switched on/off by the ON OFF signal, coming from the microprocessor. When the output voltage across the backlight becomes higher than 100V, transistor V1305 will be driven open via V1308, V1309, and V1311. This will draw away current (energy) supplied to the oscillating circuit (feedback regulation).

## 3.4 ANALOG CIRCUITS (A2)

### 3.4.1 Introduction

This paragraph describes the circuits on the analog A2 PCB in detail. Refer to circuit diagrams A2a, A2b, and A2c (figures 10.5, 10.6, and 10.7 in chapter 10).

### 3.4.2 Overview analog circuits

The analog A2 PCB contains several functional parts:

- circuits in the acquisition path
  - attenuator sections
  - EXTernal (banana) input/output circuitry
  - Analog ASIC and ADC circuitry
- control circuitry
- signal generator
- power supply and battery charger

Each of these parts will be described separately. First a short introduction is given, followed by a detailed description.

### 3.4.3 ATTENUATOR sections, CHANNEL A and B

#### - Introduction

See figure 3.7.

The attenuator sections of both channels A and B are identical. In the following only channel A is described. The corresponding components for channel B have the same numbering, except the second number, which is '1' instead of '2'. For example: R2202 in channel A corresponds with R2102 in channel B.

The attenuator section consists of a high frequency (here after referred to as H.F.) path and a low frequency (here after referred to as L.F.) path, which are combined again in the impedance converter (see figure 3.7). To get a flat frequency characteristic, both paths must overlap over a wide frequency range. Circuits are provided for automatic offset compensation.
The output of the attenuator sections of channel A and B is processed further by the A-ASIC.

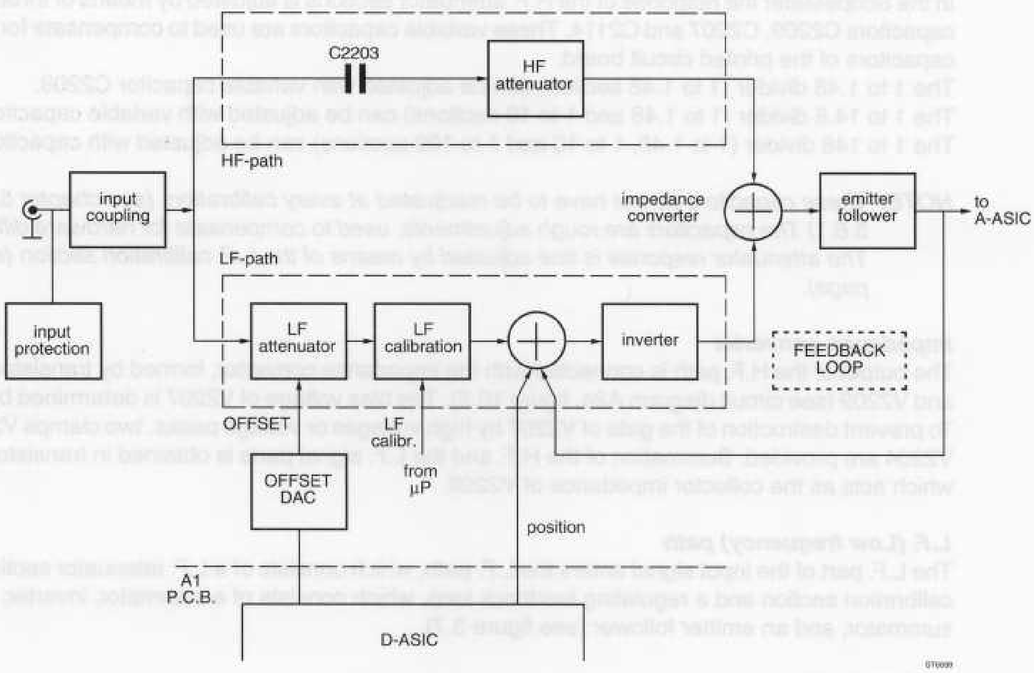



*Figure 3.7 Schematic diagram attenuator section*

## - Detailed circuit description

See figure 3.7 and circuit diagram A2a (figure 10.4).

***Input coupling***

The incoming signal first passes the AC/DC coupling section (C2202). When relay K2201 is opened, the signal is AC coupled via C2202.

***H.F. (high frequency) path***

After the coupling section, the L.F. part of the signal is blocked by capacitor C2203. Only the H.F. part of the input signal enters the H.F. attenuator. This is a triple capacitive divider, consisting of a 1 to 100, a 1 to 10, and a 1 to 1.48 divider.

The 1 to 1.48 divider section is switched on when relay switches K2202 and K2203 are in the "upper" position (as shown on circuit diagram A2a, figure 10.5).
The 1 to 1.48 divider consists of C2203 and C2209 in parallel with some parasitic capacitors. The attenuation of 1.48 times in this straight-on path is compensated for later in the circuitry.

The separate sections are switched in the signal path, depending on the attenuation required:

*Table 3.2 Sections used in various attenuator settings.*

| Attenuator Settings | Sections Used | Attenuation |
|---|---|---|
| 5 mV/div 100 mV/div | 1.48x | 1.48 times |
| 200 mV/div 1 V/div | 1.48x, 10x | 14.8 times |
| 2 V/div 10 V/div | 1.48x, 100x | 148 times |
| 20 V/div 100 V/div | 1.48x, 10x, 100x | 1480 times |

In the ScopeMeter the response of the H.F. attenuator sections is adjusted by means of three variable capacitors C2209, C2207 and C2114. These variable capacitors are used to compensate for parasitic capacitors of the printed circuit board.
The 1 to 1.48 divider (1 to 1.48 section) can be adjusted with variable capacitor C2209.
The 1 to 14.8 divider (1 to 1.48 and 1 to 10 sections) can be adjusted with variable capacitor C2207.
The 1 to 148 divider (1 to 1.48, 1 to 10 and 1 to 100 sections) can be adjusted with capacitor C2214.

NOTE: *These capacitors do not have to be readjusted at every calibration. (see chapter 5, section 5.6.1) The capacitors are rough adjustments, used to compensate for hardware differences. The attenuator response is fine adjusted by means of the L.F. calibration section (see next page).*

***Impedance converter***
The output of the H.F. path is connected with the impedance converter, formed by transistors V2207 and V2209 (see circuit diagram A2a, figure 10.5). The bias voltage of V2207 is determined by R2216. To prevent destruction of the gate of V2207 by high voltages or voltage peaks, two clamps V2206 and V2204 are provided. Summation of the H.F. and the L.F. signal parts is obtained in transistor V2207, which acts as the collector impedance of V2208.

***L.F. (Low frequency) path***
The L.F. part of the input signal enters the L.F. path, which consists of a L.F. attenuator section, a L.F. calibration section and a regulating feedback loop, which consists of a summator, inverter, another summator, and an emitter follower (see figure 3.7).

***L.F. attenuator***
Fig 3.8 shows the L.F. attenuator section in detail:

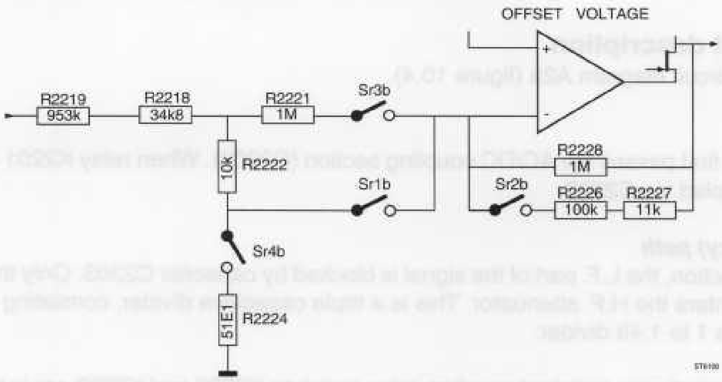



*Figure 3.8 Principal diagram L.F. attenuator section*

The L.F. attenuator consists of an inverting amplifier, N2201, which attenuates the L.F. signal by a factor, depending on the settings of switches D2201. These switches are controlled by signals named Sr1b...Sr4b. A "high" signal switches on the corresponding latched relays.

*Table 3.3 Attenuator drive signals Sr1b...Sr4b.*

| Attenuator settings | Sr1b | Sr2b | Sr3b | Attenuation |
|---|---|---|---|---|
| 5 mV/div...100 mV/div | high | low | low | 1.48 times |
| 200 mV/div...1 V/div | high | high | low | 14.8 times |
| 2 V/div...10 V/div | low | low | high | 148 times |
| 20 V/div...100 V/div | low | high | high | 1480 times |

The signal Sr4b operates the switch, which is used to ground the L.F. part of the input signal during offset calibration. This is done automatically to prevent drift.

The offset DAC circuitry (see figure 3.7) provides the offset voltage for operational amplifier N2201. The offset compensation is done automatically by means of the signals So10b...So14b, coming from the D-ASIC.

## L.F. Calibration

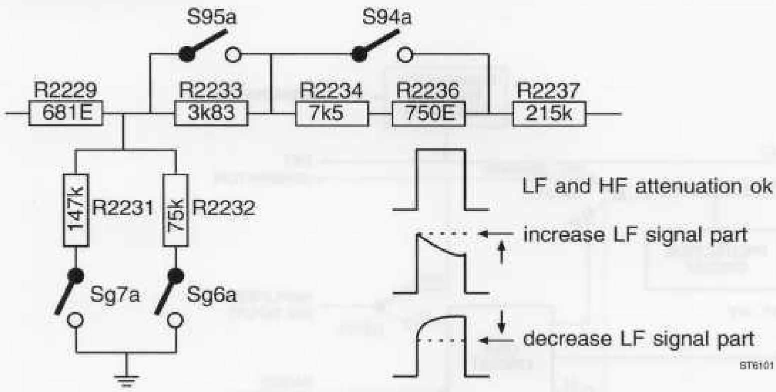



*Figure 3.9 Automatic adjustment of the L.F. attenuation*

Fine adjustment of the L.F. path attenuation is completed during calibration of the H.F. path attenuation. This is done by means of a simple 4-bits D-to-A converter, consisting of resistors R2229, R2231, R2232, R2233, R2234, R2236, and switches D2202. These switches are operated by signals Sg4a, Sg5a, Sg6a, and Sg7a, see figure 3.6. Resistors R2229, R2231 and R2232 divide the output signal of the attenuator section. Resistors R2233, R2234, and R2236 increase the input resistance of the inverting amplifier of the regulating loop.

## Feedback loop

The output signal of the impedance converter is fed back to the input of operational amplifier N2201, with the signal coming from the L.F. calibration section (via R2237) and a DC position voltage (5V via R2248), proportional with the MOVEment of the trace (via R2248). Transistor V2210 is used to enlarge the dynamic range: when D-POSCHA is active, R2270 is incorporated in the circuitry.

The feedback loop operates as follows. If, for example, the output signal of the L.F. path is too small, the correction amplifier N2201 will drive V2207 via V2208. In this way the amplitude of the L.F. path and the position voltage are increased (compensation).

***Input protection***

The input protection safeguards the ScopeMeter against overvoltage. The input protection circuit consists of C2203 and V2206/V2204 (clamp HF attenuator) and R2219 and V2212/V2213 (clamp LF attenuator).

## 3.4.4 EXTERNAL (BANANA) INPUT/OUTPUT circuitry

### - Introduction

See figure 3.10.

The ScopeMeter is provided with two banana connectors, which are used as inputs in the mV, DIODE, and OHM METER modes or as EXTernal trigger input in SCOPE mode. These connectors also serve as outputs for the built-in generator. Protection circuitry is provided to prevent damage by overvoltage.

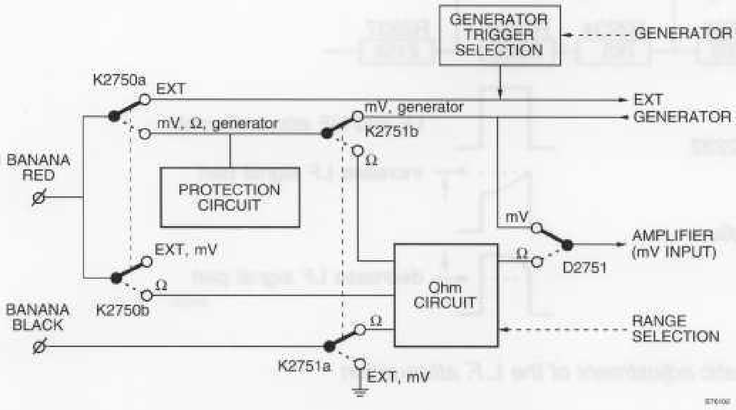



*Figure 3.10 Schematic diagram signal flow in EXTernal (banana) input/output circuitry*

### - Detailed circuit description

See figure 3.10 and circuit diagram A2b (figure 10.6).

***mV DC measurement circuitry***

The mV DC input voltage on the red banana terminal is fed to the L.F. part of the channel A attenuator section, via the following path: R2750, K2750a, K2751b, R2761, D2751 (refer to circuit diagram A2b, figure 10.6). When the ScopeMeter is switched to mV DC measurement using the EXT banana terminals, the settings are as follows:

*Table 3.4 A-ASIC and attenuator settings in mV DC mode.*

| mV DC RANGE | A-ASIC (D2301) | LF-ATTENUATOR (channel A) |
|---|---|---|
| 300 mV<br>3 V | 100 mV/div<br>100 mV/div | 1*<br>0.1* |

***Ohm measurement circuitry***

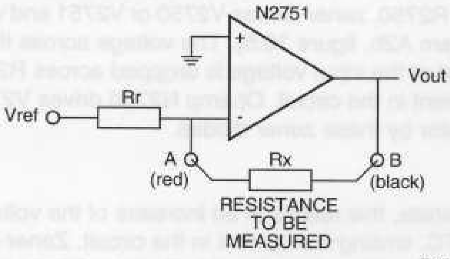



*Figure 3.11 Ohm measurement circuitry (principle of operation)*

The resistance $R_x$ to be measured is connected as a feedback resistor of an amplifier circuit (opamps N2751). The output voltage of this measuring amplifier is proportional to resistance $R_x$:

$$V_{out} = (V_{ref}/R_r) \times R_x$$

The different ranges are obtained by selecting different values for resistor $R_r$ . This can be done with the Ohm range selection circuit (D2750 and surrounding resistors), which is controlled by the Analog Control circuitry (circuit diagram A2a, figure 10.5, B-OFFSET lines).

*Table 3.5 Ohm range selection circuit control lines.*

| RANGE | Sc15 | Sc16 | Sc17 | Sc18 |
|---|---|---|---|---|
| 300Ω | 1 | 0 | 1 | 1 |
| 3kΩ | 1 | 0 | 1 | 0 |
| 30kΩ | 1 | 0 | 0 | 0 |
| 300kΩ | 1 | 1 | 0 | 0 |
| 3MΩ | 0 | 1 | 0 | 0 |
| 30MΩ | 0 | 1 | 0 | 0 |

Switches D2751 choose between the mV DC voltage and the voltage from the Ohm circuit. The outputs of these switches are connected to the L.F. part of the channel A attenuator (circuit diagram A2a, figure 10.5).

***Diode measurement circuitry***
While in DIODE METER mode, the ScopeMeter uses the same circuitry as in OHM mode.

**WARNING:** **The BLACK terminal is not connected to the BNC grounds, while in OHM or DIODE METER mode! While in OHM er DIODE METER mode, the ScopeMeter can not be grounded via the BLACK banana terminal.**

***EXTernal triggering***
The trigger signal is fed to the A-ASIC on A2a (figure 10.5) via resistor R2750 and voltage divider R2753/R2754 (see circuit diagram A2b, figure 10.6). It is also possible to trigger on the signal made by the generator. Then the trigger signal is made out of the signals STIMUL and G-OUTP by D2850, V2758, and related components.

***Generator signal***
The output of the generator (see paragraph 3.4.7) is sent to the EXT banana terminals via K2751b, K2750a and R2750.

***Protection circuit (generator mode)***
If a high voltage is applied to the banana terminals A and B, a current will flow from terminal A, through PTC (Positive Temperature Coefficient) R2750, zener diodes V2750 or V2751 and via V2752 and V2753 back to terminal B (see circuit diagram A2b, figure 10.5). The voltage across the zener diodes is limited to 7.5V for each diode. The rest of the input voltage is dropped across R2750. The resistance of this PTC will rise and limit the current in the circuit. Opamp N2750 drives V2752 and V2753, to prevent capacitive load of the generator by these zener diodes.

***Protection (Ohm and diode measurement)***
If a high voltage is put on the EXT banana terminals, this results in an increase of the voltage over PTC R2750. This increases the value of this PTC, limiting the current in the circuit. Zener diode V2764 limits the output voltage of the measuring amplifier circuit N2751. Resistor R2771 and clamp diodes V2759...V2763 protect the input of the measuring amplifier.

## 3.4.5 ANALOG ASIC (A-ASIC) and ADC circuitry

### - Introduction
See figure 3.12.

The signals coming from the channel A and B attenuators are fed to D2301. Various oscilloscope functions are integrated in this Application Specific Integrated Circuit (ASIC).
Analog ASIC D2301 selects the signal source and prepares the signal for further processing by the ADC circuitry. Also a trigger signal is derived from one of the channel A or B inputs or the external trigger input (banana connectors).

### - Detailed circuit description
See figure 3.12 and circuit diagram A2a/A2b (figure 10.5/10.6).

First a short description is given for the internal circuits of the A-ASIC. The schematic diagram of the A-ASIC D2301 is shown in figure 3.12. The A-ASIC input/output signals are also described in the following sections.

***Channel A Amplifier and Channel B Amplifier***
The output signals of the channel A and B attenuator sections are amplified in the A-ASIC to obtain the most sensitive ranges.

*Table 3.6 A-ASIC relative amplification at various attenuator settings.*

| Attenuator setting: | A-ASICrelative amplification: |
|---|---|
| 100 mV/div | 1 time |
| 50 mV/div | 2 times |
| 20 mV/div | 5 times |
| 10 mV/div | 10 times |
| 5 mV/div | 20 times |
| 2 mV/div* | 10 times |
| 1 mV/div* | 20 times |

(* both 1mV/div and 2 mV/div settings are made by multiplying times five and averaging the signal in 5 mV/div. and 10 mV/div.)

The A-ASIC itself can handle input signals with a maximum amplitude of 750 mV peak-peak. A vertical offset voltage YPOS is added to the signal in the attenuator sections (section 3.4.3). This means that 0V on an A- ASIC input terminal results in a trace in the vertical middle of the screen.

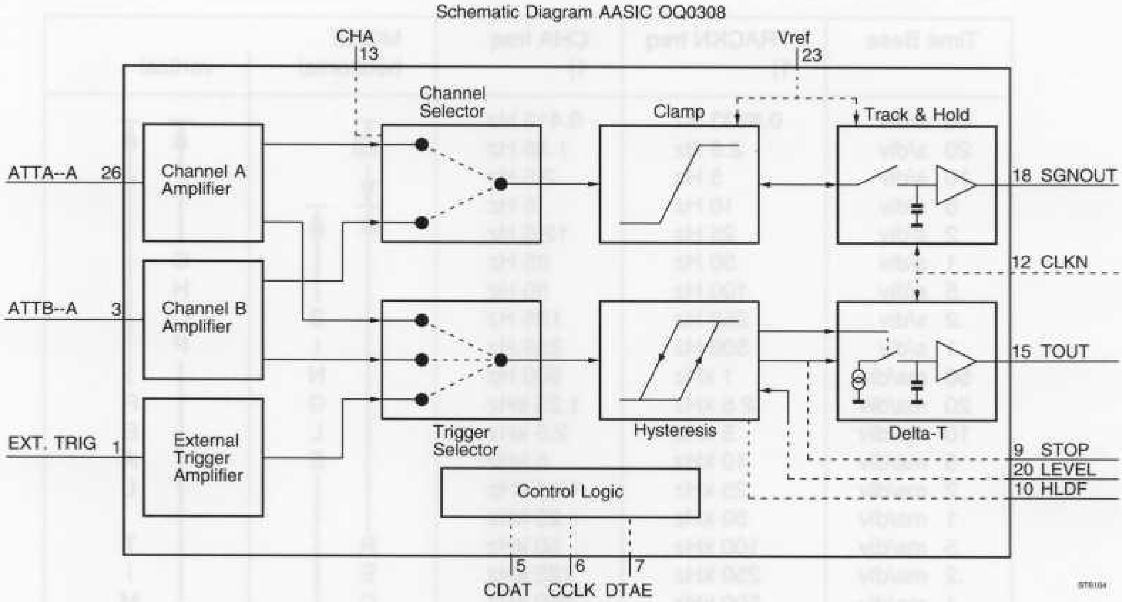



*Figure 3.12 Schematic diagram A-ASIC D2301*

***Channel Selector***

The channel selector selects channel A or channel B, depending on the level of the CHANA signal (input 13).

If CHA is "high" (> 3.5 V) channel A is selected.
If CHA is "low" (< 1.5 V) channel B is selected.

If a timebase speed faster than 20 µs is selected, both channels are displayed in alternate mode and CHA is a square wave signal with a timebase-dependent frequency (see table 3.7). If a timebase speed slower than 50 µs is selected, both channels are displayed in chopped mode. The CHA signal is a square wave signal with a trigger-dependent frequency of 500 kHz maximum.

*Table 3.7 Frequencies of A-ASIC signals in various modes.*

| Time Base | TRACKN freq 1) | CHA freq 1) | MODE horizontal | vertical |
|---|---|---|---|---|
| 60 s/div | 0.8333 Hz | 0.416 Hz | | |
| 20 s/div | 2.5 Hz | 1.25 Hz | roll | |
| 10 s/div | 5 Hz | 2.5 Hz | | |
| 5 s/div | 10 Hz | 5 Hz | | |
| 2 s/div | 25 Hz | 12.5 Hz | | |
| 1 s/div | 50 Hz | 25 Hz | | C |
| .5 s/div | 100 Hz | 50 Hz | | H |
| .2 s/div | 250 Hz | 125 Hz | S | O |
| .1 s/div | 500 Hz | 259 Hz | I | P |
| 50 ms/div | 1 kHz | 500 Hz | N | |
| 20 ms/div | 2.5 kHz | 1.25 kHz | G | R |
| 10 ms/div | 5 kHz | 2.5 kHz | L | E |
| 5 ms/div | 10 kHz | 5 kHz | E | A |
| 2 ms/div | 25 kHz | 12.5 kHz | | L |
| 1 ms/div | 50 kHz | 25 kHz | | |
| .5 ms/div | 100 kHz | 50 kHz | R | T |
| .2 ms/div | 250 kHz | 125 kHz | E | I |
| .1 ms/div | 500 kHz | 250 kHz | C | M |
| 50 µs/div | 1 MHz | 500 kHz | U | E |
| 20 µs/div | 1.25 MHz | | R | |
| 10 µs/div | 2.5 MHz | | R | |
| 5 µs/div | 5 MHz | Trigger | E | |
| 2 µs/div | 12.5 MHz | | N | A |
| 1 µs/div | 25 MHz | dependent | T | L |
| .5 µs/div | 25 MHz | | | T |
| .2 µs/div | 25 MHz | | | |
| .1 µs/div | 25 MHz | | | |
| 50 ns/div | 25 MHz | | | |
| 20 ns/div | 25 MHz | | | |
| 10 ns/div | 25 MHz | | | |

1) In MIN/MAX mode (only possible for one channel), the frequency of CHA is zero and the sample frequency TRACK is always 25 MHz.

***Clamp***

To prevent the Track & Hold circuit from overdrive, the signal is clamped. The level of the output signal can be adjusted by means of VREF (input 23). VREF is the reference voltage, made by the circuit consisting of V2301, V2302 and R2323, R2324, and R2325 (see ADC section).

***Track & Hold***

The maximum sampling frequency of the ADC used in the ScopeMeter is 25 MHz. This means that the ADC can only handle signals with frequencies up to 12.5 MHz (half the sample frequency). Because of this a Track & Hold circuit is incorporated in the A-ASIC. The Track & Hold circuit determines the frequency range of the whole system.

The timing in this part of the A-ASIC is determined by clock signal TRACKN (input 12). The frequency of the TRACKN signal depends on the selected timebase speed (see table 3.7).

The output signal, SGNOUT, (output 18) is fed to the ADC. The voltage range of SGNOUT is 1.5V...3.5V. The intermediate level of SGNOUT is derived from the VREF voltage level, which is made by the ADC.

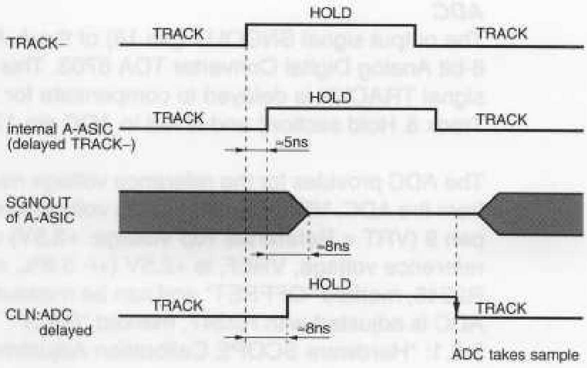



*Figure 3.13 Track & Hold timing*

***External Trigger Amplifier***

This amplifier section processes the incoming external trigger signal so that it can be used in the trigger section. The input of this section is TTL compatible.

***Trigger Selector***

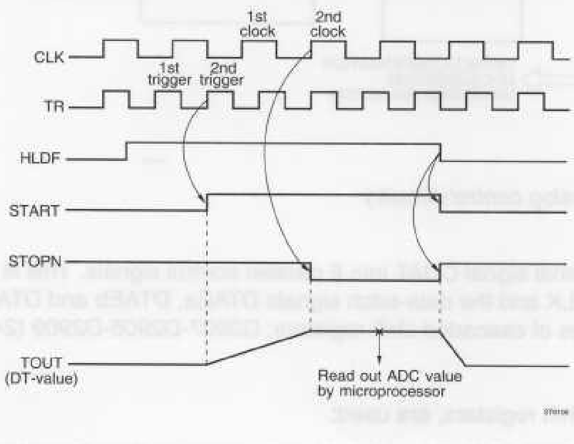
In this section the channel A, channel B or external trigger input signal is selected to act as trigger source. The trigger slope is also selected in this block.

***Hysteresis***

The hysteresis section converts the trigger signal into a pulse shaped signal. Because of the hysteresis, the circuit will not trigger on noisy signals. The LEVEL signal (input 20) that determines the trigger level, is a DC voltage between +0.5V and +2.0V. The LEVEL signal is a DC voltage, generated in the Digital ASIC. Resistor R2309 and capacitors C2312 and C2313 form a lowpass filter, to convert a pulse width modulated signal into the DC voltage.

***Delta-T circuit***

The Delta-T circuit measures the time between a trigger pulse and the moment the input signal is sampled. Figure 3.14 shows the timing diagram with relation to the signal HLDF (input 10), START (internal), STOPN (output 9), and TOUT (output 15).




START: internal (in the A-ASIC) start signal for the Delta-T measurement.

TOUT: a voltage proportional to the measured value (time) of Delta T.

*Figure 3.14 Timing diagram Delta-T circuit*

***Control logic***

The control logic section contains a serial-in parallel-out shift register. This section gets its data from the microprocessor (D1201, circuit diagram A1, figure 10.2) via the CDAT (serial data), CCLK (serial clock), and DTAE (data-latch) lines. The control logic section controls all functional blocks within the A-ASIC.

***ADC***
The output signal SNGOUT (pin 18) of the A-ASIC is fed to the 8-bit Analog Digital Converter TDA 8703. This component operates on a 25 MHz clock signal. The signal TRACKN is delayed to compensate for the internal signal delay in the A-ASIC (behind the Track & Hold section) and is fed to ADC pin 17.

The ADC provides for the reference voltage needed by the A-ASIC. This reference voltage is derived from the ADC. VREF is made of the voltages on pin 4 (VRB = Reference Bottom Voltage: +1.5V) and pen 9 (VRT = Reference Top Voltage: +3.5V) of the ADC. During normal operating conditions this reference voltage, VREF, is +2.5V (+/- 3.6%, ref. to ground). VREF is adjusted with potentiometer R2346, marked "OFFSET" and can be measured between TP331 and ground. The sensitivity of the ADC is adjusted with R2347, marked "GAIN". These calibrations are described in chapter 5, section 5.6.1: "Hardware SCOPE Calibration Adjustments".

The 8-bit output of the ADC: ADC0...ADC7 is connected to the Digital ASIC on the digital A1 PCB.

## 3.4.6 ANALOG CONTROL CIRCUIT

### - Introduction
See figure 3.13.

The various sections of the ScopeMeter, situated on the analog A2 PCB, are controlled by the microprocessor on the digital A1 PCB. This is done by means of the CCLK (serial clock), CDAT (serial data) and DTAE (data-latch) lines. This bus system creates several control signals, which for example drive the relays switches in the attenuator sections.

### - Detailed circuit description
See figure 3.13 and circuit diagram A2a (figure 10.5).

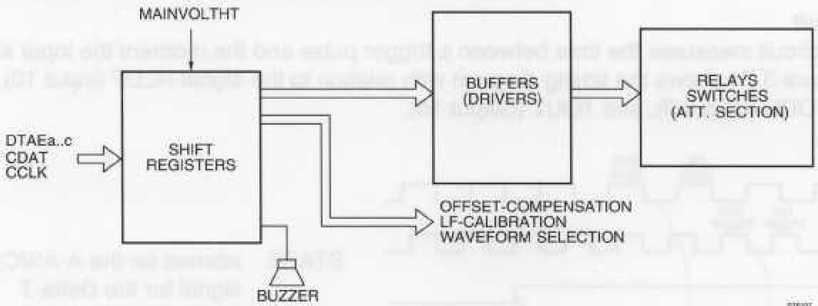



*Figure 3.15 Schematic diagram analog control circuitry*

Each shift register transforms the serial signal CDAT into 8 parallel control signals. This is done by means of the serial clock signal CCLK and the data-latch signals DTAEa, DTAEb and DTAEc. The control circuitry comprises two series of cascaded shift registers: D2907-D2908-D2909 (24 signals) and D2904- D2906(16 signals).

The signals, that are made by the shift registers, are used:

- to control the buffers (D2901 / D2902 / D2903), which drive the relays in the attenuator section.
- for offset compensation (A-RANGE and B-RANGE) in the attenuator sections.
- for L.F.-calibration (A-OFFSET and B-OFFSET) in the attenuator sections.
- to select the waveform in the signal generator section (sinewave/squarewave/DC).
- to drive the buzzer (beeper).

## - Relay tables

In the following tables the number "1" means "high" (active) signal. "0" means "low" signal and "X" means "can be high or low (don't care)".

Channel B DC coupled

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 1) 100 mV/div | 1 | 0 | 0 | x | x | x | x | 0 |
| 2) 1V/div | 1 | 1 | 0 | x | x | x | x | 0 |
| 10V/div | 1 | 0 | 1 | x | x | x | x | 0 |
| 100V/div | 1 | 1 | 1 | x | x | x | x | 0 |
| GROUND | 0 | 1 | 1 | x | x | x | x | 0 |

Channel B AC coupled

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 100 mV/div | 0 | 0 | 0 | x | x | x | x | 0 |
| 1V/div | 0 | 1 | 0 | x | x | x | x | 0 |
| 10V/div | 0 | 0 | 1 | x | x | x | x | 0 |
| 100V/div | 0 | 1 | 1 | x | x | x | x | 0 |
| GROUND | 0 | 1 | 1 | x | x | x | x | 0 |

Channel A DC coupled

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 100 mV/div | x | x | x | 1 | 0 | 0 | x | 0 |
| 1V/div | x | x | x | 1 | 1 | 0 | x | 0 |
| 10V/div | x | x | x | 1 | 0 | 1 | x | 0 |
| 100V/div | x | x | x | 1 | 1 | 1 | x | 0 |
| GROUND | x | x | x | 0 | 1 | 1 | x | 0 |

Channel A AC coupled

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 100 mV/div | x | x | x | 0 | 0 | 0 | x | 0 |
| 1V/div | x | x | x | 0 | 1 | 0 | x | 0 |
| 10V/div | x | x | x | 0 | 0 | 1 | x | 0 |
| 100V/div | x | x | x | 0 | 1 | 1 | x | 0 |
| GROUND | x | x | x | 0 | 1 | 1 | x | 0 |

1) Relay information valid for SCOPE attenuator settings up to 100 mV/div.

2) Relay information valid for SCOPE attenuator settings between 100 mV/div and 1V/div, etc.

EXTernal input

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| Ext. Trig | x | x | x | x | x | x | 0 | 0 |
| Generator | x | x | x | x | x | x | 1 | 0 |

METER V DC mode

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 300 mV | 0 | 1 | 1 | 1 | 1 | 0 | x | 0 |
| 3V | 0 | 1 | 1 | 1 | 0 | 1 | x | 0 |
| 30V | 0 | 1 | 1 | 1 | 1 | 1 | x | 0 |
| 300V | 0 | 1 | 1 | 1 | 1 | 1 | x | 0 |

METER V AC mode

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 300 mV | 0 | 1 | 1 | 0 | 1 | 0 | x | 0 |
| 3V | 0 | 1 | 1 | 0 | 0 | 1 | x | 0 |
| 30V | 0 | 1 | 1 | 0 | 1 | 1 | x | 0 |
| 300V | 0 | 1 | 1 | 0 | 1 | 1 | x | 0 |

METER V DC + AC mode

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 300 mV | 0 | 1 | 1 | 1 | 1 | 0 | x | 0 |
| 3V | 0 | 1 | 1 | 1 | 0 | 1 | x | 0 |
| 30V | 0 | 1 | 1 | 1 | 1 | 1 | x | 0 |
| 300V | 0 | 1 | 1 | 1 | 1 | 1 | x | 0 |

METER mV mode (EXTernal inputs)

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 300 mV | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 3V | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |

METER Ω mode

| | K2101 | K2102 | K2103 | K2201 | K2202 | K2203 | K2750 | K2751 |
|---|---|---|---|---|---|---|---|---|
| 300 Ohm | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 3 KOhm | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 30 KOhm | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 300 KOhm | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 3 MOhm | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 30 MOhm | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |

## - Control lines tables

Channel B DC coupled

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 mV/div | 1 | 0 | 0 | 0 | 0 | x | x | x | x | x | x | x |
| 1V/div | 1 | 1 | 0 | 0 | 0 | x | x | x | x | x | x | x |
| 10V/div | 0 | 0 | 1 | 1 | 0 | x | x | x | x | x | x | x |
| 100V/div | 0 | 1 | 1 | 1 | 0 | x | x | x | x | x | x | x |
| GROUND | 0 | 0 | 0 | 1 | 1 | x | x | x | x | x | x | x |

Channel B AC coupled

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 mV/div | 1 | 0 | 0 | 0 | 0 | x | x | x | x | x | 0 | 0 |
| 1V/div | 1 | 1 | 0 | 0 | 0 | x | x | x | x | x | 0 | 0 |
| 10V/div | 0 | 0 | 1 | 1 | 0 | x | x | x | x | x | 0 | 0 |
| 100V/div | 0 | 1 | 1 | 1 | 0 | x | x | x | x | x | 0 | 0 |
| GROUND | 0 | 0 | 0 | 1 | 1 | x | x | x | x | x | 0 | 0 |

Channel A DC coupled

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 mV/div | x | x | x | x | x | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1V/div | x | x | x | x | x | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 10V/div | x | x | x | x | x | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 100V/div | x | x | x | x | x | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| GROUND | x | x | x | x | x | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

Channel A AC coupled

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 mV/div | x | x | x | x | x | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1V/div | x | x | x | x | x | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 10V/div | x | x | x | x | x | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 100V/div | x | x | x | x | x | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| GROUND | x | x | x | x | x | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

METER V DC mode

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 mV | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3V | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 30V | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 300V | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |

METER V AC mode

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 mV | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3V | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 30V | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 300V | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |

METER V DC + AC mode

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 mV | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3V | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 30V | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 300V | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |

METER mV mode (EXTernal inputs)

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 mV | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 300V | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |

METER Ω/ —▶|— modes

| | Sr1a | Sr2a | Sr3a | Sr4a | Sgnd8b | Sr1b | Sr2b | Sr3b | Sr4b | Sgnd8a | mV | OHM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 Ohm | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 3 KOhm | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 30 KOhm | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 300 KOhm | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 3 MOhm | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 30 MOhm | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| Diode | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |

| | Sc15 | Sc16 | Sc17 | Sc18 |
|---|---|---|---|---|
| 300 Ohm | 1 | 0 | 1 | 1 |
| 3 KOhm | 1 | 0 | 1 | 0 |
| 30 KOhm | 1 | 0 | 0 | 0 |
| 300 KOhm | 1 | 1 | 0 | 0 |
| 3 MOhm | 0 | 1 | 0 | 0 |
| 30 MOhm | 0 | 1 | 0 | 0 |
| Diode | 1 | 0 | 1 | 1 |

| | G_OUTP |
|---|---|
| Ext. Trig. | 0 |
| Generator | 1 |

| | BUZ |
|---|---|
| Buzzer off | 1 |
| Buzzer on | 0 |

| | SCOPE mode Attenuator settings ≥ 20 mV/div | SCOPE mode Attenuator settings ≤ 10 mV/div | METER mode |
|---|---|---|---|
| D-POSCHA | 0 | 1 | 1 |
| D-POSCHB | 1 | 1 | x |

While the ScopeMeter is operating in METER mode or when the instrument is calibrated, the signals Si, mV, OHM, Sr1b, Sr2b, Sr3b, Sr4b, and D_POSCHB can change ("high/low"). Signals Ex and Ey are used to switch the relays. Both signals are "high" when the relays are not operated.

Signals Sg4a, Sg5a, Sg6a, and Sg7a set the L.F. gain for channel A. Sg4b, Sg5b, Sg6b, and Sg7b set the L.F. gain for channel B. Sg4a (Sg4b) is the most significant bit (MSB), Sg7a (Sg7b) is the least significant bit (LSB).

Signals So10b, So11b, S012b, So13b, and So14b are used to set the offset compensation in the preamplifier circuits of channel A. Signals Sc15, Sc16, Sc17, Sc18, and S014a are used to set the offset compensation in the preamplifier circuits of channel B. S010b (Sc15) is the most significant bit (MSB), So14b (So14a) is the least significant bit (LSB).

### 3.4.7 GENERATOR circuit

#### - Introduction

See figure 3.14.

The ScopeMeter has a built-in signal generator, which can produce the following signals, used to adjust the probes:

- square wave voltage, amplitude: 5V peak-to-peak; frequency: 976 Hz
- DC voltage: 3V

ScopeMeter model 97 can also produce:

- sine wave voltages, amplitude: 5V peak-to-peak; frequency: 976 Hz
- square wave voltages, amplitude: 5V peak-to-peak; frequencies: 488 Hz, 1.95 kHz
- slow ramp voltage, -2V...+2V
- slow ramp current, -3 mA...+3mA

The signal generator uses a square wave voltage, coming from the D-ASIC to generate the various signals. The circuit consists of an operational amplifier, a fourth order filter, and a current source. The configuration can be changed by means of programmable switches to produce different output signals.

#### - Detailed circuit description

See figure 3.16 and circuit diagram A2b (figure 10.6).

Figure 3.16 shows the basic generator circuitry:

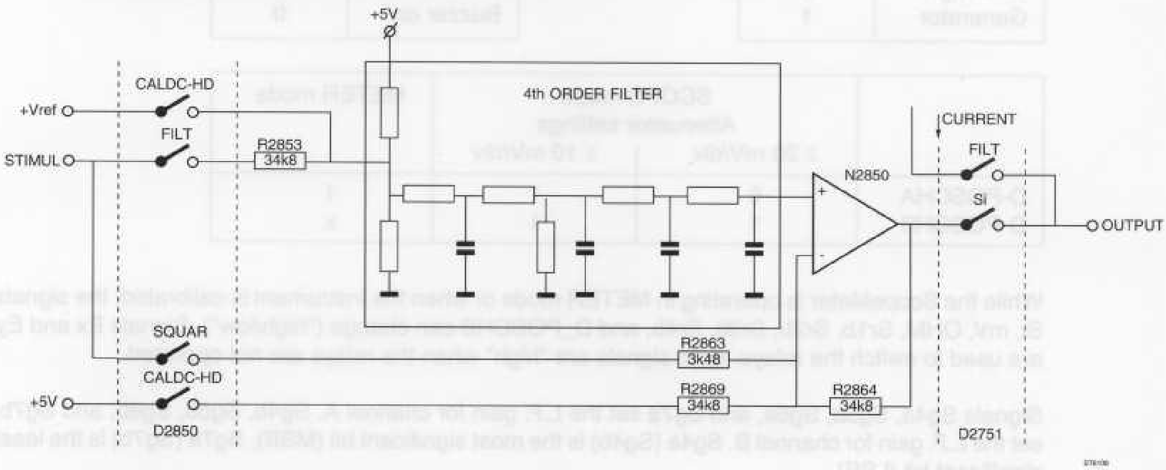



*Figure 3.16 Basic generator circuitry*

This circuit uses a square wave voltage, STIMUL, coming from the D-ASIC. This signal has an amplitude between 0V and +5V. The duty cycle of the square wave signal is varied depending on the signal to be generated. The reference voltage +Vref is used to generate the DC voltage.

The configuration depends on the settings of switches D2850 and D2751. These switches are controlled by the signals FILT, CALDC- HD, SQUAR and Si. Table 3.8 lists the various settings and resulting generator output signals.

*Table 3.8 Generator control signals for various generator output signals.*

| **STIMUL** | | **CONTROL SIGNALS** | | | | **OUTPUT SIGNAL** | |
|---|---|---|---|---|---|---|---|
| frequency | duty cycle | CALDC-HD | FILT | SQUAR | Si | amplitude | waveform |
| 488 Hz<br>976 Hz<br>1.95 kHz | 50%<br>50%<br>50% | 0<br>0<br>0 | 0<br>0<br>0 | 1<br>1<br>1 | 1<br>1<br>1 | 5 V p-p<br>5 V p-p<br>5 V p-p | Square wave voltage |
| - | - | 1 | 0 | 0 | 1 | 3 V p-p | DC voltage |
| 976 Hz | 50% | 0 | 1 | 0 | 1 | 1 V p-p | Sine wave voltage |
| 20 kHz | 0-100% | 0 | 1 | 0 | 1 | -2...+2 V p-p | Slow ramp voltage |
| 20 kHz | 0-100% | 0 | 1 | 0 | 0 | 0...+3 mA | Slow ramp current |

In this table "1" means: signal "high" (switch closed) and "0" means signal "low" (switch open).

The slow ramp current signal is made with a current source. A simplified schematic diagram is given in figure 3.17:

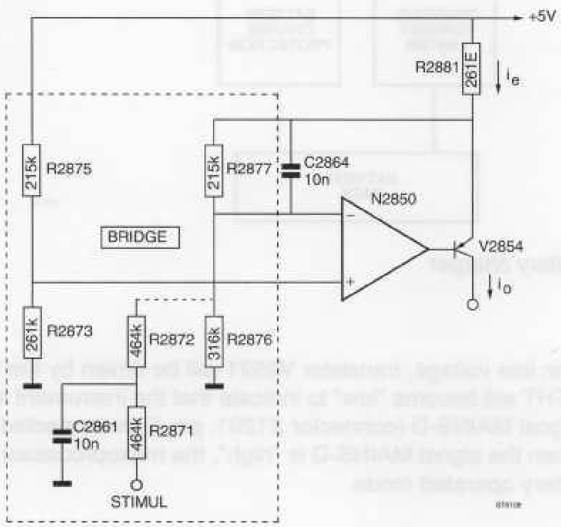



*Figure 3.17 Current source section of generator*

When the duty cycle of STIMUL is 0%, the bridge will be in balance and current $i_e = 0$. When the duty cycle of STIMUL is increased, a DC component is generated, which has a linear relation to the duty cycle. The operational amplifier tries to keep the voltages on both inputs the same. The operational amplifier will now drive transistor V2854 to increase $i_e$. Because $i_e$ is almost equal to $i_o$, the output current will also increase. In this way it is possible to regulate the current $i_o$ by means of the duty cycle of STIMUL.

## 3.4.8 BATTERY CHARGER

### - Introduction

See figure 3.18.

The battery charger consists of a switched mode power supply and some auxiliary circuitry. Whenever the ScopeMeter is connected to the line voltage (via the separate power adapter/battery charger PM8907), the instrument switches over to line voltage operation automatically. If a NiCd battery pack is installed, the ScopeMeter will charge this if line voltage is present. Special circuitry prevents discharge of the batteries when the instrument is not being used.

### - Detailed circuit description

See figure 3.18 and circuit diagram A2c (figure 10.7).

***HF Filter***

The input voltage (between 8V and 20V) first passes HF FILTER Z2501 and is used to drive a flyback converter.

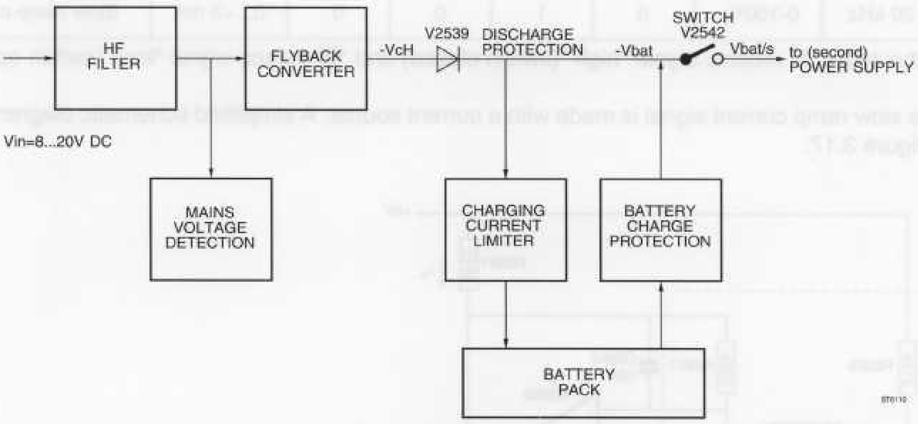



*Figure 3.18 Schematic diagram battery charger*

***Line voltage detection***

When the ScopeMeter is operated on line voltage, transistor V2521 will be driven by the (filtered) input voltage. The signal MAINVOLTHT will become "low" to indicate that the instrument is operated from the line voltage. The related signal MAINS-D (connector X1201, pin 5) is connected to the microprocessor analog input 19. When the signal MAINS-D is "high", the microprocessor will not switch off the ScopeMeter, as in battery operated mode.

***Flyback converter***
See figure 3.19 and circuit diagram A2c (figure 10.7).
The main components of this flyback converter are V2532 (converter-switch), L2504 and L2505 (windings), R2582 (sense resistor), and C2536 and V2533 (secondary circuit). The main regulating element is N2503 (see figure 3.19).

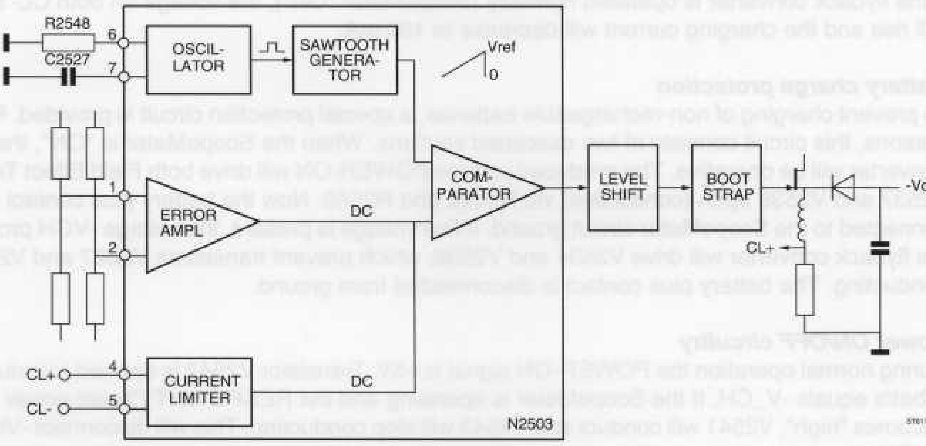



*Figure 3.19 Schematic diagram flyback converter*

N2503 incorporates an oscillator, the frequency of which is determined by R2548 and C2527 (fixed frequency of 100 kHz). This oscillator drives a sawtooth generator. The produced sawtooth voltage is compared to a DC voltage. This DC voltage is made by an internal error amplifier (voltage regulator), which compares the produced converter voltage -V_CH to a stable 5V reference voltage. This is done with a bridge circuit (R2554, R2555, R2557, R2558).

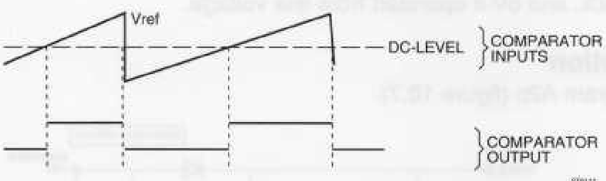



*Figure 3.20 Internal N2503 voltage waveforms*

When the sawtooth voltage is larger than the DC voltage, the output signal (CA, CB on pins 12,13) is "high". When the sawtooth voltage is less than the DC voltage, the output signal is "low". In this way the duty cycle of N2503's output signal can be changed, thus changing the energy transferred to the secondary converter circuit.

The output signal is level shifted by transistor V2526 and related circuitry. Now this square wave signal is used to drive converter switch V2532, which is bootstrapped via V2528, V2529, R2546, R2562, and C2537.

***Charging current limiter***
N2503 limits the voltage difference between CL+ (pin 4) and CL- (pin 5) to 200 mV. If the voltage between these two inputs starts to rise, the internal DC voltage will rise, and the duty cycle of the output square wave voltage will decrease (see voltage regulation described earlier).

If the ScopeMeter is connected to the line voltage and is not operational, the flyback converter operates almost without a load (only the NiCd battery pack). This implies that the current floating through windings L2504 and L2505 (averaged in time) is almost zero. Because of this, the voltage on CL+ is about 30 mA and the voltage on CL- is about 170 mV. The battery pack will be charged with 170 mA.

If the flyback converter is operated normally (ScopeMeter "ON"), the voltage on both CL- and CL+ will rise and the charging current will decrease to 100 mA.

***Battery charge protection***

To prevent charging of non-rechargeable batteries, a special protection circuit is provided. For safety reasons, this circuit consists of two cascaded sections. When the ScopeMeter is "ON", the flyback converter will be operative. The produced voltage POWER-ON will drive both Field Effect Transistors V2537 and V2538 open (conductive) via R2568 and R2569. Now the battery plus contact is connected to the ScopeMeter circuit ground. If line voltage is present, the voltage -VCH produced by the flyback converter will drive V2534 and V2536, which prevent transistors V2537 and V2538 from conducting. The battery plus contact is disconnected from ground.

***Power ON/OFF circuitry***

During normal operation the POWER-ON signal is +5V. Transistor V2542 is opened (conductive), so -Vbat/s equals -V_CH. If the ScopeMeter is operating and the RESPOWHT ("reset power supply") becomes "high", V2541 will conduct and V4542 will stop conducting. This will disconnect -Vbat/s from -V_CH.

## 3.4.9 POWER SUPPLY

### - Introduction

See figure 3.19.

Different supply voltages are needed for various ScopeMeter sections. A second flyback converter is used to convert -Vbat/s to supply voltages of -30V, -5V and +5V. This voltage, -Vbat/s, is made by the first flyback converter (in the battery charger section) or comes from the batteries. -Vbat/s is 5V if operated with NiCad battery pack, and 8V if operated from line voltage.

### - Detailed circuit description

See figure 3.19 and circuit diagram A2c (figure 10.7).

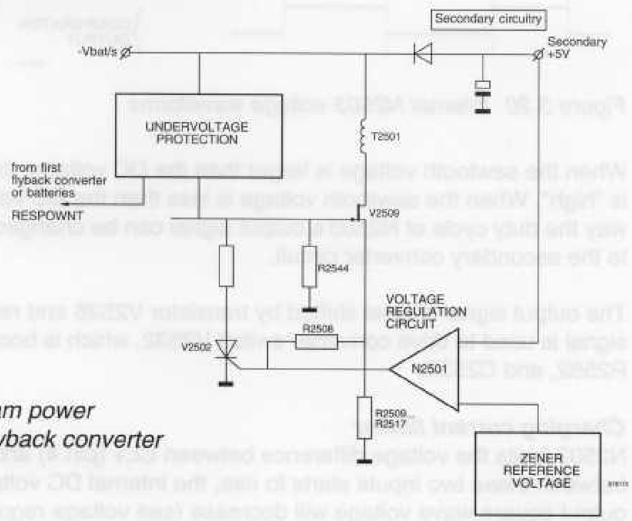



*Figure 3.21 Schematic diagram power supply, second flyback converter*

This self-oscillating flyback converter consists of:
- V2509 (converter-switch)
- R2509...R2517 (sense-resistors)
- V2502 (thyristor switch)
- R2544 (start-up resistor)
- T2501 (windings)
- 3 separate secondary circuits for -30V, -5V, and +5V

The main regulating component is operational amplifier N2501. This op-amp compares the produced secondary +5V voltage with a reference voltage, produced by zener diode N2502. If the secondary +5V increases, the fault signal generated by the N2501 will produce a current that causes an extra voltage drop over R2508. Because of this, thyristor V2502 will fire earlier. The switching frequency of the flyback converter increases and the secondary +5 V voltage decreases.

When the ScopeMeter is switched on (RSSLSTN is "active low"), V2544 (see circuit diagram A2c, figure 10.6) connects the inverting input of N2501 to ground. When the ScopeMeter starts up, capacitor C2509 causes the reference voltage and therefore the output voltage, to rise slowly, limiting the inrush ("starting") current drawn from the batteries or line voltage.

***Undervoltage detection and protection circuit***

When the flyback converter is oscillating, capacitor C2532 is charged every period via R2543 and V2516. During normal operation C2532 is discharged by V2517, which is driven via R2541, V2511, R2529, and V2509. If, for example, the secondary +5V voltage becomes too low, C2532 is not discharged by V2517. This will activate the RESPOWHT signal, and the power will be switched off completely, preventing further damage of circuits. (The +5V voltage can become too low because the input voltage -Vbat/s is too low, or the power output to the ScopeMeter circuitry is too high.)

R2542, C2531, and diode V2508 will reset C2532 during the start up of the power supply (the voltage across C2532 will become zero). This is necessary because V2517 cannot be driven via V2541, just after the ScopeMeter is switched on.

***Reference source***

The reference source provides a stable positive (+Vref) and negative reference voltage (-Vref) used in other parts of the ScopeMeter. It also uses the voltage across zener diode N2502 as an input voltage.

NOTE: *The flyback converter, used in the battery charger section (section 3.4.8) has a fixed oscillating frequency of 100 kHz. The amount of energy supplied is regulated by varying the duty cycle. The flyback converter used in this power supply, however, is self-oscillating and operates on a variable oscillating frequency and a fixed duty cycle. For alkaline batteries, for example, the oscillating frequency is about 62 kHz.*

# 4 PERFORMANCE VERIFICATION PROCEDURE

## 4.1 GENERAL INFORMATION

The ScopeMeter should be calibrated and in operating condition when you receive it.

The following performance tests are provided to ensure that the ScopeMeter is in a proper operating condition. If the instrument fails any of the performance tests, calibration adjustments (see chapter 5) and/or repair (see chapter 7) is necessary.

The Performance Verification Procedure described here consists of two parts:

- Standard Performance Verification Procedure
  (separate SCOPE- and METER-section)
- Additional Performance Verification Procedure

The **Standard Performance Verification Procedure** uses built-in ScopeMeter front panel settings or frontsettings, that can be accessed via the SERVICE MENU. To enter the SERVICE MENU, press both AC/DC/GROUND keys simultaneously. This menu allows you to choose between SCOPE and METER performance testing ("Verify").

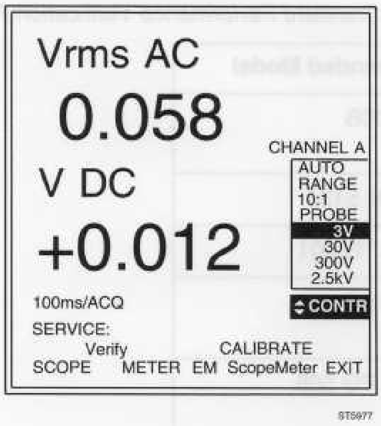



*Figure 4.1 Service menu*

When the ScopeMeter is in SERVICE mode, only the softkeys, the select/adjust keys and the ON/OFF key can be operated.
It is possible to move forward or backward through the frontsettings, that apply to the separate performance test steps. This can be done using the adjust/select keys. You can leave the Performance Verification Procedure any time by pressing the EXIT softkey. The Performance Verification Procedure steps are explained in the following sections.

The **Additional Performance Verification Procedure** can be used to do some extra checks, depending on the ScopeMeter version (93, 95 or 97). In these tests the ScopeMeter must be set up manually.

NOTE: *This Performance Verification Procedure is a quick way to check most of the instrument's specifications. Because of the highly integrated design of the ScopeMeter, it is not always necessary to check all features separately. The procedure described here often combines many test steps in one procedure step, thereby minimizing total test time.*

*The Performance Verification Procedure is based on the specifications, listed in chapter 2 of this Service Manual. The values (requirements) given here are valid for ambient temperatures between 18C and 28C.*

## 4.2 STANDARD PERFORMANCE VERIFICATION PROCEDURE

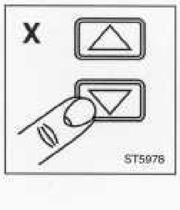
This section explains the required Performance Verification Procedure setup, with the actions that have to be done for each step. Follow the instructions described with each step.
The recommended test equipment, required for this Standard Performance Verification Procedure, is listed in table 4.1.

*Table 4.1 Recommended test equipment Standard Performance Verification Procedure*

| **Instrument Type** | **Recommended Model** |
|---|---|
| Multifunction Calibrator | Fluke 5100B |
| Function Generator | Philips PM 5134 |
| Time Mark Generator | Tektronix TG 501 |
| Constant Amplitude Sine wave Generator | Tektronix SG 503 |
| Square wave Calibration Generator | Tektronix PG 506 |

- Cables and terminations for the generators (all BNC type)
- Two standard banana test leads (delivered with the ScopeMeter)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter)

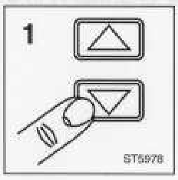
NOTE: *During the following Performance Verification Procedure, the ScopeMeter input sockets are connected to the signal generator outputs by means of cables (BNC connector channel A or B) or two standard banana test leads (COM and mV/Ohm/Diode banana connectors). The oscilloscope probes delivered with the instrument are not used during the Standard Performance Verification Procedure. The calibration of the probes is described in the Users Manual.*




In the following text, this figure is used to indicate that one of the select/adjust keys (up/down) must be pressed, to display the indicated step number "x" on the ScopeMeter screen.

## 1/2. LCD test

While in the SERVICE menu, press the SCOPE softkey to enter the **SCOPE section of the Performance Verification Procedure**.




Now a (dark) test pattern is displayed. This pattern consists of a circle placed in a square, and a diagonal line (see figure 4.2).

Observe the test pattern closely. The lines may not be interrupted; the pattern must be continuous. In this test sets the display to a high contrast, resulting in a dark display. If there are defects in the pixel columns of the Liquid Crystal Display, they must be clearly visible now as intermissions in the pattern.

After you have checked the display, press the upper select/adjust key once. Now an oscilloscope screen is displayed.

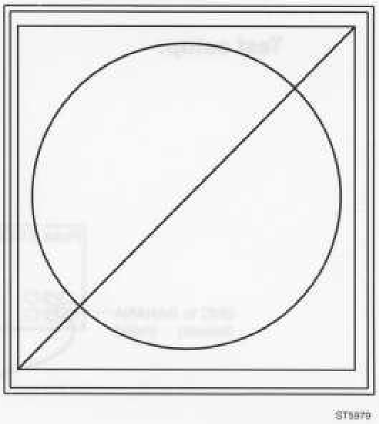
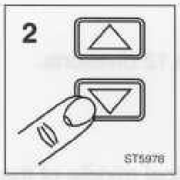
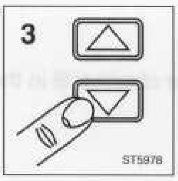



*Figure 4.2 Test pattern*




Press the upper select/adjust key again to go to step 2. Now the display shows the same pattern, but with a low contrast (bright screen). This will help you to locate any failures in the pixel rows of the LCD.

## 3. Ground level check




Press the upper select/adjust key to go to step 3. The purpose of this step is to check the ground level position adjustments (0V) for both traces. The ScopeMeter display shows the text " Verif 3", to show that this is the third SCOPE Performance Verification step (see figure 4.3).

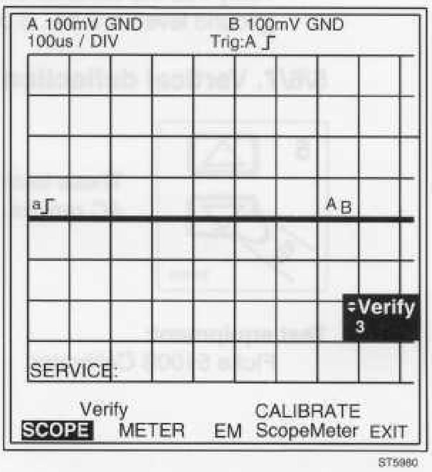
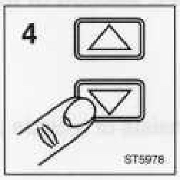



*Figure 4.3 Reference set-up*

**Requirements:**

Verify that the traces of both channels A and B are situated on the vertical middle of the screen.

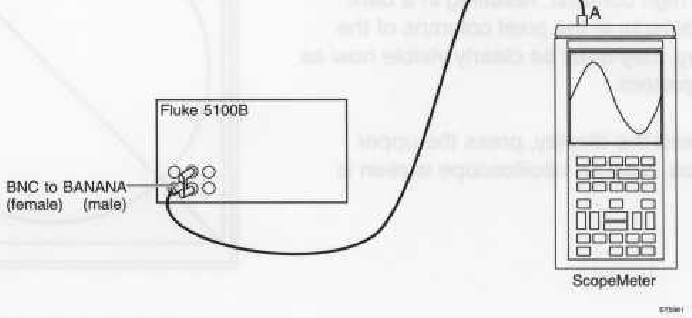
## 4. Vertical deflection coefficients channel A




These tests check the vertical deflection coefficients for channel A in the 100 mV/div DC and AC ranges.

**Test equipment:**
Fluke 5100B Calibrator

**Test setup:**



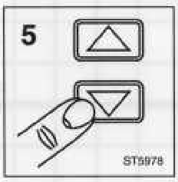

**Procedure/requirements for AC test:**

A Apply a 1 kHz sine wave signal with an amplitude of 600 mV AC peak-to-peak to the channel A BNC connector.
(Set the Fluke 5100B to 212.13 mV RMS, 1 kHz sine wave).
Verify that the amplitude of the sine wave signal displayed is 5.88...6.12 divisions.

**Procedure/requirements DC test:**

B Apply 300 mV DC to channel A.
Verify that the distance between the trace for channel A and the vertical middle of the screen (ground level) is 2.94...3.06 divisions.

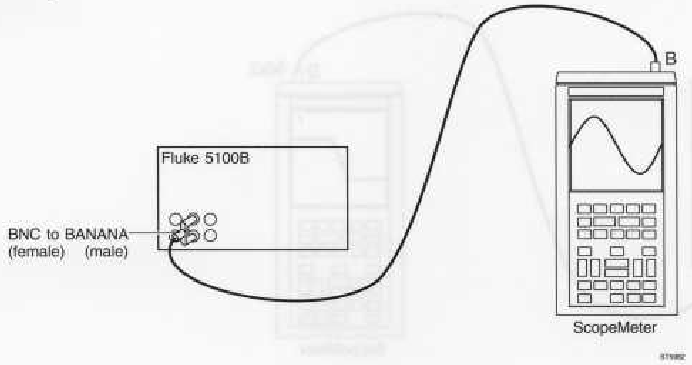
## 5/6/7. Vertical deflection coefficients channel B




These tests check the vertical deflection coefficients for channel B in the DC and AC ranges.

**Test equipment:**
Fluke 5100B Calibrator

**Test setup:**




**Procedure/requirements for channel B AC and DC tests:**

A Apply 300 mV DC to channel B.

B Change the input voltage and the setting of channel B according to table 4.2 and check that the amplitude of the signal agrees with the value listed. Use the select/adjust keys to select each step number.

*NOTE: The AC voltages listed in this are peak-to-peak voltages (sine wave). The values listed between brackets () are the RMS values that have to be chosen on the Fluke 5100B calibrator.*

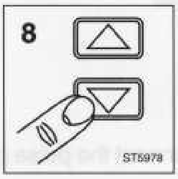
**Requirements:**

*Table 4.2 Requirements vertical deflection coefficients for channel B.*

| Input voltage | Step number on display | Requirements |
|---|---|---|
| 300 mV DC | "5" | 2.94...3.06 div. |
| 600 mV AC pp (212.13mV RMS), 1 kHz | "5" | 5.88...6.12 div. |
| 3V DC | "6" | 2.94...3.06 div. |
| 6V AC pp (2.1213V RMS), 1 kHz | "6" | 5.88...6.12 div. |
| 30V DC | "7" | 2.94...3.06 div. |
| 60V AC (21.213 V RMS), 1 kHz | "7" | 5.88...6.12 div. |

The ScopeMeter uses the same input circuitry (hardware) for the SCOPE and the METER modes (in the above attenuator settings). When the voltage accuracy is checked (see the description "METER Performance Verification Procedure" step 1), the deflection coefficients for SCOPE channel A are also tested.

## 8/9. Rise time

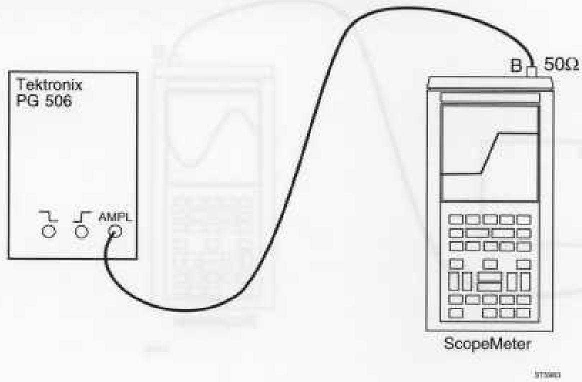



The rise time of the ScopeMeter is checked by means of a fast rise time pulse. First channel B is measured.

**Test equipment:**

Tektronix PG 506 Square Wave Calibration Generator

**Test setup channel B rise time measurement:**




**Procedure for channel B rise time measurement:**

A  Apply a fast rise time pulse, repetition frequency 1 MHz, amplitude 0.5V to channel B. Use a 50Ω termination. Set the generator in position "FAST RISE".

B  Adjust the pulse amplitude to exactly 5 divisions. See figure 4.4.

**Requirements:**

*NOTE:*

$$t_r(measured) = \sqrt{(t_r(inputsignal)^2 + t_r(ScopeMeter)^2)}$$

C  Check the rise time, measured between 10% and 90% of the pulse amplitude. See figure 4.4. The rise time $t_r$ (measured) must be 7 ns (0.7 div) or less.

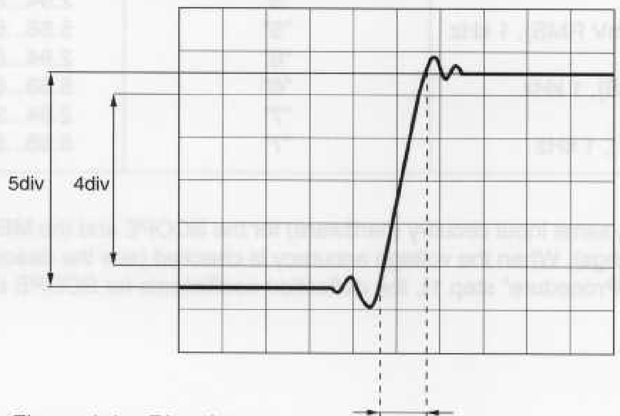
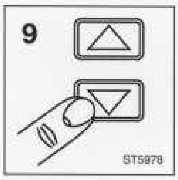



*Figure 4.4   Rise time*

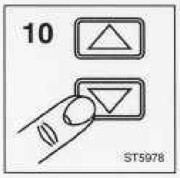



**Test setup channel A rise time measurement:**
Refer to the test set-up for channel B measurement. Connect the pulse generator to the channel A BNC input connector.

**Procedure for channel A rise time measurement:**
Refer to the settings/procedure for channel B measurement.

**Requirements:**
Refer to channel B requirements.

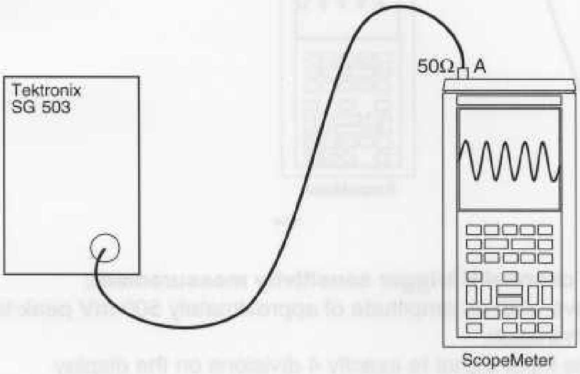
## 10/11/12/13. Frequency response




These tests check the upper transition point of the bandwidth for ScopeMeter vertical channels A and B.

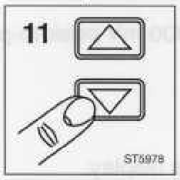
**Test equipment:**
Tektronix SG 503 Constant Amplitude Sine wave Generator

**Test setup:**




**Procedure/requirements for channel A frequency response measurement:**

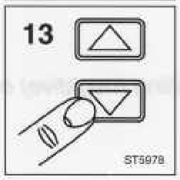
A Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to channel A. Use a 50Ω termination.
Adjust the input signal to a trace height of exactly 6 divisions.




B Without changing the amplitude of the sine wave signal, switch over to step 11 using the upper select/adjust key. Increase the frequency of the sine wave to 50 MHz and verify that the vertical deflection is 4.2 divisions or more.

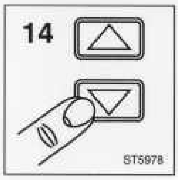

**Procedure/requirements for channel B frequency response measurement:**

C Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to channel B. Use a 50Ω termination.
Adjust the input signal to a trace height of exactly 6 divisions.




D Without changing the amplitude of the sine wave signal, switch over to step 13 using the upper select/adjust key. Increase the frequency of the sine wave to 50 MHz and check that the vertical deflection is 4.2 divisions or more.

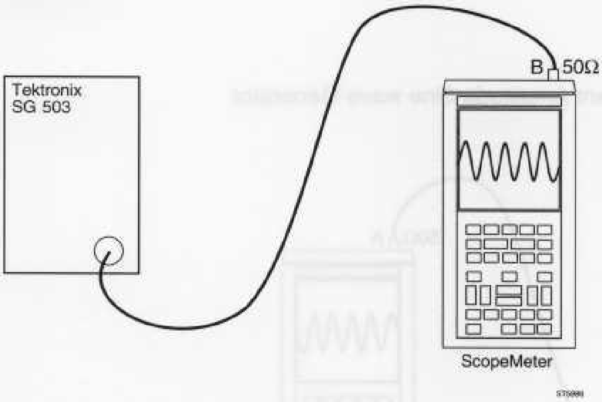
## 14/15/16/17. Trigger sensitivity channel A and B




The trigger sensitivity depends on the amplitude and frequency of the trigger signal. This test checks the trigger sensitivity of the ScopeMeter. Also the +SLOPE/-SLOPE function (triggering on negative slope) is tested for both channels A and B. Channel B is tested first.

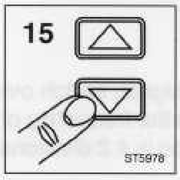
**Test equipment:**
Tektronix SG 503 Constant Amplitude Sine Wave Generator

**Test setup:**




**Procedure/requirements for channel B trigger sensitivity measurement:**

A Apply a 100 MHz sine wave, with an amplitude of approximately 500 mV peak-to-peak to channel B. Use a 50Ω termination.
B Adjust the amplitude of the input signal to exactly 4 divisions on the display.
C Verify that the signal is well triggered.
D Apply a 60 MHz sine wave, with an amplitude of approximately 100 mV peak-to-peak to channel B. Use a 50Ω termination.
E Adjust the amplitude of the input signal to exactly 1.5 divisions on the display.
F Verify that the signal is well triggered.




G Apply a 10 MHz sine wave, with an amplitude of 300 mV peak-to-peak to channel B. Use a 50Ω termination.
H Adjust the amplitude of the input signal to exactly 1.5 divisions. on the display.
I Verify that the signal is well triggered on the **falling** edge. See figure 4.5.

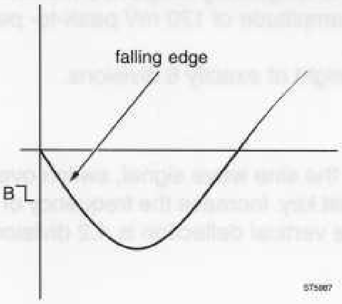
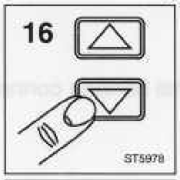
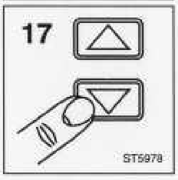



*Figure 4.5 Signal triggered on the falling (negative) edge*

**Procedure/requirements for channel A trigger sensitivity measurement:**

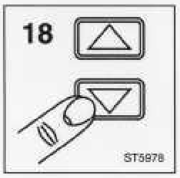



K Repeat steps G...I for channel A.




L Repeat steps A...F for channel A.

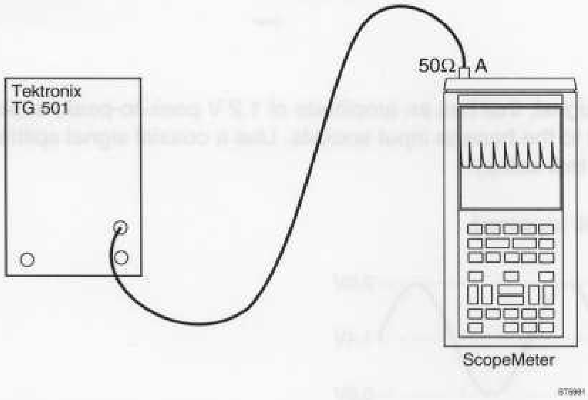
## 18. Timebase




This test uses a marker pulse calibration signal to verify the deflection coefficient of the time base.

**Test equipment:**
Tektronix TG 501 Time Mark Generator

**Test set-up:**




**Procedure/requirements:**

A Apply a 1 μs (1V peak-to-peak) time marker signal to channel A. Use a 50Ω termination.

B Verify that the distance between the $10^{th}$ marker pulse and the $10^{th}$ vertical grid line is the same as the distance between the $2^{nd}$ marker pulse and the $2^{nd}$ vertical grid line.
(Tolerance ± 1 pixel = ± 0.04 divisions).

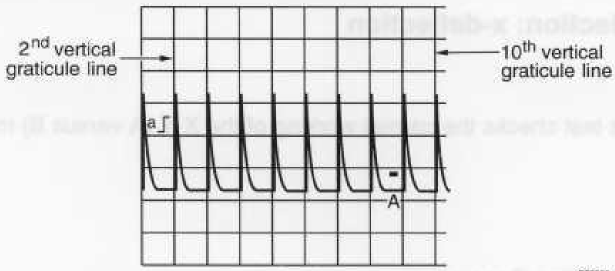
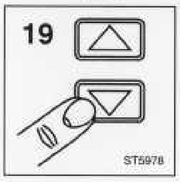



*Figure 4.6 The distance between the $10^{th}$ marker pulse and the $10^{th}$ vertical grid line must be the same as the distance between the $2^{nd}$ marker pulse and the $2^{nd}$ vertical grid line.*

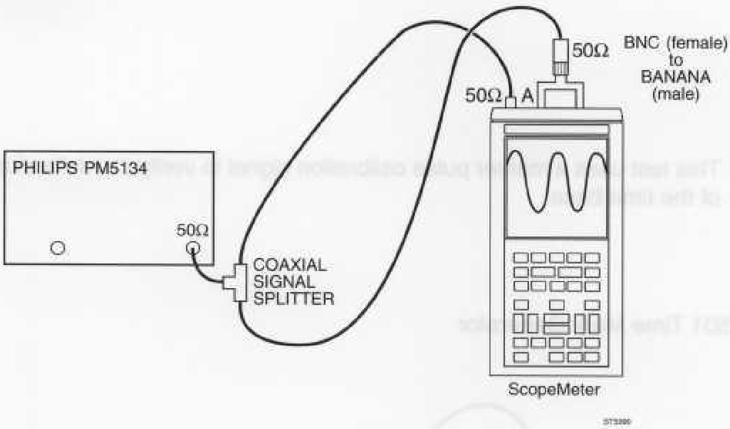
## 19. Trigger sensitivity external channel




This test checks the trigger sensitivity, using the external banana connectors as the trigger input.

**Test equipment:**
Philips PM 5134 Function Generator

**Test setup:**




**Procedure/requirements:**

A Apply a 1 kHz sine wave signal, that has an amplitude of 1.2 V peak-to-peak, superimposed on 1.4V DC to channel A and to the banana input sockets. Use a coaxial signal splitter and a BNC-to-banana converter (see test setup).
Use 50Ω terminations.

B Verify that the signal is well triggered.

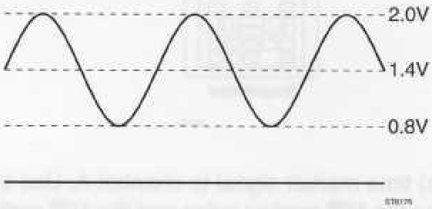


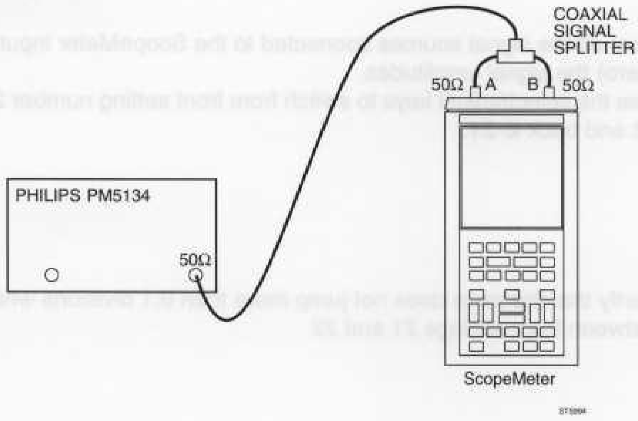

*Figure 4.7 1.2V peak-to-peak sine wave superimposed on 1.4V DC*

## 20. Horizontal deflection: x-deflection


This test checks the correct working of the X-Y (A versus B) mode.

**Test equipment:**
Philips PM 5134 Function Generator

**Test set-up:**




**Procedure:**

A Apply a 2 kHz sine wave signal of 800 mV peak-to-peak to channel A and channel B. Use 50Ω terminations.
Adjust the input signal to a trace height of 8 divisions.

**Requirements:**

Verify that a line with an angle of 45° is displayed.
See figure 4.8.

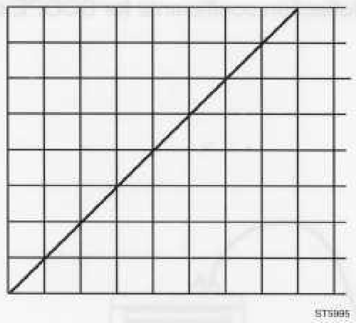
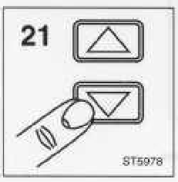



*Figure 4.8 A versus B display*

## 21/22. Base line instability

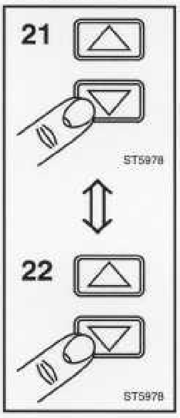



This test checks the maximum base line instability.

**Test equipment:**
none

**Test setup:**
no special setup required

**Procedure/requirements:**




A Turn off the signal sources connected to the ScopeMeter input or minimize (zero) the signal amplitudes.

B Use the select/adjust keys to switch from front setting number 21 to number 22 and back to 21.

C Verify that the trace does not jump more than 0.1 divisions while switching between front settings 21 and 22.

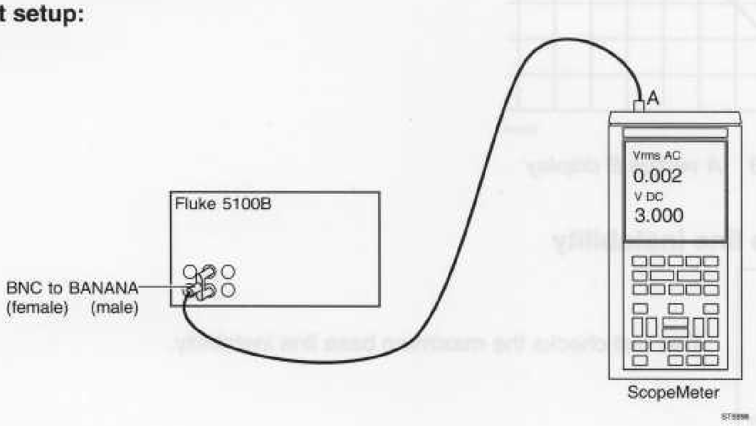
While in the SERVICE menu, press the METER softkey to enter the **METER part of the Performance Verification Procedure.**

## 1. Voltage accuracy METER mode


The following section checks the voltage accuracy in METER mode. The ScopeMeter uses the same input circuitry (hardware) for the SCOPE (channel A) and the METER modes (in these attenuator settings). When the voltage accuracy of the METER is checked, the deflection coefficients for SCOPE channel A are also tested.

**Test equipment:**
Fluke 5100B Calibrator

**Test setup:**




**Procedure:**

A Apply 300 mV DC to channel A.

B Change the input voltage and the setting of channel A according to table 4.3 and check that the amplitude of the signal agrees with the value listed.

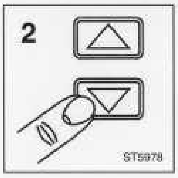
*NOTE: The ScopeMeter is set to METER "AUTORANGE" (step 1) with a dual (AC and DC) readout. This implies that the ScopeMeter range is set automatically according to the input signal.*

**Requirements:**

*Table 4.3 Requirements for voltage accuracy test channel A, METER mode.*

| Input signal | Requirements |
|---|---|
| 300 mV DC | 298.0...302.0V DC |
| 300 mV RMS AC, 1 kHz | 292.5...307.5V RMS AC |
| 3V DC | 2.980...3.020V DC |
| 3V RMS AC, 1 kHz | 2.925...3.075V RMS AC |
| 30V DC | 29.80...30.20V DC |
| 30V RMS AC, 1 kHz | 29.25...30.75V RMS AC |

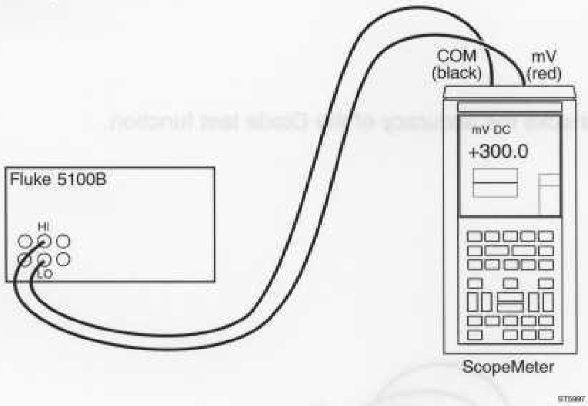
## 2. DC mV accuracy METER mode




These tests check the accuracy of the DC mV function. The signal must be supplied to the banana input connectors of the ScopeMeter.

**Test equipment:**
Fluke 5100B Calibrator

**Test setup:**



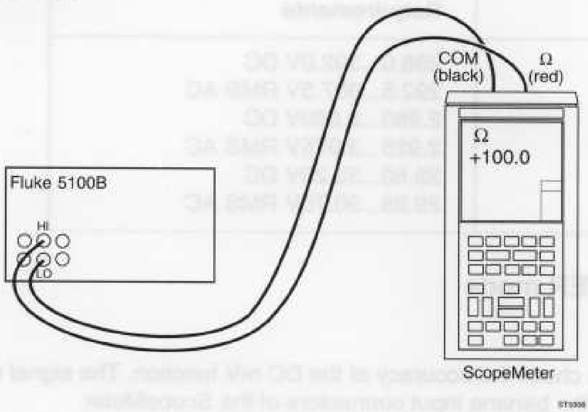

**Procedure/requirements:**
A Apply 300 mV DC to the banana connectors of the ScopeMeter.
B Verify that the readout is between 298.2...301.8 mV DC.
C Apply 3V DC to the banana connectors of the ScopeMeter.
D Verify that the readout is between 2.982...3.018V DC.

## 3. Resistance accuracy


These tests check the accuracy of the resistance measurement function. The signal has to be supplied to the banana input connectors of the ScopeMeter.

**Test equipment:**
Fluke 5100B Calibrator

**Test setup:**




**Procedure/requirements for resistance function accuracy test:**

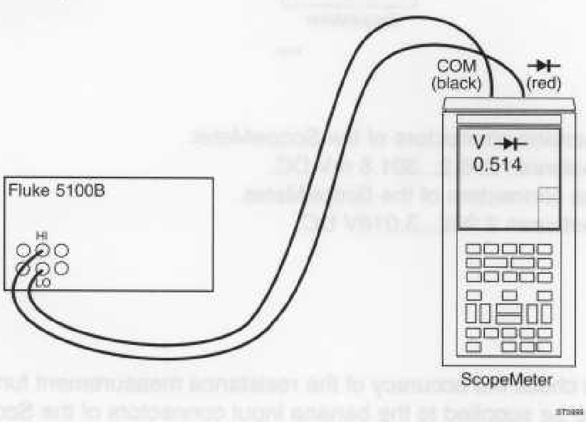
A Set the Fluke 5100B to 100Ω.
B Check that the readout is between 99.00...101.0Ω.
C Set the Fluke 5100B to 10 MΩ.
D Check that the readout is between 9.900...10.10 MΩ.

## 4. Diode test accuracy


This test checks the accuracy of the Diode test function.

**Test equipment:**
Fluke 5100B Calibrator

**Test setup:**



**Procedure/requirements for diode accuracy test:**

A Set the Fluke 5100B to 1 kΩ.

B Check that the readout is between 0.420...0.589V DC.

## 5. Signal display and frequency measurement

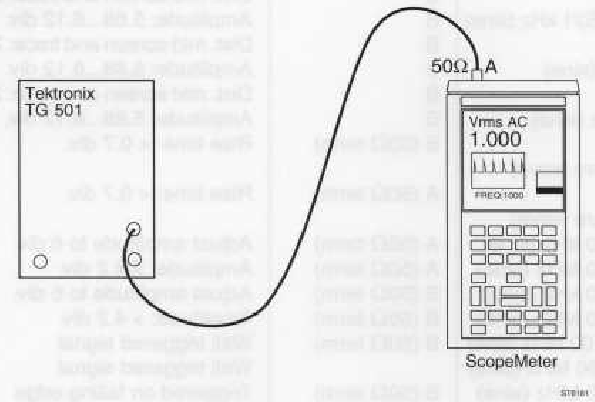
**4**


This test checks the waveform display and the frequency measurement function in METER MODE.

**Test equipment:**

Tektronix TG 501 Time Mark Generator

**Test setup:**




**Procedure/requirements for testing waveform display and frequency function:**

A Apply a 1 ms (1V peak-to-peak) time marker signal to channel A. Use a 50Ω termination.

B Check that a stable (triggered) signal is displayed.

C Check that the frequency displayed is between 993...1007 Hz.

## 4.3 STANDARD PERFORMANCE VERIFICATION PROCEDURE SUMMARY

This table provides an overview of all steps in the Standard Performance Verification Procedure. It is intended to be used as a reference for frequent users. For details on how to perform each Standard Performance Verification Procedure step, refer to section 4.2.

**SCOPE PART**

| STEP | SIGNAL SOURCE | SIGNAL AMPL/FREQ | SCOPEMETER INPUTS | REQUIRED |
|---|---|---|---|---|
| 1 | - | - | - | No interrupted lines |
| 2 | - | - | - | No interrupted lines |
| 3 | - | - | - | Traces on mid screen |
| 4 | Fluke 5100B | 212.1 mV(RMS)/1 kHz (sine) | A | Amplitude: 5.88...6.12 div. |
| | | 300 mV/DC | A | Dist. mid screen and trace: 2.94...3.06 div. |
| 5 | Fluke 5100B | 300 mV/DC | B | Dist. mid screen and trace: 2.94...3.06 div. |
| | | 212.1 mV(RMS)/1 kHz (sine) | B | Amplitude: 5.88...6.12 div. |
| 6 | Fluke 5100B | 3V/DC | B | Dist. mid screen and trace: 2.94...3.06 div. |
| | | 6V(pp)/1 kHz (sine) | B | Amplitude: 5.88...6.12 div. |
| 7 | Fluke 5100B | 30V/DC | B | Dist. mid screen and trace: 2.94...3.06 div. |
| | | 60V(pp)/1 kHz (sine) | B | Amplitude: 5.88...6.12 div. |
| 8 | Tek PG 506 | 0.5V/1 MHz (fast rise/square wave) | B (50Ω term) | Rise time: < 0.7 div. |
| 9 | Tek PG 506 | 0.5V/1 MHz (fast rise/square wave) | A (50Ω term) | Rise time: < 0.7 div. |
| 10 | Tek SG 503 | 120 mV(pp)/50 kHz (sine) | A (50Ω term) | Adjust amplitude to 6 div. |
| 11 | Tek SG 503 | 120 mV(pp)/50 MHz (sine) | A (50Ω term) | Amplitude: > 4.2 div. |
| 12 | Tek SG 503 | 120 mV(pp)/50 kHz (sine) | B (50Ω term) | Adjust amplitude to 6 div. |
| 13 | Tek SG 503 | 120 mV(pp)/50 MHz (sine) | B (50Ω term) | Amplitude: > 4.2 div. |
| 14 | Tek SG 503 | ≈500 mV(pp)/100 MHz (sine) | B (50Ω term) | Well triggered signal |
| | | ≈100 mV(pp)/60 MHz (sine) | | Well triggered signal |
| 15 | Tek SG 503 | 300 mV(pp)/10 MHz (sine) | B (50Ω term) | Triggered on falling edge |
| 16 | Tek SG 503 | 300 mV(pp)/10 MHz (sine) | A (50Ω term) | Triggered on falling edge |
| 17 | Tek SG 503 | ≈500 mV(pp)/100 MHz (sine) | A (50Ω term) | Well triggered signal |
| | | ≈100 mV(pp)/60 MHz (sine) | | Well triggered signal |
| 18 | Tek TG 501 | 1V(pp)/1 μs (marker) | A (50Ω term) | Markers on lines (tolerance ± 1 pixel = ± 0.04 div.) |
| 19 | PM 5134 | 1.2V/1 kHz (sine) (pp) on 1.4V/DC | A & EXT (both 50Ω term) | Well triggered signal |
| 20 | PM 5134 | 800 mV(pp)/2 kHz (sine) | A & B (both 50Ω term) | Line with angle 45° displayed on screen |
| 21 | - | - | - | Trace jumps < 0.1 div. when switching |
| 22 | - | - | - | between setting 21 and 22. |

**METER PART**

| STEP | SIGNAL SOURCE | SIGNAL AMPL/FREQ | SCOPEMETER INPUTS | REQUIRED |
|---|---|---|---|---|
| 1 | Fluke 5100B | 300 mV/DC | A | 298.0...302.0 mV |
| | | 300 mV(RMS)/1 kHz | | 292.5...307.5 mV |
| | | 3V/DC | | 2.980...3.020V |
| | | 3V(RMS)/1 kHz | | 2.925...3.075V |
| | | 30V/DC | | 29.80...30.20V |
| | | 30V(RMS)/1 kHz | | 29.25...30.75V |
| 2 | Fluke 5100B | 300 mV/DC | banana | 298.2...301.8 mV |
| | | 3V/DC | | 2.982...3.018V |
| 3 | Fluke 5100B | 100Ω | banana | 99.00...101.0Ω |
| | | 10 MΩ | | 9.900...10.10 MΩ |
| 4 | Fluke 5100B | 1 kΩ | banana | 0.420...0.589V |
| 5 | Tek TG 501 | 1V(pp)/1 ms (marker) | A (50Ω term) | Stable oscilloscope picture Frequency displayed: 993...1007 Hz. |

# 4.4 ADDITIONAL PERFORMANCE VERIFICATION PROCEDURE

This paragraph describes the Additional Performance Verification Procedure.
This procedure can be used to do some extra performance tests, depending on the ScopeMeter version (93, 95, or 97). Follow the instructions described with each step.

The recommended test equipment required for this Additional Performance Verification Procedure is listed in table 4.4.

*Table 4.4 Recommended test equipment for Additional Performance Verification Procedure.*

| Instrument Type | Recommended Model |
|---|---|
| Function Generator | Philips PM 5134 |
| Multimeter | Philips PM 2525 |
| Power Supply | Philips PE 1537 |
| Time Mark Generator | Tektronix TG 501 |
| Constant Amplitude Sine wave Generator | Tektronix SG 503 |
| Square wave Calibration Generator | Tektronix PG 506 |

- Cables and terminators for the generators (all BNC type)
- Two standard banana test leads (delivered with the ScopeMeter)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter)
- 5 mm. Power Jack connector plug with attached cable (e.g.: 4822 321 20125)

NOTE: *During the following Performance Verification Procedure, you must connect the ScopeMeter input connectors to the signal generator outputs. This connection must be made by cables (BNC connector channel A or B) or two standard banana test leads (COM and mV/Ohm/Diode banana connectors). The Additional Performance Verification Procedure does not use the oscilloscope probes delivered with the instrument. The calibration of the probes is described in the Operating Manual.*

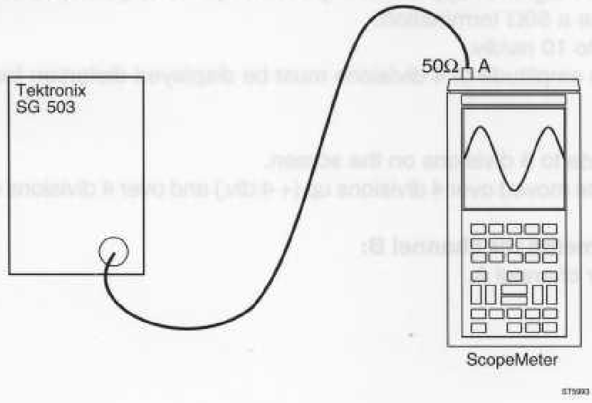
## 1. Autoset

*** All models ***

This test checks the correct operation of the AUTO SET function.

**Test equipment:**
Tektronix SG 503 Constant Amplitude Sine wave Generator

**Test setup:**



**Settings/procedure/requirements:**

A Apply a 50 MHz sine wave signal of 100 mV peak-to-peak to channel A. Use a 50Ω termination.

B Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode. Now press the AUTO SET key. Check that the display is stable and well triggered. Minimal 2 and maximal 20 signal periods must be displayed, over 8 divisions. The signal amplitude must be approximately 5 divisions. The NOTRIG indication on the display must not flash.

C Repeat settings/procedure for channel B.

## 2. Vertical dynamic range and position range (move control)

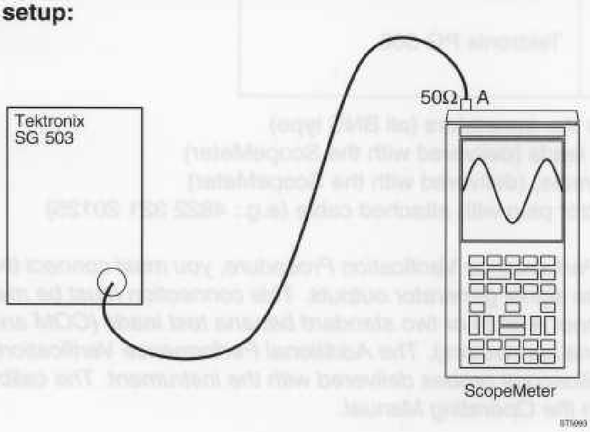
*** All models ***

This test checks the vertical dynamic range, together with the position range (move control). A certain overdrive of the ScopeMeter must be allowed.

**Test equipment:**

Tektronix SG 503 Constant Amplitude Sine wave Generator

**Test setup:**




**Settings/procedure/requirements for channel A:**

**Vertical dynamic range check:**

A Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode.

B Apply a 50 kHz sine wave signal of 950 mV peak-to-peak to channel A. Use a 50Ω termination.

C Press the AUTO SET key. Set channel A to 100 mV/div. and set the timebase speed to 10μs/div.

D Use the vertical MOVE key to shift the bottom of the sine wave vertically over the screen in the lower division. Shift the top of the sine wave in the upper division. Verify that the top and bottom of the sine wave signal of 9.5 divisions can be displayed distortion free.

E Apply a 50 MHz sine wave signal of approximately 500 mV peak- to-peak (4 divisions on the screen) to channel A. Use a 50Ω termination.

F Set the timebase speed to 10 ns/div.

G Now a sine wave with an amplitude of 4 divisions must be displayed distortion free.

**Move control check:**

A Adjust the signal amplitude to 8 divisions on the screen.

B Check that the trace can be moved over 4 divisions up (+ 4 div.) and over 4 divisions down (- 4 div.).

**Settings/procedure/requirements for channel B:**

Repeat the total procedure for channel A.

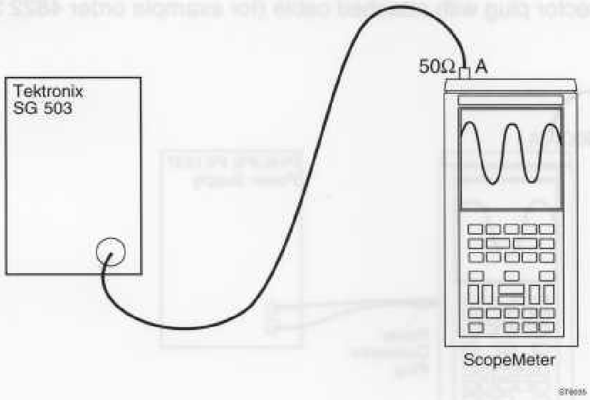
## 3. Trigger level control range channel A and B

*** All models ***

This test checks the trigger level control range.

**Test equipment:**
Tektronix SG 503 Constant Amplitude Sine wave Generator

**Test setup:**




**Settings/procedure/requirements:**

A Apply a 500 kHz sine wave with an amplitude of 950 mV peak-to-peak to channel A. Use a 50Ω termination.

B Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode. Now press the AUTO SET key.

C Verify that the signal is well triggered.

D Set channel A to 100 mV/div.

E Press the TRIGGER key. Use the select/adjust keys to verify that the trigger level range is more than 8 divisions (4 divisions up and 4 divisions down). The selected trigger level is shown on the display (reversed indication "⇕ LEVEL"). Also the trigger level indication, marked with an A will shift, while shifting the trigger level. See figure 4.9.

F Repeat the same procedure for channel B.

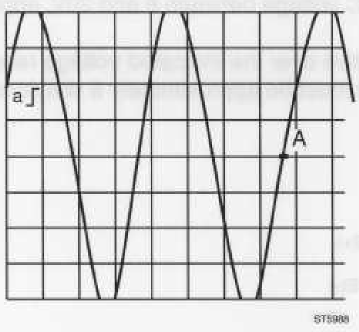



*Figure 4.9 Trigger level indication on screen*

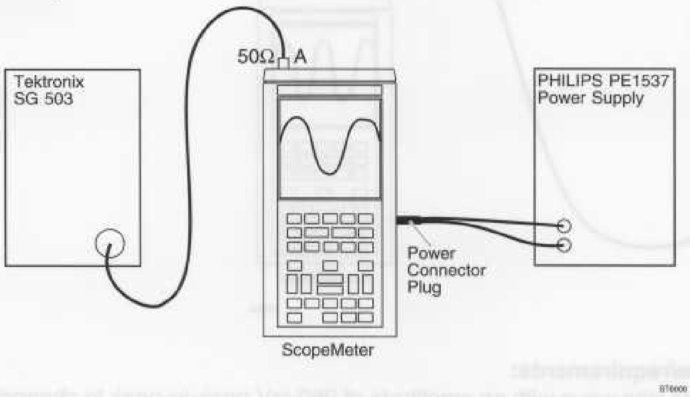
## 4. Power supply voltage range

*** All models ***

This test checks the correct operation of the ScopeMeter within the boundaries of the DC supply voltage.

**Test equipment:**
Philips PE 1537 Power Supply 0-40V/0-1A
Tektronix SG 503 Constant Amplitude Sine Wave Generator
5 mm Power Jack connector plug with attached cable (for example order 4822 321 20125)

**Test set-up:**




**Settings/procedure:**

A Insert the power plug into the power adapter contact on the side of the ScopeMeter.
B Switch on the power supply and set the voltage to a wanted value between 8 and 20V DC.
C Apply a 50 kHz sine wave with an amplitude of 100 mV peak-to- peak to channel A. Use a 50Ω termination.
D Switch on the ScopeMeter. At power on, a beep tone must be audible.
E Press AUTO SET and verify that a well triggered signal with an amplitude of approximately 5 divisions is displayed over the whole supply voltage range.

**Requirements:**

A The ScopeMeter must start at any DC voltage between 8 and 20V, applied at its power adapter contact.
B The ScopeMeter must remain operative over the indicated voltage range.
C The amplitude of the trace displayed must be approximately 5 divisions, independent of the supply voltage.

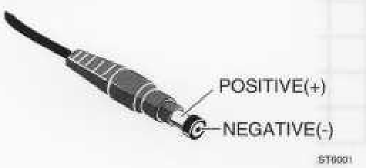



*Figure 4.10 Power Jack connector*

## 5. Supply current

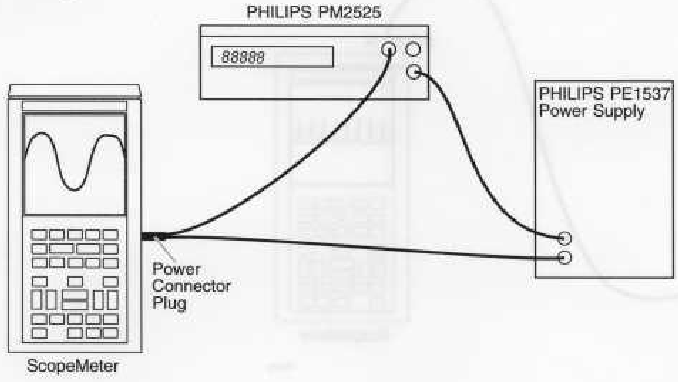
*** All models ***

This test checks the total supply current (ScopeMeter supply current and the built-in battery charger current).

**Test equipment:**

Philips PE 1537 Power Supply 0-40V/0-1A
Digital Multimeter (Philips PM 2525 or equivalent)
5 mm Power Jack connector plug with attached cable (for example order 4822 321 20125).

**Test set-up:**




**Settings/procedure/requirements:**

*NOTE: A PM 9086 battery pack (included in the shipment) has to be installed for this test. Only NiCad batteries can be charged by the ScopeMeter!*

A Set the power supply to 15V DC.
B Check that the charging current is 200 mA (typical reading on multimeter).
C Switch on the ScopeMeter.
D Check that the total supply current is 330 mA (typical reading on multimeter).

## 6. Battery backup functional test

*** All models ***

This test verifies that the ScopeMeter settings will be kept in memory if power is switched off while the batteries are installed.

**Test equipment:**

none

**Test setup:**

no specific test setup required

**Settings/procedure:**

A Switch on the ScopeMeter and press the SCOPE key to get into scope mode.
B Press the AUTO SET key and set channel A and B to 500 mV/div. Set the timebase to 1 ms/div.
C Switch off the ScopeMeter with the ON/OFF key and keep it switched off for one hour to enable all capacitors to discharge.
D Press the ON/OFF key to switch on the ScopeMeter again, and verify that the settings for the timebase and attenuator have not changed.

**Requirements:**

ScopeMeter settings at power off must be restored the next time power is switched on.

## 7. Cursor measurements: time accuracy

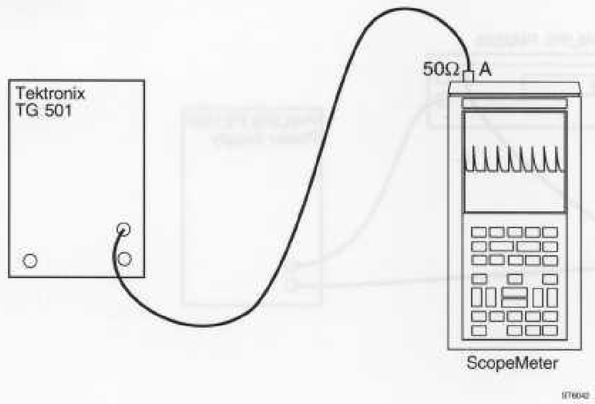
*** Models 95/97 only! ***

This test checks the accuracy of the cursors while measuring time.

**Test equipment:**

Tektronix TG 501 Time Mark Generator

**Test setup:**




**Setting/procedure:**

A Apply a 1 ms time marker signal to channel A. Use a 50Ω termination.
B Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode. Now press the AUTO SET key.
C Set the timebase to 1 ms/div.
D Press the HOLD/RUN key to freeze the display.
E Press the CURSOR DATA key to get into the cursor menu.
F Press the CURSOR softkey to turn on the cursor lines.
G Position the cursor lines with the <CURSOR -1-> and <CURSOR 2-> keys, so that they cover a distance of 6 time marker intervals. Position the markers exactly to the top of the marker pulses. See figure 4.11.

**Requirements:**

The measured time distance between the cursors is displayed at the right side next to the traces. This value must be 5.99...6.01 ms.

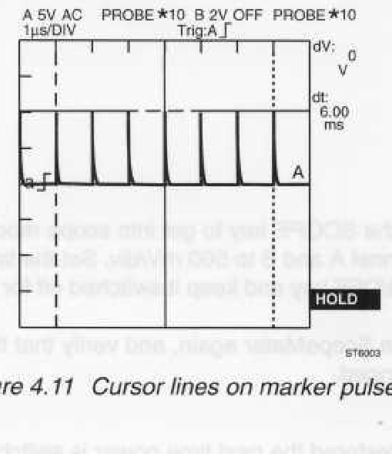



*Figure 4.11 Cursor lines on marker pulses*

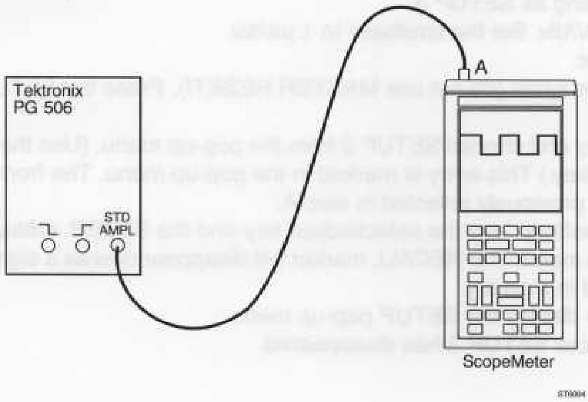
## 8. Cursor measurements: voltage accuracy

*** Models 95/97 only! ***

This test checks the accuracy of the cursors while measuring voltage.

**Test equipment:**
Tektronix PG 506 Square Wave Calibration Generator

**Test setup:**




**Settings/procedure:**

A Apply a 1 kHz square wave voltage of 1V peak-to-peak to channel A. Use the "STD AMPL" output of the PG 506.
B Switch on the ScopeMeter and press the SCOPE key to get into SCOPE mode. Now press the AUTO SET key.
C Set channel A to 200 mV/div and to AC coupling.
D Press the HOLD/RUN key to freeze the display
E Press the CURSOR DATA key to get into the cursor menu.
F Press the CURSOR softkey to activate the cursor lines.
G Position the first cursor in the horizontal middle of the top of the waveform. Use the <CURSOR -1-> key to position cursor 1.
H Position the second cursor in the horizontal mid of the bottom of the waveform. Use the <CURSOR -2-> key to position cursor 2.
I Use the most right softkey to select NORMAL readout.

**Requirements:**

The measured voltage between the cursors is displayed at the right side next to the traces. This value must be 0.98V...1.02V.

## 9. SETUP memory functions

*** Model 97 only! ***

ScopeMeter model 97 enables storing up to 10 front settings that will be kept in a memory with a battery backup.
This test checks this function.

**Test equipment:**
none

**Test setup:**
no specific set-up required

**Setting/procedure:**

A Switch on the ScopeMeter and switch to SCOPE mode.
Operate the keys to get a front setting that differs from the default settings:
Set channel A and B to 500 mV/div.
Set the timebase to 1 ms/div.

B Press the SETUP key to get into the SETUP menu

C Press the SAVE softkey, select SETUP 3 from the pop-up menu, and press ENTER. This will save the current front setting as SETUP 3.

D Set channel A and B to 2V/div. Set the timebase to 1 µs/div.

E Switch off the ScopeMeter.

F Switch on the ScopeMeter again (do not use MASTER RESET!). Press the SETUP key to get into the SETUP menu.

G Press the RECALL softkey and choose SETUP 3 from the pop-up menu. (Use the select/adjust keys and the ENTER softkey.) This entry is marked in the pop-up menu. The front setting must be restored to the setting previously selected in step A.

H Now press the DELETE softkey. Use the select/adjust key and the ENTER softkey to choose SETUP 3 from the pop-up menu. The RECALL marker will disappear now as a sign that the front setting is no longer stored in memory.

I Press the SAVE button to display the SETUP pop-up menu.
Verify that the marker before SETUP 3 has disappeared.

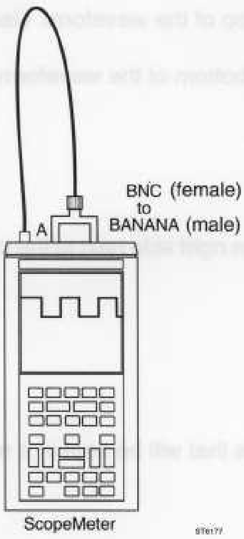
## 10. Generator

*** Model 97 only! ***

This test checks the built-in generator.

**Test equipment:**
none

**Test setup:**



**Settings/procedure/requirements:**

***Square wave***

A Switch on the ScopeMeter and press the SCOPE key to get into scope mode.

B Press the SPECIAL FUNCT key. Now press the left most softkey, marked GENERATE. This will reveal the GENERATE pop- up menu.

C Use the select/adjust keys to select "Square: 976 Hz" and press the right most ENTER softkey to activate the generator.

D Press the LCD key, and then press the softkey PROBE CAL. This will reveal the CAL&ADJUST pop-up menu. Use the select/adjust keys to select "Channel A 1:1" and press the ENTER softkey to activate 1:1 coupling.

E Now press AUTO SET.

F Press the CURSOR DATA key. This will get you to the CURSOR DATA menu.

G Press the CURSOR softkey. Use the <-CURSOR 1-> key to position the left cursor line on the most negative part of the square wave signal. Use the <-CURSOR 2-> key to position the right cursor line on the top of the square wave signal.

H Now press the FUNCTION softkey. This will reveal the FUNCTION pop-up menu. Use the select/adjust keys to select "FREQUENCY" and press the ENTER softkey to activate the frequency measurement. Press the FUNCTION softkey again. This will remove the FUNCTION pop-up menu.

I The ScopeMeter display will look like figure 4.12. The generator must produce a square wave signal with an amplitude of 5V and a frequency of 976 Hz (typical values).

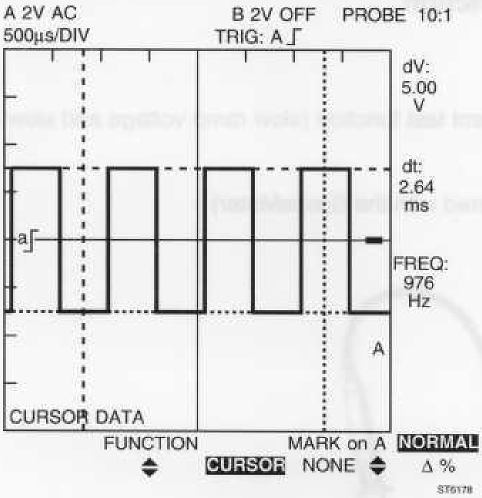



*Figure 4.12 Generator produces square wave signal*

***Sine wave***

J Now press the SPECIAL FUNCT key. Press the GENERATE softkey to reveal the GENERATE pop-up menu. Use the select/adjust keys to select "SINEWAVE" and press the ENTER softkey to activate the generator.

K Use the mV/V keys to adjust the attenuator.

L The ScopeMeter display will look like figure 4.13. The generator must produce a sine wave signal with an amplitude of 1V and a frequency of 976 Hz (typical values).

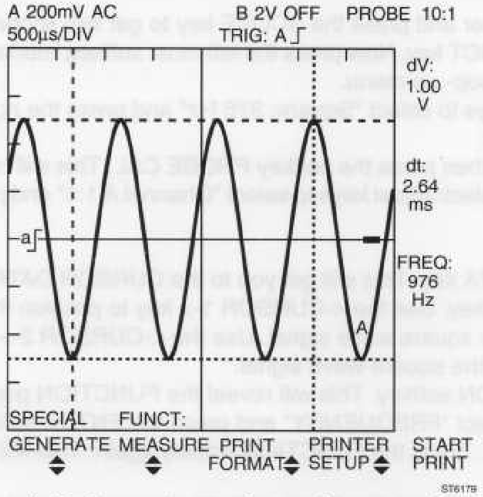



*Figure 4.13 Generator produces sine wave signal*

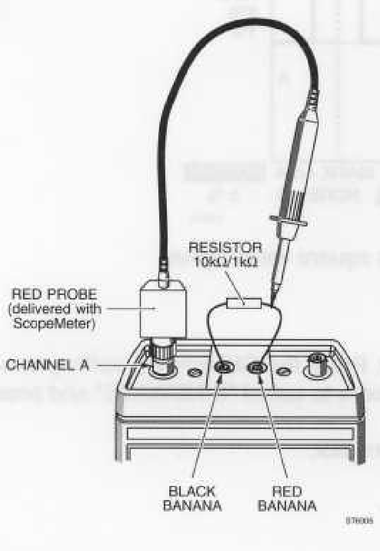
## 11. Component test function

*** Model 97 only! ***

This test checks the component test function (slow ramp voltage and slow ramp current).

**Test equipment:**
Red scope probe (delivered with the ScopeMeter)

**Test setup:**




**Settings/procedure/requirements:**

A Switch on the ScopeMeter and press the SPECIAL FUNCT key to enter the SPECIAL FUNCT menu.

B Now press the MEASURE softkey. This will reveal the MEASURE pop-up menu.

C Use the select/adjust keys to select "Components: VOLTAGE", and press the ENTER softkey (most right) to start the component test function.

D Adjust the channel A attenuator (press the mV/V key once in the direction "mV") to set the vertical axis to 500 mV/div.

E The ScopeMeter display will now look like figure 4.14.
If you use a 10 kΩ resistor, a 45° line will be shown.

F Press the MEASURE softkey and use the select/adjust keys to select "Components: CURRENT" from the MEASURE pop-up menu. Activate the selection by pressing the ENTER softkey.

G Exchange the 10 kΩ resistor for a 1 kΩ resistor.

H Now the ScopeMeter display will show a line under 45°, in the upper left quadrant.

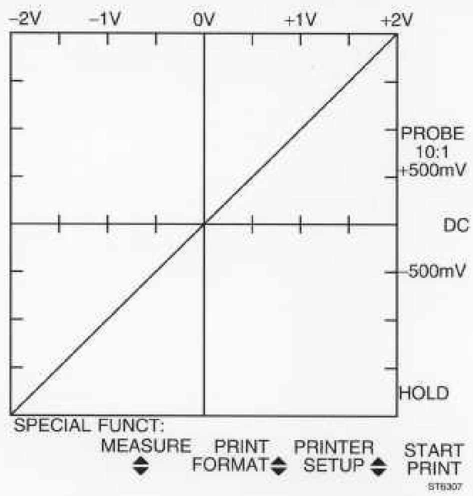



*Figure 4.14 Component test "VOLTAGE" mode*

# 5 CALIBRATION ADJUSTMENT PROCEDURE

## 5.1 GENERAL INFORMATION

The following information provides the complete Calibration Adjustment Procedure for the ScopeMeter. Because various control functions are interdependent, a certain order of adjustment is necessary. The procedure is therefore presented in a sequence that is best suited to this order. Before you make calibration adjustments, always use the Performance Verification Procedure in chapter 4 to check the ScopeMeter performance.

The Calibration Adjustment Procedure, described here, consists of the following three parts:

- CONTRAST Calibration Adjustment Procedure
- SCOPE Calibration Adjustment Procedure
- METER Calibration Adjustment Procedure

Almost all Calibration Adjustments can be done without opening the instrument. Only the first four steps of the SCOPE Calibration Adjustment Procedure require disassembling of the ScopeMeter (see section 5.6.1).

*NOTE: Every year use the Performance Verification Procedure in chapter 4 to check the ScopeMeter. If the ScopeMeter fails the Performance Verification Procedure, Calibration Adjustments must be made. If the ScopeMeter also fails the Calibration Adjustment Procedure, repair is necessary (see chapter 7). (After repair, it is sometimes also necessary to do also a Hardware Calibration Adjustment, see section 5.6.1)*

Sections 5.5, 5.6 and 5.7 describe the calibration process in detail. Section 5.8 contains a summary of all calibration adjustments as a reference for more frequent users.

## 5.2 RECOMMENDED CALIBRATION ADJUSTMENT EQUIPMENT

The equipment recommended for the Calibration Adjustment Procedure is listed in table 5.1.

All calibration adjustments must be done in ambient temperatures between 18C and 28C. The ScopeMeter can be used immediately: there is no warm-up time specified.

*Table 5.1 Recommended calibration adjustment equipment survey.*

| **Instrument Type** | **Recommended Model** |
|---|---|
| Multifunction Calibrator | Fluke 5100B |
| Square Wave Calibration Generator | Tektronix PG 506 |
| Function Generator | Philips PM 5134 |
| *) Personal Computer | Any IBM compatible PC, running MS-DOS |
| *) Optical to RS-232 Interface Cable | PM9080/001 |
| *) Flash ROM Refresh software | Contact your Service Center |
| *) +12V (± 2.5%) Programming voltage | |

*) These items are required after three calibrations, see note paragraph 5.3, pag 5.3 for details.

- Cables and terminators for the generators (all BNC type)
- Standard banana test leads
  (two banana test leads are delivered with the ScopeMeter)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter)
- The red and grey probes, delivered with the ScopeMeter.

## 5.3 ENTERING THE CALIBRATION PROCEDURE

The Calibration Adjustment Procedure is operated via built-in sequences. Before you can activate a calibration sequence, you must first connect a 12V DC programming voltage to the ScopeMeter. To do this, first remove the battery pack. See section 6.2.1.


*Figure 5.1 Position of the +12V and 0 contacts for calibration (items 25)*

If you have removed the ScopeMeter battery pack and the battery cover (figure 5.1, item 17), you will have access to the +12V/0 contacts (figure 5.1, item 25). These contacts are placed in the left middle (+12V) and the right middle (0) of the battery compartment. Connect +12V DC to the contact marked "+12V" and 0V to the contact marked "0".

**CAUTION: To avoid damaging the Flash ROM circuitry be sure to apply the polarity of 12V programming voltage correctly.**

*NOTE: After you have performed the Calibration Procedure, remove the 12V programming voltage. Do not perform measurements with the ScopeMeter, while the programming voltage is still present.*

Connect the ScopeMeter to the Power Adapter/Battery Charger PM 8907. Use MASTER RESET to switch the ScopeMeter on. (To do this press the LCD key and keep it pressed. Then also press the ON/OFF key. When the ScopeMeter switches on, you will hear two beeps.) Now press both AC/DC/GROUND keys simultaneously. This will start the SERVICE menu (see figure 4.1, chapter 4). This menu allows you to start the calibration sequence. Press the corresponding softkey marked "CALIBRATE ScopeMeter". This will start the CALIBRATE menu.

*NOTE: The ScopeMeter will show the message:*
***"Space for X more calibration sessions."*** *(X is: 2, 1, or 0)*

After three electronic calibrations, the ScopeMeter will display: "Space for 0 more calibration sessions". This means that the internal Flash ROMs of the ScopeMeter are full. To enable another calibration, you must first empty the Flash ROMs and reinstall the ScopeMeter operating software. To do this, send the ScopeMeter to your nearest Service Center. It is also possible to "refresh" the FlashROMs by yourself, using a PC. For more information: contact your nearest Service Center.

## 5.4 OPERATING THE CALIBRATION PROCEDURE

***Softkeys in the CALIBRATE menu***

In the CALIBRATE menu, it is possible to choose the calibration mode (sequence) to be performed.

Press the softkey marked:
- CONTRAST for the CONTRAST Calibration Adjustment Procedure (see section 5.5).
- SCOPE for the SCOPE Calibration Adjustment Procedure (see section 5.6).
- METER for the METER Calibration Adjustment Procedure (see section 5.7).

When one of these three calibration sequences is chosen, the corresponding text on the screen will be shown in reverse. This shows that this calibration mode is active.

If you press the ESCAPE softkey, the ScopeMeter will leave the CALIBRATE menu and return to the SERVICE menu.

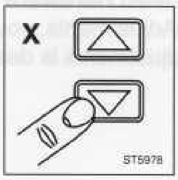
*NOTE: If you use the ESCAPE softkey to leave the CALIBRATION menu before storing the calibrations with the CAL STORE softkey, you will lose all new calibration values. The instrument will continue using the calibration values that were used before entering the CALIBRATE menu.*

The CAL STORE softkey saves the new calibration values that are obtained in the CONTRAST, SCOPE or METER sequences, to the Flash ROM. From the moment you press the CAL STORE softkey, the ScopeMeter uses the new calibration data. The old calibration data is no longer valid. This will also fill one calibration field in the Flash ROM. See section 5.3.

*NOTE: After calibrating the ScopeMeter, reset the instrument (use a MASTER RESET), before performing measurements.*

***Keys in CONTRAST, SCOPE, or METER Calibration mode***

The calibration is presented as a sequence. You can advance through this sequence by pressing the select/adjust keys. Pressing the upper select/adjust key advances one step; pressing the lower adjust/select key brings you back one step.




In sections 5.5, 5.6 and 5.7 this figure is used to indicate that one of the select/adjust keys (up/down) must be pressed to display the indicated step number "x" displayed on the ScopeMeter screen.

When the ScopeMeter LCD displays the indication " CAL", you must first apply the appropriate input (calibration) signal. When the correct signal is present at the correct terminal, you start the built-in calibration by pressing the most right READY softkey. The text "READY" will be in reverse video, to show that the ScopeMeter's internal calibration is active. When the process is ready, the "READY" text will change again, from inverted to normal. Now you can use the select/adjust keys to advance to the next calibration step or return to a previous calibration step.

After you have completed a calibration sequence, press either CONTRAST, SCOPE or METER softkey again to return to the CALIBRATE menu. The new calibration data will stay in memory to enable you to store it permanently with the CAL STORE key.

Press the ESCAPE softkey to leave the active calibration mode without storing the new calibration data. This will also return you to the CALIBRATE menu.

## 5.5 CONTRAST CALIBRATION ADJUSTMENT PROCEDURE

You activate the CONTRAST Calibration Adjustment Procedure from the CALIBRATE menu, by pressing the left most CONTRAST softkey. When this softkey is depressed, the text "CONTRAST" is shown in reverse video, to show that this calibration mode is active.

Now use the adjust/select keys to adjust the contrast of the LCD to your own (personal) setting. When you have found the correct setting, you can make this setting ready for calibration storage, by pressing the READY softkey once.

NOTE: *When you press the READY softkey, this does not mean that the new value of the LCD contrast is actually stored in the Flash ROMs of the ScopeMeter. This only happens when you press the CAL STORE softkey.*

Press the CONTRAST softkey again to leave the CONTRAST Calibration Adjustment Procedure. The text "CONTRAST" will change from reverse video into normal again.

## 5.6 SCOPE CALIBRATION ADJUSTMENT PROCEDURE

You can start the SCOPE Calibration Adjustment Procedure from the CALIBRATE menu by pressing the SCOPE softkey. When this softkey is pressed, the text "SCOPE" is shown in reverse video, to show that this calibration mode is active.

The SCOPE Calibration Adjustment Procedure is divided into two parts:

- Hardware SCOPE Calibration Adjustments: steps H1 to H4
- Closed Case SCOPE Calibration Adjustments: steps S5 to S29

NOTE: *During the following Calibration Adjustment Procedure,you must connect the ScopeMeter input connectors to the signal generator outputs by means of cables (BNC connector channel A or B) or two standard banana test leads (COM and mV/Ohm/Diode banana connectors).*

### 5.6.1 Hardware SCOPE Calibration Adjustments

The first four steps of the SCOPE Calibration Adjustment Procedure are called **Hardware SCOPE Calibration Adjustments**. To perform the Hardware SCOPE Calibration Adjustments, you must open the ScopeMeter. The disassembly procedure for these calibration adjustments is described in chapter 6 (section 6.1 and 6.2.3).

**WARNING: To prevent personal injury, do not perform any disassembly procedures before reading chapter 6.**

When the ScopeMeter is disassembled, it is not possible to apply the +12V programming voltage in the normal way. It is possible to apply the +12V programming voltage by means of two test clips (see figure 5.2).

Remove all voltage sources from the ScopeMeter. Turn the digital A1 PCB, mounted in the top cover so that the display and the keyboard are facing down. Connect the +12V programming voltage to the appropriate places on the PCB. It can be helpful to first install two metal screws again. See figure 5.2. Be sure not to short circuit with the metal shielding, mounted on the analog A1 PCB. Turn the top cover and the mounted PCB. Connect the ScopeMeter to the power supply and switch the instrument on. Go to the SERVICE menu and press the CALIBRATE ScopeMeter softkey. You can make the adjustments necessary with six trim capacitors (three for the attenuator of each channel) and two adjustment potentiometers (for the Analog ASIC).

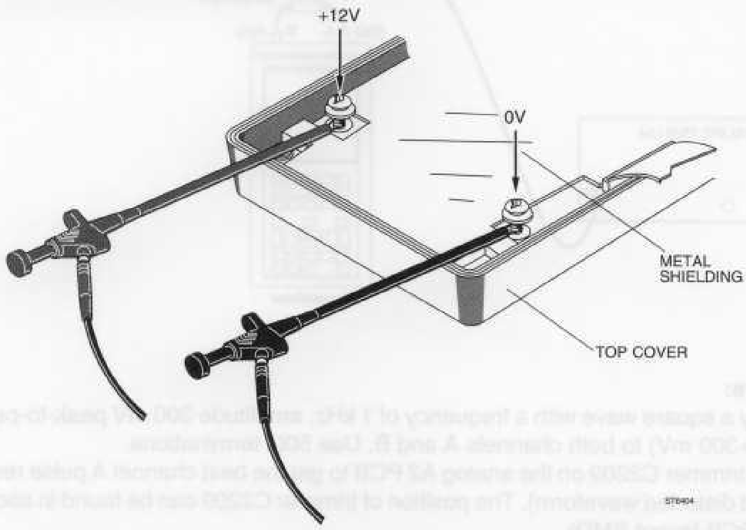



*Figure 5.2 Connecting the +12V programming voltage for Hardware SCOPE Calibration Adjustments.*

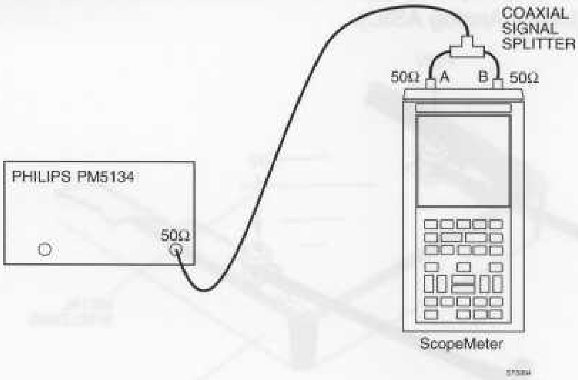
*NOTE: You only have to do Hardware SCOPE Calibration Adjustments, if you have repaired the ScopeMeter in the Attenuator sections or in the Analog ASIC circuitry. After you have done a Hardware SCOPE Calibration Adjustment or you have adjusted one of the potentiometers, you always need to do a full (software) SCOPE and METER calibration.*
*If you decide not to do the Hardware Calibration Adjustment now, you can advance to calibration S5 by pressing the upper select/adjust key 4 times.*

## H1. Hardware pulse response of the *1 attenuation


Purpose: optimal pulse response of the *1 attenuation circuit.

**Calibration equipment:**
Philips PM 5134 Function Generator

**Calibration setup:**




**Procedure:**

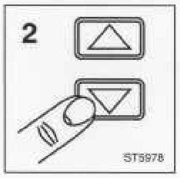
A - Apply a square wave with a frequency of 1 kHz, amplitude 300 mV peak-to-peak (between 0 mV and +300 mV) to both channels A and B. Use 50Ω terminations.

B - Turn trimmer C2209 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2209 can be found in section 10: figure 10.3 (A2 PCB layout SMD).

C - Turn trimmer C2109 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2109 can be found in section 10: figure 10.3 (A2 PCB layout SMD).

D - Press the READY softkey.

## H2. Hardware pulse response of the *10 attenuation




Purpose: optimal pulse response of the *10 attenuation circuit.

**Calibration equipment:**
Philips PM 5134 Function Generator

**Calibration setup:**
See calibration setup H1.

**Procedure:**

A - Apply a square wave with a frequency of 1 kHz, amplitude 3V peak-to-peak (between 0V and +3V) to both channels A and B. Use 50Ω terminations.

B - Turn trimmer C2207 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2207 can be found in section 10: figure 10.3 (A2 PCB layout SMD).

C - Turn trimmer C2107 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2107 can be found in section 10: figure 10.3 (A2 PCB layout SMD).

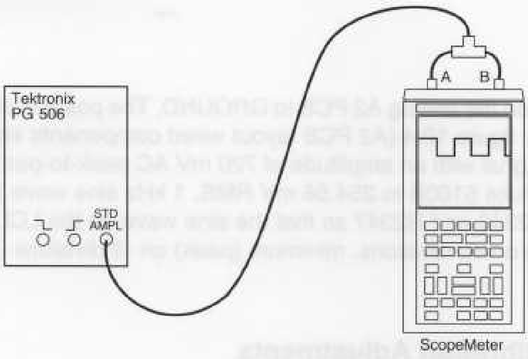
D - Press the READY softkey.

## H3. Hardware pulse response of the *100 attenuation


Purpose: optimal pulse response of the *100 attenuation circuit.

**Calibration equipment:**
Tektronix PG 506 Square Wave Calibration Generator

**Calibration setup:**




**Procedure:**

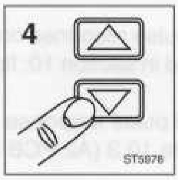
A - Apply a square wave with a frequency of 1 kHz, amplitude 20V peak-to-peak (between 0V and +20V) to both channels A and B. Set the generator to the position "STD AMPL".

B - Turn trimmer C2214 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2214 can be found in section 10: figure 10.3 (A2 PCB layout SMD).

C - Turn trimmer C2114 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2114 can be found in section 10: figure 10.3 (A2 PCB layout SMD).

D - Press the READY softkey.

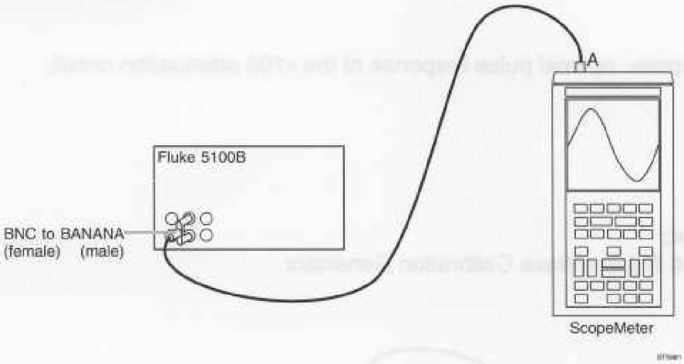
### H4. Hardware offset and gain




Purpose: optimal response of complete analog A2 circuitry.

**Calibration equipment:**
Fluke 5100B Calibrator

**Calibration setup:**

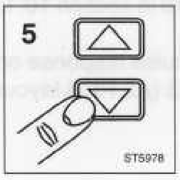



**Procedure:**
A - Connect Test Point TP209 on the analog A2 PCB to GROUND. The position of Test Point TP209 can be found in section 10: figure 10.4 (A2 PCB layout wired components side).
B - Apply a 1 kHz sine wave signal with an amplitude of 720 mV AC peak-to-peak to the channel A BNC connector. (Set the Fluke 5100B to 254.56 mV RMS, 1 kHz sine wave.)
C - Turn the potentiometers R2346 and R2347 so that the sine wave on the LCD is exactly 6 divisions: maximum (peak) on +3 divisions, minimum (peak) on -3 divisions (tolerance ± 1 dot).
D - Press the READY softkey.

## 5.6.2 Closed Case SCOPE Calibration Adjustments

*NOTE: The following calibration adjustments are done electronically. For these calibrations, the ScopeMeter must be in a fully assembled state!*

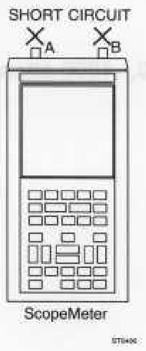
### S5. Offset correction




Purpose: remove offset of channel A and B input operational amplifiers.

**Calibration equipment:**
none.

**Calibration setup:**




**Procedure:**
A - Short circuit both channel A and channel B inputs.
B - Press the READY softkey.

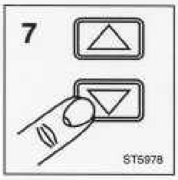
## S6/7. Pulse response of the *1/*10 attenuation (fine adjustments)


Purpose: optimal pulse response of the *1, *10 attenuation circuit.

**Calibration equipment:**
Philips PM 5134 Function Generator

**Calibration setup:**
See calibration setup H1.

**Procedure:**
A - Apply a square wave with a frequency of 1 kHz, amplitude 300 mV peak-to-peak (between 0 mV and +300 mV) to both channels A and B. Use 50Ω terminations.
B - Press the READY softkey.




C - Apply a square wave with a frequency of 1 kHz, amplitude 3V peak-to-peak (between 0V and +3V) to both channels A and B. Use 50Ω terminations.
D - Press the READY softkey.

## S8/9. Pulse response of the *100/*1000 attenuation (fine adjustments)


Purpose: optimal pulse response of the *100, *1000 attenuation circuit.

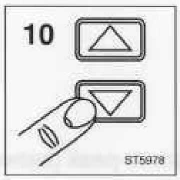
**Calibration equipment:**
Tektronix PG 506 Square Wave Calibration Generator

**Calibration setup:**
See calibration setup H3.

**Procedure:**
A - Apply a square wave with a frequency of 1 kHz, amplitude 20V peak-to-peak (between 0V and +20V) to both channels A and B. Set the generator to the position "STD AMPL".
B - Press the READY softkey.


C - Apply a square wave with a frequency of 1 kHz, amplitude 50V peak-to-peak (between 0V and +50V) to both channels A and B. Set the generator to the position "STD AMPL".
D - Press the READY softkey.

## S10/11/12/13/14/15/16/17
## Gain for 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 2V, 20V




Purpose: correction of the system gain (from BNC to microprocessor) in attenuator settings: 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 2V, 20V.

**Calibration equipment:**
Tektronix PG 506 Square Wave Calibration Generator

**Calibration setup:**
See calibration setup H3.

**Procedure:**
A - Apply a square wave with a frequency of 1 kHz, amplitude 20 mV peak-to-peak to both channels A and B. Set the generator to the position "STD AMPL".
B - Press the READY softkey.
C - Change the input voltage according to table 5.2.
After each calibration press the READY softkey. Use the adjust/select keys to advance/go back in the list.

*NOTE: These steps calibrate both channel A and B at the same time.*

*Table 5.2 Calibration signals for step S10...S17.*

| Calibration step number | Calibration voltage |
|---|---|
| S10 | square wave, 1 kHz, 20 mV peak-to-peak |
| S11 | square wave, 1 kHz, 50 mV peak-to-peak |
| S12 | square wave, 1 kHz, 100 mV peak-to-peak |
| S13 | square wave, 1 kHz, 200 mV peak-to-peak |
| S14 | square wave, 1 kHz, 500 mV peak-to-peak |
| S15 | square wave, 1 kHz, 1V peak-to-peak |
| S16 | square wave, 1 kHz, 10V peak-to-peak |
| S17 | square wave, 1 kHz, 100V peak-to-peak |

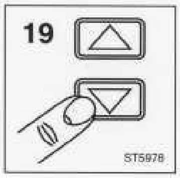
## S18/19. Shift gain *1 mode and /8 mode


Purpose: correct for the shift gain in "times 1 mode" and in "divided by 8 mode".

**Calibration equipment:**
Tektronix PG 506 Square Wave Calibration Generator

**Calibration setup:**
See calibration setup H3.

**Procedure:**
A - Apply a square wave with a frequency of 1 kHz, amplitude 200 mV peak-to-peak (between 0 mV and +200 mV) to both channels A and B. Set the generator to the position "STD AMPL".
B - Press the READY softkey.



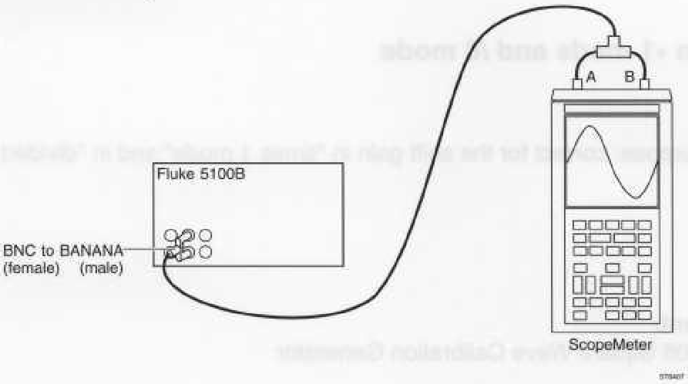

C - Apply a square wave with a frequency of 1 kHz, amplitude 20 mV peak-to-peak (between 0 mV and +20 mV) to both channels A and B. Set the generator to the position "STD AMPL".
D - Press the READY softkey.

## S20/21/22/23. Channel A and channel B 50% and 90% trigger level


Purpose: calibrate the 50% and 90% analog trigger level of channel A and channel B.

**Calibration equipment:**
Fluke 5100B Calibrator

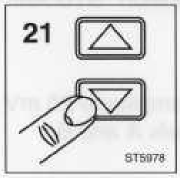
**Calibration setup:**



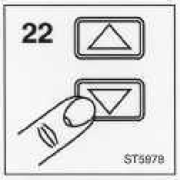

**Procedure:**

A - Apply a sine wave with a frequency of 50 kHz, amplitude 1V peak-to-peak to both channels A and B. Use 50Ω terminations. (Set the Fluke 5100B to 0.353.5 mV RMS, 5 kHz sine wave).

B - Press the READY softkey.




C - Press the READY softkey.




D - Press the READY softkey.

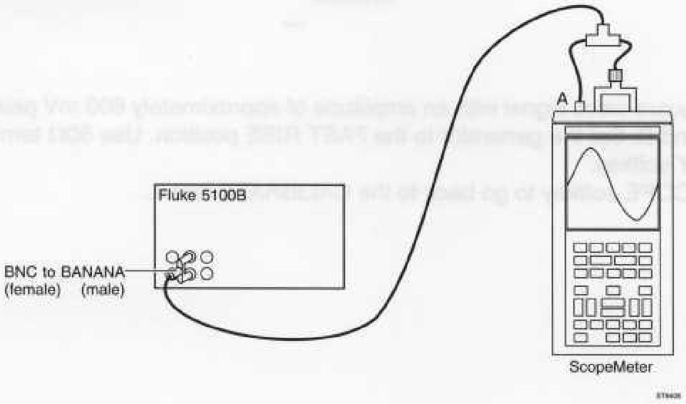

E - Press the READY softkey

## S24. External triggering


Purpose: calibrate the 0.2V external trigger level.

**Calibration equipment:**
Fluke 5100B Calibrator

**Calibration setup:**




**Procedure:**

A - Apply a 50 kHz sine wave signal with an amplitude of 1V peak-to-peak to channel A and also to the banana connectors. Use a coaxial signal splitter and a BNC(female)-to-banana(male) converter (see calibration setup). (Set the Fluke 5100B to 0.35355V RMS, 5 kHz sine wave).

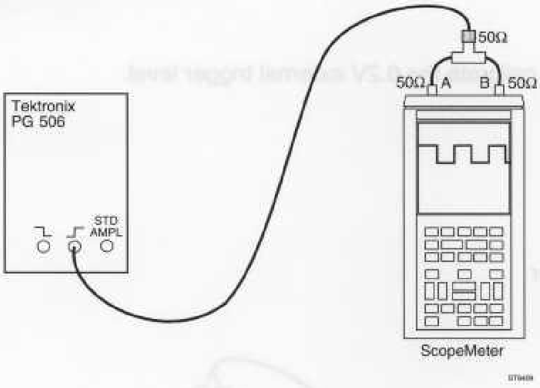
B - Press the READY softkey.

## S25. Random sampling


Purpose: calibration of the random sampling levels.

**Calibration equipment:**
Tektronix PG 506 Square Wave Calibration Generator

**Calibration setup:**




**Procedure:**

A - Apply a 1 MHz square wave signal with an amplitude of approximately 600 mV peak-to-peak to both channel A and B. Set the generator to the FAST RISE position. Use 50Ω terminations.

B - Press the READY softkey.

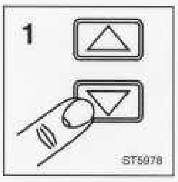
C - Now press the SCOPE softkey to go back to the CALIBRATE menu.

## 5.7 METER CALIBRATION ADJUSTMENT PROCEDURE

Press the METER softkey to activate the METER Calibration Adjustment Procedure from the CALIBRATE menu. When you press this softkey, the text "METER" will be shown in reverse video to show that this calibration mode is active.

*NOTE: During the METER calibration, the values displayed on the LCD do not represent the values of the input voltages!*

### M1. Linearity calibration and M2. Zeroing the ranges




Purpose M1: calibration of the linearization table, used by the ScopeMeter.

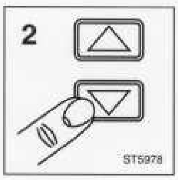
Purpose M2: this calibration zeros all ranges of the ScopeMeter in METER mode: 300 mV, 3V, 30V and 300V on channel A and 300 mV and 3V of the banana connectors.

**Calibration equipment:**
none

**Calibration set-up:**

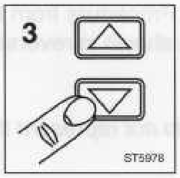

**Procedure:**
A - Short circuit the channel A BNC and the banana connectors.
B - Press the READY softkey.

*NOTE: During this calibration step many internal calibration constants are being set. This process can last up to 3 minutes.*




(C - Short circuit the channel A BNC and the banana connectors.)
D - Press the READY softkey.

## M3. Channel A, 300 mV range: zero for open input




Purpose: zero channel A in the 300 mV range with open input.

**Calibration equipment:**
none

**Calibration setup:**
Channel A BNC open.

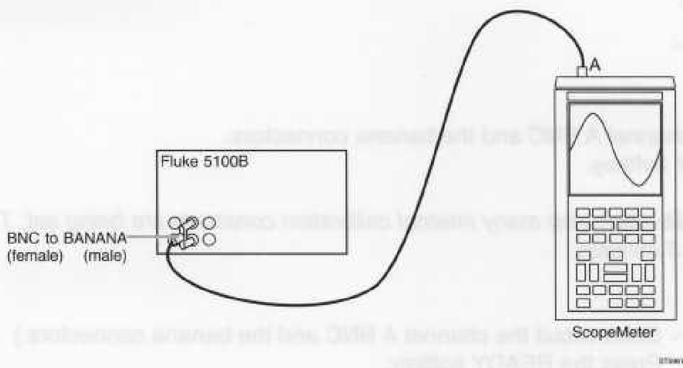
**Procedure:**
A - Remove any connection from the channel A BNC.
B - Press the READY softkey.

## M4/5/6/7. Channel A, 300 mV/3V/30V/300V range: gain calibration


Purpose: calibration of the channel A gain in the 300 mV, 3V, 30V and 300V ranges.

**Calibration equipment:**
Fluke 5100B Calibrator

**Calibration setup:**



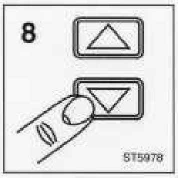

**Procedure:**
A - Apply 300 mV DC to channel A.
B - Press the READY softkey.
C - Change the input voltage according to table 5.3. After each calibration press the READY softkey. Use the adjust/select keys to advance/go back in the list.

*Table 5.3 Calibration signals for step M4...M7.*

| Calibration Step Number | Calibration Voltage |
|---|---|
| M4 | 300 mV DC |
| M5 | 3V DC |
| M6 | 30V DC |
| M7 | 300V DC |

**WARNING:** **After you have performed calibration M7, deactivate the Fluke 5100B to remove the 300V DC. Always set the Fluke 5100B to 300 mV DC before touching the connection cables!**

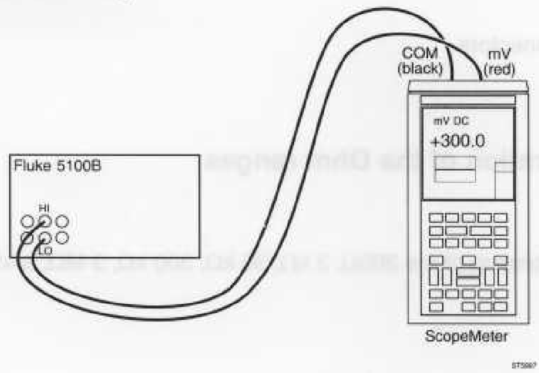
## M8/9. External input, 300 mV/3V range: gain calibration



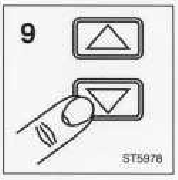

Purpose: calibration of the external input gain in the 300 mV and 3V ranges.

**Calibration equipment:**
Fluke 5100B Calibrator

**Calibration setup:**

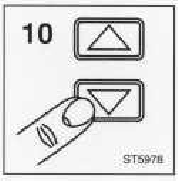



**Procedure:**
A - Apply 300 mV DC to the banana connectors.
B - Press the READY softkey.




C - Apply 3V DC to the banana connectors.
D - Press the READY softkey.

## M10. All ranges 0Ω calibration



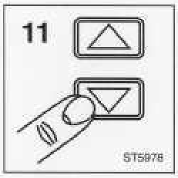

Purpose: calibration of the 0Ω points in all ranges.

**Calibration equipment:**
none

**Calibration setup:**


**Procedure:**
A - Short circuit the banana connectors.
B - Press the READY softkey.

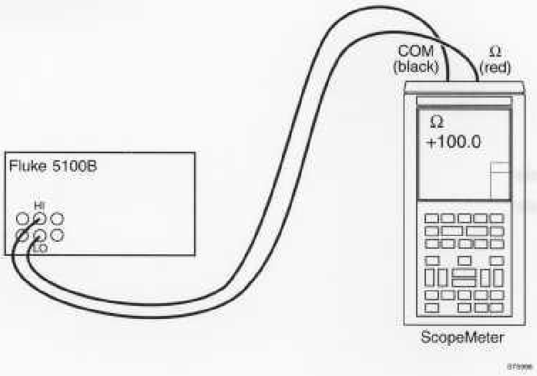
## M11/12/13/14/15/16. Calibration of the Ohm ranges




Purpose: calibration of the 300Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, and 30 MΩ ranges.

**Calibration equipment:**
Fluke 5100B Calibrator

**Calibration setup:**



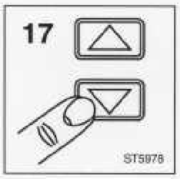

**Procedure:**

A - Connect 100Ω to the banana connectors.
B - Press the READY softkey.
C - Change the resistance according to table 5.4. After each calibration press the READY softkey. Use the adjust/select keys to advance/go back in the list.

*Table 5.4 Calibration signals for step M11...M16.*

| Calibration Step Number | Calibration Resistance |
|---|---|
| M11 | 100Ω |
| M12 | 1 kΩ |
| M13 | 10 kΩ |
| M14 | 100 kΩ |
| M15 | 1 MΩ |
| M16 | 10 MΩ |

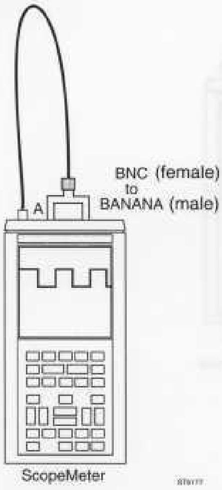
## M17. Voltage ramp calibration




Purpose: calibration of the voltage ramp of the circuit tester.

**Calibration equipment:**
none

**Calibration setup:**

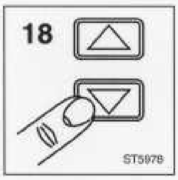



**Procedure:**

A - Connect the channel A BNC to the red GENERATOR OUT banana connector, by means of a BNC cable and a BNC (female)-to- banana(male) connector.

B - Press the READY softkey.

## M18. Current ramp calibration

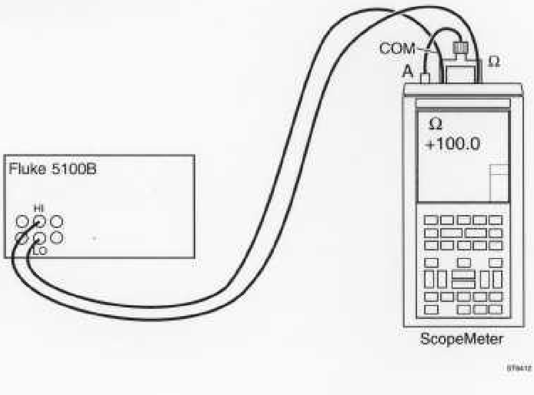



Purpose: calibrate the current ramp of the circuit tester.

**Calibration equipment:**

Fluke 5100B Calibrator

**Calibration setup:**

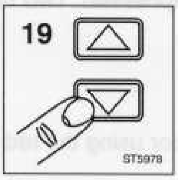



**Procedure:**

A - Connect a resistance of 100Ω between both banana connectors. Connect channel A to the red banana connector. Do not use a probe! Refer to the calibration setup.

B - Press the READY softkey.

## M19/20
## 10:1 calibration for channel A (red) and channel B (grey) probes

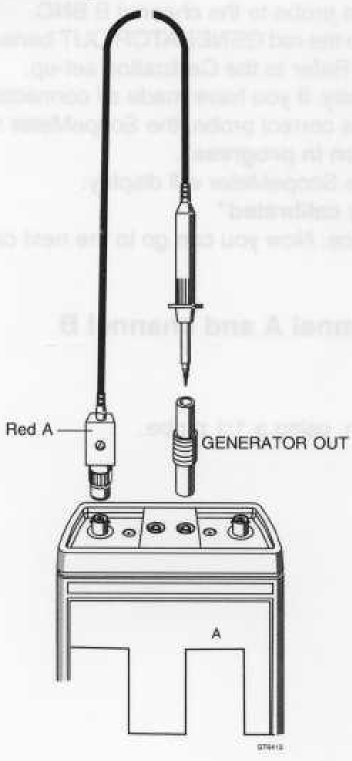



Purpose: determine the gain, using a 10:1 probe.

**Calibration equipment:**

Red scope probe (delivered with the ScopeMeter)
Grey scope probe (delivered with the ScopeMeter)
Red adjust adapter (delivered with the ScopeMeter)

**Calibration setup:**




**IMPORTANT: Calibration steps M19 and M20 determine the internal calibration constants that compensate for probe characteristics. To achieve full accuracy (as listed in the specifications in chapter 2), calibrations M19 and M20 must be performed, using the probes that are normally to be used with the instrument.**

**If the probes delivered with the ScopeMeter are not available at the time of calibration, use other probes specifically designed for the ScopeMeter. In this case you must notify the user that these calibrations have been performed, using different probes. To achieve full accuracy, the user must do a User Probe Calibration, using his own probes. This procedure is described in the ScopeMeter Users Manual. Because the results of these User Probe Calibrations**

**are stored in battery backed up RAM, they must be repeated if the batteries are removed for a longer period. You will also loose the results of the User Probe Calibration when you do a MASTER RESET. (A MASTER RESET is done when the ScopeMeter is switched on while the LCD key is depressed. Two beeps are audible.)**

**Procedure:**

A - Connect the red scope probe to the channel A BNC.

B - Connect the probe tip to the red GENERATOR OUT banana connector using the red adjust adapter. Refer to the Calibration setup.

C - Press the READY softkey. If you have made all connections correctly and you have connected the correct probe, the ScopeMeter will display the text:
**"DC PROBE calibration in progress"**.
After a few seconds the ScopeMeter will display:
**"PROBE successfully calibrated"**
and will also beep once. Now you can go to the next calibration step.


D - Connect the grey scope probe to the channel B BNC.

E - Connect the probe tip to the red GENERATOR OUT banana connector using the red adjust adapter. Refer to the Calibration set-up.

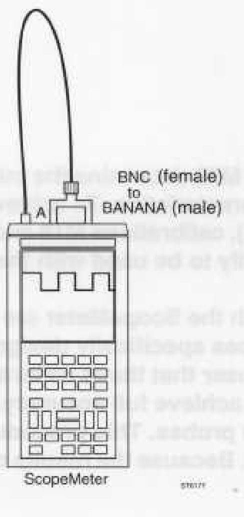
F - Press the READY softkey. If you have made all connections correctly and you have connected the correct probe, the ScopeMeter will display the text:
**"DC PROBE calibration in progress"**.
After a few seconds the ScopeMeter will display:
**"PROBE successfully calibrated"**
and it will also beep once. Now you can go to the next calibration step.

## M21/22. 1:1 probe calibration for channel A and channel B


Purpose: determine the gain, using a 1:1 probe.

**Calibration equipment:**
none

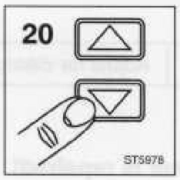
**Calibration set-up:**



**Procedure:**

A - Connect the channel A BNC to the red GENERATOR OUT banana connector, by means of a BNC cable and a BNC (female)-to- banana(male) connector.

B - Press the READY softkey.
If all connections are good, the ScopeMeter will display the text:
**"DC PROBE calibration in progress"**.
After a few seconds the ScopeMeter will display:
**"PROBE successfully calibrated"**
and will also beep once. Now you can go to the next calibration step.




C - Connect the channel B BNC to the red GENERATOR OUT banana connector, by means of a BNC cable and a BNC(female)-to-banana(male) connector.

D - Press the READY softkey. If all connections are good, the ScopeMeter will display the text:
**"DC PROBE calibration in progress"**.
After a few seconds the ScopeMeter will display:
**"PROBE successfully calibrated"**
and it will also beep once.
Calibration is now complete.

## 5.8 Calibration Adjustment Procedure Summary

This table provides an overview of all steps in the Calibration Adjustment Procedure. It is intended to be used as a reference for frequent users. For details on how to perform each Calibration Adjustment step, refer to sections 5.5, 5.6 and 5.7.

*Table 5.5 Calibration Adjustment Procedure Summary.*

| STEP | SIGNAL SOURCE | SIGNAL AMPL/FREQ | SCOPEMETER INPUTS | ACTIONS |
|---|---|---|---|---|
| **CONTRAST Calibration Adjustment Procedure** | | | | |
| - | - | - | - | Adjust for clear picture. |
| **SCOPE Calibration Adjustment Procedure** | | | | |
| **Hardware SCOPE Calibration Adjustments: only to be done when ScopeMeter is repaired!** | | | | |
| H1 | PM 5134 | 300 mV(pp)/1 kHz (square) | A & B (50Ω termin.) | Adjust C2109/C2209. |
| H2 | PM 5134 | 3V(pp)/1 kHz (square) | A & B (50Ω termin.) | Adjust C2107/C2207. |
| H3 | Tek PG 506 | 20V(pp)/1 kHz (square) | A & B | Adjust C2114/C2214. |
| H4 | Fluke 5100B | 254.5 mV (RMS)/1 kHz (sine) | A | Adjust R2346/R2347, Ground testpoint 209. |
| **Closed case SCOPE Calibration Adjustments** | | | | |
| S5 | - | - | - | Short circuit BNCs. |
| S6 | PM 5134 | 300 mV(pp)/1 kHz (square) | A & B (50Ω termin.) | - |
| S7 | PM 5134 | 3V(pp)/1 kHz (square) | A & B (50Ω termin.) | - |
| S8 | Tek PG 506 | 20V(pp)/1 kHz (square) | A & B | - |
| S9 | Tek PG 506 | 50V(pp)/1 kHz (square) | A & B | - |
| S10 | Tek PG 506 | 20 mV(pp)/1 kHz (square) | A & B | - |
| S11 | Tek PG 506 | 50 mV(pp)/1 kHz (square) | A & B | - |
| S12 | Tek PG 506 | 100 mV(pp)/1 kHz (square) | A & B | - |
| S13 | Tek PG 506 | 200 mV(pp)/1 kHz (square) | A & B | - |
| S14 | Tek PG 506 | 500 mV(pp)/1 kHz (square) | A & B | - |
| S15 | Tek PG 506 | 1V(pp)/1 kHz (square) | A & B | - |
| S16 | Tek PG 506 | 10V(pp)/1 kHz (square) | A & B | - |
| S17 | Tek PG 506 | 100V(pp)/1 kHz (square) | A & B | - |
| S18 | Tek PG 506 | 200 mV(pp)/1 kHz (square) | A & B | - |
| S19 | Tek PG 506 | 20 mV(pp)/1 kHz (square) | A & B | - |
| S20 | Fluke 5100B | 353.5 mV (RMS)/50 kHz (sine) | A & B | - |
| S21 | Fluke 5100B | 353.5 mV (RMS)/50 kHz (sine) | A & B | - |
| S22 | Fluke 5100B | 353.5 mV (RMS)/50 kHz (sine) | A & B | - |
| S23 | Fluke 5100B | 353.5 mV (RMS)/50 kHz (sine) | A & B | - |
| S24 | Fluke 5100B | 353.5 mV (RMS)/50 kHz (sine) | A & banana | - |
| S25 | Tek PG 506 | 500 mV(pp)/1 MHz | A & B (50Ω termin.) | - |

| STEP | SIGNAL SOURCE | SIGNAL AMPL/FREQ | SCOPEMETER INPUTS | ACTIONS |
|---|---|---|---|---|
| **METER Calibration Adjustments** | | | | |
| M1 | - | - | - | Short circuit BNCs & banana |
| M2 | - | - | - | Short circuit A BNC & banana |
| M3 | - | - | - | A BNC open |
| M4 | Fluke 5100B | 300 mV DC | A | - |
| M5 | Fluke 5100B | 3V DC | A | - |
| M6 | Fluke 5100B | 30V DC | A | - |
| M7 | Fluke 5100B | 300V DC | A | - |
| M8 | Fluke 5100B | 300 mV DC | bananas | - |
| M9 | Fluke 5100B | 3V DC | bananas | - |
| M10 | - | - | - | Short circuit banana input |
| M11 | Fluke 5100B | 100 Ω | bananas | - |
| M12 | Fluke 5100B | 1 kΩ | bananas | - |
| M13 | Fluke 5100B | 10 kΩ | bananas | - |
| M14 | Fluke 5100B | 100 kΩ | bananas | - |
| M15 | Fluke 5100B | 1 MΩ | bananas | - |
| M16 | Fluke 5100B | 10 MΩ | bananas | - |
| M17 | - | - | A BNC to bananas | - |
| M18 | Fluke 5100B | 100 Ω | resistor between bananas, connect A BNC to banana | |
| M19 | red probe | - | probe tip to bananas | - |
| M20 | grey probe | - | probe tip to bananas | - |
| M21 | - | - | A BNC to bananas | - |
| M22 | - | - | B BNC to bananas | - |

# 6 DISASSEMBLING THE SCOPEMETER

## 6.1 GENERAL INFORMATION

Whenever the ScopeMeter needs repair and/or Hardware SCOPE Calibration Adjustments, the instrument must be disassembled.

*NOTE: For replacement of components refer to section 7.2; for Hardware SCOPE Calibration Adjustments refer to section 5.6.1.*

This section provides the required disassembling procedures. Both printed circuit boards removed from the instrument must be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. During the disassembly process, make a careful note of all disconnected leads so that they can be reconnected to their correct terminals when you reassemble the instrument.

**WARNING: Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals may be live. To avoid electric shock, disconnect the instrument from all voltage sources and remove batteries before disassembling the instrument. If any adjustment, maintenance, or repair of the disassembled instrument under voltage is required, it shall be carried out only by qualified personnel using customary precautions against electric shock. Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources and batteries have been removed.**

## 6.2 DISASSEMBLY PROCEDURES

The following sections describe the disassembly process of the ScopeMeter in sequence (from fully assembled instrument to separate printed circuit boards and chassis parts). Start and end disassembly at the appropriate heading levels.

**WARNING: To avoid electric shock, disconnect test leads, probes and power supply from any live source and from the ScopeMeter itself.**

### 6.2.1 Removing the battery pack

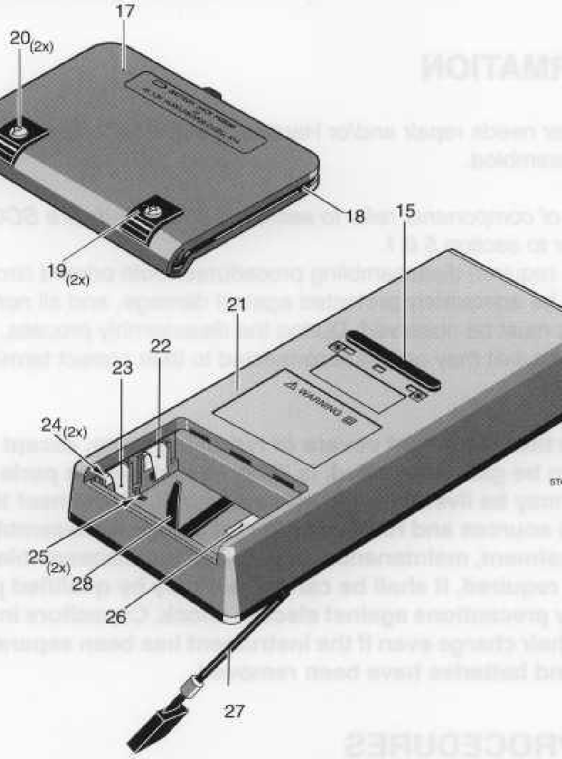



*Figure 6.1 Removing the battery pack*

1. The battery cover (item 17) is secured to the ScopeMeter with two black M3 Torx screws (item 20). Use a Torx screwdriver to loosen the two screws (do not remove them) from the battery cover.

2. Lift the battery cover from the ScopeMeter.

3. Pull the black battery pull strip (item 28) carefully to lift the battery pack.

4. Remove the battery pack.

### 6.2.2 Opening the ScopeMeter

Referring to figure 6.2, use the following procedure to open the ScopeMeter.

1. Loosen the two black M3 Torx screws (item 4) (do not remove them) from the front cover.

2. Lift the front cover assembly (item 3) from the ScopeMeter.

*NOTE: The gasket, between the front cover and the two case halves, is sealed to, and must remain with, the front cover. The front cover assembly lifts away from the top and bottom case halves easily. Do not damage the gasket or separate it from the front cover.*
*A correctly fitted gasket assures the sealing of the ScopeMeter.*

3. Remove the battery pack (see Section 6.2.1).

4. The bottom cover assembly is secured to the top cover with two M3 Torx screws (item 29) that are accessible in the battery compartment. Use a Torx screwdriver to remove the two screws.

5. Lift the bottom cover a little from the top cover and unfold the ScopeMeter.

*NOTE: Do not damage the black gaskets and keep them with the front cover and the lower case half. A correctly fitted gasket assures proper sealing of the ScopeMeter.*

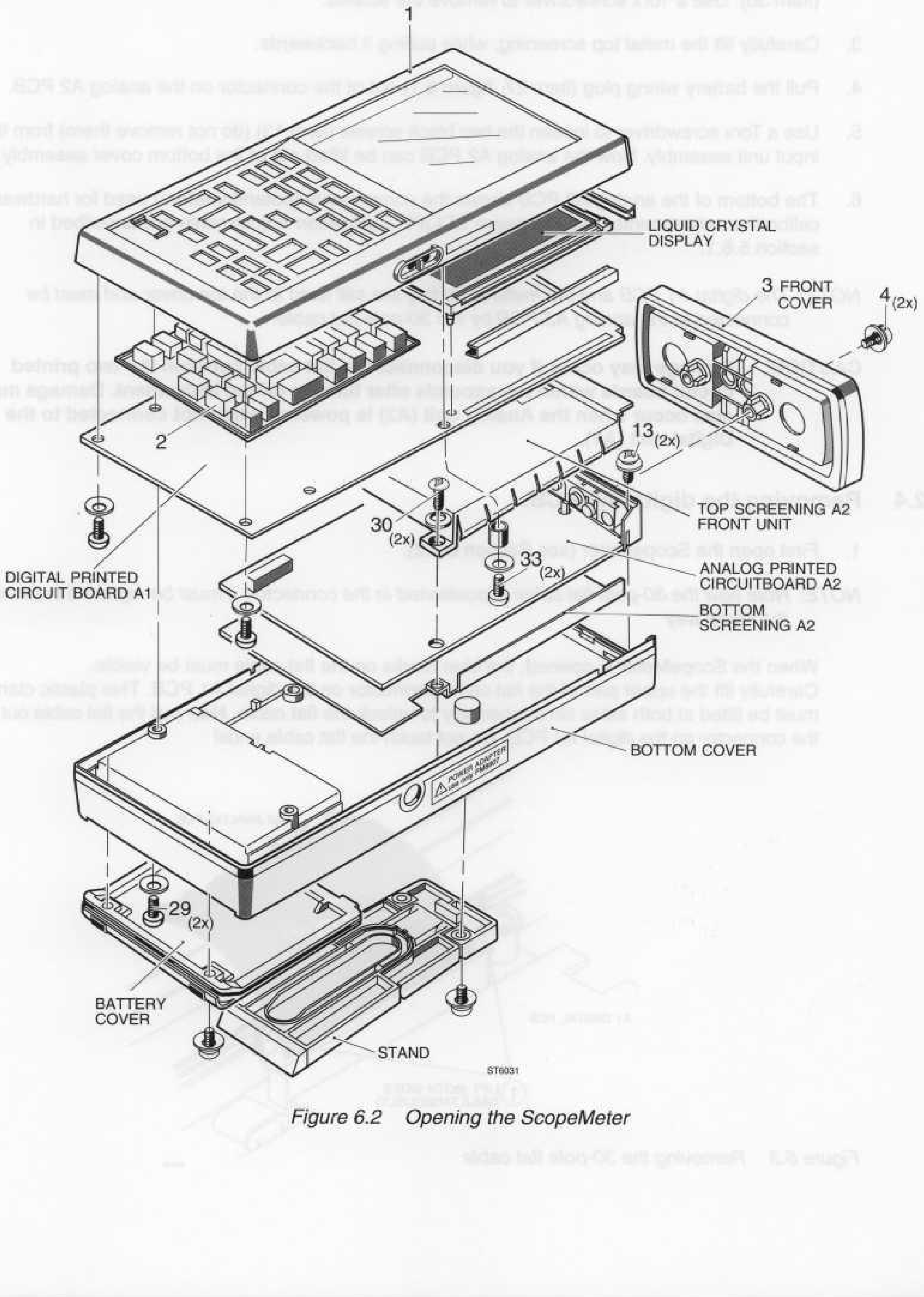



*Figure 6.2 Opening the ScopeMeter*

### 6.2.3 Removing the analog A2 PCB, to enable Hardware SCOPE Calibration Adjustments

Referring to figure 6.2, use the following procedure to remove the analog A2 PCB.

1. First open the ScopeMeter (see Section 6.2.2).
2. The analog A2 PCB and top screening are secured to the bottom cover with two M3 Torx screws (item 30). Use a Torx screwdriver to remove the screws.
3. Carefully lift the metal top screening, while pulling it backwards.
4. Pull the battery wiring plug (item 27, figure 6.1) out of the connector on the analog A2 PCB.
5. Use a Torx screwdriver to loosen the two black screws (item 13) (do not remove them) from the input unit assembly. Now the analog A2 PCB can be lifted out of the bottom cover assembly.
6. The bottom of the analog A2 PCB shows the components (potentiometers) used for hardware calibration adjustments. The Hardware SCOPE Calibration Adjustments are described in section 5.6.1.

*NOTE: The digital A1 PCB and the metal shielding are still fixed to the top cover and must be connected to the analog A2 PCB by the 30-pole flat cable.*

**CAUTION: Damage may occur if you disconnect the flat cable between the two printed circuit boards within ten seconds after turning off the instrument. Damage may also occur when the Analog unit (A2) is powered when not connected to the Digital unit (A1).**

### 6.2.4 Removing the digital A1 PCB.

1. First open the ScopeMeter (see Section 6.2.2).

*NOTE: Note how the 30-pole flat cable is positioned in the connector: it must be replaced in exactly the same way*

When the ScopeMeter is opened, the blue marks on the flat cable must be visible.
Carefully lift the upper part of the flat cable connector on the digital A1 PCB. This plastic clamp must be lifted at both sides simultaneously to unlock the flat cable. Now pull the flat cable out of the connector on the digital A1 PCB. Do not touch the flat cable ends!

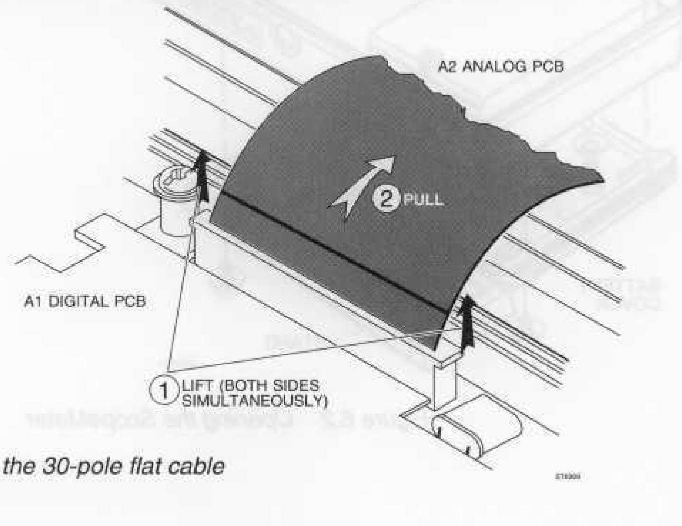



*Figure 6.3 Removing the 30-pole flat cable*

3. The digital A1 PCB and metal screening are secured to the top cover with four M3 Torx screws (item 33). Two of these screws contain small standoffs. Be sure to reinstall them in the correct place when the ScopeMeter is reassembled. Use a Torx screwdriver to remove the screws.

8. Remove the metal A1 screening from the digital A1 PCB.

9. Remove the digital A1 PCB from of the top cover. Be careful not to damage the infrared LED and phototransistor of the optical interface.

*NOTE: When reassembling the digital A1 PCB, make sure that the infrared LED and phototransistor are exactly aligned with the holes in the top cover.*

# 7 CORRECTIVE MAINTENANCE

## 7.1 DIAGNOSTIC TESTING AND TROUBLESHOOTING

### 7.1.1 Introduction

The ScopeMeter provides semimodular design to aid in troubleshooting. This section describes procedures needed to isolate a problem in a specific functional area. Finally, troubleshooting hints for each functional area are presented.

If the ScopeMeter fails, first verify that you are operating the ScopeMeter correctly by reviewing the Operation Verification Procedure found in the Users Manual.

**WARNING: Opening the case may expose hazardous voltages. Always disconnect the instrument from all voltage sources and remove the batteries before opening the case. Remember that repairs or servicing should be performed by qualified personnel only.**

### 7.1.2 Troubleshooting techniques

If a fault appears, the following test sequence can be used to help you to locate the defective component:

- Check to verify that the control settings of the instrument are correct. Consult the operating instructions in the Users Manual.
- Check the equipment to which the instrument is connected and check the interconnection cables.
- Verify that the instrument is properly calibrated. If it is not, refer to Chapter 5: "Calibration Adjustment Procedure".
- Locate the circuit(s) in which you suspect the fault: the symptom often suggests the faulty circuit. If the power supply is defective, the symptom may appear to be caused by several circuits.
- Check the circuit(s) in which you suspect the fault. Often it is possible to find faults such as cold or defective solder joints, intermittent or open interconnection plugs and wires or damaged components.

### 7.1.3 Display and error messages

To ease the ScopeMeter operation display messages are generated. If you operate the ScopeMeter incorrectly, it will display error messages. Each error message is displayed for 5 seconds.

The following table describes the display messages and error messages and the possible solutions. If no specific model number is stated, the message and solution apply to all ScopeMeter models.

| MESSAGE | CAUSE |
|---|---|
| **Key not possible in this ScopeMeter mode.** (SCOPE/METER mode) | You have pressed an incorrect key. For example: you have pressed the trigger key, while in meter mode. |
| Solution: Press a correct key. | |
| **Not executed: at least one trace on LCD** (SCOPE mode) | You have attempted to switch off the only displayed trace in the CHAN AB menu or WAVEFORM menu (Model 97). |
| Solution: Turn on another channel. | |
| **Not executed: already max. traces on LCD** (SCOPE mode) | (Model 97) You have attempted to turn on more than four traces simultaneously in the CHAN AB menu and the WAVEFORM menu. |
| Solution: Turn off another trace. | |
| **Chosen function changed other settings.** (SCOPE mode) | Sometimes some functions, for example events and n-cycle, can adapt (change) other ScopeMeter settings automatically. |
| Solution: Switch off the chosen function and check the settings. | |
| **Time base limit reached for present mode** (SCOPE mode) | The s TIME ns key has been pressed, forcing the timebase to exceed the limit. For example, if the limit of 100 ns in single trigger mode is exceeded. |
| Solution: Select RECURRENT trigger mode. | |
| **ScopeMeter auto shut down in 5 minutes!** (SCOPE/METER mode) | No new key has been activated in the last 10 minutes. To save battery power, the ScopeMeter shuts down. |
| Solution: Press a key. | |
| **ScopeMeter model 9x ; Vx.xx ; yy-yy-yy** (SCOPE/METER mode) | ScopeMeter "model number; software version; software date". Both softkeys 1 (left) and 5 (right) have been pressed at the same time. |
| Solution: - | |

**Scope mode: not more than 5 measurements**
(SCOPE mode)

You have attempted to switch on more than five cursor measurements simultaneously in the cursor function pop-up menu.

Solution: Turn off another cursor function.

**Unknown probe or wrong connection.**
(SCOPE/METER mode)

No probe or a defective probe has been connected during probe DC calibration.

Solution: Connect a correct probe and do another DC calibration. If the warning is still displayed, refer to the troubleshooting information of the Analog A2 PCB later in this section.

**No valid memory setup that can be used.**
(SCOPE mode)

You have tried to recall a waveform and the corresponding setup (Setup recall active), while a setup has not been saved for the stored waveform.

Solution: Choose a waveform for which there is a valid setup stored, or switch off the "Setup recall" function.

**Not executed: no 12V programming voltage**
(SCOPE/METER mode)

The CALIBRATE ScopeMeter softkey has been pressed in the SERVICE menu without the 12V programming voltage being connected to the programming contacts in the battery compartment.

Solution: Connect the 12V programming voltage, before pressing the CALIBRATE softkey.

*NOTE: Calibration is to be done by qualified service personnel. Incorrect calibration data is stored if 12V programming voltage is connected, while the CALIBRATE ScopeMeter mode is turned on. For calibration of the Scopemeter refer to chapter 5: "Calibration Adjustment Procedure".*

**CAL STORE error: no 12V or no space left**
(SCOPE/METER mode)

1. **No 12V**. The 12V programming voltage that is connected to the programming contacts in the battery compartment has disappeared during the calibration adjustments.

2. **No space left**. The internal Flash ROMs with the calibration constants are full.

Solution:
1. Check the 12V programming voltage connection in the battery compartment.
2. The calibration constants part in the Flash Roms must be emptied before other calibrations can be made. For refreshing the Flash ROMs, contact your nearest Fluke/Philips Service Center.

**PRINTER error: please reset printer.**
(SCOPE/METER mode, model 97 only)

No printing or the printing has stopped via the optically isolated RS- 232-C interface PM9080.

Solution: Check the settings on the printer (ON LINE and BAUD RATE). Reset the printer. Verify that if the optically isolated RS-232-C interface is still connected to the ScopeMeter.

**CALIBRATION error: wrong input signal(s)**
(SCOPE/METER mode)

The ScopeMeter has rejected the connected calibration adjustment signal during calibration.

Solution: Check the calibration signal and repeat the calibration step. If the signal is correct and the error message remains, refer to the troubleshooting information of the Analog A2 PCB later in this section.

**PROBE successfully calibrated.**
(SCOPE/METER mode)

The probe calibration has been successful.

**** ERROR *** PLEASE RESET INSTRUMENT *****
(SCOPE/METER mode)

General error message: something has gone wrong, which cannot be undone easily.

Solution: Switch off the ScopeMeter and switch it on again, using MASTER RESET: Press the LCD key and keep it pressed. Now press the ON/OFF key. The ScopeMeter will give two beeps and will start up in a default condition.

**No AUTOSET on time or att: no channels**
(SCOPE mode)

You have tried to do an AUTOSET, while both channels A and B were switched off (only waveforms in memory displayed!).

Solution: Switch on channel A and/or channel B before you activate AUTOSET.

**REF differs from present meter mode.**
(METER mode)

The settings of the ScopeMeter have been changed, so that previously determined references are not valid.

Solution: Set new references.

**PROBE CAL. Use AUTO SET to exit.**
(SCOPE/METER mode)

The ScopeMeter has been set into the AC ADJUST mode for channel A or B in the PROBE CAL popup menu.

Solution: AC adjust the probe and/or press the AUTO SET key.

**AUTO SET .. AUTO SET .. AUTO SET**
(SCOPE/METER mode)

The ScopeMeter performs an auto set after the AUTO SET key has been pressed.

Solution: Wait until the warning disappears (about 1 second). If the warning stays, refer to the troubleshooting information later in this section.

**Connect PROBE to GENERATOR OUT.**
(SCOPE/METER mode)

The AC ADJUST or the DC CAL item in the PROBE CAL pop up menu has been selected.

Solution: Connect a probe to the generator output and select AC ADJUST or DC CAL or wait for five seconds.

**DC PROBE calibration in progress**
(SCOPE/METER mode)

The DC CAL item in the PROBE CAL pop-up menu has been selected.

Solution: Wait until the warning disappears. A beep signals the end of the DC PROBE calibration. If the calibration has been successful, the message "PROBE successfully calibrated" will appear.

## 7.1.4 Main tests

### *7.1.4.1 Operation Verification Procedure*

This test verifies the ScopeMeter with a minimum of test steps and actions. It does not check every facet of the ScopeMeter's characteristics, but it gives you an indication of correct operation.

For operation verification purposes, the ScopeMeter generates a 975 Hz/ 5V peak-to-peak square wave signal that can be measured and verified. This signal is measured in the SCOPE and METER mode.

*NOTE: To use the ScopeMeter to its fullest capability it is essential to use only calibrated probes with your instrument. These calibrated probes are delivered with the ScopeMeter.*

Operation Verification Procedure:

1. Turn ON the ScopeMeter.
2. Connect the red 10:1 scope probe to channel A (red BNC) input.
3. Connect the red adjust adapter to the red banana GENERATOR OUTput connector.
4. Connect the red probe to the red banana/scope tip adapter.
5. Press the **SCOPE** key.
6. Press the **LCD/CAL** key.
7. Press the **PROBE CAL** softkey to select the CALibration & ADJUST pop-up menu.
8. Press the △ ▽ select/adjust keys to select AC ADJUST of channel A.
9. Press the **ENTER** softkey to enter the AC ADJUST mode.

- Check the **SCOPE** display on the following settings and results:

| | |
|---|---|
| Channel Configuration | Channel A |
| Vertical Amplitude | 1V/div |
| Channel Input Coupling | AC |
| Probe Selected | PROBE x10 |
| Time Base | 100 µs/div |
| Trigger Mode (Press **SCOPE** key) | Recurrent |
| Trigger Source (Press **TRIGGER** key) | Channel A |
| Trigger Slope (Press **TRIGGER** key) | + Slope |

Result (see Figure 7.1): Square wave,
Ampl 5V peak-to=peak ± 10%
Freq 976 Hz ± 1%

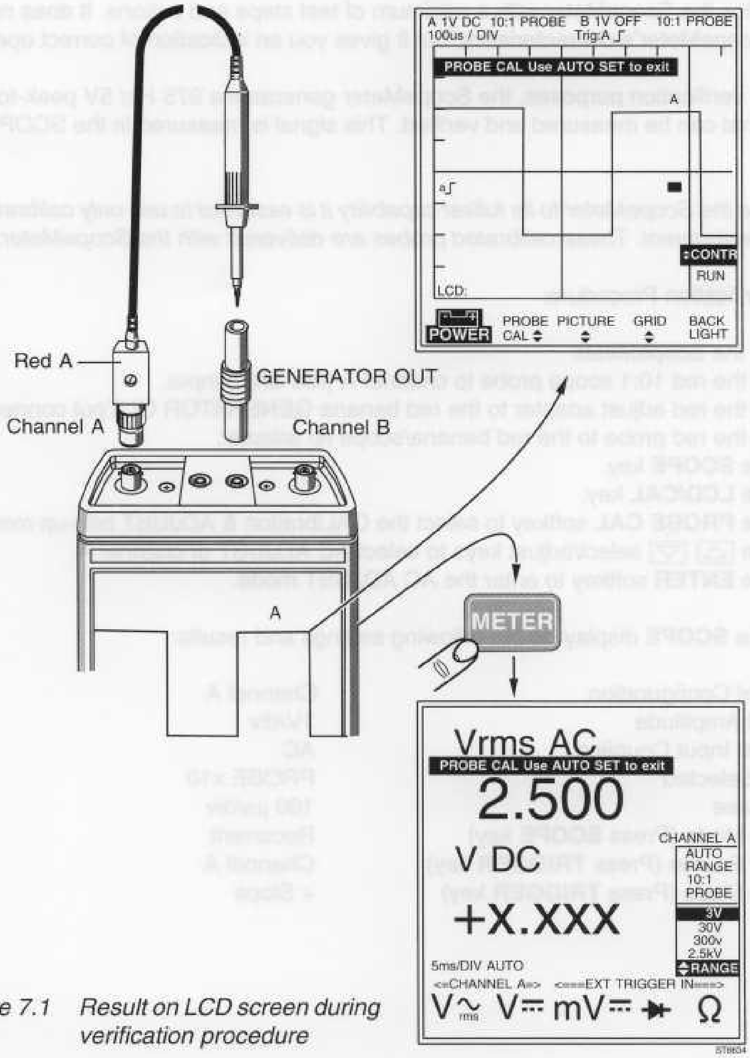



*Figure 7.1 Result on LCD screen during verification procedure*

10. Press the **METER** key.
    The ScopeMeter sets itself to the initial METER measurement function.

- Check the **METER** display on the following settings and results:
  Result (see Figure 7.1): Vrms AC 2.500 ±10%
  Ranging (see Figure 7.1): AUTO, 3V

11. Press the **AUTO SET** key to end the operation verification procedure for channel A.

*NOTE: To verify the SCOPE operation of Channel B, proceed in the same order as Channel A, use the grey channel B BNC socket and the grey 10:1 scope probe.*

*7.1.4.2 Performance Verification Procedure*

The Performance Verification Procedure is a very quick way to check most of the ScopeMeter's specifications. It is based on the specifications listed in Chapter 2 of this Service Manual. If the instrument fails of any of these tests, Calibration Adjustments (see chapter 5) and/or repair (see chapter 7) is necessary. The complete Performance Verification Procedure is described in chapter 4.

## 7.1.5 Troubleshooting

*7.1.5.1 Trouble shooting hints*

OPENING THE SCOPEMETER:
To troubleshoot the ScopeMeter, open the instrument as described in subsection 6.2.2 "Opening the ScopeMeter" of chapter 6 "DISASSEMBLING THE SCOPEMETER".

TEST POINT AND COMPONENTS LOCATION:
Added with the PCB layouts figures 10.1, 10.4, and 10.5 and the circuit diagrams figures 10.2, 10.3, 10,6, 10.7, and 10.8 are location reference lists for fast location of the test points and the components.

CONNECTING THE GROUND (ZERO) LOGIC 0 REFERENCE:
While performing measurements, it is possible to use the metal shielding as zero reference. It is also possible to install the metal screws, as is described in section 5.6.1 "Hardware SCOPE Calibration Adjustments". You can use one of the screws as a zero reference: refer to figure 5.2.

LOGIC 1 LEVEL:
The logic one level is +5V.

## 7.1.6 Digital A1 PCB Troubleshooting

First remove the digital A1 PCB as described in section 6.2.4 "Removing the digital PCB".

*7.1.6.1 Powering the ScopeMeter*

Power the ScopeMeter with the powerAdapter/Battery Charger PM8907.

*7.1.6.2 Kernel Test*

The Kernel tests the Address/Data outputs from the microprocessor (D1201), the interface transmitter and receiver circuits of the optical interface, and the Random Access Memories (RAM). The test results are measured with an oscilloscope.

*NOTE: If loading the ScopeMeters FlashROMs fails, it is possible to get a ScopeMeter which is not functioning. For example: if the operating system of the ScopeMeter is corrupted, it is not possible to operate the instrument normally. In this case you should also use the following procedure to establish communication with the ScopeMeter. When communication is established, you can reload the operating software into the FlashROMs. (For this action you need special software: contact your nearest Fluke/Philips Service Center.)*

1. Power the ScopeMeter with the Power Adapter/Battery Charger PM8907.

2. Ground testpoint TP216, turn on the ScopeMeter and release the ground (from testpoint TP216).

***MICROPROCESSOR D1201***

3. Measure on connector contact X1201/6 to test the microprocessor D1201.
   Correct = 0.5 Hz.
   Incorrect (defect microprocessor D1201) = not 0.5 Hz.

***OPTICAL INTERFACE***

4. Shine with a lamp in the "Optical Interface" holes to test the optical interface receiver.

5. Measure on the transceiver line D1201/32.
   Apply light and verify that the signal level changes from 0V DC (dark) to 0.3V DC (light).

***ADDRESS/DATA LINES***

6. Measure on address/data bus 00 (AD00, D1201/2).
   Correct = Logic 0.
   All other address data lines (AD01 to AD15) are logic 1 (+5V).

7. Ground and release testpoint TP217 (first time) and the next address/data AD01 line will go low (to logic 0).
   Continue grounding and releasing testpoint TP217 until address/data line AD15 goes low (fifteenth time).
   With steps 6 and 7 the buffered addresses throughout the whole instrument are active and can be traced.

***RAMS D1204 AND D1206.***

8. The next grounding of testpoint TP217 (sixteenth time) starts the RAM test of the first RAM D1204. Measure on connector contact X1201/6.
   During the RAM test connector contact starts at logic 0.
   RAM correct = 0.5 Hz.
   RAM incorrect = logic 1.

9. Ground and release testpoint TP217 (seventeenth time) to start the RAM test of the second RAM D1206. Measure on connector contact X1201/6.
   During the RAM test connector contact X1201/6 starts at logic 0.
   RAM correct = 0.5 Hz.
   RAM incorrect = logic 1.

***ESTABLISHING COMMUNICATION.***

10. After the seventeenth time of grounding TP217, the ScopeMeter sends an <XON> via the RS-232 interface. Now communication is established, it is possible to reprogram the FlashROMs. For special software contact your nearest Fluke/Philips Service Center.

11. Ground testpoint TP216 one more time to abort the Kernel Test.

### *7.1.6.3 Test point signals.*

The digital A1 PCB is provided with test points, marked: "TP" See figure 10.1: A1 PCB layout (component side). These can be used to check correct functioning of the PCB.

All measurements are made in the default MASTER RESET condition (start the measurements in the ScopeMeter using **MASTER RESET**).

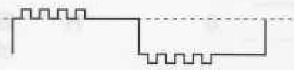
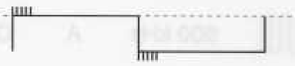
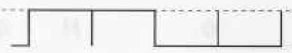
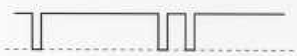
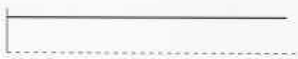
A MASTER RESET is performed as follows:

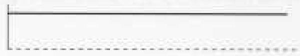
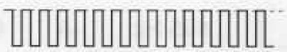
1. Remove all signals from the ScopeMeter.
2. Turn off the ScopeMeter.
3. Hold down the LCD key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The ScopeMeter is automatically set to the METER mode.

Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the test points. See table 7.1:

*Table 7.1. Overview on Test Points on the digital A1 PCB.*

Logic 0=0V, Logic 1=+5V

| TP | Name | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 207 | Y40 |  | 595 Hz | A | Output 40, D1404 |
| 208 | Y120 |  | 595 Hz | A | Output 120, D1406 |
| 209 | Y200 |  | 595 Hz | A | Output 200, D1407 |
| 210 | X40 |  | 595 Hz | A | Output 40, D1401 |
| 211 | X120 |  | 595 Hz | A | Output 120, D1402 |
| 212 | X200 |  | 595 Hz | A | Output 200, D1403 |
| 213 | WEN |  | | A | Write Enable Not, point 10 of D1203 |
| 214 | REN |  | | A | Read Enable Not, point 11 of D1203 |
| 216 | TEST1 |  | 0 | H | TEST 1/analog channel 3, point 16 of D1201 |
| 217 | TEST2 |  | 12.1 kHz | A | TEST 2/timer 2 clock, point 64 of D1201 |
| 219 | ON_OFF |  | 0 | L | ON OFF/high speed input 0.2, point 53 of D1201 |
| 221 | POWER_ON |  | 0 | H | POWER ON |

| TP | Name | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 222 | NOT_ON |  | 0 | L | NOT ON |
| 223 | RAM_POWER |  | 0 | H | RAM POWER |
| 224 | +VRAM |  | 0 | H | +Supply Voltage for the RAM/... |
| 233 | V1 |   | 0 | H | Power supply for LCD drive (+2.3V) |
| 234 | V2 |   | 0 | L | Power supply for LCD drive (-23V) |
| 235 | V3 |   | 0 | L | Power supply for LCD drive (-0.8V) |
| 237 | V5 |   | 0 | L | Power supply for LCD drive (-22V) |
| 239 | µPCLK |  | 12.5 MHz | A | µProcessor clock, point 9 of D1201 |
| 241 | BAT_LEVEL |  | 0 | H | BATtery LEVEL/analog channel 6, point 20 of D1201 |
| 244 | RAMSELN |  | | A | RAM SELect Not, point 20 of D1204 |
| 246 | OPTSELN |  | 500 kHz | A | Option Select Not |
| 247 | A15 |  | 100 kHz | A | .../ROM 1 select not |
| 248 | -20V |  | 0 | H | -20V supply |
| 249 | +5V |  | 0 | H | +5V supply |

*7.1.6.4 Default signals measured in the digital circuits.*

The Digital A1 PCB is provided with large integrated circuits. For testing the board, the input signals and output signals of the large integrated circuits are given in tables 7.2 up to 7.5. and the corresponding figures. These signals can be used to check correct functioning of the large Integrated Circuits on the digital A1 PCB.

All measurements are made in the default MASTER RESET condition (start the measurements in the ScopeMeter using **MASTER RESET**).

A MASTER RESET is performed as follows:

1. Remove all signals from the ScopeMeter.
2. Turn off the ScopeMeter.
3. Hold down the LCD key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The ScopeMeter is automatically set to the Meter mode.

Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the integrated circuits.

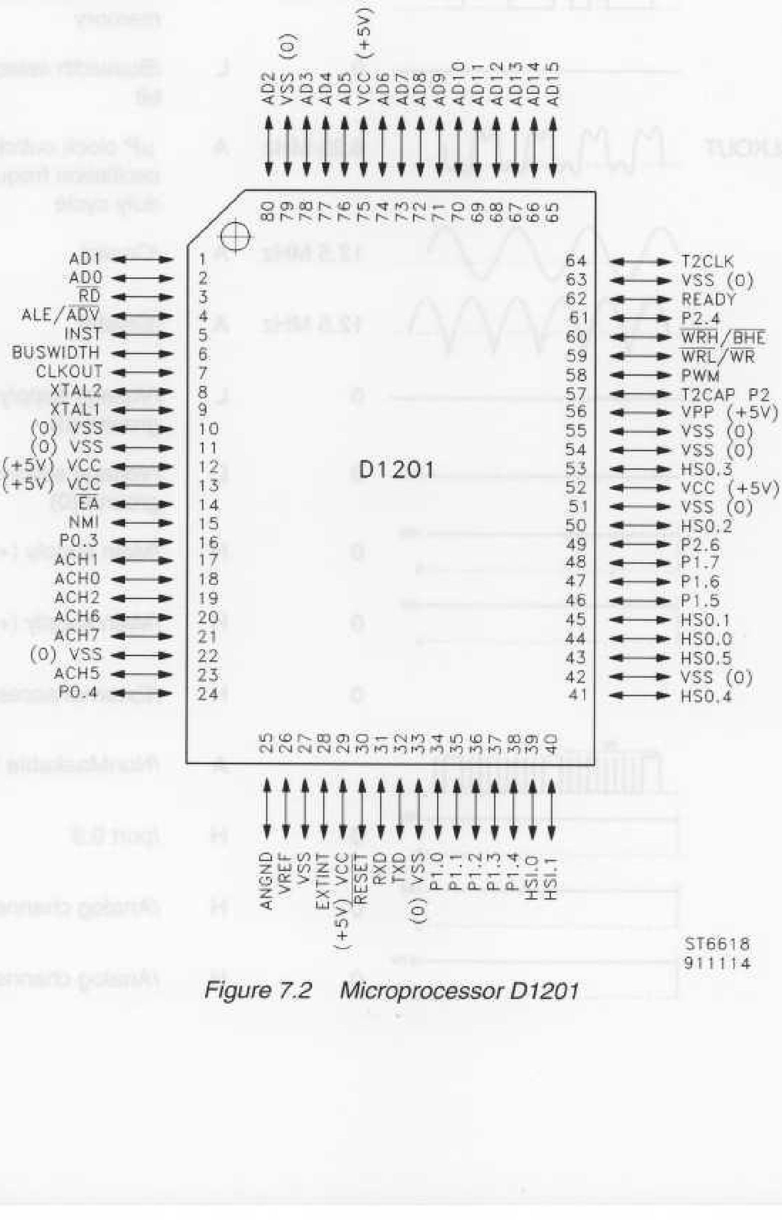
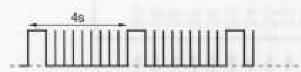
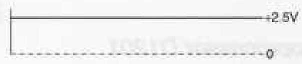



*Figure 7.2 Microprocessor D1201*

*Table 7.2 Signals measured on microprocessor D1201.*

Logic 0=0V, Logic 1=+5V

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| **D1201** | | | | | |
| 1 | AD01 /AD1/P3 |  | 1.5 MHz | A | Address Data1/Address Data1 port3 |
| 2 | AD00 /AD0/P3 |  | 2 MHz | A | Address Data0/Address Data0 port3 |
| 3 | RDIN /$\overline{RD}$ |  | 2 MHz | A | Read not/Read |
| 4 | ADVN /ALE/$\overline{ADV}$ |  | 2 MHz | A | Address valid not/Address latch enable/Address valid output |
| 5 | /INST |  | 200 kHz | A | /Instruction fetch for external memory |
| 6 | /BUSWIDTH | | 0 | L | /Buswidth selection, 8 or 16 bit |
| 7 | μPCLKOUT/CLKOUT |  | 6.25 MHz | A | μP clock out/clock out 1/2 oscillation frequency 50% duty cycle |
| 8 | /X-TAL2 |  | 12.5 MHz | A | /Crystal |
| 9 | /X-TAL1 |  | 12.5 MHz | A | /Crystal |
| 10 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 11 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 12 | /VCC |   | 0 | H | /Main supply (+5V) |
| 13 | /VCC |   | 0 | H | /Main supply (+5V) |
| 14 | /$\overline{EA}$ | | 0 | H | /External access |
| 15 | /NMI |   | | A | /NonMaskable Interrupt |
| 16 | /PO.3 |   | 0 | H | /port 0.3 |
| 17 | /ACH1 |   | 0 | H | /Analog channel 1 |
| 18 | /ACH0 |   | 0 | H | /Analog channel 0 |

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 19 | /ACH2 | | 0 | H | /Analog channel 2 |
| 20 | /ACH6 | | 0 | H | /Analog channel 6 |
| 21 | /ACH7 | | 0 | A | /Analog channel 7 |
| 22 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 23 | /ACH5 | | 0 | L | /Analog channel 5 |
| 24 | HLDOFN/ACH4 | | | H | /A Hold off not /Analog channel 4 |
| 25 | /ANGND | | 0 | L | /Analog ground (A/D convertor) |
| 26 | /VREF | | 0 | H | /Vreference (A/D convertor) |
| 27 | /VSS | | 0 | L | /Clock Detect Enable |
| 28 | ACQRDY/EXTINT | | 5 Hz | A | Acquisition ready/External interrupt |
| 29 | /VCC | | 0 | H | /Main supply (+5V) |
| 30 | µPRESET/RESET | | 0 | H | µP reset /reset |
| 31 | /RXD | | 0 | H | /Receive data/port 2 |
| 32 | /TXD | | 0 | H | /Transmit data/port 2 |
| 33 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 34 | CDAT /P1.0 | | 5 Hz | A | Cbus DATA /Port 1.0 |
| 35 | DTAEb/P1.1 | | 0 | L | DATA enable /Port 1.1 |
| 36 | FRONTCLOCK/P1.2 | | 60 kHz | A | Front clock /Port 1.2 |
| 37 | CCLK /P1.3 | | 100 kHz | A | Cbus clock /Port 1.3 |
| 38 | PS0 /P1.4 | | 40 Hz | A | page select 0 /Port 1.4 |
| 39 | FRONTDATA1/HS1.0 | | 0 | H | Frontdata1 /High speed input 1.0 |

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 40 | FRONTDATA2/HS1.1 | +5V 0 | 0 | H | Frontdata2 /High speed input 1.1 |
| 41 | /HS0.4 | | 400 Hz | A | /High Speed input 0.4 |
| 42 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 43 | AD15 /HS0.5 | | | L/A | Address data 15/High Speed input 0.5 |
| 44 | LIGHT/HS0.0 | | 0 | L | Light /High Speed input 0.0 |
| 45 | /HS0.1 | | 0 | L | /High Speed input 0.1 |
| 46 | PS1 /P1.5 | | 0 | L | page select 1 /port 1.5 |
| 47 | PS2 /P1.6 | | 45-1.5 kHz | A | page select 2 /port 1.6 |
| 48 | PS3 /P1.7 | | 45-1.5 kHz | A | page select 3 /port 1.7 |
| 49 | DTAEC/P2.6 | | 0 | L | Data enable C /port 2.6 |
| 50 | /HS0.2 | | 0 | L | /High Speed input 0.2 |
| 51 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 52 | /VCC | +5V 0 | 0 | H | /Main supply (+5V) |
| 53 | ON OFF/HS0.3 | | 0 | L | on off /High Speed input 0.2 |
| 54 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 55 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 56 | /VPP | +5V 0 | 0 | H | / (+5V) |
| 57 | FRONT LATCH /T2CAP/P2 | | | H/A | Front latch / |
| 58 | TEST2/PWM | | 12 kHz | A | Test 2 /Pulse width modulator |
| 59 | WRIN /$\overline{WRL}$/$\overline{WR}$ | | 2.08 MHz | A | Write not /Write low/Write |
| 60 | /$\overline{WRH}$/$\overline{BHE}$ | | 2.08 MHz | A | /Write high, Bus High Enable |

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 61 | ADC7 /P2.4 | | | A | Analog digital convertor/ port 2.4 |
| 62 | SYNCRDY/READY | | 2 MHz | A | Synchronisation ready/Ready |
| 63 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 64 | TEST2/T2CLK | | 12 kHz | A | Test 2 /Timer 2 clock |
| 65 | AD15 /AD15 | | 100 kHz | A | Address data 15/Address data 15 |
| 66 | AD14 /AD14 | | 100 kHz | A | Address data 14/Address data 14 |
| 67 | AD13 /AD13 | | 100 kHz | A | Address data 13/Address data 13 |
| 68 | AD12 /AD12 | | 100 kHz | A | Address data 12/Address data 12 |
| 69 | AD11 /AD11 | | 100 kHz | A | Address data 11/Address data 11 |
| 70 | AD10 /AD10 | | 100 kHz | A | Address data 10/Address data 10 |
| 71 | AD09 /AD | | 100 kHz | A | Address data 09/Address data 09 |
| 72 | AD08 /AD | | 100 kHz | A | Address data 08/Address data 08 |
| 73 | AD07 /AD | | 1-2 MHz | A | Address data 07/Address data 07 |
| 74 | AD06 /AD | | 1-2 MHz | A | Address data 06/Address data 06 |
| 75 | /VCC | +5V 0 | 0 | H | /Main supply (+5V) |
| 76 | AD05 /AD | | 1.5 MHz | A | Address data 05/Address data 05 |
| 77 | AD04 /AD | | 1.5 MHz | A | Address data 04/Address data 04 |
| 78 | AD03 /AD | | 1.5 MHz | A | Address data 03/Address data 03 |
| 79 | /VSS | | 0 | L | /Voltage supply ground (0) |
| 80 | AD02 /AD2 | | 1.5 MHz | A | Address data 02/Address data 02 |

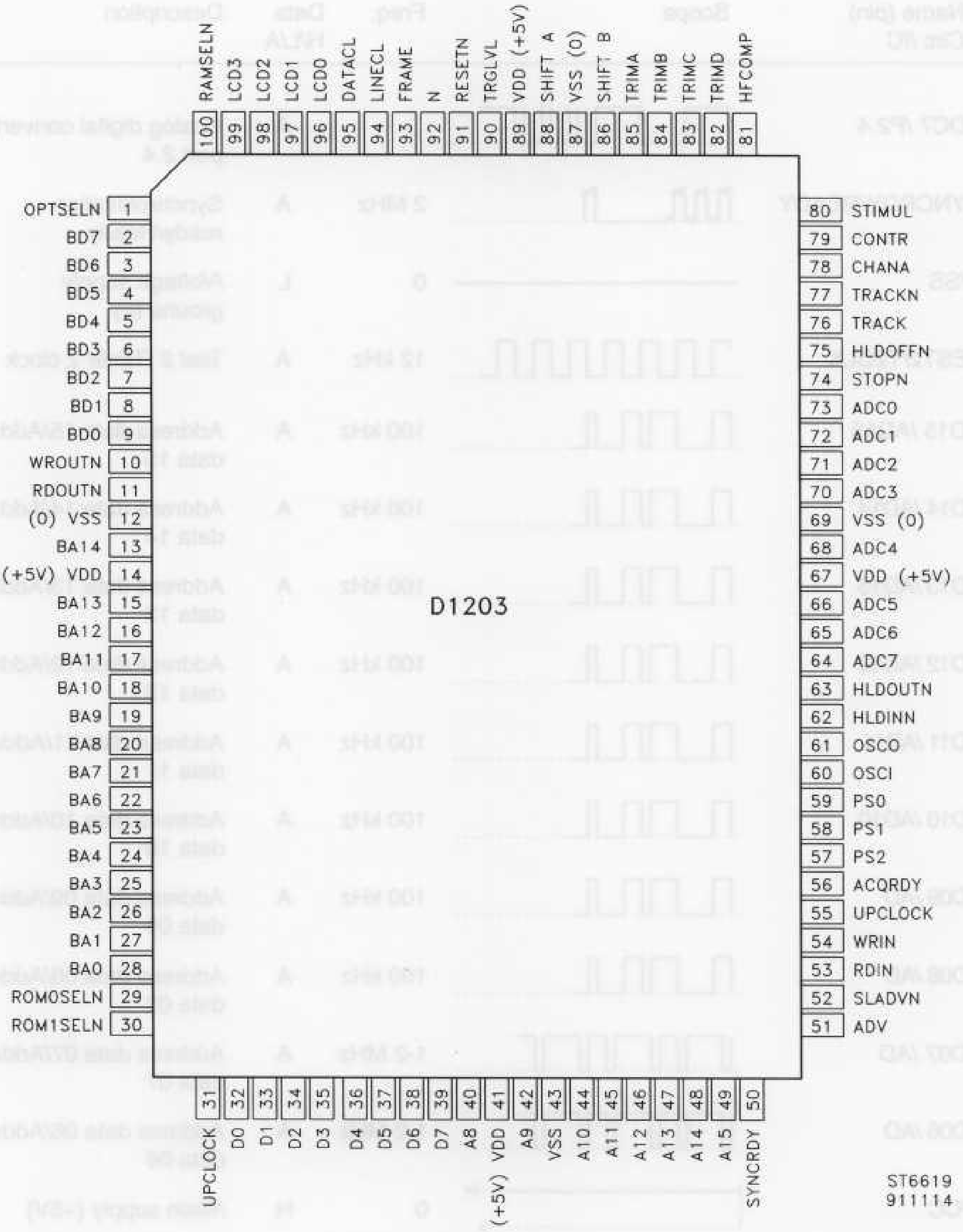
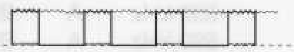


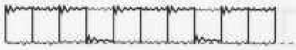
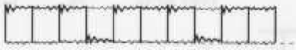
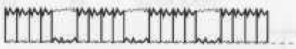
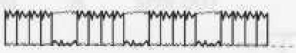

*Figure 7.3 Digital ASIC D1203*

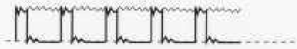
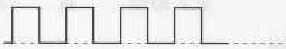
*Table 7.3 Signals measured on digital ASIC D1203.*

Logic 0=0V Logic 1=+5V

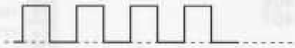
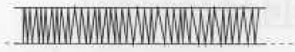
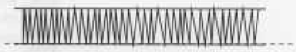
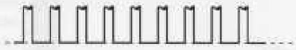
| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| **D1203** | | | | | |
| 1 | /OPTSELN |  | 499.8 kHz | A | Optional RAM Select Not |

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 2 | BD07/BD7 | Unstable  | 100 kHz | A | Buffered Data |
| 3 | BD06/BD6 | Unstable  | 100 kHz | A | Buffered Data |
| 4 | BD05/BD5 | Unstable  | 100 kHz | A | Buffered Data |
| 5 | BD04/BD4 | Unstable  | 100 kHz | A | Buffered Data |
| 6 | BD03/BD3 | Unstable  | 100 kHz | A | Buffered Data |
| 7 | BD02/BD2 | Unstable  | 100 kHz | A | Buffered Data |
| 8 | BD01/BD1 | Unstable  | 100 kHz | A | Buffered Data |
| 9 | BD00/BD0 | Unstable  | 100 kHz | A | Buffered Data |
| 10 | WEN/WROUTN | Unstable  | 32 kHz | A | Write Enable Not/Write Out Not |
| 11 | REN/RDOUTN | Unstable  | 1.4995 MHz | A | Read Enable Not/Read Out Not |
| 12 | VSS | | 0 | L | Volt Supply ground |
| 13 | BA14/BA14 | Unstable  | 200 kHz | A | Buffered Address |
| 14 | +5VD/VDD |  | 0 | H | Volt Supply |
| 15 | BA13/BA13 | Unstable  | 635 kHz | A | Buffered Address |
| 16 | BA12/BA12 | Unstable  | 635 kHz | A | Buffered Address |
| 17 | BA11/BA11 | Unstable  | 635 kHz | A | Buffered Address |

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 18 | BA10/BA10 | Unstable  | 635 kHz | A | Buffered Address |
| 19 | BA09/BA9 | Unstable  | 635 kHz | A | Buffered Address |
| 20 | BA08/BA8 | Unstable  | 635 kHz | A | Buffered Address |
| 21 | BA07/BA7 | Unstable  | 616 kHz | A | Buffered Address |
| 22 | BA06/BA6 | Unstable  | 616 kHz | A | Buffered Address |
| 23 | BA05/BA5 | Unstable  | 616 kHz | A | Buffered Address |
| 24 | BA04/BA4 | Unstable | 590 kHz | A | Buffered Address |
| 25 | BA03/BA3 | Unstable | 599 kHz | A | Buffered Address |
| 26 | BA02/BA2 | Unstable | 599 kHz | A | Buffered Address |
| 27 | BA01/BA1 | Unstable | 599 kHz | A | Buffered Address |
| 28 | BA00/BA0 | Unstable  | 624 kHz | A | Buffered Address |
| 29 | CEN/ROM0SELN | 1 | 0 | H | ......../Rom 0 Select Not |
| 30 | A15/ROM1SELN | 1 | 0 | H | Address 15/Rom 1 Select Not |
| 31 | UPCLOCK |  | 12.496 MHz | A | Micro-processor Clock |
| 32 | AD00/D0 | 0 | 0 | O | Address Data/Data Bus I/O 0 |
| 33 | AD01/D1 | 0 | 0 | O | Address Data/Data Bus I/O 1 |
| 34 | AD02/D2 | 0 | 0 | O | Address Data/Data Bus I/O 2 |
| 35 | AD03/D3 | 0 | 0 | O | Address Data/Data Bus I/O 3 |
| 36 | AD04/D4 | 0 | 0 | O | Address Data/Data Bus I/O 4 |
| 37 | AD05/D5 | 0 | 0 | O | Address Data/Data Bus I/O 5 |
| 38 | AD06/D6 | 0 | 0 | O | Address Data/Data Bus I/O 6 |
| 39 | AD07/D7 | 0 | 0 | O | Address Data/Data Bus I/O 7 |
| 40 | AD08/D8 | 0 | 0 | O | Address Data/Data Bus I/O 8 |
| 41 | +5VD/VDD | 1 | 0 | H | Volt Supply |
| 42 | AD09/D9 | 0 | 0 | O | Address Data/Data Bus I/O 9 |
| 43 | ..../VSS | 0 | 0 | L | Volt Supply Ground |
| 44 | AD10/A10 | 0 | 0 | O | Address Data/Data Bus I/O 10 |
| 45 | AD11/A11 | 0 | 0 | O | Address Data/Data Bus I/O 11 |
| 46 | AD12/A12 | 0 | 0 | O | Address Data/Data Bus I/O 12 |
| 47 | AD13/13 | 0 | 0 | O | Address Data/Data Bus I/O 14 |
| 48 | AD14/A14 | 0 | 0 | O | Address Data/Data Bus I/O |
| 49 | AD15/A15 | 0 | 0 | O | Address Data/Data Bus I/O 15 |
| 50 | SYNCRDY /SYNCRDY | 0 | 0 | O | Synchronisation ready |

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 51 | ADVN/ADVN | Unstable  | 1.200 MHz | A | Address Valid Not |
| 52 | SLADVN | 1 | 0 | H | Slow Address Valid Not (not used) |
| 53 | RDIN/RDIN | Unstable  | 1.200 MHz | A | Read In |
| 54 | WRIN/WRIN | Unstable  | 33 kHz | A | Write In |
| 55 | UPCLOCK/UPCLOCK |  | 6.248 MHz | A | Micro Processor Clock |
| 56 | ACQRDY/ACQRDY |  | 5Hz | A | Acquisition Ready |
| 57 | PS2/PS2 | Unstable  | 130 Hz | A | Page Select 2 |
| 58 | PS1/PS1 |  | 0 | O | Page Select 1 |
| 59 | PS0/PS0 | Unstable  | 125 Hz | A | Page Select 0 |
| 60 | .../OSCI |  | 25 MHz | X | Oscillator In |
| 61 | .../OSCO |  | 25 MHz | X | Oscillator Out |
| 62 | /HLDINN | Unstable  | 5 Hz | A | Hold In Not |
| 63 | /HLDOUTN | Unstable  | 5 Hz | A | Hold Out Not |
| 64 | ADC7/ADC7 | Unstable  | 100 Hz | A | ADC data output 7 |
| 65 | ADC6/ADC6 | Unstable  | 100 Hz | A | ADC data output 6 |
| 66 | ADC5/ADC5 | Unstable  | 100 Hz | A | ADC data output 5 |
| 67 | +5VD/VDD |   | 0 | H | Volt Supply |

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 68 | ADC4/ADC4 | Unstable | 100 Hz | A | ADC data output 4 |
| 69 | .../VSS | 0 | 0 | L | Volt Supply Ground |
| 70 | ADC3/ADC3 | Unstable | 500 Hz | A | ADC data output 3 |
| 71 | ADC2/ADC2 | Unstable | 1 kHz | A | ADC data output 2 |
| 72 | ADC1/ADC1 | Unstable | 2.5 kHz | A | ADC data output 1 |
| 73 | ADC0/ADC0 | Unstable | 2.7 kHz | A | ADC data output 0 |
| 74 | STOPN/STOPN | Unstable | 5 Hz | A | Acquisition Stop Not |
| 75 | HLDOFFN /HLDOFFN | Unstable | 5 Hz | A | Trigger Hold Off Not |
| 76 | TRACK/TRACK | Unstable | 11 kHz | A | Track (acquisition clock ADC) |
| 77 | .../TRACKN | not used | | | Track |
| 78 | CHANA/CHANA | 1 | 0 | H | Channel A |
| 79 | CONTR/CONTR | | 4.88 kHz | A | Contrast |
| 80 | STIMUL/STIMUL | | 976 Hz | A | Stimulus output |
| 81 | HF-COMP/HFCOMP | Unstable | 4.882 kHz | A | High Frequency Compensation (32 digit zero meter correction) |
| 82 | TRIMD/TRIMD | | 4.882 kHz | A | Trimming output D |
| 83 | .../TRIMC | | 0 | L | Trimming output C |
| 84 | .../TRIMB | | 4.882 kHz | A | Trimming output B (not used) |
| 85 | .../TRIMA | | 4.882 kHz | A | Trimming output A (not used) |
| 86 | POS-CHB/SHIFTB | | 4.882 kHz | A | Position-Channel B/Shift channel B |

| Comp | Name (pin) Circ /IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 87 | .../VSS | Logic 0=0V | 0 | L | Voltage Supply Ground |
| 88 | POS-CHA/SHIFTA |  | 4.882 kHz | A | Position Channel A/Shift channel A |
| 89 | +5VD/VDD |  | 0 | H | Volt Supply |
| 90 | LEVEL/TRGLVL |  | 4.882 kHz | A | Level/Trigger Level |
| 91 | RESETN/RESETN |  | 0 | H | Reset Not |
| 92 | M/M |  | 35 Hz | A | Multiplex LCD |
| 93 | FRAME/FRAME |  | 70 Hz | A | Frame clock |
| 94 | LINECL/LINECL |  | 16.66 kHz | A | Line Clock |
| 95 | DATACL/DATACL |  | 999.6 kHz | A | Data Clock |
| 96 | D0/LCD0 | Unstable  | 60 kHz | A | Data 0/Liquid Crystal Display D0 |
| 97 | D1/LCD1 | Unstable  | 60 kHz | A | Data 1/Liquid Crystal Display D1 |
| 98 | D2/LCD2 | Unstable  | 58 kHz | A | Data 2/Liquid Crystal Display D2 |
| 99 | D3/LCD3 | Unstable  | 58 kHz | A | Data 3/Liquid Crystal Display D3 |
| 100 | .../RAMSELN |  | 999.6 kHz | A | Ram Select Not |

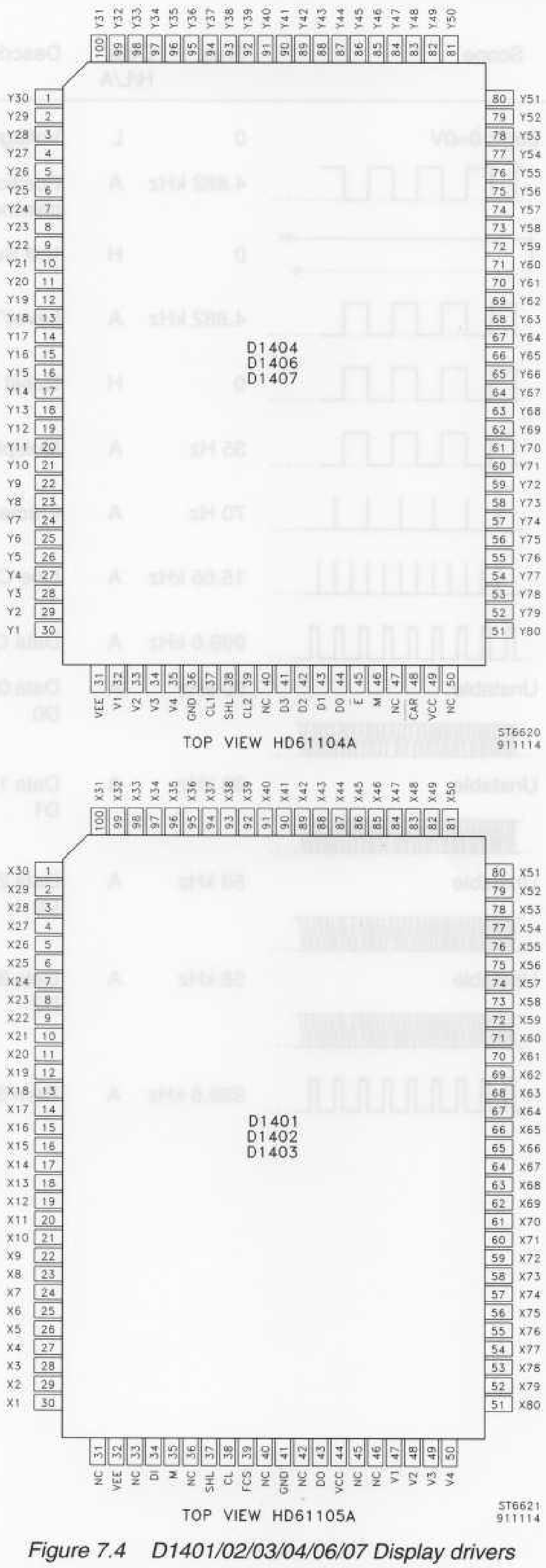
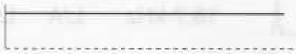
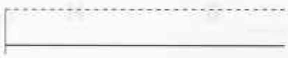



*Figure 7.4 D1401/02/03/04/06/07 Display drivers*

*Table 7.4 Signals measured on display drivers D1401/02/03.*

Logic 0=0V Logic 1=+5V

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| **D1401/D1402/D1403** | | | | | |
| 31 | NC | | 0 | L | Not Connected |
| 32 | -20V /VEE |   | 0 | H | Power supply |
| 33 | NC | | 0 | L | Not Connected |
| 34 | FRAME/DI |  | 70 Hz | A | .../shift register Data Input |
| 35 | M /M |  | 34.7 Hz | A | Signal to convert LCD driver signalinto AC |
| 36 | NC | | 0 | L | Not Connected |
| 37 | /SHL | | 0 | L | Select shift direction |
| 38 | /CL |  | 16.7 kHz | A | shift CLock |
| 39 | /FCS | | 0 | L | shift clock phase |
| 40 | NC | | 0 | L | Not Connected |
| 41 | GND | | 0 | L | GROUND (0V) |
| 42 | NC | | 0 | L | Not Connected |
| 43 | /DO |  | 70 Hz | A | shift register Data Output |
| 44 | VCC |   | 0 | H | Volt supply (+5V) |
| 45 | NC | | 0 | L | Not Connected |
| 46 | NC | | 0 | L | Not Connected |
| 47 | V1 /V1 |  | 0 | H | Power supply for LCD drive |
| 48 | V2 /V2 |  | 0 | H | Power supply for LCD drive |
| 49 | V5 /V5 |  | 0 | H | Power supply for LCD drive |

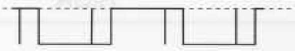
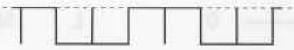
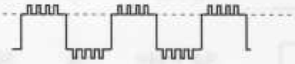
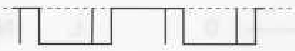
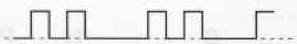
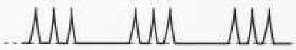
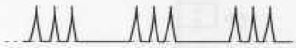
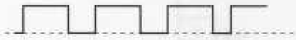
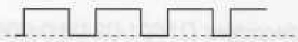
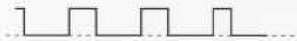
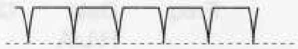
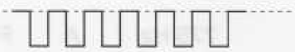
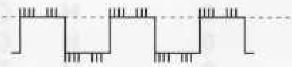
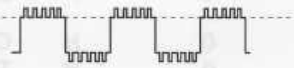
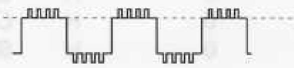
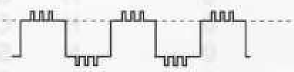
| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 50 | V6 /V6 | | 0 | H | Power supply for LCD drive |
| 5 | X26 /X26<br>X106 /X26<br>X186 /X26 |  | 34.7 Hz | A | Liquid crystal driver output 5 |
| 21 | X10 /X10<br>X90 /X10<br>X170 /X10 |  | 34.7 Hz | A | Liquid crystal driver output 21 |
| 55 | X76 /X76<br>X156 /X76<br>X236 /X76 |  | 34.7 Hz | A | Liquid crystal driver output 55 |
| 79 | X52 /X52<br>X132 /X52<br>X212 /X52 |  | 34.7 Hz | A | Liquid crystal driver output 79 |
| 96 | X35 /X35<br>X115 /X35<br>X195 /X35 |  | 34.7 Hz | A | Liquid crystal driver output 96 |

*Table 7.5 Signals measured on display drivers D1404/06/07.*

Logic 0=0V Logic 1=+5V

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| **D1404/D1406/D1407** | | | | | |
| 31 | -20V /VEE | | 0 | H | Power supply (-20V) |
| 32 | V1 /V1 | | 0 | H | Power supply for LCD drive |
| 33 | V2 /V2 | | 0 | H | Power supply for LCD drive |
| 34 | V3 /V3 | | 0 | H | Power supply for LCD drive |
| 35 | V4 /V4 | | 0 | H | Power supply for LCD drive |
| 36 | /GND | | 0 | L | GROUND (0V) |
| 37 | LINECL/CL1 |  | 16.7 kHz | L/A | LINE CLock/Latch Clock 1 |
| 38 | /SHL | | 0 | H | .../SHift direction |
| 39 | DATACL/CL2 |  | 833 kHz | A | .../shift CLock 2 |
| 40 | NC | | 0 | L | Not Connected |
| 41 | D0 /D3 |  | 16.7 kHz | A | |

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 42 | D1 /D2 |  | 41.6 kHz | A | |
| 43 | D2 /D1 |  | 112 kHz | A | |
| 44 | D3 /D0 |  | 100 kHz | A | |
| 45 | /E_N D1404 |  | 16.7 kHz | A | .../Enable input |
| | /E_N D1406 |  | 16.7 kHz | A | .../Enable input |
| | /E_N D1607 | | 0 | L | .../Enable input |
| 46 | M /M |  | 34.7 Hz | A | switch signal to convert LCD drive waveform in AC |
| 47 | NC | | 0 | L | Not Connected |
| 48 | /CAR_N D1404 |  | 16.7 kHz | H/A | Enable output for cascade connection |
| | /CAR_N D1406 |  | 16.7 kHz | H/A | Enable output for cascade connection |
| | /CAR_N D1407 |  | 16.7 kHz | H/A | Enable output for cascade connection |
| 49 | /VCC |  | 0 | H | Power supply (+5V) |
| 50 | NC | | 0 | L | Not Connected |
| 5 | Y26 /Y26<br>Y106 /Y26<br>Y186 /Y26 |  | 35 Hz | A | Liquid crystal driver output 5 |
| 21 | Y10 /Y10<br>Y90 /Y10<br>Y170 /Y10 |  | 35 Hz | A | Liquid crystal driver output 21 |
| 55 | Y76 /Y76<br>Y156 /Y76<br>Y236 /Y76 |  | 35 Hz | A | Liquid crystal driver output 55 |
| 79 | Y52 /Y52<br>Y132 /Y52<br>Y212 /Y52 |  | 35 Hz | A | Liquid crystal driver output 79 |
| 96 | Y35 /Y35<br>Y115 /Y35<br>Y195 /Y35 |  | 35 Hz | A | Liquid crystal driver output 96 |

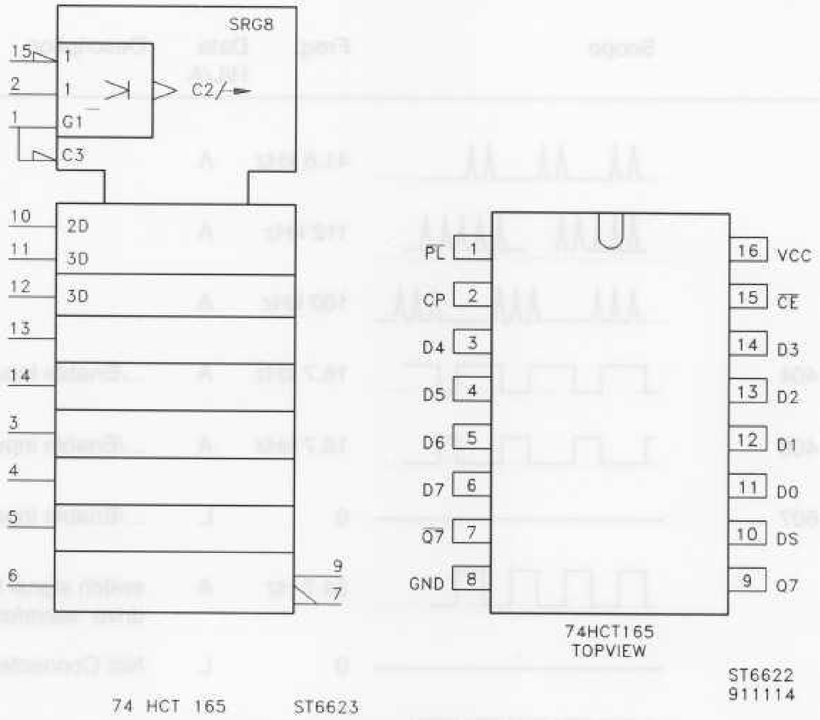



*Figure 7.5 Keyboard decoders D1601/02/03/04/06*

*Table 7.6 Signals measured on keyboard decoders D1601/02/03/04/06.*

Logic 0=0V Logic 1=+5V

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| **D1601/D1602/D1603/D1604/D1606** | | | | | |
| 1 | FRONT-LATCH/G1 | Unstable | 34 Hz | A | FRONT LATCH signal |
| 2 | FRONT-CLOCK/>1 | Unstable | 775 Hz | A | FRONT CLOCK signal |
| 3 | CURSOR2-L/... | D1601 | 0 | H | CURSOR2-Left key |
| | B-MOVE-UP/... | D1602 | 0 | H | Channel B-MOVE-UP key |
| | CURSOR1-R/... | D1603 | 0 | H | CURSOR1-Right key |
| | TIME-ns/... | D1604 | 0 | H | TIME-ns key |
| | LCD/... | D1606 | 0 | H | Liquid Crystal Display key |
| 4 | CURSOR1-L/... | | 0 | H | CURSOR1-Left key |
| | TIME-s/... | | 0 | H | TIME-s key |
| | SOFT-5/... | | 0 | H | Soft key -5 |
| | A-MOVE-UP/... | | 0 | H | Channel A-MOVE-UP key |
| | SPECIAL/.... | | 0 | H | SPECIAL FUNCTion key |
| 5 | SOFT-4/... | | 0 | H | Soft key -4 |
| | A-mV/... | | 0 | H | Channel A-mV key |
| | SOFT-3/... | | 0 | H | Soft key -3 |
| | B-AC/DC/... | | 0 | H | Channel B-AC/DC/GROUND key |
| | HOLD/RUN/... | | 0 | H | HOLD/RUN |

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 6 | SOFT-2/... | | 0 | H | Soft key -2 |
| | CHAN-A/B/... | | 0 | H | CHANnel A/B key |
| | SOFT-1/... | | 0 | H | Soft key -1 |
| | TRIGGER/... | | 0 | H | TRIGGER key |
| | SETUP/... | | 0 | H | SETUP key |
| 7 | not used | | 0 | L | not used |
| 8 | VSS | Logic 0=0V | 0 | L | Volt Supply ground |
| 9 | FRONT-DATA2/... | | 0 | H | FRONT-DATA block 2 |
| | D1602/9 connected to D1601/10 | | 0 | H | |
| | FRONT-DATA1/... | | 0 | H | FRONT-DATA block 1 |
| | D1604/9 connected to D1603/10 | | 0 | H | |
| | D1606/9 connected to D1604/10 | | 0 | H | |
| 10 | D1601/10 connected tp D1602/9 | | 0 | H | |
| | WAVEFORM/... | | 0 | H | WAVEFORM key |
| | D1603/10 connected tp D1604/9 | | 0 | H | |
| | D1604/10 connected tp D1606/9 | | 0 | H | |
| | E/... | | 0 | H | not used |
| 11 | AUTOSET/... | | 0 | H | AUTOSET key |
| | RECORD/... | | 0 | H | RECORD key |
| | A AC/DC/... | | 0 | H | Channel A-AC/DC/GROUND key |
| | B V/... | | 0 | H | Channel B-V key |
| | D/... | | 0 | H | not used |
| 12 | METER/... | | 0 | H | METER key |
| | B MOVE DOWN/... | | 0 | H | Channel B-MOVE DOWN key |
| | CURSOR DATA/... | | 0 | H | CURSOR DATA key |
| | A MOVE DOWN/... | | 0 | H | Channel A-MOVE DOWN key |
| | UNDO/... | | 0 | H | UNDO key |
| 13 | SCOPE/... | | 0 | H | SCOPE key |
| | MOVE L/... | | 0 | H | MOVE Left key |
| | DOWN/... | | 0 | H | DOWN key |
| | A MOVE DOWN/... | | 0 | H | Channel A MOVE DOWN key |
| | MATH/... | | 0 | H | MATH key |
| 14 | UP/... | | 0 | H | UP key |
| | A V/... | | 0 | H | Channel A-V key |
| | CURSOR 2 R/... | | 0 | H | CURSOR 2-Right key |
| | B mV/... | | 0 | H | Channel B-mV key |
| | A/... | | 0 | H | not used |
| 15 | FRONTCLOCK/... |  | 60kHz | A | |
| 16 | VCC/... |   | 0 | H | Main supply |

## 7.1.7 Analog A2 PCB Troubleshooting.

*7.1.7.1 Test point signals.*

The analog A2 PCB is provided with test points, marked: "TP" See figure 10.4: A2 PCB layout (wired components side). These can be used to check correct functioning of the PCB.

All measurements are made in the default MASTER RESET condition (start the measurements in the ScopeMeter using **MASTER RESET**).

A MASTER RESET is performed as follows:
1. Remove all signals from the ScopeMeter.
2. Power the ScopeMeter with the Power Adapter/Battery charger PM8907.
3. Turn off the ScopeMeter
4. Hold down the LCD key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The ScopeMeter is automatically set to the meter mode.

*NOTE: For the measurements on Test Points 101...529 and 901...921 apply a 10 kHz square wave signal to the channel A BNC. Press the SCOPE button to go to SCOPE mode and press AUTOSET to get a stable picture on the LCD.*

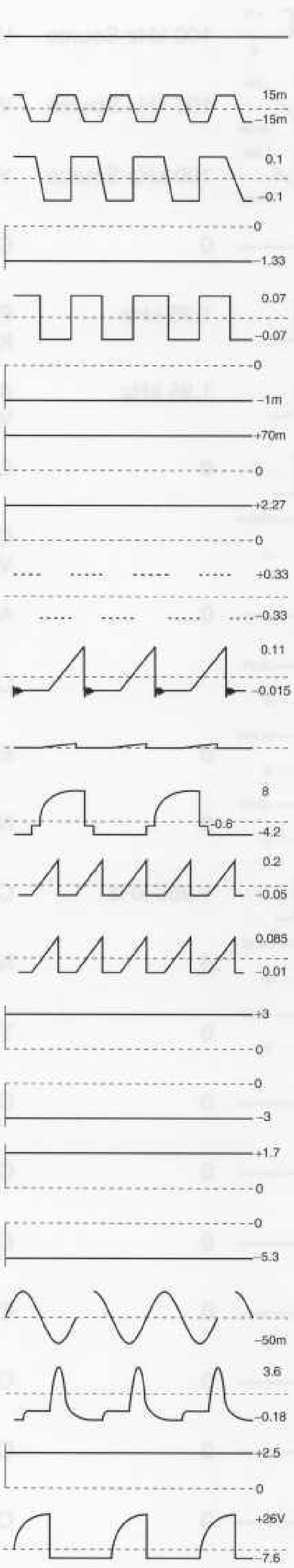
*NOTE: For the measurements on Test Points 700...806 first switch on the ScopeMeter using a MASTER RESET. Then press the SPECIAL FUNCTion key and the GENERATE softkey. Use the select/adjust keys to select "square 1.95 kHz", and press the right most ENTER softkey to activate the generator.*

Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the test points. See table 7.7:

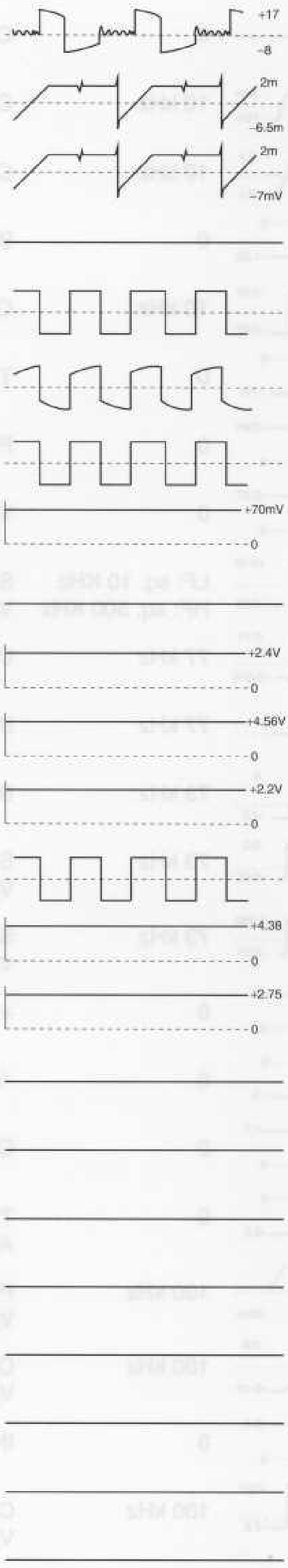
*Table 7.7 Overview signals on Test Points (TP) on analog A2 PCB.*

Logic 0=0V, Logic 1=+5V

| TP | Name | Scope | Freq. | Data | Description |
|---|---|---|---|---|---|
| 101 | | | 0 | | Base V2112 |
| 102 | | | 0 | | Output D2101 |
| 103 | |   | 0 | | Output N2101 |
| 104 | | | 0 | | Collector V2105 |
| 106 | |   | 0 | | Base V2104 |
| 107 | ATTB--A |   | 0 | | Collector V2111 |
| 108 | | | 0 | | TP for OFFSET DAC |
| 109 | POS-CHB |   | 0 | | POS-CHB |
| 201 | | | 0 | | Base V2212 |



| | | | | |
|---|---|---|---|---|
| 202 | mV-in from A2d | | 0 | Output D2201 |
| 203 | | 15m / -15m | 10 kHz | Output N2201, $V_{DC}$ = -1.5V |
| 204 | | 0.1 / -0.1 | 10 kHz | Collector V2205 |
| 206 | | 0 / -1.33 | 0 | Base V2204 |
| 207 | ATTA--A | 0.07 / -0.07 | 10 kHz | Collector V2211 |
| 208 | | 0 / -1m | 0 | TP for offset DAC |
| 209 | POS-CHA | +70m / 0 | 0 | POS-CHA |
| 331 | | +2.27 / 0 | 0 | VREF D2301 |
| 332 | | +0.33 / -0.33 | LF: sq. 10 KHz<br>HF: sq. 500 KHz | SGN-in N2301<br>$V_{DC}$ = 2.3V |
| 501 | | 0.11 / -0.015 | 77 kHz | Collector V2517, $V_{DC}$ = -7.7V |
| 502 | | | 77 kHz | Base V2517 |
| 503 | | 8 / -0.8 / -4.2 | 73 kHz | Base V2503, $V_{DC}$ = -3,83 V |
| 504 | | 0.2 / -0.05 | 73 kHz | Sense Resistors, Pos. side<br>$V_{DC}$ = -7.7V |
| 506 | | 0.085 / -0.01 | 73 kHz | Sense Resistors, Neg. side<br>$V_{DC}$ = -7.75V |
| 507 | +Vref | +3 / 0 | 0 | +Vref |
| 508 | -Vref | 0 / -3 | 0 | -Vref |
| 509 | | +1.7 / 0 | 0 | Output N2501 |
| 511 | | 0 / -5.3 | 0 | TP for FEEDBACK AMPLIFIER |
| 521 | | -50m | 100 kHz | PSG-Input Z2501,<br>$V_{DC}$ = -1.1 mV |
| 522 | | 3.6 / -0.18 | 100 kHz | Oscillator N2503,<br>$V_{DC}$ = 0.24V |
| 523 | | +2.5 / 0 | 0 | INV N2503 |
| 524 | | +26V / -7.6 | 100 kHz | Collector V2526,<br>$V_{DC}$ = -0.12V |




| | | |
|---|---|---|
| 526 | 100 kHz Source | V2532, $V_{DC}$ = -0.4V |
| 527 | 100 kHz Source | V2537, $V_{DC}$ = -1.05V |
| 528 | 100 kHz Source | V2538, $V_{DC}$ = -1.7V |
| 529 | 0 | CLN N2503 |
| 700 | 1.95 kHz | Relay contact K2750a/K2751b $V_{DC}$ = 0.29V |
| 701 | 1.95 kHz | Anode Zener V2752 $V_{DC}$ = 0.27V |
| 702 | 0 | Output D2850 |
| 704 | | Collector V2761, $V_{DC}$ = 0.27V |
| 706 | 0 | Anode zener V2764 |
| 801 | | Output D2850, $V_{DC}$ = 2.5V |
| 802 | 0 | Emitter V2852 |
| 803 | 0 | Non-inverting input N2850a |
| 804 | 1.953 kHz | Output N2850, $V_{DC}$ = 0.29V |
| 805 | 0 | Non-inverting input N2850b |
| 806 | 0 | TP for CURRENT SOURCE |
| 901 | 0 | Output 1&2 D2901 |
| 902 | 0 | Output 3&4 D2901 |
| 903 | 0 | Output 5&6 D2901 |
| 904 | 0 | Output 7&8 D2901 |
| 906 | 0 | Output 1&2 D2902 |
| 907 | 0 | Output 3&4 D2902 |
| 908 | 0 | Output 5&6 D2902 |
| 909 | 0 | Output 7&8 D2902 |

| | | | | |
|---|---|---|---|---|
| 911 | | | 0 | Output 1&2 D2903 |
| 912 | | | 0 | Output 3&4 D2903 |
| 914 | | | 0 | Output 7&8 D2903 |
| 916 | Sgnd8a | | 0 | Sgnd8a D2904 |
| 917 | Ex/Ey | +5V<br>0 | 0 | Ex/Ey D2906 |
| 918 | Sgnd8b | | 0 | Sgnd8b D2907 |
| 919 | Sr4b | | 0 | Sr4b D2908 |
| 921 | D-POSCHB | | 0 | D-POSCHB D2909 |

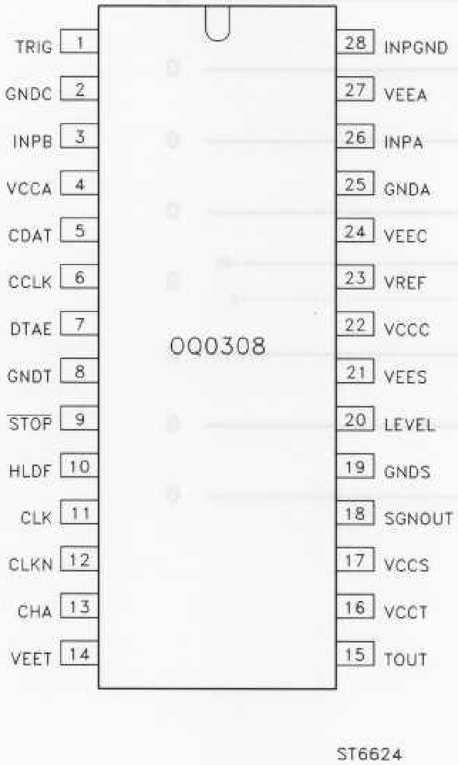
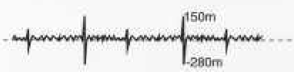
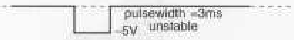
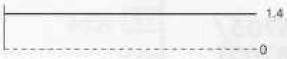
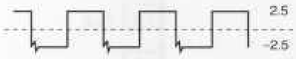
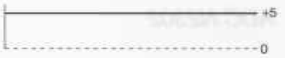
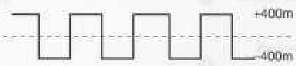
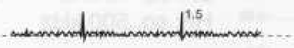



*Figure 7.6 Analog ASIC D2301*

*Table 7.8 Signals measured on analog ASIC D2301.*

Logic 0=0V Logic 1=+5V

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 1 | TRIG |  | 0 | | EXT. Trigger input |
| 2 | GNDa | | 0 | | Ground<br>Analog-input-circuit |
| 3 | INPB |  | 0 | | Input signal B |
| 4 | VCCa |  | 0 | | Positiv power supply<br>Analog-input-circuit |
| 5 | CDAT |  | 500 kHz | | Serial Data line VDC = 5V |
| 6 | CCLK |  | 100 kHz | | Clock line<br>$V_{DC}$ = 18 mV |
| 7 | DTAE |  | 500 kHz | | Latch enable line<br>$V_{DC}$ = 20.7 mV |
| 8 | GNDt | | 0 | | Ground Trigger-output-circuit |

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 9 | STOP |   | | | Trigger output<br>$V_{DC}$ = 0.5V |
| 10 | HLDF<br>VDC = 5 |   | | | Hold off |
| 11 | CLK |   | 0 | | Clock |
| 12 | CLKN |   | 1 MHz | | $V_{DC}$ = 0.55V |
| 13 | CHA |   | 50 kHz | | Chanel switch<br>$V_{DC}$ = 2.4V |
| 14 | VEEt |   | 0 | | Negativ power supply<br>Trigger-output-circuit |
| 15 | TOUT |   | 20 Hz | | DC-Trigger output |
| 16 | VCCt |   | 0 | | Positiv power supply<br>Trigger-output-circuit |
| 17 | VCCs |   | 0 | | Positiv power supply<br>Signal-output-circuit |
| 18 | SNGOUT |   | LF: sq. 10 kHz<br>HF: sq. 500 kHz | | Output signal, $V_{DC}$ = 2.3V |
| 19 | GNDs |  | 0 | | Ground<br>Signal-output-curcuit |
| 20 | LEVEL |   | 0 | | Trigger level input |
| 21 | VEEs |   | 0 | | Negativ power supply<br>Signal-output-circuit |
| 22 | VCCc |   | 0 | | Positiv power supply<br>Control-logica-circuit |
| 23 | VREF |   | 0 | | Reference potential |
| 24 | VEEc |   | 0 | | Negativ power supply<br>Control-logica-circuit |
| 25 | GNDc |   | 0 | | Ground control-logica-circuit |
| 26 | INPa |   | 10 kHz | | Input signal A, $V_{DC}$ = -17 mV |
| 27 | VEEa |   | 0 | | Negativ power supply<br>Analog-input-circuit |
| 28 | INPGND |   | 0 | | Ground input |

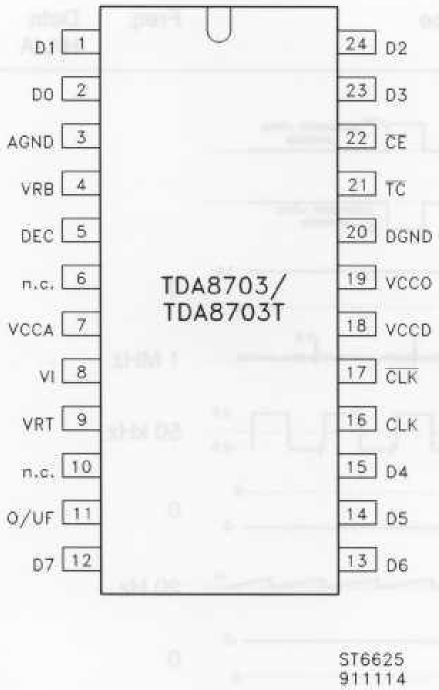
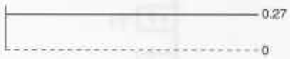
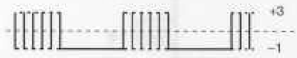
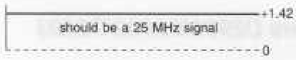
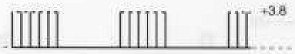



*Figure 7.7 ADC N2302*

*Table 7.9 Signals measured on ADC N2302.*

Logic 0=0V Logic 1=+5V

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 1 | D1 | unstable; 1.6, 0.8, -3.4 | | | Data output bit no.1<br>$V_{DC}$ = 2.6V; for HF see no. 12 |
| 2 | D0 | unstable; 2.8, 2, -3 | | | Data output bit no.0<br>$V_{DC}$ = 2.1V; for HF see no. 12 |
| 3 | AGND | | 0 | | |
| 4 | VRB | +1.4, 0 | 0 | | |
| 5 | DEC | +3.7, 0 | 0 | | |
| 6 | NC | | 0 | | Not Connected |
| 7 | VCCa | +5, 0 | 0 | | |
| 8 | IN | +0.33, -0.33 | LF: sq. 10 kHz<br>HF: sq. 500 kHz | | $V_{DC}$ = 2.3V |
| 9 | VRT | +3.2, 0 | 0 | | |

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 10 | NC | | 0 | | Not Connected |
| 11 | O/UFL |   | 0 | | Not Connected |
| 12 | D7 |   | LF: 10 kHz | | Data output bit no.7 $V_{DC}$ = 3.1V |
| | |   | HF: 500 kHz | | |
| 13 | D6 |   | LF: 10 kHz | | Data output bit no.6 $V_{DC}$ = 1.1V; for HF see no.12 |
| 14 | D5 | see pin no. 13 | | | Data output bit no.5, $V_{DC}$ = 1.1V |
| 15 | D4 | see pin no. 13 | | | Data output bit no.4, $V_{DC}$ = 1.1V |
| 16 | CL |   | 0 | | $V_{DC}$ = 1.42V |
| 17 | CLN |   | 1 MHz | | $V_{DC}$ = 0.55V |
| 18 | VCCD |   | 0 | | |
| 19 | VCCO |   | 0 | | |
| 20 | DGND | | 0 | | |
| 21 | OCTN |   | 0 | | |
| 22 | CEN | | 0 | | |
| 23 | D3 |   | | | Data output bit no.3 $V_{DC}$ = 0.27V; for HF see no. 12 |
| 24 | D2 |   | | | Data output bit no.2 VDC = 1.84V; for HF see no. 12 |

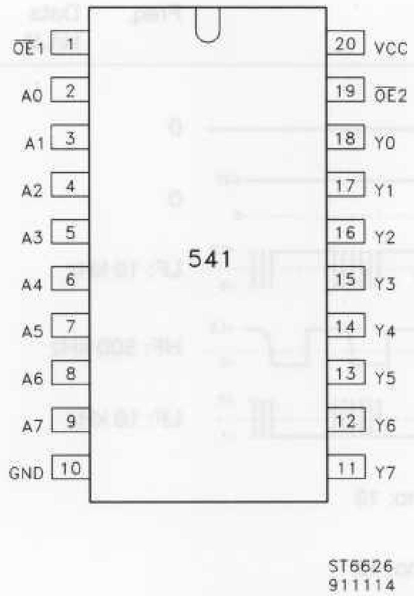



*Figure 7.8 Buffer/drivers D2901/D2902/D2903*

*Table 7.10 Signals measured on buffer/driver D2901.*

Logic 0=0V Logic 1=+5V

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 1 | Ex | | 0 | | Control signal |
| 2 | Sg4b | | 0 | | Input no.1 |
| 3 | Sg4b | | 0 | | Input no.2 |
| 4 | Sg5b | | 0 | | Input no.3 |
| 5 | Sg5b | | 0 | | Input no.4 |
| 6 | Sg6b | | 0 | | Input no.5 |
| 7 | Sg6b | | 0 | | Input no.6 |
| 8 | So10b | | 0 | | Input no.7 |
| 9 | So10b | | 0 | | Input no.8 |
| 10 | GND | | 0 | | Ground |

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 11 | | | 0 | | Output no.8 |
| 12 | | | 0 | | Output no.7 |
| 13 | | | 0 | | Output no.6 |
| 14 | | | 0 | | Output no.5 |
| 15 | | | 0 | | Output no.4 |
| 16 | | | 0 | | Output no.3 |
| 17 | | | 0 | | Output no.2 |
| 18 | | | 0 | | Output no.1 |
| 19 | Ex | | 0 | | Control signal |
| 20 | Vcc | | 0 | | Power supply |

*Table 7.11 Signals measured on buffer/driver D2902*

Logic 0=0V Logic 1=+5V

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 1 | Ey | | 0 | | Control signal |
| 2 | Sg4b | | 0 | | Input no.1 |
| 3 | Sg4b | | 0 | | Input no.2 |
| 4 | Sg5b | | 0 | | Input no.3 |
| 5 | Sg5b | | 0 | | Input no.4 |
| 6 | Sg6b | | 0 | | Input no.5 |
| 7 | Sg6b | | 0 | | Input no.6 |
| 8 | So11b | | 0 | | Input no.7 |

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 9 | So11b | +5V 0 | 0 | | Input no.8 |
| 10 | Gnd | | 0 | | Ground |
| 11 | | | 0 | | Output no.8 |
| 12 | | | 0 | | Output no.7 |
| 13 | | | 0 | | Output no.6 |
| 14 | | | 0 | | Output no.5 |
| 15 | | | 0 | | Output no.4 |
| 16 | | | 0 | | Output no.3 |
| 17 | | | 0 | | Output no.2 |
| 18 | | | 0 | | Output no.1 |
| 19 | Ey | +5V 0 | 0 | | Control signal |
| 20 | Vcc | +5V 0 | 0 | | Power supply |

*Table 7.12 Signals measured on buffer/driver D2903.*

Logic 0=0V Logic 1=+5V

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 1 | Ey | +5V 0 | 0 | | Control signal |
| 2 | Sg4a | | 0 | | Input no.1 |
| 3 | Sg4a | | 0 | | Input no.2 |
| 4 | Sg5a | +5V 0 | 0 | | Input no.3 |
| 5 | Sg5a | +5V 0 | 0 | | Input no.4 |
| 6 | Sg6a | +5V 0 | 0 | | Input no.5 |
| 7 | Sg6a | +5V 0 | 0 | | Input no.6 |

| Comp | Name Circ/IC | Scope | Freq. | Data H/L/A | Description |
|---|---|---|---|---|---|
| 8 | Sc16 | | 0 | | Input no.7 |
| 9 | Sc16 | | 0 | | Input no.8 |
| 10 | Gnd | | 0 | | Ground |
| 11 | | | 0 | | Output no.8 |
| 12 | | | 0 | | Output no.7 |
| 13 | | | 0 | | Not connected |
| 14 | | | 0 | | Not connnected |
| 15 | | | 0 | | Output no.4 |
| 16 | | | 0 | | Output no.3 |
| 17 | | | 0 | | Output no.2 |
| 18 | | | 0 | | Output no.1 |
| 19 | Ey | +5V<br>0 | 0 | | Control signal |
| 20 | Vcc | +5V<br>0 | 0 | | Power supply |

# 7.2 REPLACEMENTS

## 7.2.1 Standard parts

Electrical and mechanical parts replacements can be obtained through your local FLUKE/PHILIPS organization or representative. However, many generic electronic components can be obtained from other sources. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE: *Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade the instrument's performance.*

## 7.2.2 Special parts

In addition to the standard electronic components, some special components are used:

- Components, custom manufactured or selected by FLUKE/PHILIPS to meet specific performance requirements.
- Components that are important for the safety of personnel.

NOTE: *Both type of components may only be replaced by components obtained through your local FLUKE/PHILIPS organization or representative.*

## 7.2.3 Transistors and integrated circuits

Some notes on handling these components:

- Do not replace or swap semiconductor devices unnecessarily, because the change may affect the calibration of the instrument.
- When a device has been replaced, check the circuit that may be affected for proper operation. See also the Performance Verification Procedure in chapter 4.

## 7.2.4 Static-sensitive components

In the ScopeMeter the black/yellow "static-sensitive components" symbol is present (see also figure 7.4). This means that this instrument contains electrical components that can be damaged by electrostatical discharge. Although all MOS integrated circuits incorporate protection against electrostatic discharge, they nevertheless can be damaged by accidental overvoltages.

*Figure 7.9 Static-sensitive symbol (black/yellow)*

It is also possible that a delayed failure or "winding" effect may occur. When this happens, the component will fail anywhere between two hours to six months later.

When storing and handling static-sensitive components, the normal precautions for these devices are recommended. Handling and servicing static-sensitive assemblies and components should be done only at a static free workstation by qualified personnel.

**CAUTION: Testing, handling, and mounting call for special attention. Personnel handling static-sensitive devices should normally be connected to ground via a high-ohmic resistor.**

## 7.2.5 Replacement of parts

### *7.2.5.1 Replacing parts in the battery compartment*

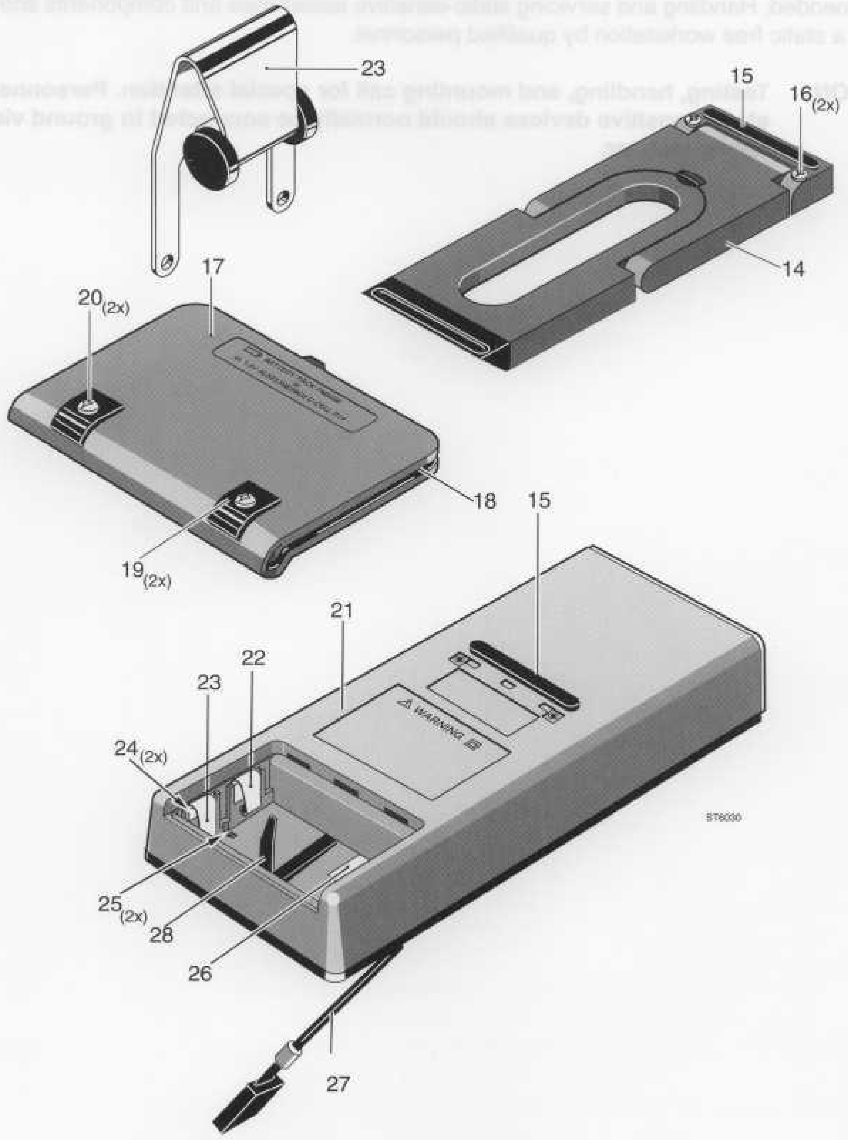



*Figure 7.10 Replacing parts in battery compartment*

Referring to figure 7.10, use the following procedure for replacements in the battery compartment.

***Battery cover assembly replacement***

1. The battery cover (item 17) is secured to the ScopeMeter with two black M3 Torx screws (item 20). Use a Torx screwdriver to loosen the two screws (do not remove them) from the battery cover.

2. Lift the battery cover from the ScopeMeter.

3. Reinstall the new battery cover.

***Battery-cover Gasket replacement***

1. Remove the battery cover (item 17).

2. Use a pair of tweezers to pull the elastic gasket (item 18) from the battery cover.

3. Mount the new elastic gasket on the battery cover.

NOTE: *Take care that the gasket is not damaged. A correctly fitted gasket assures the sealing of the ScopeMeter.*

***Battery cover Torx screws and Feet replacement***

1. Remove the battery cover.

2. The black M3 Torx screws are of a captured type (item 20). Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: *Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.*

3. Pull the two rubber feet (item 19) from the battery cover.

4. Push the new rubber feet onto the battery cover.

5. Reinstall the (new) black M3 Torx screws into the battery cover.

*7.2.5.2 Replacing parts on front cover*

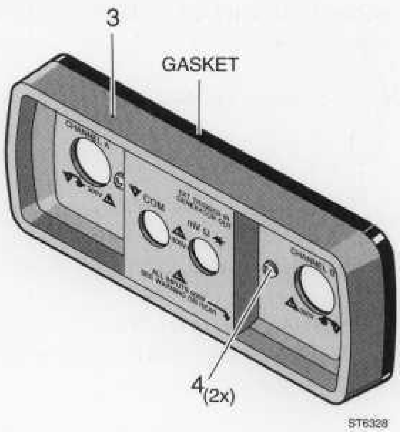



*Figure 7.11 Replacing parts on front cover*

Referring to figure 7.11, use the following procedure for replacements on the front cover.

***Front cover assembly replacement***

1. The front cover is secured to the ScopeMeter with two black M3 Torx screws (item 4). Use a Torx screwdriver to loosen the two screws (do not remove them) from the front cover.

2. Lift the front cover assembly (item 3) from the ScopeMeter.

*NOTE: The gasket between the front cover and the two case halves is sealed to, and must remain with, the front cover. The front cover lifts away easily. Do not damage the gasket and do not separate the front cover from the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter.*

3. Reinstall the new front cover.

***Front cover Torx screw replacement***

1. Remove the front cover.

2. The two black M3 Torx screws (item 4) are captured type screws. Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

*NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.*

3. Reinstall the new Torx screws into the front cover.

*7.2.5.3 Replacing parts on bottom cover*

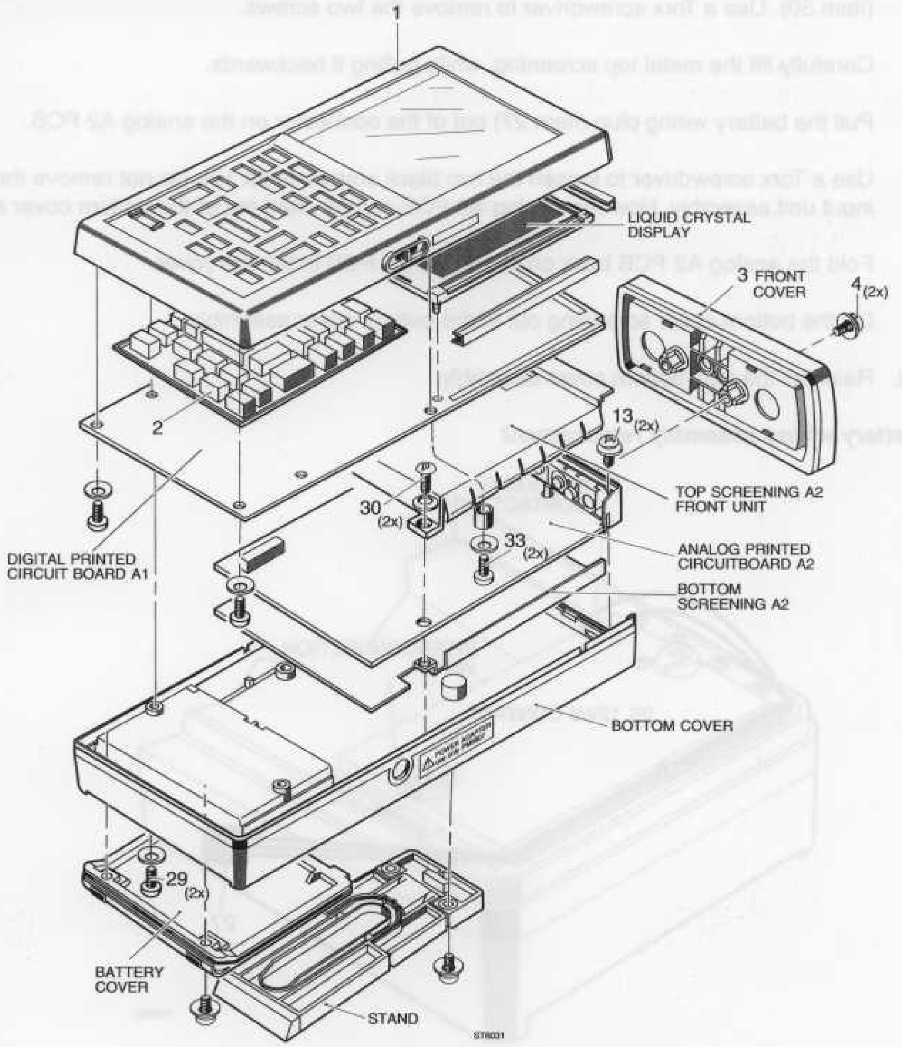



*Figure 7.12 Bottom cover replacements*

Referring to figure 7.12, use the following procedure for replacements in the bottom cover.

***Bottom cover assembly replacements***

1. First remove the battery cover assembly (see Section 7.2.5.1.)

2. The bottom cover is secured to the top cover by two M3 Torx screws (item 29) that are accessible in the battery compartment. Use a Torx screwdriver to remove the two screws.

3. Lift the bottom cover a little from the top cover and unfold the ScopeMeter.

*NOTE: A flat cable is used for interconnection between the bottom cover with the analog A1 PCB and the digital A2 PCB. To remove the flat cable, refer to Section 6.2.4. The gasket between the two case halves is sealed to, and must remain with, the lower case half. The upper case half lifts away easily. Do not damage the gasket and do not separate the lower case half from the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter.*

4. The analog A2 PCB and top screening are secured to the bottom cover by two M3 Torx screws (item 30). Use a Torx screwdriver to remove the two screws.

5. Carefully lift the metal top screening, while pulling it backwards.

6. Pull the battery wiring plug (item 27) out of the connector on the analog A2 PCB.

7. Use a Torx screwdriver to loosen the two black screws (item 13). Do not remove them from the input unit assembly. Now the analog A2 PCB can be lifted out of the bottom cover assembly.

8. Fold the analog A2 PCB back on the digital A1 PCB in the top cover.

9. Lift the bottom cover screening out of the bottom cover assembly.

10. Reinstall the new bottom cover assembly.

***Battery wiring assembly replacement***

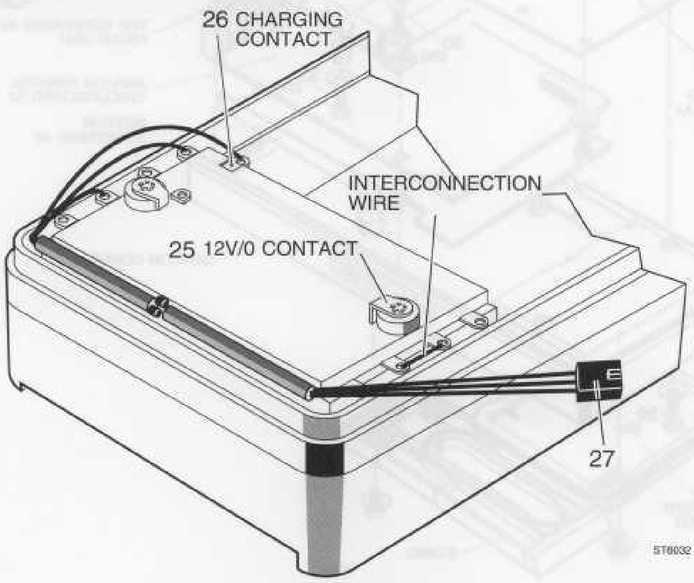



*Figure 7.13 Wiring assembly replacement*

Referring to figures 7.10 and 7.13, use the following procedure for replacing the battery wiring and battery contacts.

1. First remove the bottom cover assembly.

2. Unsolder the battery wiring assembly (item 27) from the battery compartment.

3. Reinstall the new battery wiring assembly.

***Battery contacts replacement***

1. First remove the bottom cover assembly.

2. Remove the battery wiring assembly.

3. Unsolder the small battery contact interconnection wire (see figure 7.13).

4. Bend the solder tags of the battery contacts (figure 7.10, item 23) in the bottom cover in such way that the contacts can be pulled out of the battery compartment.

5. Pull the battery contacts (figure 7.5, items 22 and 23) and the black buffers (figure 7.10, item 24) out of the battery compartment with a pair of tweezers.

*NOTE: The extra black plastic buffers in two battery contacts (see figure 7.10, item 23) prevent erroneous charging of the battery. Mount these battery contacts in the correct position!*

6. Reinstall the new battery contacts.

***Battery charging contact and +12V/0 contact replacement***

1. First remove the bottom cover assembly.

2. Remove the battery wiring assembly.

3. Bend the solder lugs of the contacts (figure 7.10, items 25 and 26) in the bottom cover so that the contacts can be pulled from the battery compartment.

4. Pull the contacts from the battery compartment.

5. Reinstall the new charging contact and/or the new +12V/0 contacts.

*7.2.5.4 Stand replacement*

Referring to figure 7.10, use the following procedure for stand replacement.

***Stand assembly replacement***

1. The stand is secured to the ScopeMeter with two black M3 Torx screws (figure 7.10, item 16). Use a Torx screwdriver to loosen the two screws.

2. Lift the stand from the ScopeMeter.

3. Reinstall the new stand.

***Stand Torx screw replacement***

1. Remove the stand assembly (figure 7.10, item 15).

2. The black M3 Torx screws are of a captured type (item 16).Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

*NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.*

3. Reinstall the new Torx screws.

*7.2.5.5 30-pole flat cable replacement*

Refer to Section 6.2.4. of this Service Manual for instructions on how to replace the 30-pole flat cable.

*7.2.5.6 Input unit assembly replacement*

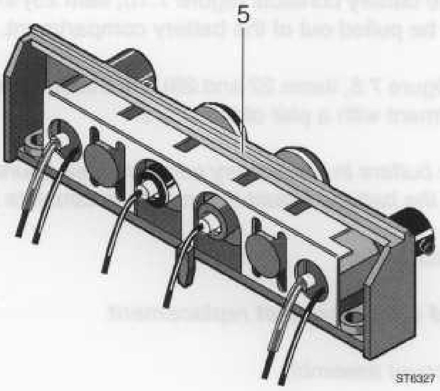



*Figure 7.14 Input unit assembly*

Referring to figure 7.14, use the following procedure for input unit assembly replacement.

1. Remove the front cover assembly.
2. Disassemble the bottom cover assembly.
3. Remove the 30-pole flat cable.
4. Unsolder the wiring (6x) of the input terminals from the analog A2 PCB.
5. The input unit assembly is clamped onto the analog A2 PCB. Loosen these clamps and pull the input unit assembly from the analog A2 PCB.

*NOTE: The white gaskets on the input terminals (4x) are sealed to, and must remain with the input unit assembly. Do not damage the gaskets and do not separate them from the input unit assembly. Correctly fitted gaskets assure the sealing of the ScopeMeter.*

6. Reinstall the front unit assembly.

*7.2.5.7 Top cover assembly replacement.*

Referring to figure 7.12, use the following procedure for top cover assembly replacement.

1. Remove the bottom cover assembly.
2. Remove the 30-pole flat cable.
3. The digital A1 PCB and metal screening are secured to the top cover with four M3 Torx screws (item 33). Two of these screws contain standoffs. be sure to put them on the right place again. Use a Torx screwdriver to remove the screws.
4. Remove the metal A1 screening from the digital A1 PCB.
5. Lift the digital A1 PCB out of the top cover. Be careful not to damage the infrared LED and phototransistor of the optical interface.

*NOTE: The gasket between the two Optical RS-232-C Interface LEDs on the digital A1 PCB and front cover must remain with the LEDs. The top cover lifts away easily. Do not damage the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter.*

6. Lift the keypad from the top cover (item 2).

7. Reinstall the new top cover (item 1).

*7.2.5.8 Keypad replacement*

1. Remove the bottom cover assembly.

2. Remove the 30-pole flat cable.

3. Disassemble the top cover assembly.

4. Lift the keypad from the top cover (item 2).

5. Reinstall the new keypad.

*7.2.5.9 Liquid crystal display (LCD), contact strips and backlight foil (Model 97 only) replacement.*

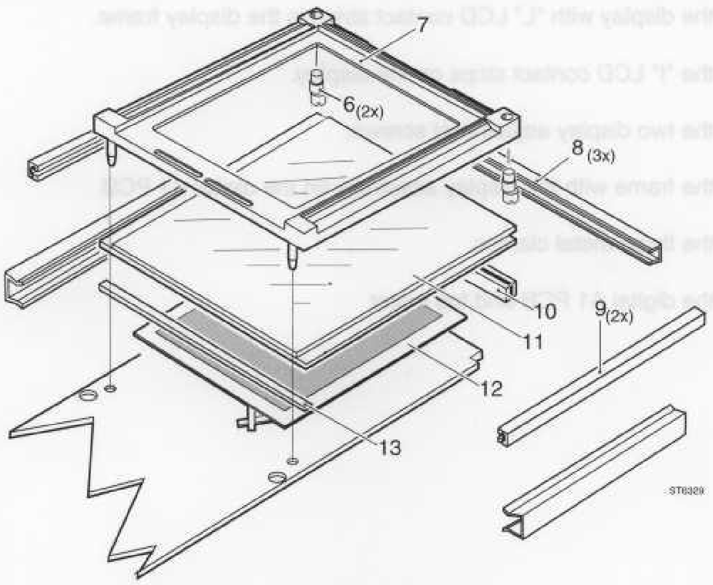



*Figure 7.15 LCD replacement*

Referring to figure 7.15, use the following procedure for LCD replacement.

1. Remove the bottom cover assembly.

2. Remove the 30-pole flat cable.

3. Disassemble the top cover assembly.

*NOTE: Oils or dirt from the hands are ennemies of the LCD contact strips used in the LCD assembly. Whenever handling these strips, it is advised that tweezers be used so as not to contaminate them. Care should also be taken when handling the front panel lens or LCD glass. Dirt or finger prints on these parts will be visible to the user and may impair the readability of the display.*

4. Pull the three metal clamps from the display (item 8).
5. Lift the LCD complete in its frame from the digital A1 PCB.
6. Push the LCD including the LCD contact strips out of the display frame.
7. Take the two display adjustment screws (item 6) out of the display frame.
8. Lift the top "I" LCD contact strip (item 10) from the display.
9. Pull the left and right "L" LCD contact strips (item 9) from the display.
10. (MODEL 97 ONLY)
    The backlight foil (item 12) is glued to the reflective LCD (Model 97 only). The backlight foil has two contact legs that make contact with two large rectangle spots on the digital A1 PCB.
11. Pull the backlight foil from the display.
12. Reinstall the LCD rubber filling part (item 13) and the back light foil.
13. Reinstall the two "L" LCD contact strips.
14. Reinstall the display with "L" LCD contact strips in the display frame.
15. Reinstall the "I" LCD contact strips on the display.
16. Reinstall the two display adjustment screws.
17. Reinstall the frame with the display assembly on the digital A1 PCB.
18. Reinstall the three metal clamps.
19. Reinstall the digital A1 PCB and top cover.

# 7.3 SOLDERING TECHNIQUES

## 7.3.1 General soldering techniques

Method:

- Carefully unsolder the soldering leads of the semiconductor one after the other.
- Remove all superfluous soldering material. Use desoldering wick, ordering code: 4822 321 40042.
- Verify that the leads of the replacement part are clean and have pre-tinned leads.
- Place the replacement semiconductor exactly in the same position, and solder each lead to the relevant printed circuit padon the PCB.

*NOTE: The maximum permissible soldering time is 10 seconds during which the temperature of the leads must not exceed 250C. The use of solder with a low melting point is recommended. Take care not to damage the plastic encapsulation of the semiconductor (softening point of the plastic is 150C).*

**CAUTION: When you are soldering inside the instrument it is essential to use a low voltage soldering iron, the tip of which must be connected to the ground of the ScopeMeter.**

A suitable soldering iron is:

- Mini soldering iron station, WECP-COD3 (regulated transformer) and Weller LR-20 (soldering iron).

Ordinary 60/40 tin/lead solder with flux core and a 35W to 40W pencil- type soldering iron can be used to do most of the soldering. If a higher wattage soldering iron is used on the circuit PCB, excessive heat may cause the circuit wiring to separate from the PCB base material.

## 7.3.2 Soldering micro-miniature semiconductors

Because of the small dimensions of these SOT semiconductors and the lack of space between the components on the PCB, it is necessary to use a miniature soldering iron with a pinpoint tip (max. diameter 1 mm.) to solder a SOT onto a PCB.

Suitable soldering tools are:

- Mini soldering iron station, WECP-COD3 (regulated transformer) and Weller MLR-20 (mini soldering iron).
- A hot-air solder tool: Leister Hot-Jet

Next, the following materials are recommended:

- Soldering tin, diameter 0.8 mm., SnPb 60/40 with a Resin Mildly Activated (RMA) flux. Ordering code: 4822 390 80133.
- Desolder braided wire. Ordering code 4822 321 40042.
- Solder paste 26.
- Non-corrosive and Resin Mildly Activated (RMA) flux-Colophony. Ordering code: 4822 390 50025.

Refer to the **Support Bulletin OSC 296 (ordering code 4822 872 08407)** for a complete discussion of the soldering techniques for SMD's.

## 7.4 SPECIAL TOOLS

### 7.4.1 Extender flat cable.

For diagnostic testing and troubleshooting, a 30-pole 50 cm extender flat cable can be used. Using this extender flat cable makes it easier to separate the two units A1 and A2 without breaking the interconnection.

The ordering code for the extender flat cable is: 5322 321 61369.

## 7.5 RECALIBRATION AFTER REPAIR

After any electrical component has been replaced the performance of that particular circuit should be checked, as well as the performance of other closely-related circuits. If necessary a recalibration must be performed. Since the power supply influences all circuits, the performance of the entire instrument should be verified if work has been done in the power supply or if the transformer has been replaced. If necessary a recalibration must be done. If parts of the attenuator circuits and/or the Analog ASIC have been replaced, it might be necessary to do Hardware SCOPE Calibration Adjustments. Refer to section 5.6.1 of this Service Manual.

## 7.6 INSTRUMENT REPACKING

If the ScopeMeter is to be reshipped to a Service Centre for service or repair, attach a tag showing the full address and the name of the individual at the users firm that can be contacted.

The Service Centre needs the complete ScopeMeter, **including the RED and the GREY scope probe**, its serial number, and a complete description of the problem and the work that is to be done. If the original container is not available, repack the instrument so that no damage occurs during transport.

# 8 MAINTENANCE OF THE PRIMARY CIRCUIT (PM8907/...)

The ScopeMeter itself has no primary (mains) power supply.
The instrument is powered with a separate **Power adapter/battery charger PM8907/...**, in which the primary power supply is located. The PM8907/... is non-repairable. It can be ordered at your nearest Fluke/Philips Service Center.

*Table 8.1 Power adapter/battery charger survey.*

| Typenumber | Description |
|---|---|
| PM8907/001 | Universal Europe 220V, 50 Hz |
| PM8907/003 | North American UL, CSA, 110V, 60 Hz |
| PM8907/004 | United Kingdom 240V, 50 Hz |
| PM8907/008 | Universal 115V / 230V |

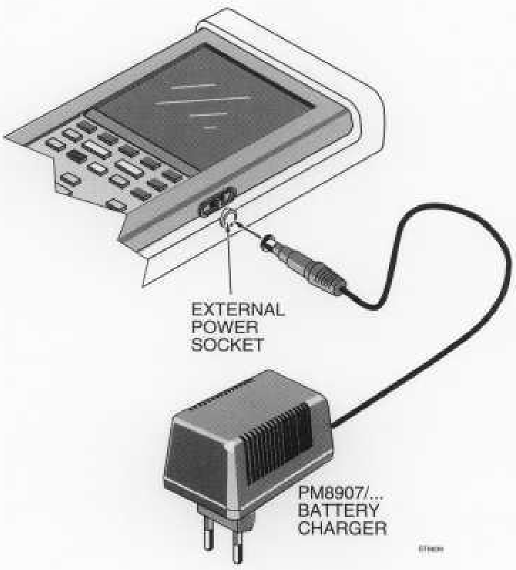



*Figure 8.1 ScopeMeter Power Adapter/battery Charger PM8907/....*

# 9 REPLACEABLE PARTS LIST



## 9.1 INTRODUCTION

The replaceable parts section provides illustrated parts lists for the ScopeMeter models Philips PM93/PM95/PM97 and Fluke 93/95/97.

The mechanical parts are listed numerically by asssembly. The electrical parts on the printed circuit boards A1 and A2 are listed alphanumerically by assembly. Each part is shown in an accompanying illustration.

The parts lists provide the following information for each part:

- Item number
- Figure number
- Description
- Ordering code
- Total quantity of componenents per assembly

## 9.2 HOW TO OBTAIN PARTS

### For Philips Export B.V.:

Contact your local Philips Sales and Service representative. The addresses and telephone numbers are listed in this manual in section 11: "Sales & Service all over the world".

### For the John Fluke Mfg. Co., Inc.:

Contact your local Fluke authorized representative. In the U.S. order directly from the Fluke Parts Dept. by calling 1- 800-526-4731.

To ensure prompt and efficient handling of your order, include the following information:

1. Mode number (PM xx), (Fluke xx), Code number (9444 ... .....) and Serial number (DM......). The items are printed on the type plate on the bottom cover.
2. Ordering code
3. Item number
4. Description
5. Quantity

*Table 9.1 ScopeMeter final assembly. (See figure 9.1)*

When servicing the ScopeMeter, use only the replacement parts specified.

| Item | Figure | Description | Ordering code | Qty |
|---|---|---|---|---|
| 1 | 9.1 | Top cover assembly PM93 | 5322 447 70108 | 1 |
| 1 | 9.1 | Top cover assembly PM95 | 5322 447 70109 | 1 |
| 1 | 9.1 | Top cover assembly PM97 | 5322 447 70104 | 1 |
| 1 | 9.1 | Top cover assembly 93 | 5322 447 70105 | 1 |
| 1 | 9.1 | Top cover assembly 95 | 5322 447 70111 | 1 |
| 1 | 9.1 | Top cover assembly 97 | 5322 447 70115 | 1 |
| 2 | 9.1 | Keypad PM93/93 | 5322 218 61461 | 1 |
| 2 | 9.1 | Keypad PM95/95 | 5322 218 61459 | 1 |
| 2 | 9.1 | Keypad PM97/97 | 5322 218 61457 | 1 |
| 29 | 9.1 | Bottom cover torx-screw blank M3 | 5322 502 13772 | 2 |
| 30 | 9.1 | Board A2 torx-screw blank M3 | 5322 502 13772 | 2 |
| 31 | 9.1 | Input unit torx-screw blank M3 | 5322 502 13772 | 2 |
| 32 | 9.1 | 30-pole flat cable | 5322 321 61238 | 1 |
| - | - | 30-pole extender flat cable for repair purposes | 5322 321 61369 | 1 |
| 33 | 9.1 | Top cover torx-screw blank M3 | 5322 502 13772 | 2 |

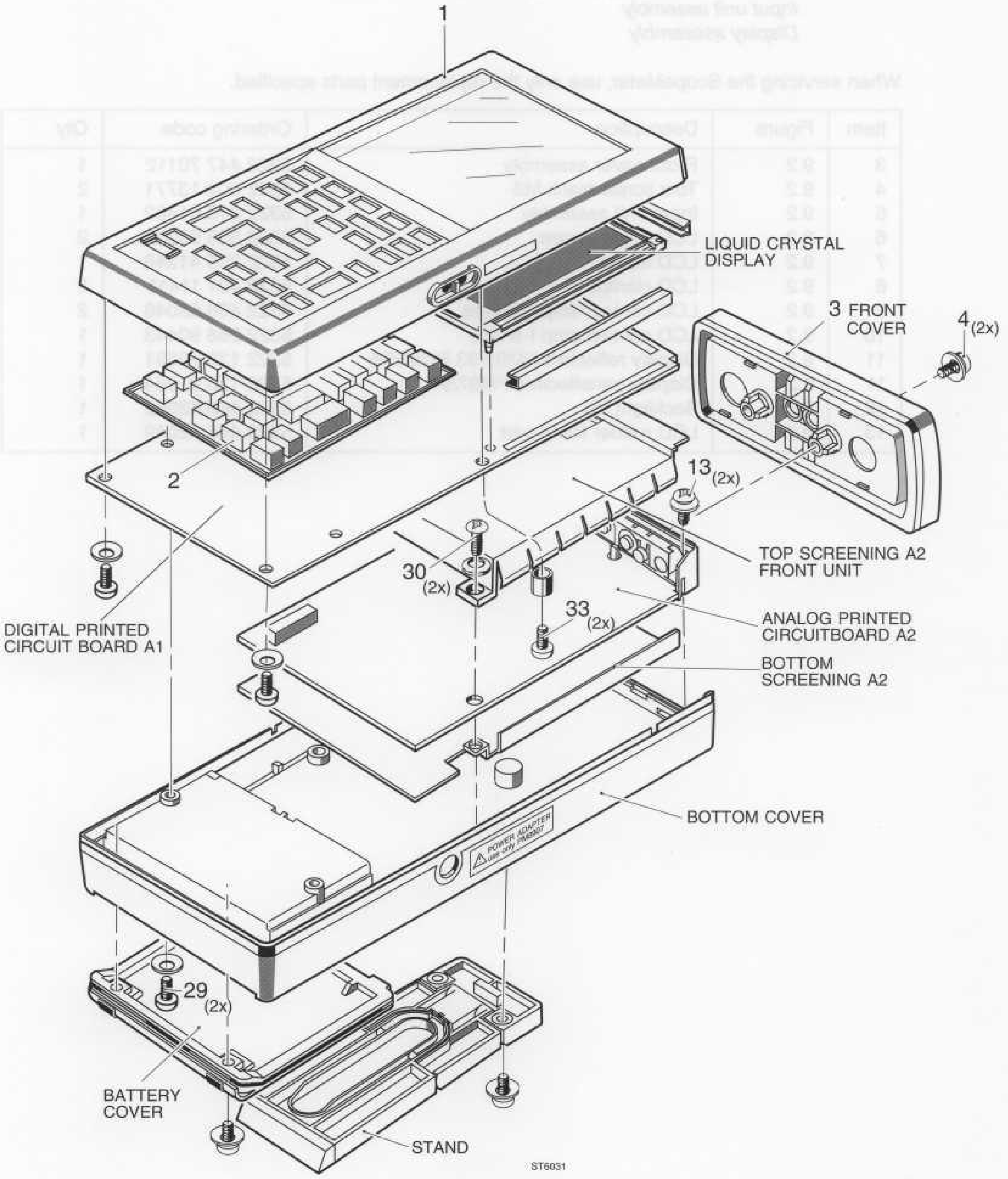
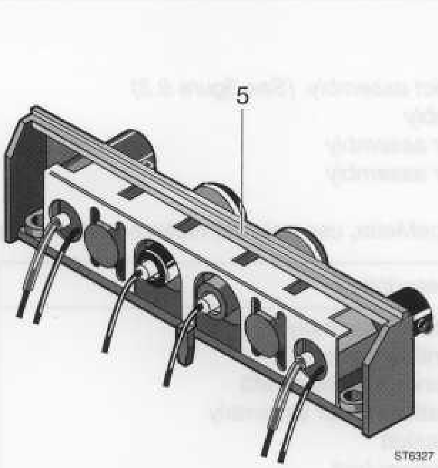


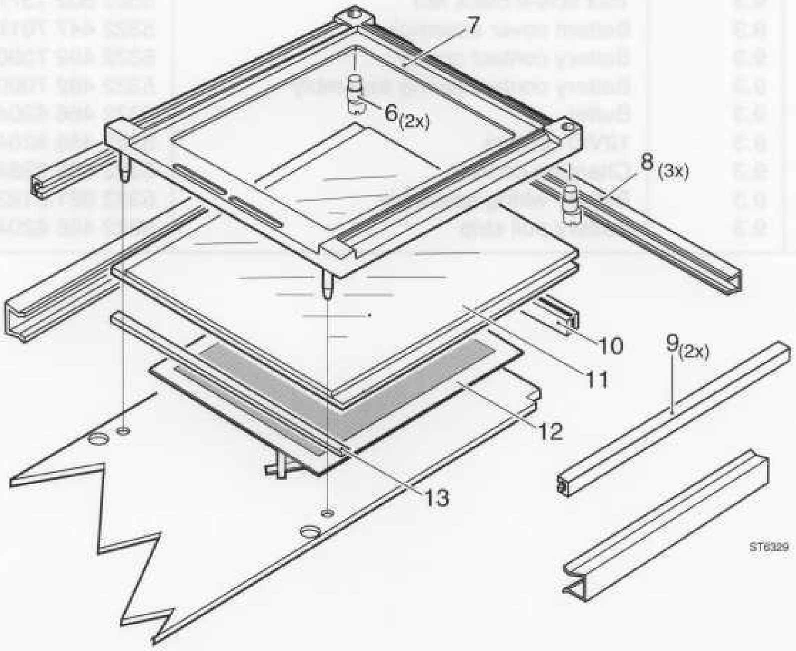

*Figure 9.1 ScopeMeter final assembly*

*Table 9.2 Front cover assembly (See figure 9.2)*
*Input unit assembly*
*Display asssembly*

When servicing the ScopeMeter, use only the replacement parts specified.

| Item | Figure | Description | Ordering code | Qty |
|---|---|---|---|---|
| 3 | 9.2 | Front cover assembly | 5322 447 70112 | 1 |
| 4 | 9.2 | Torx screw black M3 | 5322 502 13771 | 2 |
| 5 | 9.2 | Input unit assembly | 5322 218 61462 | 1 |
| 6 | 9.2 | LCD adjust screw | 5322 535 93237 | 2 |
| 7 | 9.2 | LCD frame | 5322 255 41246 | 1 |
| 8 | 9.2 | LCD clamps | 5322 401 11411 | 3 |
| 9 | 9.2 | LCD contact strip L-shape | 5322 466 62048 | 2 |
| 10 | 9.2 | LCD contact strip I-shape | 5322 268 90443 | 1 |
| 11 | 9.2 | Display reflective PM93/93 PM95/95 | 5322 130 90991 | 1 |
| 11 | 9.2 | Display transflective PM97/97 | 5322 130 91054 | 1 |
| 12 | 9.2 | Backlight foil | 5322 466 62052 | 1 |
| 13 | 9.2 | LCD rubber filling part | 5322 466 62049 | 1 |



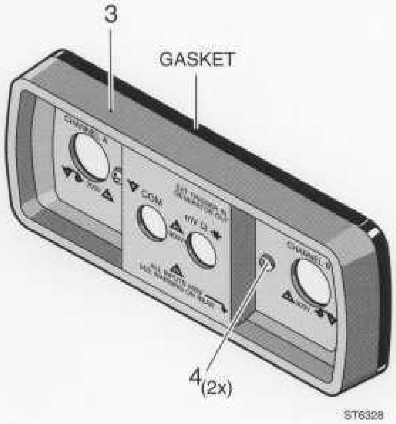




*Figure 9.2 Front cover assembly*
*Display assembly*
*Input assembly*

*Table 9.3 Battery contact assembly. (See figure 9.3)*
*Stand assembly*
*Battery cover assembly*
*Bottom cover assembly*

When servicing the ScopeMeter, use only the replacement parts specified.

| Item | Figure | Description | Ordering code | Qty |
|---|---|---|---|---|
| 14 | 9.3 | Stand assembly | 5322 456 90416 | 1 |
| 15 | 9.3 | Anti slip strip | 5322 466 62045 | 1 |
| 16 | 9.3 | Torx screw black M3 | 5322 502 13771 | 1 |
| 17 | 9.3 | Battery cover assembly | 5322 447 70116 | 1 |
| 18 | 9.3 | Gasket | 5322 530 51238 | 1 |
| 19 | 9.3 | Rubber foot | 5322 462 41825 | 2 |
| 20 | 9.3 | Torx screw black M3 | 5322 502 13771 | 2 |
| 21 | 9.3 | Bottom cover assembly | 5322 447 70113 | 1 |
| 22 | 9.3 | Battery contact spring | 5322 492 70908 | 3 |
| 23 | 9.3 | Battery contact spring assembly | 5322 492 70909 | 1 |
| 24 | 9.3 | Buffer | 5322 466 62047 | 4 |
| 25 | 9.3 | 12V/0 contact | 5322 466 82843 | 2 |
| 26 | 9.3 | Charging contact | 5322 466 82842 | 1 |
| 27 | 9.3 | Battery wiring assembly | 5322 321 61237 | 1 |
| 28 | 9.3 | Battery pull strip | 5322 466 62046 | 1 |

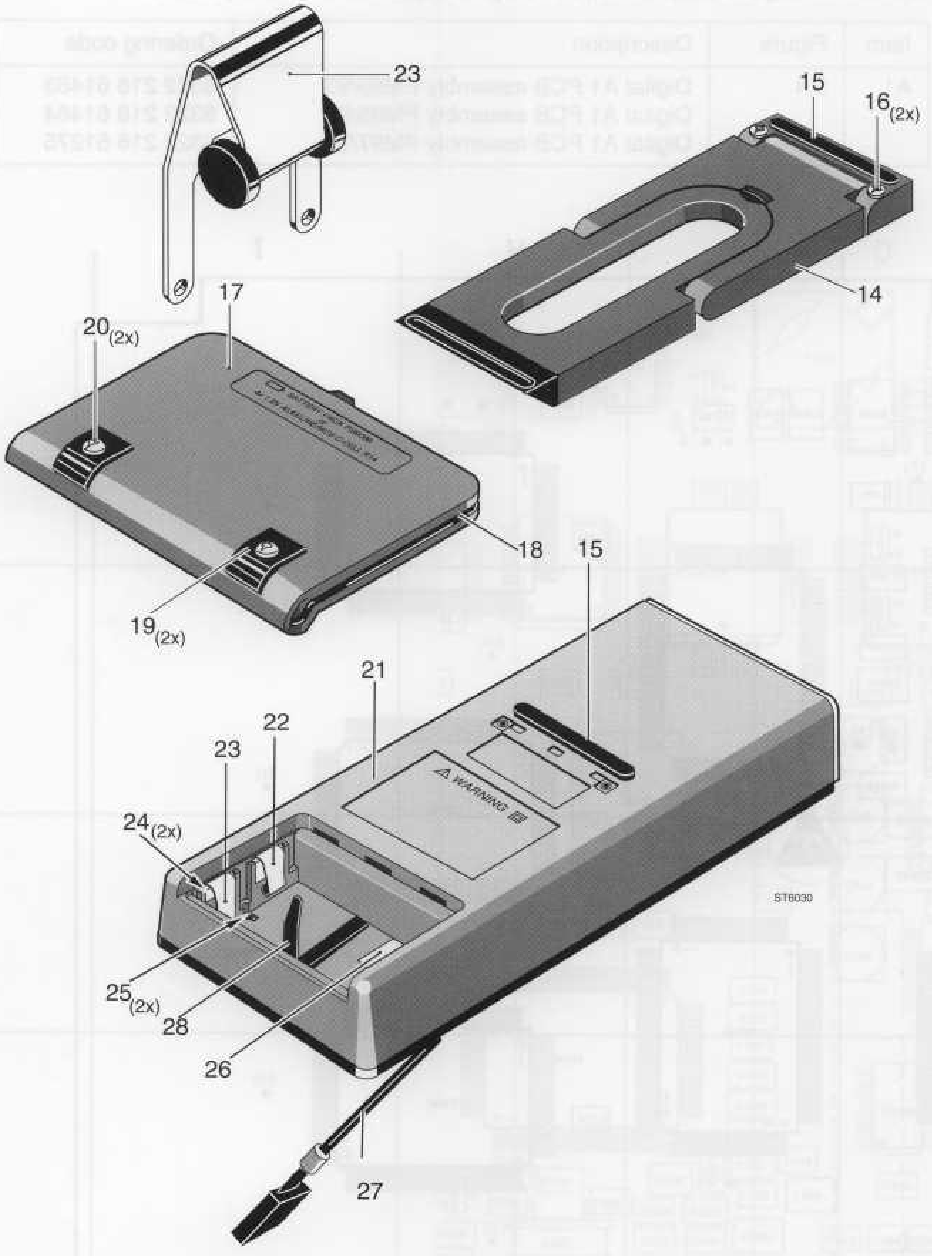
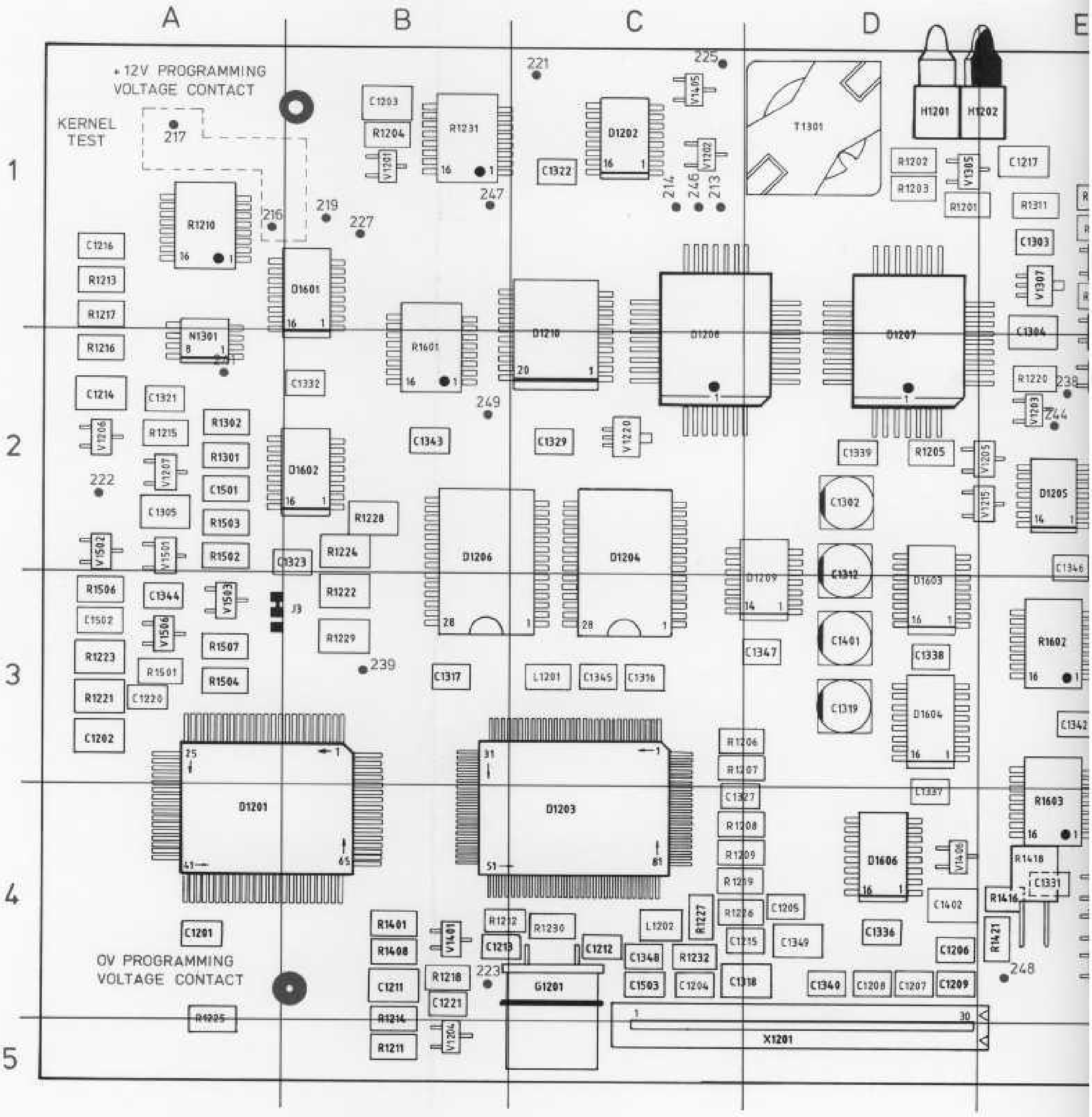



*Figure 9.3* *Battery contact assembly*
*Stand assembly*
*Battery cover assembly*
*Bottom assembly*



A
B
C
D
E
1
2
3
4
5
+12V PROGRAMMING
VOLTAGE CONTACT
KERNEL
TEST
0V PROGRAMMING
VOLTAGE CONTACT
D1201
D1203
D1206
D1204
D1207
D1208
D1210
D1601
D1602
T1301
H1201
H1202
G1201
X1201

*Table 9.4 Digital A1 PCB assembly (figure 9.4)*

When servicing the ScopeMeter, use only the replacement parts specified.

| Item | Figure | Description | Ordering code | Qty |
|---|---|---|---|---|
| A1 | 9.4 | Digital A1 PCB assembly PM93/93<br>Digital A1 PCB assembly PM95/95<br>Digital A1 PCB assembly PM97/97 | 5322 218 61463<br>5322 218 61464<br>5322 216 51275 | 1<br>1<br>1 |

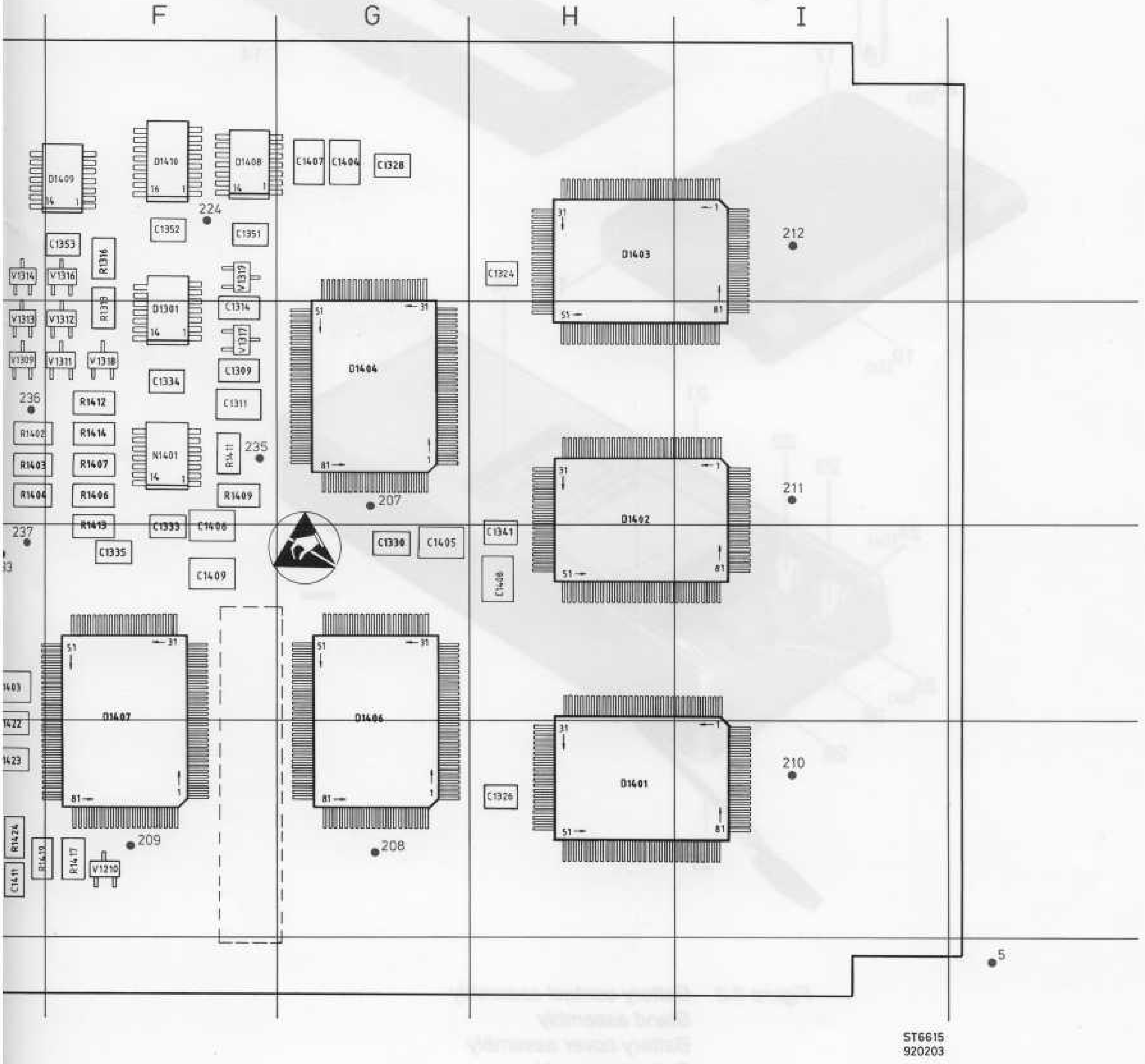



*Figure 9.4a Digital A1 PCB assembly*

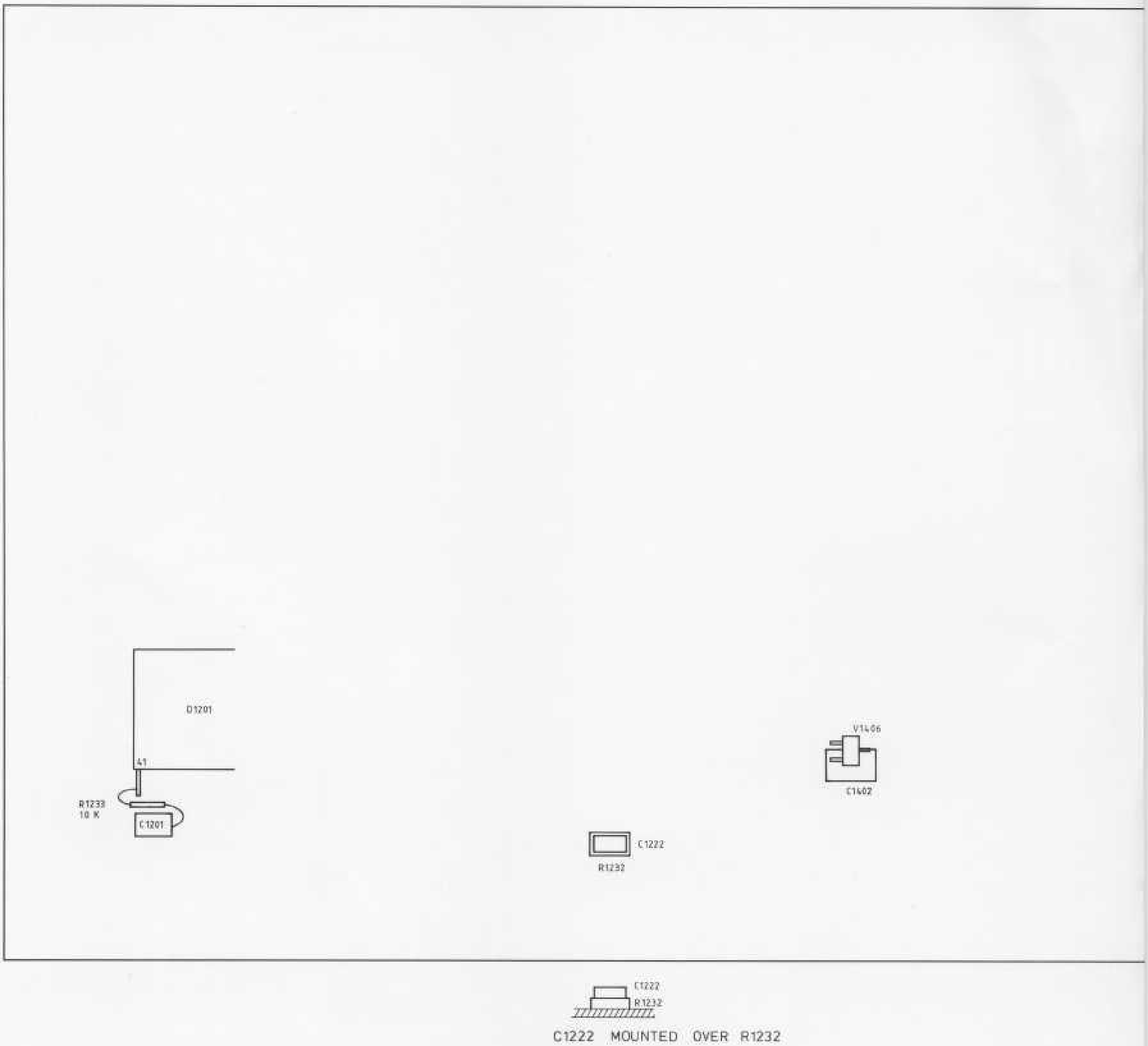



*Figure 9.4b  Modifications Digital A1 PCB assembly*

ST6849
920203

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| **CAPACITORS** | | | | | |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1201 |
| 5322 126 10785 | CAP.CHIP | 63V | 10% | 100NF | C 1202 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1203 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 1204 |
| 5322 122 33869 | CAP.CHIP | 63V | 5% | 15PF | C 1205 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1206 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1207 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1208 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1209 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1211 |
| 5322 122 33869 | CAP.CHIP | 63V | 5% | 15PF | C 1212 |
| 5322 122 33869 | CAP.CHIP | 63V | 5% | 15PF | C 1213 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1214 |
| 5322 122 33869 | CAP.CHIP | 63V | 5% | 15PF | C 1215 |
| 4822 122 33498 | CAP.CHIP | 63V | 10% | 2.7NF | C 1216 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1217 |
| 5322 126 10733 | CAP.CHIP | 63V | 5% | 680PF | C 1220 |
| 5322 122 32448 | CAP.CERAMIC | 63V | 5% | 10PF | C 1221 |
| 4822 126 10004 | CAP.CHIP | 63V | 5% | 120PF | C 1222 |
| 5322 124 42332 | CAP.ELECTROLYT. | 50V | 20% | 10UF | C 1302 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1303 |
| 5322 126 10785 | CAP.CHIP | 63V | 10% | 100NF | C 1304 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1305 |
| 4822 122 33498 | CAP.CHIP | 63V | 10% | 2.7NF | C 1309 |
| 5322 126 10785 | CAP.CHIP | 63V | 10% | 100NF | C 1311 |
| 5322 124 42331 | CAP.ELECTROLYT. | 6.3V | 20% | 100UF | C 1312 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1316 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1317 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1318 |
| 5322 124 42332 | CAP.ELECTROLYT. | 50V | 20% | 10UF | C 1319 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1321 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1322 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1323 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1324 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1326 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1327 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1328 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1329 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1330 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1332 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1333 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1334 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1335 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1336 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1337 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1338 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1339 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1340 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1341 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1344 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1346 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1347 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1348 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1349 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1351 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1352 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1353 |
| 5322 124 42332 | CAP.ELECTROLYT. | 50V | 20% | 10UF | C 1401 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1402 |
| 5322 126 10785 | CAP.CHIP | 63V | 10% | 100NF | C 1403 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1404 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1405 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1406 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1407 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1408 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 1409 |
| 5322 126 10733 | CAP.CHIP | 63V | 5% | 680PF | C 1411 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 1503 |

## RESISTORS

| | | | | | |
|---|---|---|---|---|---|
| 5322 111 91899 | RES.CHIP | RMC1/8 | 1% | 261E | R 1201 |
| 5322 116 81226 | RES.CHIP | RC-02H | 1% | 215E | R 1202 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 1203 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 1204 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1205 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1206 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1207 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1208 |
| 5322 111 91811 | RES.CHIP | RC-02H | 1% | 5K62 | R 1209 |
| 5322 111 91993 | RES.NETWORK | 002-563 | | 56K | R 1210 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1211 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 1212 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1213 |
| 4822 116 82885 | RES.METAL FILM | RC-02H | 1% | 51K1 | R 1214 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 1215 |
| 5322 116 82904 | RES.MET.GLAZED | RMC1/8 | 1% | 464K | R 1216 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 1217 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1218 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 1219 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1220 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1221 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1222 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1223 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 1225 |
| 4822 116 81789 | RES.CHIP | RMC1/8 | 1% | 316E | R 1226 |
| 5322 111 91899 | RES.CHIP | RMC1/8 | 1% | 261E | R 1227 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 1228 |
| 4822 111 91826 | RES.CHIP | RC-02H | 1% | 511E | R 1229 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 1230 |
| 5322 111 91993 | RES.NETWORK | 002-563 | | 56K | R 1231 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 1232 |
| 5322 116 82011 | RES.METAL FILM | RC-02H | 1% | 147K | R 1301 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 1302 |
| 5322 116 81795 | RES.CHIP | RC-02H | 1% | 3K48 | R 1309 |
| 5322 116 81226 | RES.CHIP | RC-02H | 1% | 215E | R 1311 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 1312 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 1313 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 1314 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 1316 |
| 5322 116 81226 | RES.CHIP | RC-02H | 1% | 215E | R 1319 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1401 |
| 5322 111 91811 | RES.CHIP | RC-02H | 1% | 5K62 | R 1402 |
| 5322 111 91811 | RES.CHIP | RC-02H | 1% | 5K62 | R 1403 |
| 4822 111 91828 | RES.CHIP | RC-02H | 1% | 68K1 | R 1404 |
| 5322 111 91811 | RES.CHIP | RC-02H | 1% | 5K62 | R 1406 |
| 5322 111 91811 | RES.CHIP | RC-02H | 1% | 5K62 | R 1407 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 1408 |
| 5322 111 91963 | RES.CHIP | RMC1/8 | 1% | 34E8 | R 1409 |
| 5322 111 91963 | RES.CHIP | RMC1/8 | 1% | 34E8 | R 1411 |
| 5322 111 91963 | RES.CHIP | RMC1/8 | 1% | 34E8 | R 1412 |
| 5322 111 91963 | RES.CHIP | RMC1/8 | 1% | 34E8 | R 1413 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 1414 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1416 |
| 5322 116 82902 | RES.MET.GLAZED | RMC1/8 | 1% | 23K7 | R 1417 |
| 4822 130 90972 | TEMP.SENSOR | KTY81-220 | | | R 1418 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 1419 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 1421 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 1422 |
| 4822 116 82889 | RES.METAL FILM | RC-02H | 1% | 90K9 | R 1423 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 1424 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 1501 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 1502 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 1503 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 1504 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 1506 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 1507 |
| 5322 111 91993 | RES.NETWORK | 002-563 | | 56K | R 1601 |
| 5322 111 91993 | RES.NETWORK | 002-563 | | 56K | R 1602 |
| 5322 111 91993 | RES.NETWORK | 002-563 | | 56K | R 1603 |

| Ordering code | Description | | Item |
|---|---|---|---|
| **SEMI-CONDUCTORS** | | | |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1201 |
| 5322 130 32731 | DIODE,CHIP | BZX84-C3V6 | V 1202 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1203 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1205 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 1206 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 1207 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 1210 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1215 |
| 5322 130 82043 | DIODE,CHIP | BZV49-C13 | V 1220 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1304 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 1305 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1306 |
| 5322 130 62237 | TRANSISTOR,CHIP | BCX54-16 | V 1307 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 1308 |
| 4822 130 82521 | DIODE,CHIP | BZX84-B47 | V 1309 |
| 4822 130 82521 | DIODE,CHIP | BZX84-B47 | V 1311 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 1312 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 1313 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 1314 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 1316 |
| 4822 130 42132 | TRANSISTOR,CHIP | BC807 | V 1317 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1318 |
| 4822 130 82262 | DIODE,CHIP | BAT54S | V 1319 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 1401 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1402 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1403 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 1404 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 1405 |
| 4822 130 82262 | DIODE,CHIP | BAT54S | V 1406 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 1501 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 1502 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 1503 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 1506 |
| **INTEGRATED CIRCUITS** | | | |
| 5322 209 30822 | U-PROCESSOR | S83C196 | D 1201 |
| 5322 209 73179 | INTEGR.CIRCUIT | PC74HCT74T | D 1202 |
| 5322 209 30819 | DIGITAL ASIC | SCOPEMETER | D 1203 |
| 5322 209 30228 | SRAM 32Kx8 | HM62256 | D 1204 |
| 5322 209 60428 | INTEGR.CIRCUIT | PC74HC132T | D 1205 |
| 5322 209 30228 | INTEGR.CIRCUIT | HM62256 | D 1206 |
| 4822 209 63758 | FROM 16Kx8 | N28F256-A200 | D 1207 |
| 5322 209 30674 | FROM 32Kx8 | N28F512-200P1C4 | D 1208 |
| 5322 209 60428 | INTEGR.CIRCUIT | PC74HC132T | D 1209 |
| 5322 209 73181 | INTEGR.CIRCUIT | PC74HCT373T | D 1210 |

| Ordering code | Description | | | Item |
|---|---|---|---|---|
| 5322 209 11147 | INTEGR.CIRCUIT | HEF4093BT | | D 1301 |
| 4822 209 63761 | LCD DRIVER | HD61105A | | D 1401 |
| 4822 209 63761 | LCD DRIVER | HD61105A | | D 1402 |
| 4822 209 63761 | LCD DRIVER | HD61105A | | D 1403 |
| 4822 209 63759 | LCD DRIVER | HD61104A | | D 1404 |
| 4822 209 63759 | LCD DRIVER | HD61104A | | D 1406 |
| 4822 209 63759 | LCD DRIVER | HD61104A | | D 1407 |
| 4822 209 30208 | INTEGR.CIRCUIT | PC74HCT86T | | D 1408 |
| 5322 209 11996 | INTEGR.CIRCUIT | PC74HCT393T | | D 1409 |
| 5322 209 30675 | INTEGR.CIRCUIT | PC74HCT163T | | D 1410 |
| 4822 209 63762 | I.C. INTERFACE | PC74HCT165T | | D 1601 |
| 4822 209 63762 | I.C. INTERFACE | PC74HCT165T | | D 1602 |
| 4822 209 63762 | I.C. INTERFACE | PC74HCT165T | | D 1603 |
| 4822 209 63762 | I.C. INTERFACE | PC74HCT165T | | D 1604 |
| 4822 209 63762 | I.C. INTERFACE | PC74HCT165T | | D 1606 |
| 4822 209 60175 | INTEGR.CIRCUIT | LM358M | | N 1301 |
| 5322 209 61473 | INTEGR.CIRCUIT | LM324M | | N 1401 |

## COILS

| | | | | |
|---|---|---|---|---|
| 5322 157 63648 | COIL | 1UH | 5% | L 1201 |
| 5322 157 63651 | COIL | CB-322513T | | L 1202 |

## MISCELLANEOUS

| | | | | |
|---|---|---|---|---|
| 5322 242 80215 | CRYSTAL | 25MHZ | HC-49/U | G 1201 |
| 5322 130 61296 | INFRARED ELEMENT | SFH409-2 | | H 1201 |
| 5322 130 62923 | PHOTO TRANSISTOR | SFH309F-4 | | H 1202 |

## CONNECTORS

| | | | |
|---|---|---|---|
| 5322 267 70302 | CONNECTOR | 30-PIN STRAIGHT | X 1201 |

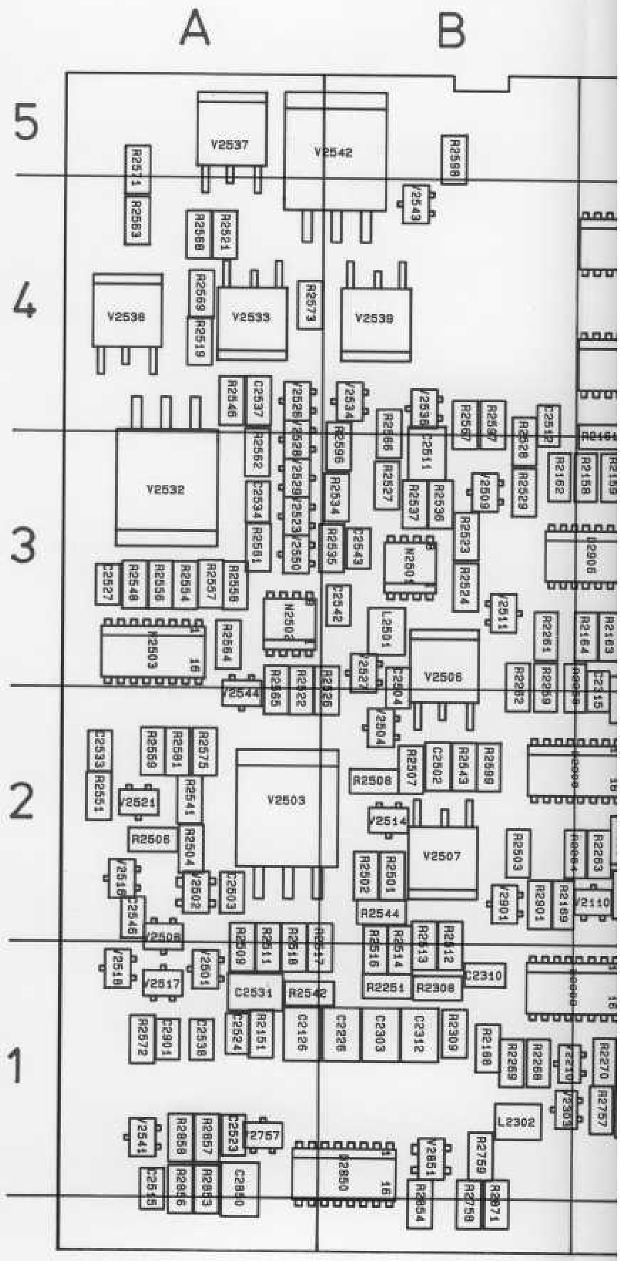


*Table 9.5 Analog A2 PCB assembly (Figure 9.5)*

When servicing the ScopeMeter, use only the replacement parts specified.

| Item | Figure | Description | Ordering code | Qty |
|---|---|---|---|---|
| A2 | 9.5/9.6 | Analog A2 PCB assembly | 5322 218 61465 | 1 |

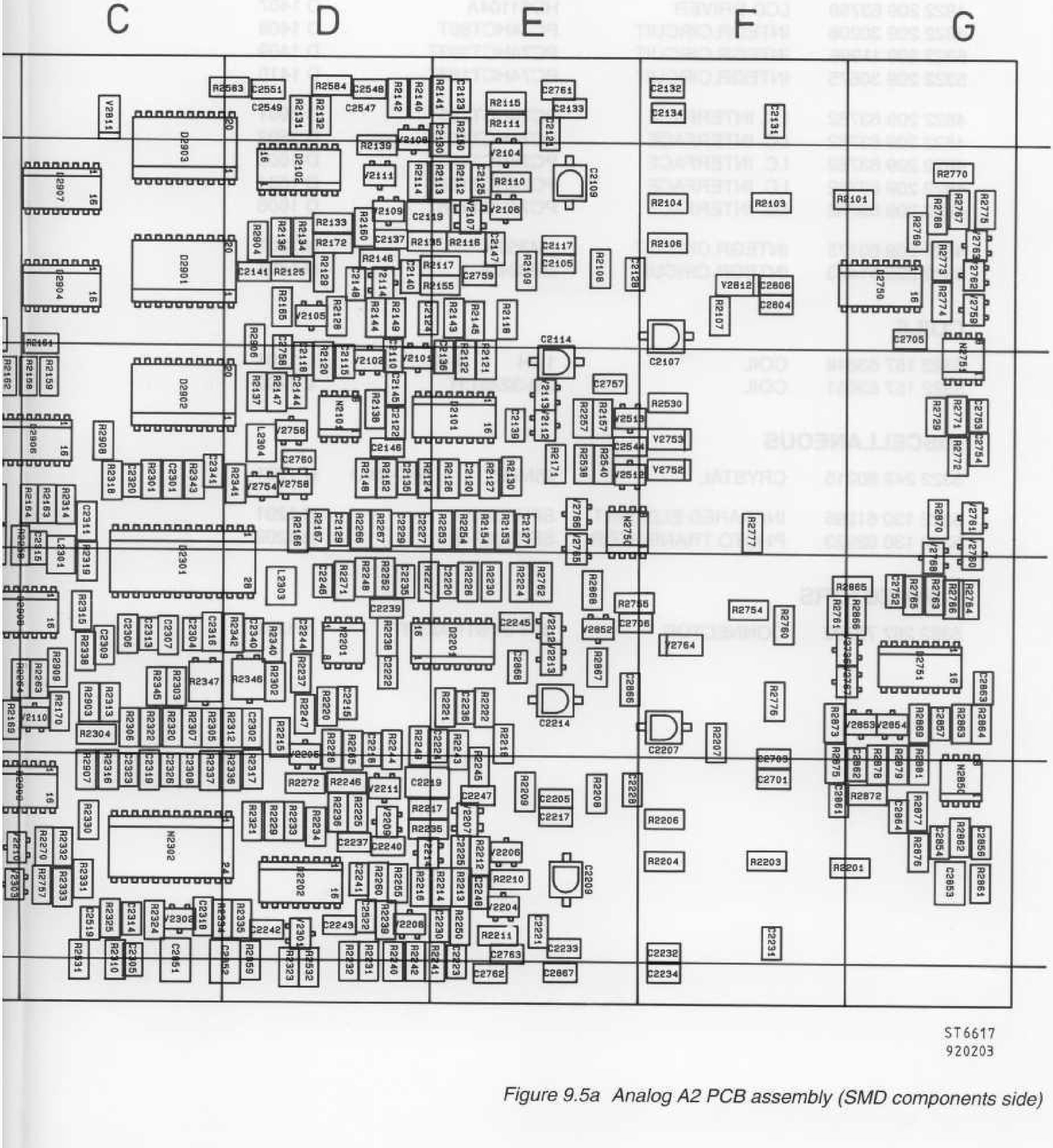



*Figure 9.5a Analog A2 PCB assembly (SMD components side)*

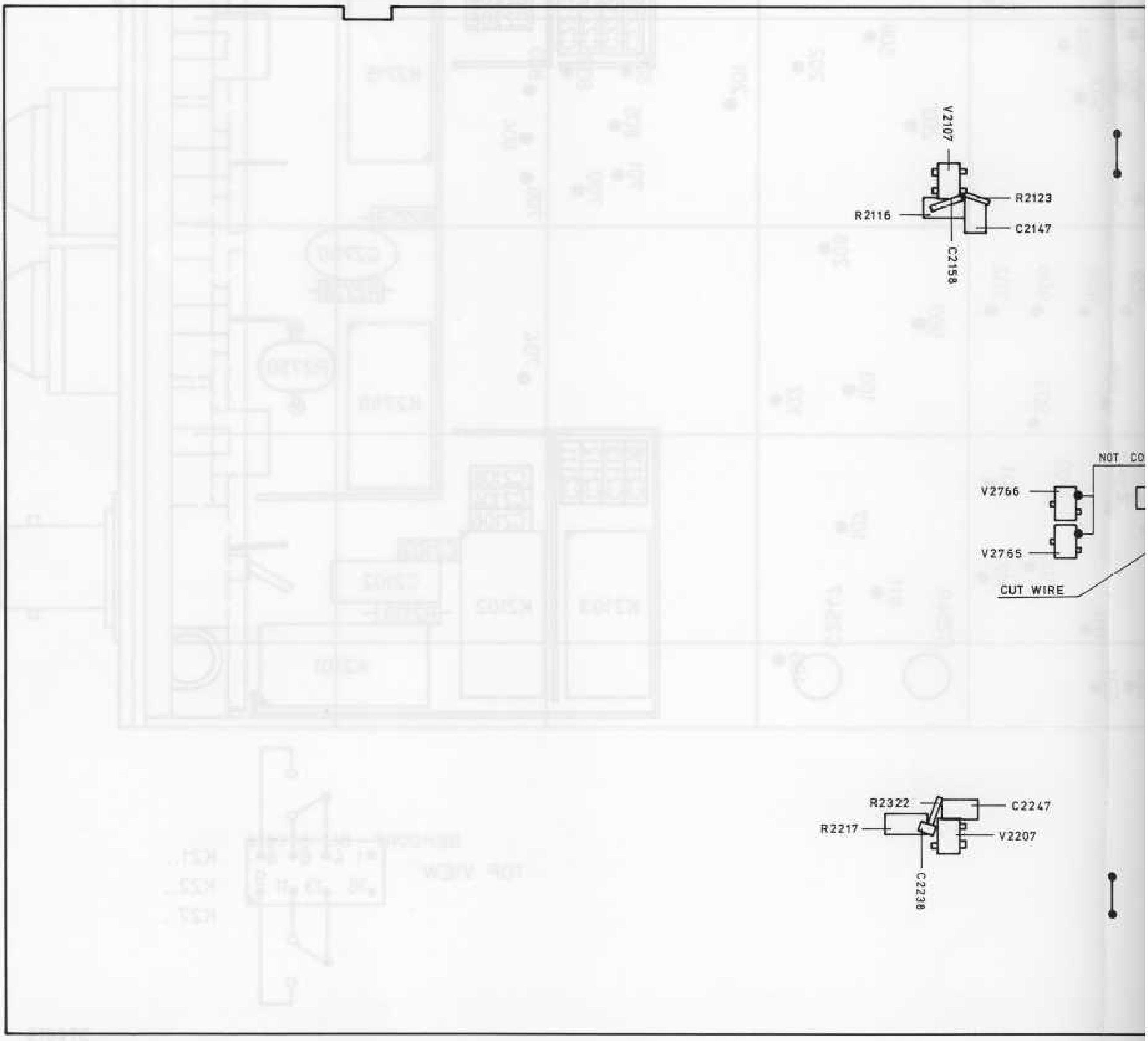
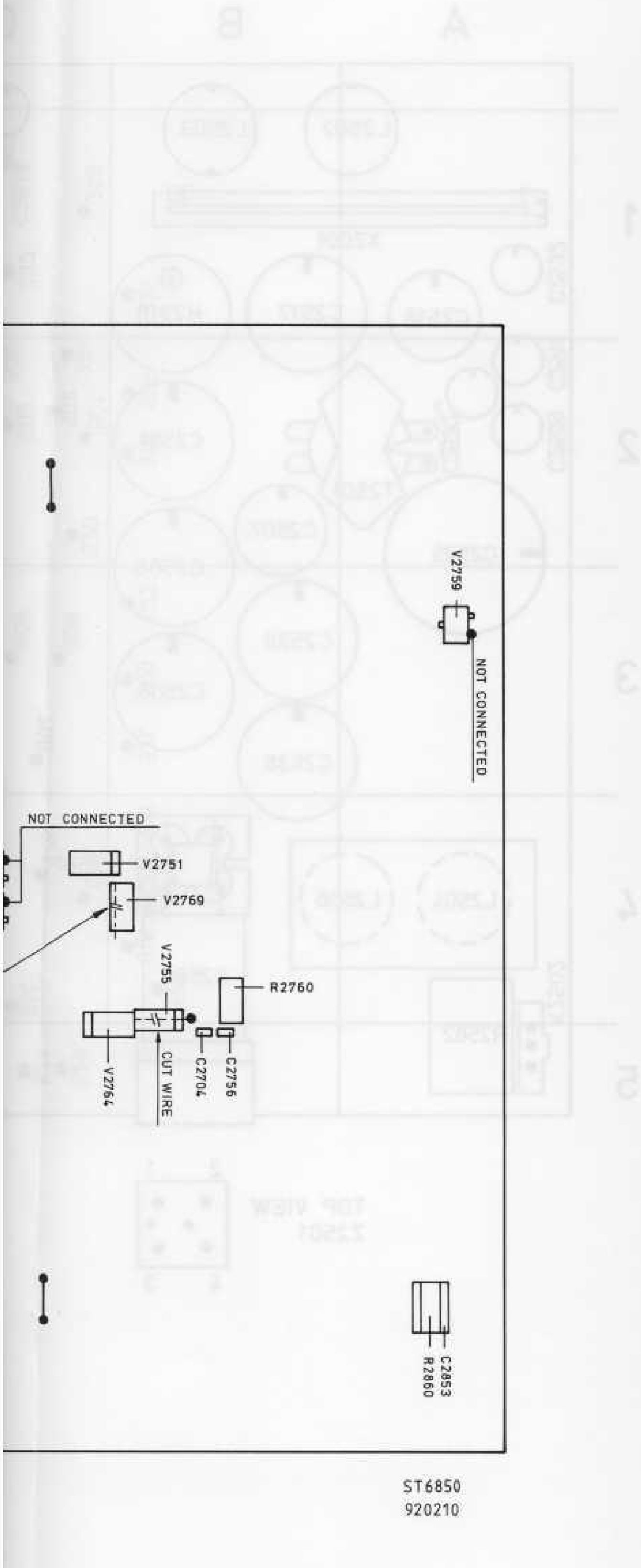
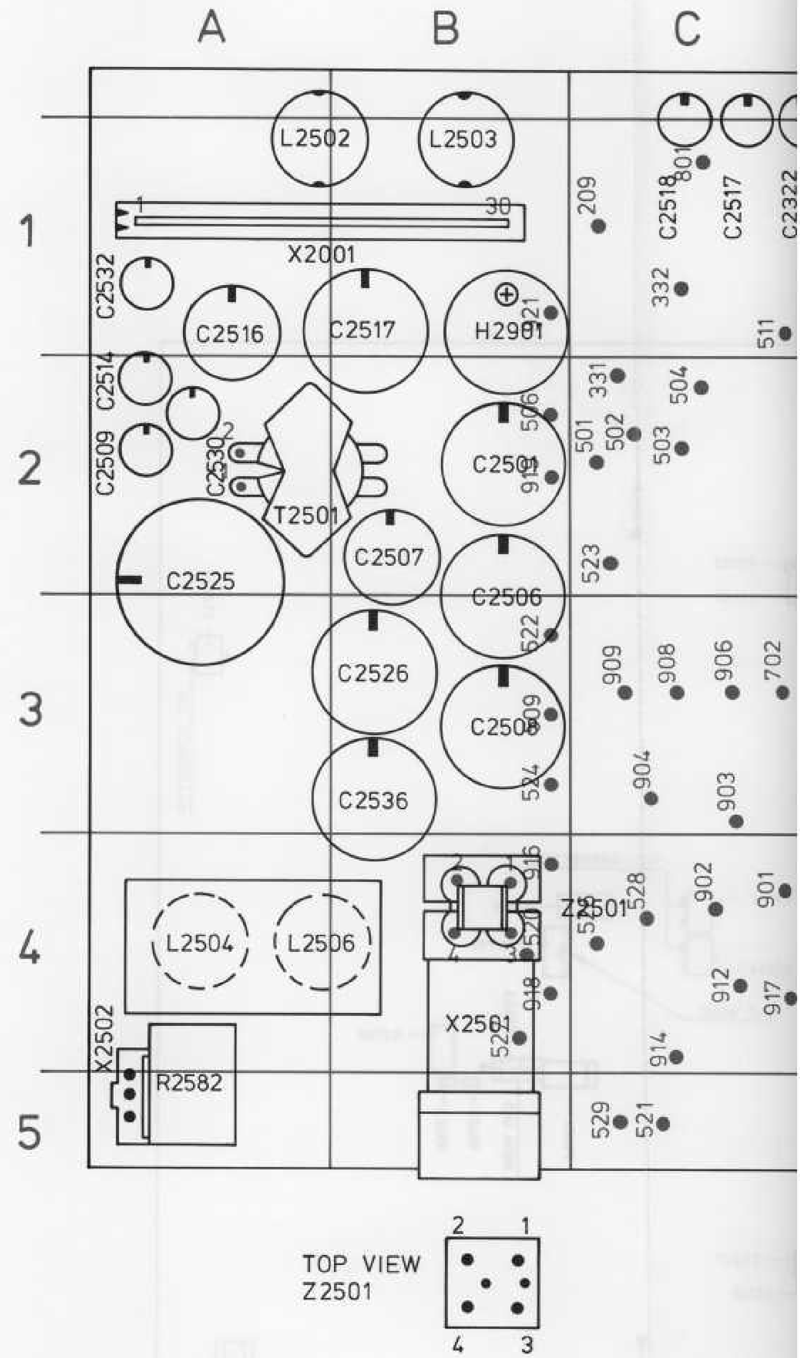



*Figure 9.5b  Modifications Analog A2 PCB (SMD Component side)*




ST6850
920210


A
B
C
1
2
3
4
5
L2502
L2503
X2001
C2532
C2516
C2517
H2901
C2514
C2509
C2530
T2501
C2501
C2525
C2507
C2506
C2526
C2508
C2536
L2504
L2506
Z2501
X2501
X2502
R2582
C2518
C2517
C2322
TOP VIEW
Z2501

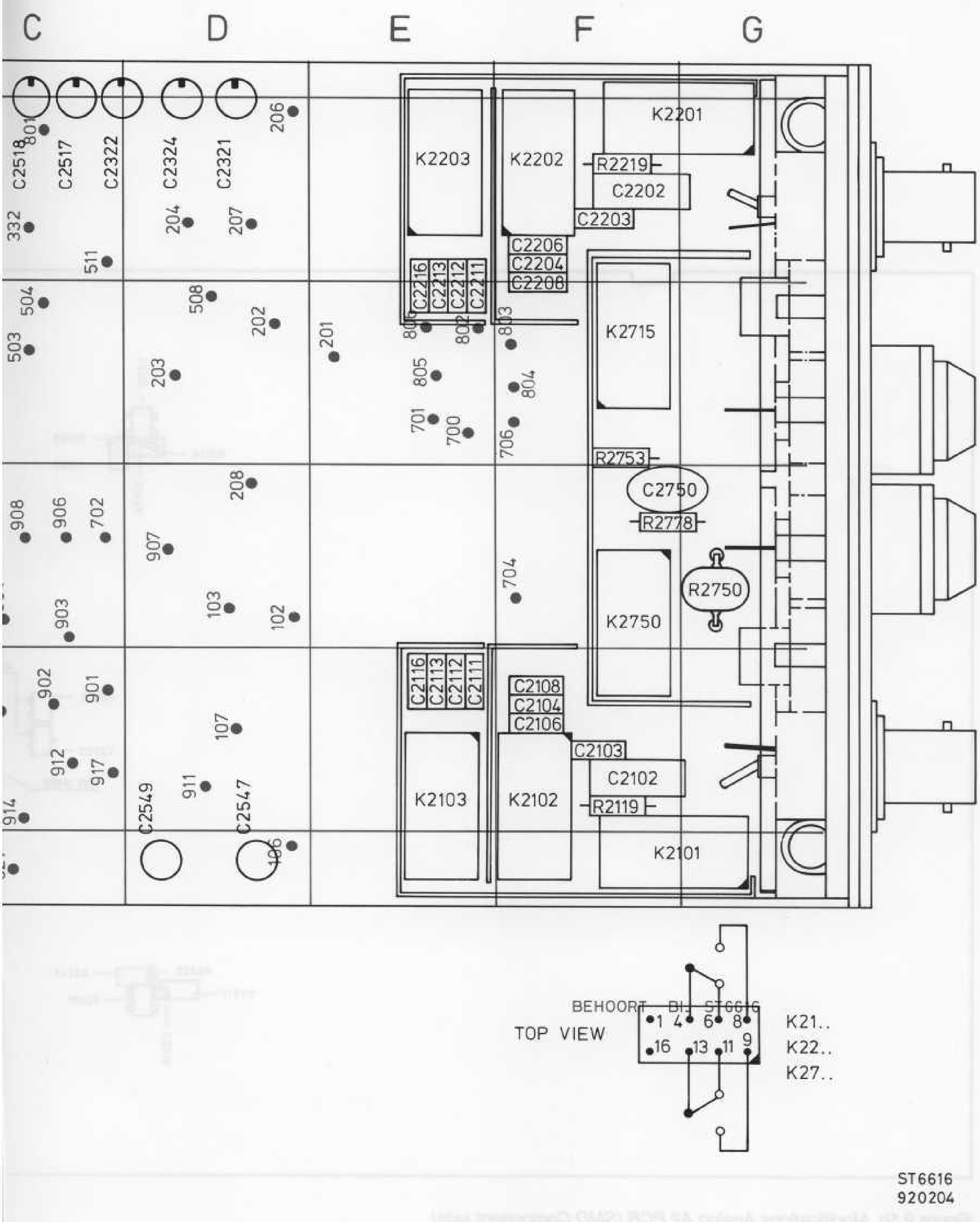



*Figure 9.6 Analog A2 PCB assembly (Wired components side)*

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| **CAPACITORS** | | | | | |
| 5322 121 40308 | CAP.FOIL | 400V | 10% | 22NF | C 2102 |
| 5322 122 32982 | CAP.CERAMIC | | 2% | 56PF | C 2103 |
| 4822 122 31194 | CAP.CERAMIC | | 0.25PF | 8.2PF | C 2104 |
| 5322 122 33869 | CAP.CERAMIC | 63V | 5% | 15PF | C 2105 |
| 4822 122 31195 | CAP.CERAMIC | | 2% | 10PF | C 2106 |
| 5322 125 11029 | CAP.VARIABLE | | 10 PF | MUR | C 2107 |
| 4822 122 31072 | CAP.CERAMIC | | 2% | 47PF | C 2108 |
| 5322 125 11029 | CAP.VARIABLE | | 10 PF | MUR | C 2109 |
| 4822 122 30149 | CAP.CERAMIC | | 0.25PF | 6.8PF | C 2111 |
| 4822 122 31049 | CAP.CERAMIC | | 0.25PF | 6.8PF | C 2112 |
| 4822 122 32027 | CAP.CERAMIC | | 2% | 56PF | C 2113 |
| 5322 125 11029 | CAP.VARIABLE | | 10 PF | MUR | C 2114 |
| 5322 861 12331 | CAP.CHIP | 63V | 5% | 330PF | C 2115 |
| 4822 122 31194 | CAP.CERAMIC | | 0.25PF | 8.2PF | C 2116 |
| 5322 122 32661 | CAP.CHIP | 63V | 5% | 56PF | C 2117 |
| 5322 861 12331 | CAP.CHIP | 63V | 5% | 330PF | C 2118 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 2119 |
| 5322 122 32967 | CAP.CERAMIC | 63V | 5% | 5.6PF | C 2120 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2121 |
| 4822 122 33339 | CAP.CHIP | 63V | 10% | 4.7NF | C 2122 |
| 4822 122 33891 | CAP.CHIP | 63V | 10% | 3.3NF | C 2123 |
| 4822 122 33891 | CAP.CHIP | 63V | 10% | 3.3NF | C 2124 |
| 4822 126 10004 | CAP.CHIP | 63V | 5% | 120PF | C 2125 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 2126 |
| 4822 122 32891 | CAP.CERAMIC | 63V | 10% | 68NF | C 2127 |
| 4822 122 32448 | CAP.CERAMIC | 63V | 0.5PF | 10PF | C 2128 |
| 4822 122 33891 | CAP.CHIP | 63V | 10% | 3.3NF | C 2129 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2130 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2131 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2132 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2133 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2134 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2135 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2138 |
| 4822 122 33515 | CAP.CHIP | 63V | 5% | 82PF | C 2137 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2139 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2140 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2141 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2144 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2145 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2146 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2147 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2148 |
| 5322 121 40308 | CAP.FOIL | 400V | 10% | 22NF | C 2202 |
| 5322 122 32982 | CAP. | | 2% | 56P | C 2203 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 4822 122 31194 | CAP.CERAMIC | | 0.25PF | 8.2PF | C 2204 |
| 5322 122 33869 | CAP.CERAMIC | 63V | 5% | 15PF | C 2205 |
| 4822 122 31195 | CAP.CERAMIC | | 2% | 10PF | C 2206 |
| 5322 125 11029 | CAP.VARIABLE | | 10 PF | MUR | C 2207 |
| 4822 122 31072 | CAP.CERAMIC | | 2% | 47PF | C 2208 |
| 5322 125 11029 | CAP.VARIABLE | | 10 PF | MUR | C 2209 |
| 4822 122 30149 | CAP.CERAMIC | | 0.25PF | 6.8PF | C 2211 |
| 4822 122 31049 | CAP.CERAMIC | | 0.25PF | 6.8PF | C 2212 |
| 4822 122 32027 | CAP.CERAMIC | | 2% | 56PF | C 2213 |
| 5322 125 11029 | CAP.VARIABLE | | 10 PF | MUR | C 2214 |
| 5322 861 12331 | CAP.CHIP | 63V | 5% | 330PF | C 2215 |
| 4822 122 31194 | CAP.CERAMIC | | 0.25PF | 8.2PF | C 2216 |
| 5322 122 32661 | CAP.CHIP | 63V | 5% | 56PF | C 2217 |
| 4822 122 33216 | CAP.CHIP | 63V | 5% | 270PF | C 2218 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 2219 |
| 5322 122 32967 | CAP.CERAMIC | 63V | 5% | 5.6PF | C 2220 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2221 |
| 4822 122 33339 | CAP.CHIP | 63V | 10% | 4.7NF | C 2222 |
| 4822 122 33891 | CAP.CHIP | 63V | 10% | 3.3NF | C 2223 |
| 4822 122 33891 | CAP.CHIP | 63V | 10% | 3.3NF | C 2224 |
| 4822 126 10004 | CAP.CHIP | 63V | 5% | 120PF | C 2225 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 2226 |
| 4822 122 32891 | CAP.CERAMIC | 63V | 10% | 68NF | C 2227 |
| 4822 122 32448 | CAP.CERAMIC | 63V | 0.5PF | 10PF | C 2228 |
| 4822 122 33891 | CAP.CHIP | 63V | 10% | 3.3NF | C 2229 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2230 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2231 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2232 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2233 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2234 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2235 |
| 4822 122 33515 | CAP.CHIP | 63V | 5% | 82PF | C 2237 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2238 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2239 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2240 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2241 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2242 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2243 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2244 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2245 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2246 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2247 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2248 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2301 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2302 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2303 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2304 |
| 5322 122 33869 | CAP.CHIP | 63V | 5% | 15PF | C 2305 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2306 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2307 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2308 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2309 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2310 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2311 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 2312 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2313 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2314 |
| 4822 122 32139 | CAP.CHIP | 63V | 5% | 12PF | C 2315 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2316 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2317 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2318 |
| 4822 122 33496 | CAP.CHIP | 63V | 10% | 100NF | C 2319 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2320 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2321 |
| 4822 124 23627 | CAP.ELECTROLYT. | | 20% | 4.7UF | C 2322 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2323 |
| 4822 124 23627 | CAP.ELECTROLYT. | | 20% | 4.7UF | C 2324 |
| 5322 122 32452 | CAP.CERAMIC | 63V | 5% | 47PF | C 2326 |
| 5322 122 33869 | CAP.CHIP | 63V | 5% | 15PF | C 2340 |
| 5322 122 33869 | CAP.CHIP | 63V | 5% | 15PF | C 2341 |
| 5322 121 43885 | CAP.FOIL | | 20% | 470UF | C 2501 |
| 4822 122 32891 | CAP.CERAMIC | 63V | 10% | 68NF | C 2502 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2503 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2504 |
| 5322 121 43884 | CAP.FOIL | | 20% | 1200UF | C 2506 |
| 5322 121 43886 | CAP.FOIL | | 20% | 180UF | C 2507 |
| 5322 121 43884 | CAP.FOIL | | 20% | 1200UF | C 2508 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2509 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 2511 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2512 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2514 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2515 |
| 5322 121 43887 | CAP.FOIL | | 20% | 470UF | C 2516 |
| 5322 121 43887 | CAP.FOIL | | 20% | 470UF | C 2517 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2518 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2519 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2521 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2522 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2523 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2524 |
| 5322 121 43885 | CAP.FOIL | | 20% | 470UF | C 2526 |
| 5322 126 10733 | CAP.CHIP | 63V | 5% | 680PF | C 2527 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2530 |
| 4822 122 32916 | CAP.CHIP | 63V | 10% | 220NF | C 2531 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2532 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2533 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2534 |
| 5322 121 43885 | CAP.FOIL | | 20% | 470UF | C 2536 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 4822 122 32891 | CAP.CERAMIC | 63V | 10% | 68NF | C 2537 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2538 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2542 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2543 |
| 4822 126 10004 | CAP.CHIP | 63V | 5% | 120PF | C 2544 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2546 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2547 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2548 |
| 4822 124 11162 | CAP.ELECTROLYT. | | 20% | 68UF | C 2549 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2551 |
| 5322 124 42329 | CAP.ELECTROLYT. | | 20% | 3900UF | C 2552 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2701 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2703 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2705 |
| 5322 126 11389 | CAP.CERAMIC | | 10% | 22PF | C 2750 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2752 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2753 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2754 |
| 5322 122 32654 | CAP.CHIP | 63V | 10% | 22NF | C 2756 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2757 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2758 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2759 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2760 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2761 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2762 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2763 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2804 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2806 |
| 5322 122 33897 | CAP.CERAMIC | 63V | 5% | 3.3NF | C 2850 |
| 5322 122 33897 | CAP.CERAMIC | 63V | 5% | 3.3NF | C 2851 |
| 5322 122 33897 | CAP.CERAMIC | 63V | 5% | 3.3NF | C 2852 |
| 5322 122 33816 | CAP.CERAMIC | 63V | 5% | 2.2NF | C 2853 |
| 5322 126 10733 | CAP.CHIP | 63V | 5% | 680PF | C 2854 |
| 4822 122 33216 | CAP.CHIP | 63V | 5% | 270PF | C 2856 |
| 5322 122 32452 | CAP.CERAMIC | 63V | 5% | 47PF | C 2857 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2861 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2862 |
| 5322 122 32452 | CAP.CERAMIC | 63V | 5% | 47PF | C 2863 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2864 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2866 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2867 |
| 4822 122 33127 | CAP.CHIP | 63V | 10% | 2.2NF | C 2868 |
| 5322 122 34098 | CAP.CHIP | 63V | 10% | 10NF | C 2901 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| **RESISTORS** | | | | | |
| 5322 116 82895 | RES.CHIP | RMC1/8 | 1% | 31E6 | R 2101 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2103 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2104 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2106 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2107 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2108 |
| 5322 111 91963 | RES.CHIP | RMC1/8 | 1% | 34E8 | R 2109 |
| 4822 116 81789 | RES.CHIP | RMC1/8 | 1% | 316E | R 2110 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2111 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2112 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2113 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2114 |
| 4822 116 82408 | RES.CHIP | RC-02H | 1% | 1K33 | R 2115 |
| 4822 051 51331 | RES.CHIP | RMC1/8 | 1% | 133E | R 2116 |
| 5322 111 91899 | RES.CHIP | RMC1/8 | 1% | 261E | R 2117 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2118 |
| 4822 050 29534 | RES.METAL FILM | MRS25 | 1% | 953K | R 2119 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2120 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2121 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2122 |
| 4822 051 51005 | RES.CHIP | RC-02H | 1% | 1M | R 2123 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2124 |
| 4822 051 57502 | RES.MET.GLAZED | RMC1/8 | 1% | 7K5 | R 2125 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2126 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2127 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2128 |
| 5322 116 82112 | RES.CHIP | RMC1/8 | 1% | 681E | R 2129 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2130 |
| 5322 116 82011 | RES.METAL FILM | RC-02H | 1% | 147K | R 2131 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2132 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2133 |
| 5322 116 80609 | RES.MET.GLAZED | RC-02H | 1% | 7K5 | R 2134 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2135 |
| 4822 116 82384 | RES.CHIP | RC-02H | 1% | 750E | R 2136 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2137 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 2138 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2139 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2140 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2141 |
| 4822 051 51781 | RES.NETWORK | RMC1/8 | 1% | 178E | R 2142 |
| 5322 116 81795 | RES.CHIP | RC-02H | 1% | 3K48 | R 2143 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 2144 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2145 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2146 |
| 5322 116 82011 | RES.METAL FILM | RC-02H | 1% | 147K | R 2147 |
| 5322 116 82904 | RES.MET.GLAZED | RMC1/8 | 1% | 464K | R 2148 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2149 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2150 |
| 4822 116 82886 | RES.CHIP | RC-02H | 1% | 61K9 | R 2151 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2152 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2153 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2154 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2155 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2157 |
| 4822 116 82885 | RES.METAL FILM | RC-02H | 1% | 51K1 | R 2158 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2159 |
| 4822 111 91826 | RES.CHIP | RC-02H | 1% | 511E | R 2160 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2161 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2162 |
| 5322 116 82904 | RES.MET.GLAZED | RMC1/8 | 1% | 464K | R 2163 |
| 4822 116 82888 | RES.METAL FILM | RC-02H | 1% | 825K | R 2164 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2165 |
| 4822 116 90788 | RES.CHIP | RMC1/8 | 1% | 68E1 | R 2166 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2167 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2168 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2169 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2170 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2171 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2172 |
| 5322 116 82895 | RES.CHIP | RMC1/8 | 1% | 31E6 | R 2201 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2203 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2204 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2206 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2207 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2208 |
| 4822 111 91887 | RES.CHIP | RMC1/8 | 1% | 42E2 | R 2209 |
| 4822 116 81789 | RES.CHIP | RMC1/8 | 1% | 316E | R 2210 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2211 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2212 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2213 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2214 |
| 4822 116 82408 | RES.CHIP | RC-02H | 1% | 1K33 | R 2215 |
| 4822 051 51331 | RES.CHIP | RMC1/8 | 1% | 133E | R 2216 |
| 5322 111 91899 | RES.CHIP | RMC1/8 | 1% | 261E | R 2217 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2218 |
| 4822 050 29534 | RES.METAL FILM | MRS25 | 1% | 953K | R 2219 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2220 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2221 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2222 |
| 4822 051 51005 | RES.CHIP | RC-02 | 1% | 1M | R 2223 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2224 |
| 5322 116 82901 | RES.MET.GLAZED | RMC1/8 | 1% | 19K6 | R 2225 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2226 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2227 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2228 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 5322 116 82112 | RES.CHIP | RMC1/8 | 1% | 681E | R 2229 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2230 |
| 5322 116 82011 | RES.METAL FILM | RC-02H | 1% | 147K | R 2231 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2232 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2233 |
| 5322 116 80609 | RES.MET.GLAZED | RC-02H | 1% | 7K5 | R 2234 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2235 |
| 4822 116 82384 | RES.CHIP | RC-02H | 1% | 750E | R 2236 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2237 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 2238 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2239 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2240 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2241 |
| 4822 051 51781 | RES.NETWORK | RMC1/8 | 1% | 178E | R 2242 |
| 5322 116 81795 | RES.CHIP | RC-02H | 1% | 3K48 | R 2243 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 2244 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2245 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2246 |
| 5322 116 82011 | RES.METAL FILM | RC-02H | 1% | 147K | R 2247 |
| 5322 116 82904 | RES.MET.GLAZED | RMC1/8 | 1% | 464K | R 2248 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2249 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2250 |
| 4822 116 82886 | RES.CHIP | RC-02H | 1% | 61K9 | R 2251 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2252 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2253 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2254 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2255 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2257 |
| 4822 116 82885 | RES.METAL FILM | RC-02H | 1% | 51K1 | R 2258 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2259 |
| 4822 111 91826 | RES.CHIP | RC-02H | 1% | 511E | R 2260 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2261 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2262 |
| 5322 116 82904 | RES.MET.GLAZED | RMC1/8 | 1% | 464K | R 2263 |
| 4822 116 82888 | RES.METAL FILM | RC-02H | 1% | 825K | R 2264 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2265 |
| 4822 116 90788 | RES.CHIP | RMC1/8 | 1% | 68E1 | R 2266 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2267 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2268 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2269 |
| 5322 116 82899 | RES.MET.GLAZED | RMC1/8 | 1% | 3K83 | R 2270 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2271 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2272 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2301 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2302 |
| 4822 116 82408 | RES.CHIP | RC-02H | 1% | 1K33 | R 2303 |
| 4822 111 91892 | RES.METAL FILM | RC-02H | 1% | 511K | R 2304 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2305 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2306 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2307 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2308 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2309 |
| 5322 111 91899 | RES.CHIP | RMC1/8 | 1% | 261E | R 2310 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2312 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2313 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2314 |
| 5322 111 91901 | RES.CHIP | RMC1/8 | 1% | 348E | R 2315 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2316 |
| 4822 111 91828 | RES.CHIP | RC-02H | 1% | 68K1 | R 2317 |
| 5322 116 82897 | RES.MET.GLAZED | RMC1/8 | 1% | 383E | R 2318 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2319 |
| 4822 116 82885 | RES.METAL FILM | RC-02H | 1% | 51K1 | R 2320 |
| 4822 116 82884 | RES.CHIP | RC-02H | 1% | 316K | R 2321 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2322 |
| 5322 116 82898 | RES.MET.GLAZED | RMC1/8 | 1% | 464E | R 2323 |
| 4822 116 81789 | RES.CHIP | RMC1/8 | 1% | 316E | R 2324 |
| 4822 111 91821 | CAP.CHIP | RC-02H | 1% | 2K61 | R 2325 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2330 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2331 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2332 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2333 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2334 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2335 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2336 |
| 4822 111 91888 | RES.CHIP | RMC1/8 | 1% | 56E2 | R 2337 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2338 |
| 5322 116 82895 | RES.NETWORK | RMC1/8 | 1% | 31E6 | R 2340 |
| 5322 116 82895 | RES.NETWORK | RMC1/8 | 1% | 31E6 | R 2341 |
| 5322 116 82896 | RES.MET.GLAZED | RMC1/8 | 1% | 46E4 | R 2342 |
| 5322 116 82896 | RES.MET.GLAZED | RMC1/8 | 1% | 46E4 | R 2343 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2345 |
| 5322 101 60082 | POTM.TRIMMER | VG4 | 25% | 10K | R 2346 |
| 5322 101 60082 | POTM.TRIMMER | VG4 | 25% | 10K | R 2347 |
| 4822 111 91826 | RES.CHIP | RC-02H | 1% | 511E | R 2501 |
| 4822 111 91826 | RES.CHIP | RC-02H | 1% | 511E | R 2502 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2503 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2504 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2506 |
| 5322 111 91963 | RES.CHIP | RMC1/8 | 1% | 34E8 | R 2507 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 5E1 | R 2508 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2509 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2511 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2512 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2513 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2514 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2516 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2517 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2518 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2519 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2521 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2522 |
| 5322 116 81795 | RES.CHIP | RC-02H | 1% | 3K48 | R 2523 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 2524 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2526 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2527 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2528 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 2529 |
| 5322 116 81228 | RES.CHIP | RC-02H | 1% | 5K11 | R 2530 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2531 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2532 |
| 5322 116 82901 | RES.MET.GLAZED | RMC1/8 | 1% | 19K6 | R 2534 |
| 4822 116 82885 | RES.METAL FILM | RC-02H | 1% | 51K1 | R 2535 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 2536 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2537 |
| 5322 116 82367 | RES.METAL FILM | RC-02H | 1% | 3K16 | R 2538 |
| 5322 116 82367 | RES.METAL FILM | RC-02H | 1% | 3K16 | R 2540 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2541 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2542 |
| 5322 116 81228 | RES.CHIP | RC-02H | 1% | 5K11 | R 2543 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2544 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 2546 |
| 4822 111 91816 | RES.CHIP | RC-02H | 1% | 14K7 | R 2548 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2551 |
| 4822 116 82408 | RES.CHIP | RC-02H | 1% | 1K33 | R 2554 |
| 5322 111 91811 | RES.CHIP | RC-02H | 1% | 5K62 | R 2556 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2557 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2558 |
| 5322 116 81794 | RES.CHIP | RC-02H | 1% | 2K15 | R 2559 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2561 |
| 4822 116 82532 | RES.CHIP | RC-02H | 1% | 11K | R 2562 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2563 |
| 5322 111 91811 | RES.CHIP | RC-02H | 1% | 5K62 | R 2564 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2565 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2566 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2567 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2568 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2569 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2571 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2572 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2573 |
| 4822 116 82885 | RES.METAL FILM | RC-02H | 1% | 51K1 | R 2575 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2581 |
| 5322 113 41318 | RES. | SMW02 | 5% | 0E1 | R 2582 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2583 |
| 4822 111 91885 | RES.CHIP | RMC1/8 | 1% | 10E | R 2584 |
| 5322 116 82901 | RES.MET.GLAZED | RMC1/8 | 1% | 19K6 | R 2596 |
| 5322 116 82901 | RES.MET.GLAZED | RMC1/8 | 1% | 19K6 | R 2597 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2598 |
| 5322 116 82901 | RES.MET.GLAZED | RMC1/8 | 1% | 19K6 | R 2599 |
| 4822 116 82886 | RES.CHIP | RC-02H | 1% | 61K9 | R 2729 |
| 5322 116 40214 | RES.N.T.C. | SPEC | | | R 2750 |
| 5322 116 82905 | RES.METAL FILM | R25 487K 1% | | | R 2753 |
| 4822 111 91892 | RES.METAL FILM | RC-02H | 1% | 511K | R 2754 |
| 5322 116 80427 | RES.CHIP | RC-02H | 1% | 1K | R 2755 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2757 |
| 5322 116 80428 | RES.CHIP | RC-02H | 1% | 10K | R 2758 |
| 5322 111 91899 | RES.CHIP | RMC1/8 | 1% | 261E | R 2759 |
| 4822 116 90788 | RES.NETWORK | RMC1/8 | 1% | 68E1 | R 2760 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2761 |
| 4822 116 81165 | RES.CHIP | RC-02H | 1% | 1M | R 2762 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2763 |
| 4822 111 91828 | RES.CHIP | RC-02H | 1% | 68K1 | R 2764 |
| 5322 116 82901 | RES.MET.GLAZED | RMC1/8 | 1% | 19K6 | R 2766 |
| 5322 116 81228 | RES.CHIP | RC-02H | 1% | 5K11 | R 2767 |
| 4822 116 82883 | RES.CHIP | RC-02H | 1% | 237K | R 2768 |
| 5322 116 82011 | RES.METAL FILM | RC-02H | 1% | 147K | R 2769 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2770 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2771 |
| 5322 116 80429 | RES.CHIP | RC-02H | 1% | 100K | R 2772 |
| 4822 051 51002 | RES.CHIP | RC-02H | 1% | 1K | R 2773 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 2774 |
| 5322 116 81795 | RES.CHIP | RC-02H | 1% | 3K48 | R 2775 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2776 |
| 5322 111 91893 | RES.CHIP | RMC1/8 | 1% | 51E1 | R 2777 |
| 5322 116 82905 | RES.METAL FILM | R25 | 1% | 487K | R 2778 |
| 4822 051 53483 | RES.MET.GLAZED | RMC1/8 | 1% | 34K8 | R 2853 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2854 |
| 4822 111 91828 | RES.CHIP | RC-02H | 1% | 68K1 | R 2856 |
| 4822 111 91828 | RES.CHIP | RC-02H | 1% | 68K1 | R 2857 |
| 4822 051 10108 | RES.CHIP | RC-01 | 5% | 1E | R 2858 |
| 4822 116 82887 | RES.CHIP | RC-02H | 1% | 75K | R 2859 |
| 4822 051 10106 | RES.CHIP | RC-01 | 5% | 10M | R 2860 |
| 4822 116 82883 | RES.CHIP | RC-02H | 1% | 237K | R 2861 |
| 5322 111 91812 | RES.METAL FILM | RC-02H | 1% | 562K | R 2862 |
| 5322 116 81795 | RES.CHIP | RC-02H | 1% | 3K48 | R 2863 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2864 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2865 |
| 4822 111 91814 | RES.CHIP | RC-02H | 1% | 121E | R 2866 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2867 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2868 |

| Ordering code | Description | | | | Item |
|---|---|---|---|---|---|
| 4822 051 53483 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2869 |
| 5322 116 82111 | RES.CHIP | RC-02H | 1% | 261K | R 2870 |
| 5322 116 82904 | RES.MET.GLAZED | RMC1/8 | 1% | 464K | R 2871 |
| 5322 116 82904 | RES.MET.GLAZED | RMC1/8 | 1% | 464K | R 2872 |
| 5322 116 82111 | RES.CHIP | RC-02H | 1% | 261K | R 2873 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2875 |
| 4822 116 82884 | RES.CHIP | RC-02H | 1% | 316K | R 2876 |
| 5322 111 91809 | RES.METAL FILM | RC-02H | 1% | 215K | R 2877 |
| 4822 116 82885 | RES.METAL FILM | RC-02H | 1% | 51K1 | R 2878 |
| 5322 116 82901 | RES.MET.GLAZED | RMC1/8 | 1% | 19K6 | R 2879 |
| 5322 111 91899 | RES.CHIP | RMC1/8 | 1% | 261E | R 2881 |
| 5322 116 82901 | RES.MET.GLAZED | RMC1/8 | 1% | 19K6 | R 2901 |
| 5322 116 82011 | RES.METAL FILM | RC-02H | 1% | 147K | R 2903 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2904 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2906 |
| 4822 111 91891 | RES.METAL FILM | RC-02H | 1% | 34K8 | R 2907 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2908 |
| 5322 116 82903 | RES.MET.GLAZED | RMC1/8 | 1% | 31K6 | R 2909 |

## SEMI-CONDUCTORS

| Ordering code | Description | | Item |
|---|---|---|---|
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2104 |
| 5322 130 44787 | TRANSISTOR,CHIP | BFR31 | V 2105 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2106 |
| 5322 130 61707 | TRANSISTOR | BF991 | V 2107 |
| 5322 130 42718 | TRANSISTOR,CHIP | BFS20 | V 2108 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2109 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2110 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2111 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2112 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2113 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2114 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2204 |
| 5322 130 44787 | TRANSISTOR,CHIP | BFR31 | V 2205 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2206 |
| 5322 130 61707 | TRANSISTOR | BF991 | V 2207 |
| 5322 130 42718 | TRANSISTOR,CHIP | BFS20 | V 2208 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2209 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2210 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2211 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2212 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2213 |
| 5322 130 42145 | TRANSISTOR,CHIP | BFR92 | V 2214 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2301 |
| 5322 130 44711 | TRANSISTOR,CHIP | BFT92 | V 2302 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2303 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2501 |
| 5322 130 62661 | TRANSISTOR,CHIP | BRY62 | V 2502 |
| 5322 130 62659 | TRANSISTOR,CHIP | BUZ11A | V 2503 |

| Ordering code | Description | | Item |
|---|---|---|---|
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2504 |
| 5322 130 62922 | DIODE | MBRD630CTT4 | V 2506 |
| 5322 130 62922 | DIODE | MBRD630CTT4 | V 2507 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2508 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2509 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2511 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2512 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2513 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2514 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2516 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2517 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2518 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2521 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2523 |
| 4822 130 42133 | TRANSISTOR,CHIP | BC817 | V 2526 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2527 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2528 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2529 |
| 5322 130 62922 | DIODE | MBRD630CTT4 | V 2533 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2534 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2536 |
| 5322 130 62921 | TRANSISTOR | 2SK974STR | V 2537 |
| 5322 130 62921 | TRANSISTOR | 2SK974STR | V 2538 |
| 5322 130 62922 | DIODE | MBRD630CTT4 | V 2539 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2541 |
| 4822 130 82262 | DIODE,CHIP | BAT54S | V 2543 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2544 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2736 |
| 4822 130 82522 | DIODE,CHIP | BZD27-C7V5 | V 2751 |
| 4822 130 82522 | DIODE,CHIP | BZD27-C7V5 | V 2752 |
| 4822 130 82522 | DIODE,CHIP | BZD27-C7V5 | V 2753 |
| 4822 130 82522 | DIODE,CHIP | BZD27-C7V5 | V 2755 |
| 5322 130 44787 | TRANSISTOR,CHIP | BFR31 | V 2754 |
| 5322 130 44787 | TRANSISTOR,CHIP | BFR31 | V 2756 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2757 |
| 5322 130 60502 | TRANSISTOR,CHIP | BSS83 | V 2758 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2759 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2760 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2761 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2762 |
| 5322 130 34337 | DIODE,CHIP | BAV99 | V 2763 |
| 4822 130 82522 | DIODE,CHIP | BZD27-C7V5 | V 2764 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2765 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2766 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2767 |
| 5322 130 42136 | TRANSISTOR,CHIP | BC848C | V 2768 |
| 4822 130 82522 | DIODE,CHIP | BZD27-C7V5 | V 2811 |

| Ordering code | Description | | Item |
|---|---|---|---|
| 4822 130 82522 | DIODE,CHIP | BZD27-C7V5 | V 2769 |
| 4822 130 82522 | DIODE,CHIP | BZD27-C7V5 | V 2812 |
| 5322 130 60502 | TRANSISTOR,CHIP | BSS83 | V 2851 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2852 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2853 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2854 |
| 4822 130 42513 | TRANSISTOR,CHIP | BC858C | V 2901 |

## INTEGRATED CIRCUITS

| | | | |
|---|---|---|---|
| 4822 209 63764 | I.C. INTERFACE | PC74HC4316T | D 2101 |
| 4822 209 63764 | I.C. INTERFACE | PC74HC4316T | D 2102 |
| 4822 209 63764 | I.C. INTERFACE | PC74HC4316T | D 2201 |
| 4822 209 63764 | I.C. INTERFACE | PC74HC4316T | D 2202 |
| 5322 209 30821 | ANALOG ASIC | OQ00308 | D 2301 |
| 4822 209 63764 | I.C. INTERFACE | PC74HC4316T | D 2750 |
| 4822 209 63764 | I.C. INTERFACE | PC74HC4316T | D 2751 |
| 4822 209 63764 | I.C. INTERFACE | PC74HC4316T | D 2850 |
| 4822 209 63763 | I.C. INTERFACE | PC74HC541T | D 2901 |
| 4822 209 63763 | I.C. INTERFACE | PC74HC541T | D 2902 |
| 4822 209 63763 | I.C. INTERFACE | PC74HC541T | D 2903 |
| 5322 209 12171 | INTEGR.CIRCUIT | PC74HC4094T | D 2904 |
| 5322 209 12171 | INTEGR.CIRCUIT | PC74HC4094T | D 2906 |
| 5322 209 12171 | INTEGR.CIRCUIT | PC74HC4094T | D 2907 |
| 5322 209 12171 | INTEGR.CIRCUIT | PC74HC4094T | D 2908 |
| 5322 209 12171 | INTEGR.CIRCUIT | PC74HC4094T | D 2909 |
| 4822 209 63757 | INTEGR.CIRCUIT | LF453CM | N 2101 |
| 4822 209 63757 | INTEGR.CIRCUIT | LF453CM | N 2201 |
| 5322 209 30676 | INTEGR.CIRCUIT | TDA8703T/C4 | N 2302 |
| 4822 209 60175 | INTEGR.CIRCUIT | LM358M | N 2501 |
| 4822 209 63765 | INTEGR.CIRCUIT | LM285M-1.2 | N 2502 |
| 5322 209 71807 | INTEGR.CIRCUIT | SG3524D | N 2503 |
| 5322 209 31309 | INTEGR.CIRCUIT | TLC27M2ACDR | N 2750 |
| 5322 209 31309 | INTEGR.CIRCUIT | TLC27M2ACDR | N 2751 |
| 4822 209 63757 | INTEGR.CIRCUIT | LF453CM | N 2850 |

## COILS

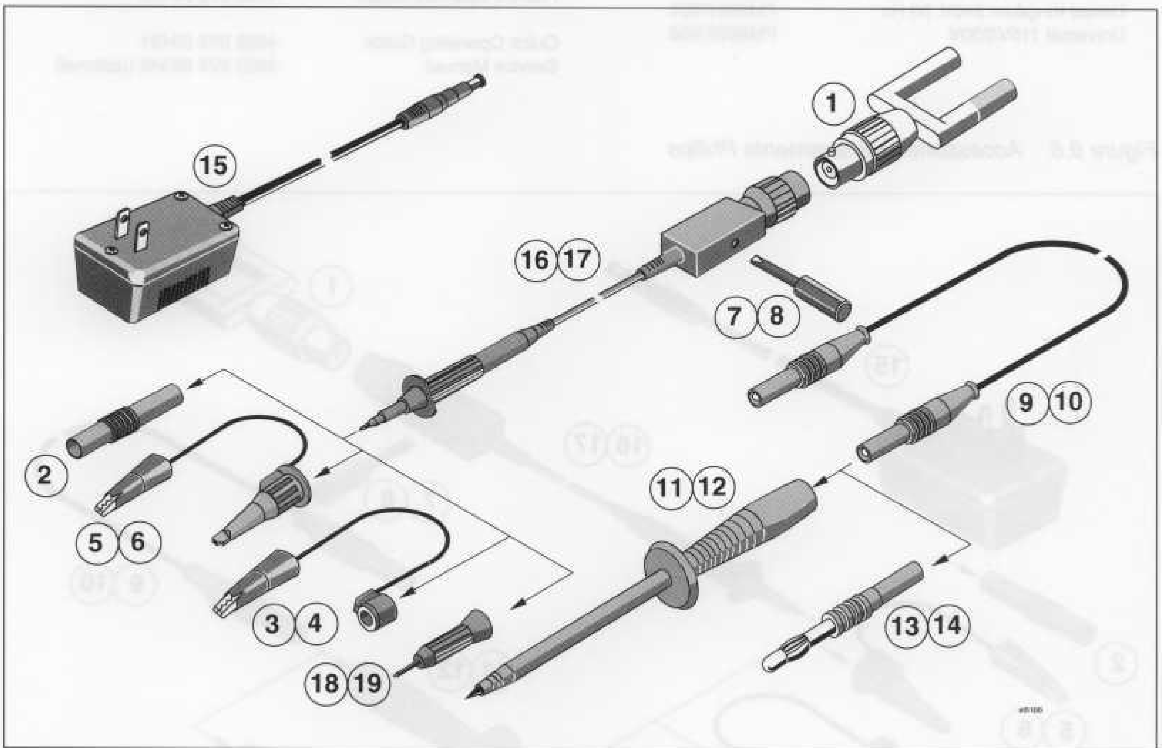
| | | | |
|---|---|---|---|
| 5322 157 63649 | COIL | 39NH 20% | L 2301 |
| 5322 157 63648 | COIL | 1UH 5% | L 2302 |
| 5322 157 63647 | COIL | 0.1UH 5% | L 2303 |
| 5322 157 63647 | COIL | 0.1UH 5% | L 2304 |
| 5322 157 63648 | COIL | 1UH 5% | L 2501 |
| 5322 157 63092 | COIL | 68UH | L 2502 |
| 5322 157 63092 | COIL | 68UH | L 2503 |
| 5322 157 52707 | COIL | 22UH | L 2504 |
| 5322 157 52707 | COIL | 22UH | L 2506 |
| 5322 156 11139 | COIL | FILTER 50V-10A | Z 2501 |

| Ordering code | Description | | Item |
|---|---|---|---|
| **MISCELLANEOUS** | | | |
| 5322 280 10245 | BUZZER | MEB-12B-12 | H 2901 |
| 5322 280 80745 | RELAY | RAL3W-K | K 2101 |
| 5322 280 80745 | RELAY | RAL3W-K | K 2102 |
| 5322 280 80745 | RELAY | RAL3W-K | K 2103 |
| 5322 280 80745 | RELAY | RAL3W-K | K 2201 |
| 5322 280 80745 | RELAY | RAL3W-K | K 2202 |
| 5322 280 80745 | RELAY | RAL3W-K | K 2203 |
| 5322 280 80745 | RELAY | RAL3W-K | K 2750 |
| 5322 280 80745 | RELAY | RAL3W-K | K 2751 |
| **CONNECTORS** | | | |
| 5322 267 70302 | CONNECTOR | 30-PIN STRAIGHT | X 2001 |
| 4822 267 30431 | SOCKET | HEC0739-01-010 | X 2501 |
| 5322 265 30434 | CONNECTOR | 3-PIN STRAIGHT | X 2502 |

Table 9.7 Accessories replacements Fluke

| ORDER NUMBER /MODEL NUMBER | DESCRIPTION | ITEM |
|---|---|---|
| PM9086/001 | NiCad Battery Pack | - |
| PM8907/003 | Line Voltage Adapter/Battery Charger (North America) | 15 |
| PM8918/002 | Safety-Designed ScopeMeter Probe Set | 16, 17, 18, 19, 3, 4, 7, 8, |
| PM9081/001 | Safety-Designed Dual Banana Plug to Female BNC Adapter | 1 |
| PM9083/001 | ScopeMeter Yellow Protective Holster | - |
| C75 | Accessory Case | - |
| Fluke 916015 | Multimeter Test Lead Set | 9, 10, 11, 12, 13, 14, |
| Fluke 916010 | ProbeTip to Banana Plug Adapter/Adjust adapter | 2 |
| Fluke 916127 | Quick Operating Guide | - |
| Fluke 916119 | ScopeMeter English Users Manual | - |
| Fluke 916122 | ScopeMeter French, Spanish, Italian Users Manual | - |
| Fluke 915970 | Service Manual | - |

*Figure 9.6 Accessories replacements Fluke*



## Table 9.8 Accessories replacements Philips

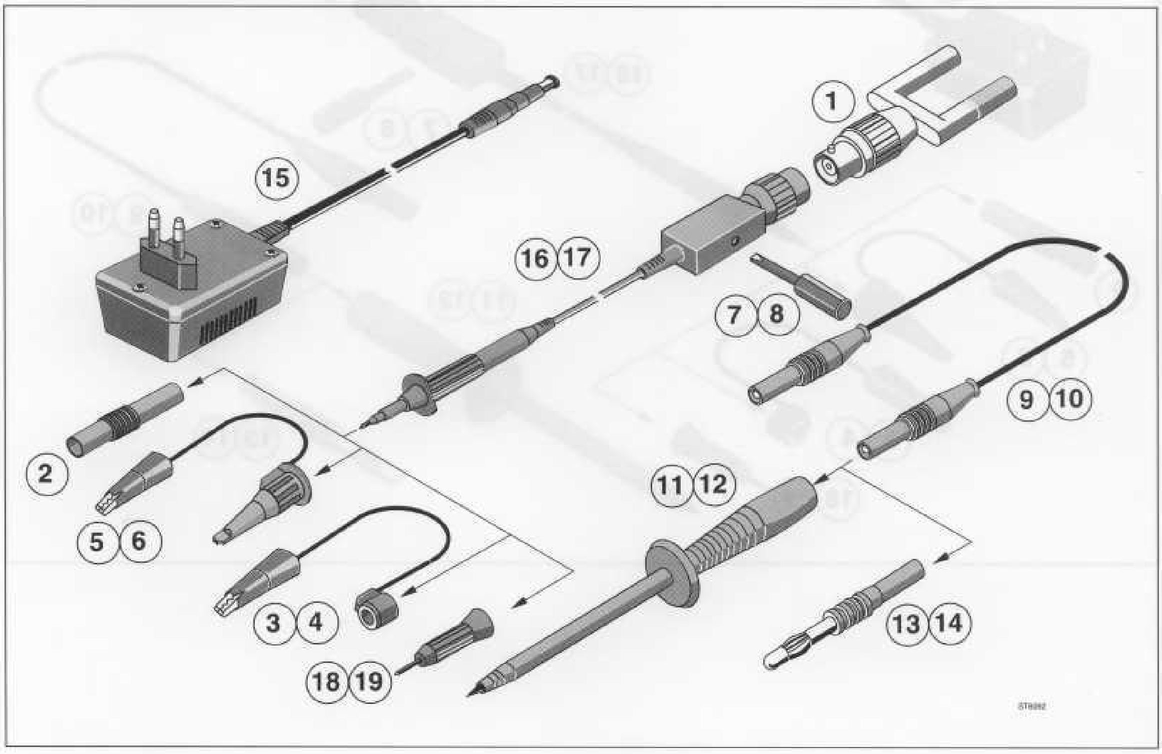
| ITEM | DESCRIPTION | ORDER NUMBER /MODEL NUMBER | |
|---|---|---|---|
| 1 | Adapter Banana/BNC | PM9081/001 | |
| 2 | Adjust adapter RED | 5322 263 50192 | |
| 3 | HF adapter BLACK | 5322 263 50193 | |
| 4 | HF adapter BLACK | 5322 263 50193 | |
| 5 | Mini test hook RED | 5322 210 70131 | |
| 6 | Mini test hook GREY | 5322 210 70129 | |
| 7 | Trim screwdriver RED | 5322 395 50417 | |
| 8 | Trim screwdriver GREY | 5322 395 50416 | |
| 9 | Test lead RED | 5322 397 60157 | PM9266/041 |
| 10 | Test lead BLACK | 5322 397 60156 | PM9266/041 |
| 11 | Test pin RED | 5322 264 20046 | PM9266/041 |
| 12 | Test pin BLACK | 5322 264 20045 | PM9266/041 |
| 13 | Banana adapter RED | 5322 264 20051 | PM9266/041 |
| 14 | Banana adapter BLACK | 5322 264 20052 | PM9266/041 |
| 15 | Power adapters/Battery chargers | | |
| | Universal Europe 220V, 50 Hz | PM8907/001 | |
| | North America UL, CSA, 110V, 60 Hz | PM8907/003 | |
| | United Kingdom 240V, 50 Hz | PM8907/004 | |
| | Universal 115V/230V | PM8907/008 | |

| ITEM | DESCRIPTION | | ORDER NUMBER /MODEL NUMBER |
|---|---|---|---|
| 16 | Scope probe RED | | PM8918/002 |
| 17 | Scope probe GREY | | PM8918/002 |
| 18 | High voltage testpin RED | 5322 264 20087 | PM8918/002 |
| 19 | High voltage test pin GREY | 5322 264 20088 | PM8918/002 |
| 3 | HF adapter BLACK | 5322 263 50193 | PM8918/002 |
| 4 | HF adapter BLACK | 5322 263 50193 | PM8918/002 |
| 7 | Trim screwdriver RED | 5322 395 50417 | PM8918/002 |
| 8 | Trim screwdriver GREY | 5322 395 50416 | PM8918/002 |
| - | NiCad Battery Pack | PM9086/001 | |
| - | Holster | PM9083/001 | |
| - | Accessory case | C 75 | |

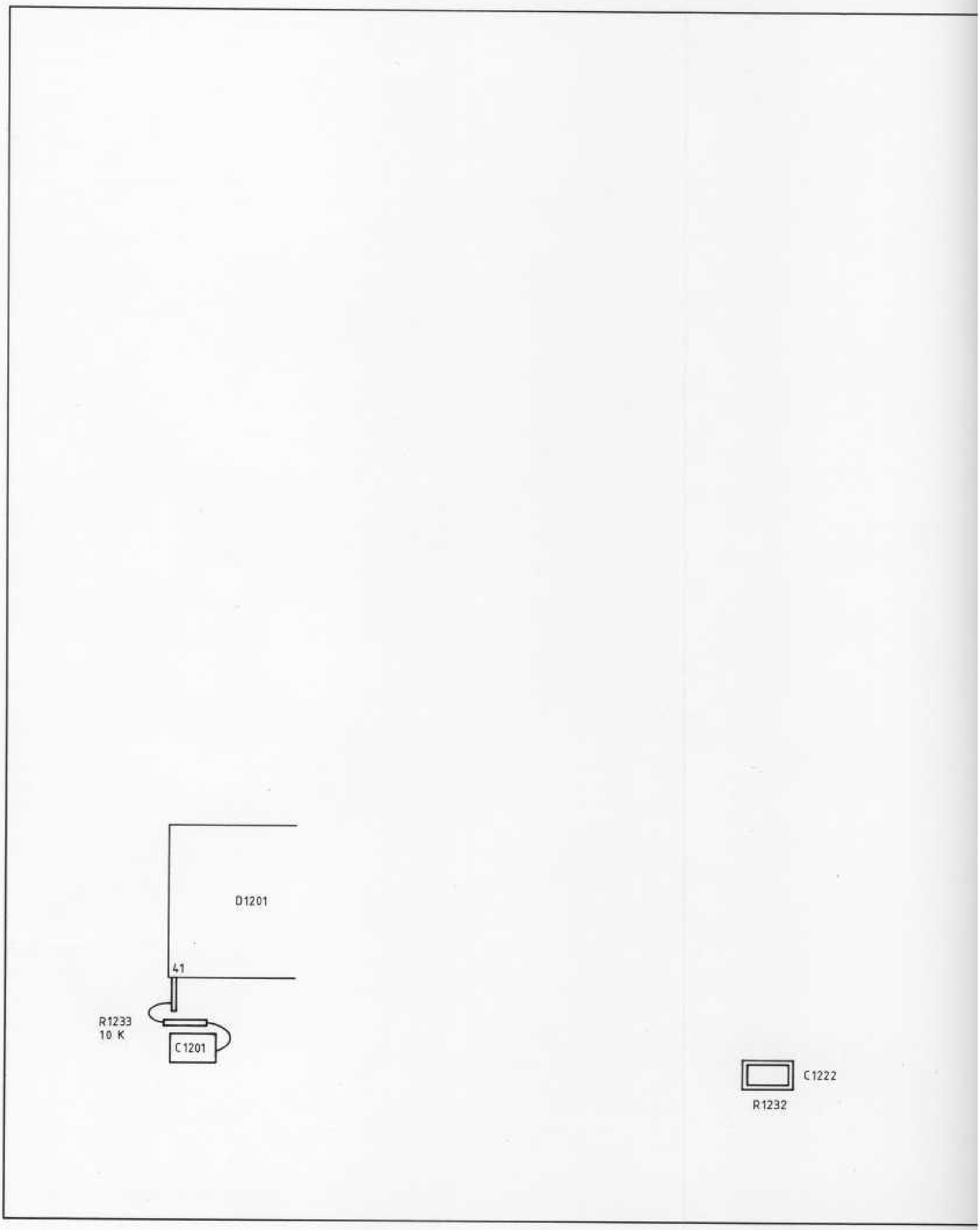
**Users Manuals**

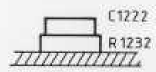
| | |
|---|---|
| English | 4822 872 00492 |
| Dutch, German, French | 4822 872 00494 |
| Swedish, Danish, Finnish, Norwegian | 4822 872 00495 |
| French, Spanish, Italian | 4822 872 00493 |
| Quick Operating Guide | 4822 872 00491 |
| Service Manual | 4822 872 05346 (optional) |

*Figure 9.6 Accessories replacements Philips*

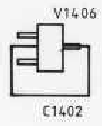


# 10 CIRCUIT DIAGRAMS

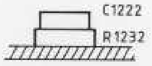


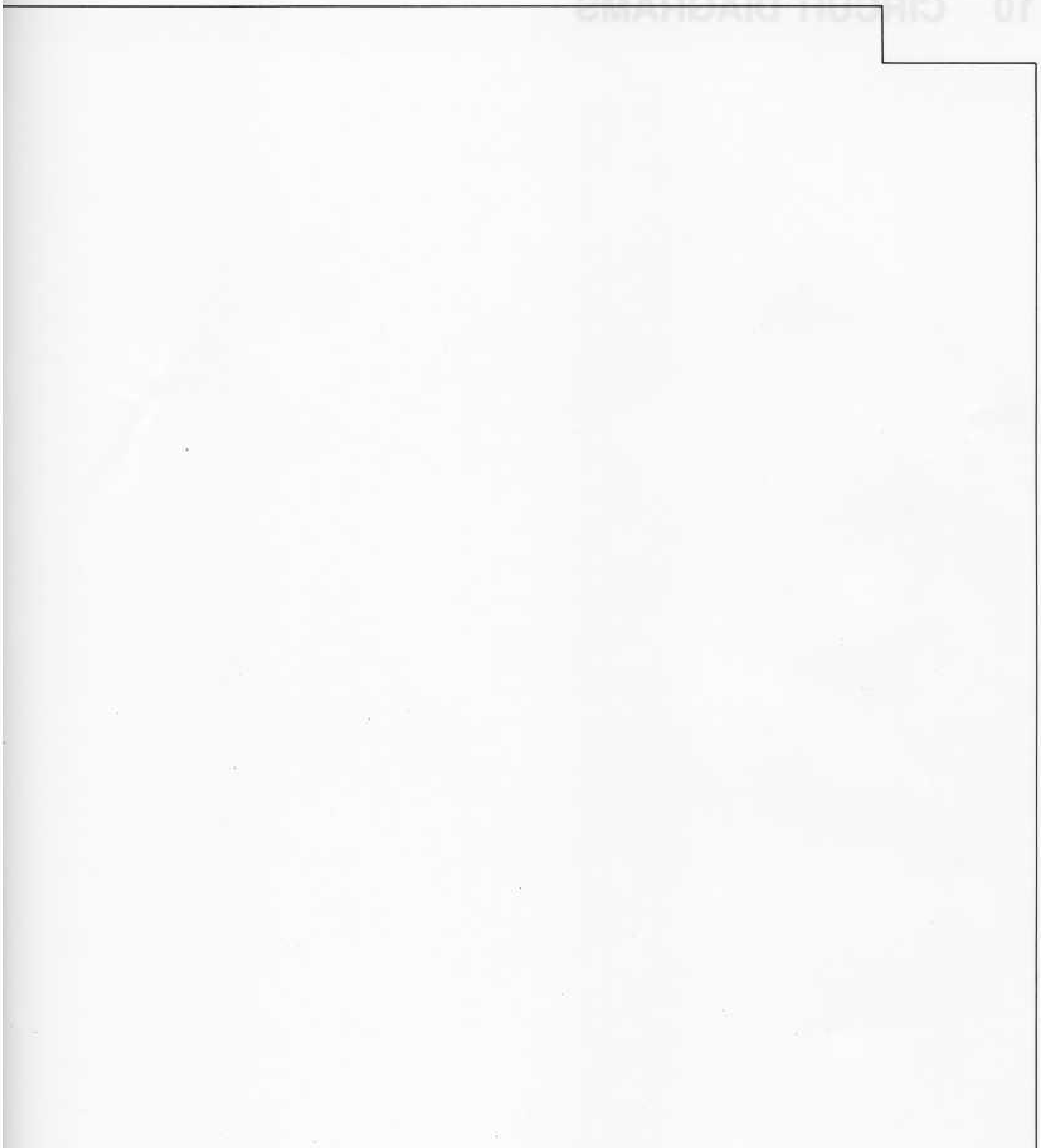

C1222 MOUNTED OVER R1232








C1222 MOUNTED OVER R1232



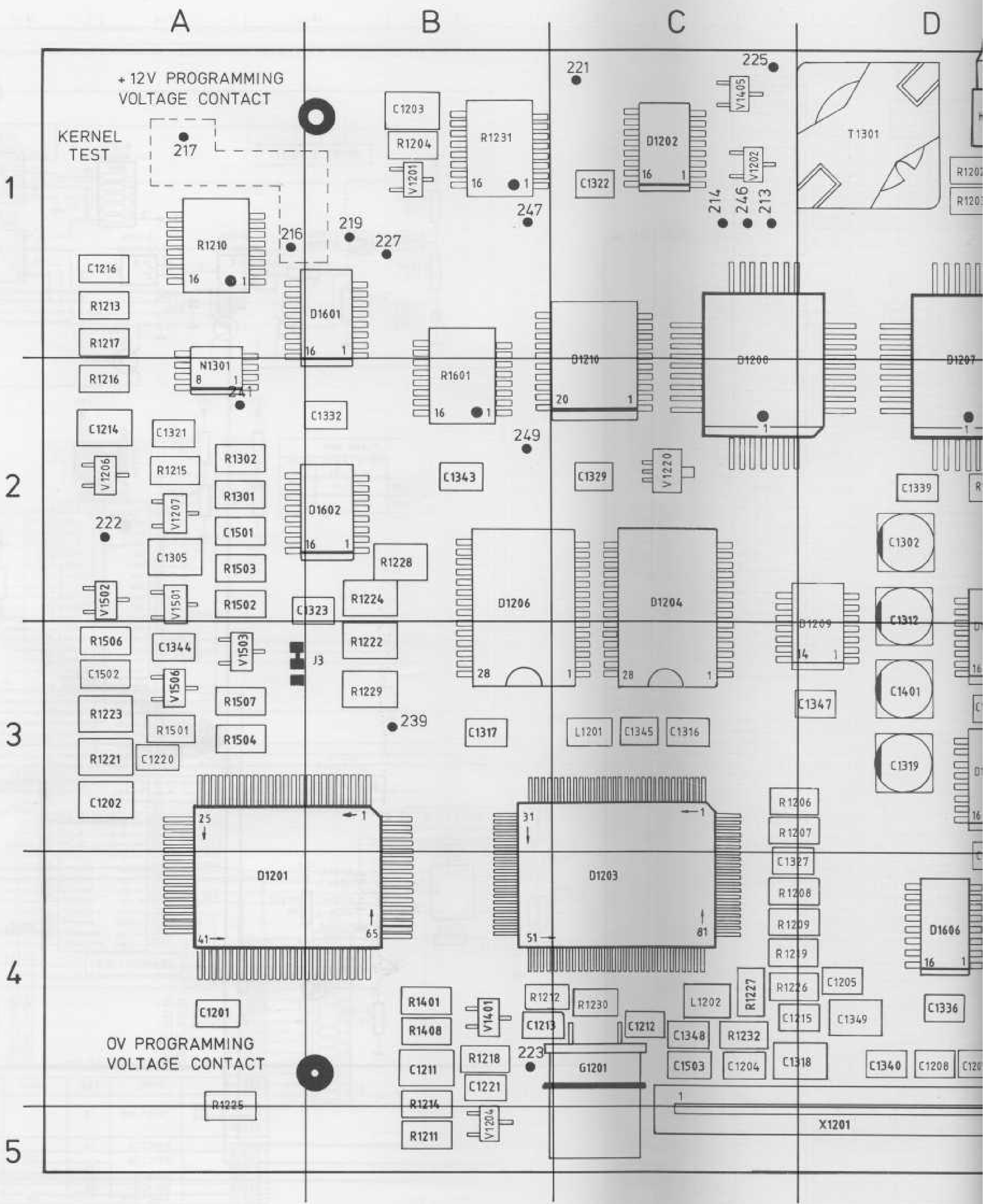
ST6849
920203

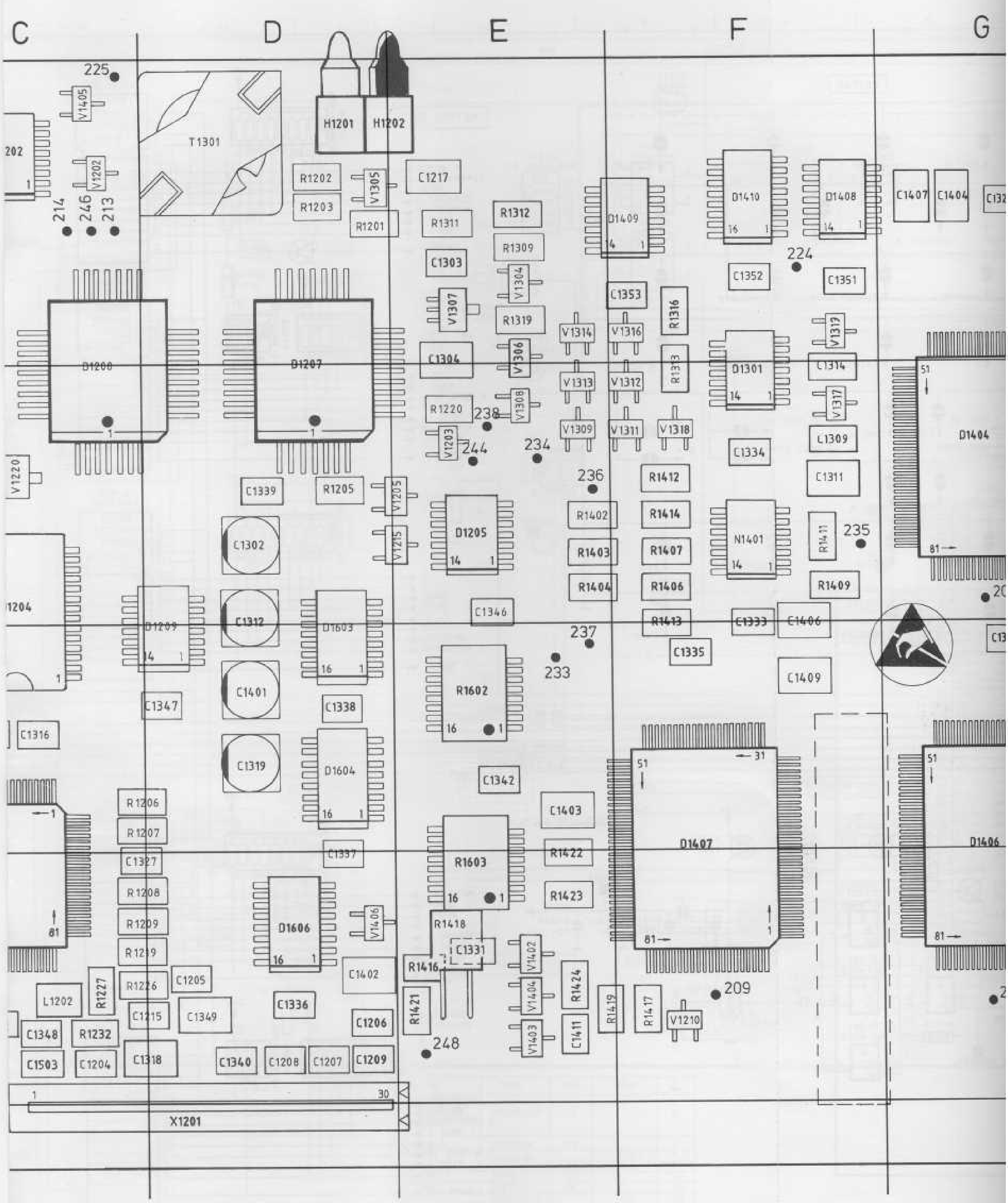
*Figure 10.1a Modifications Digital A1 PCB*

This chapter contains all circuit diagrams and PCB layouts of both the ScopeMeter analog and digital PCBs.

## PARTS LOCATION A1 (PCB)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C1201 | A4 | C1340 | D4 | D1603 | D2 | R1313 | F2 | V1311 | F2 |
| C1202 | A3 | C1341 | H2 | D1604 | D3 | R1316 | F1 | V1312 | F2 |
| C1203 | B1 | C1342 | E3 | D1606 | D4 | R1319 | E1 | V1313 | E2 |
| C1204 | C4 | C1343 | B2 | G1201 | C4 | R1401 | B4 | V1316 | F1 |
| C1205 | D4 | C1344 | A3 | H1201 | D1 | R1402 | E2 | V1317 | F2 |
| C1206 | D4 | C1345 | C3 | H1202 | D1 | R1403 | E2 | V1318 | F2 |
| C1207 | D4 | C1346 | E2 | J3 | A3 | R1404 | E2 | V1319 | F1 |
| C1208 | D4 | C1347 | D3 | L1201 | C3 | R1406 | F2 | V1401 | B4 |
| C1209 | D4 | C1348 | C4 | L1202 | C4 | R1407 | F2 | V1402 | E4 |
| C1211 | B4 | C1349 | D4 | N1301 | A2 | R1408 | B4 | V1403 | E4 |
| C1212 | C4 | C1351 | F1 | N1401 | F2 | R1409 | F2 | V1404 | E4 |
| C1213 | B4 | C1352 | F1 | R1201 | D1 | R1411 | F2 | V1405 | C1 |
| C1214 | A2 | C1353 | F1 | R1202 | D1 | R1412 | F2 | V1407 | C1 |
| C1215 | C4 | C1401 | D3 | R1203 | D1 | R1413 | F2 | V1501 | A2 |
| C1216 | A1 | C1402 | D4 | R1204 | B1 | R1414 | F2 | V1502 | A2 |
| C1217 | E1 | C1403 | E3 | R1205 | D2 | R1415 | E4 | V1503 | A3 |
| C1220 | A3 | C1404 | G1 | R1206 | C3 | R1416 | E4 | V1506 | A3 |
| C1221 | B4 | C1405 | G3 | R1207 | C3 | R1417 | F4 | TP207 | G2 |
| C1302 | D2 | C1406 | D4 | R1208 | C4 | R1419 | E4 | TP208 | G4 |
| C1303 | E1 | C1406 | F2 | R1209 | C4 | R1421 | E4 | TP209 | F4 |
| C1304 | E1 | C1407 | G1 | R1210 | A1 | R1422 | E3 | TP210 | I4 |
| C1305 | A2 | C1408 | H3 | R1211 | B5 | R1423 | E4 | TP211 | I2 |
| C1309 | F2 | C1409 | F3 | R1212 | B4 | R1424 | E4 | TP212 | I1 |
| C1311 | F2 | C1411 | E4 | R1213 | A1 | R1501 | A3 | TP213 | C1 |
| C1312 | D2 | C1501 | A2 | R1214 | B4 | R1502 | A2 | TP214 | C1 |
| C1314 | F1 | C1502 | A3 | R1215 | A2 | R1503 | A2 | TP214 | A2 |
| C1316 | C3 | D1201 | A3 | R1216 | A2 | R1504 | A3 | TP216 | A1 |
| C1317 | B3 | D1202 | C1 | R1217 | A1 | R1506 | A3 | TP217 | A1 |
| C1318 | C4 | D1203 | C4 | R1218 | B4 | R1507 | A3 | TP219 | B1 |
| C1319 | D3 | D1204 | C2 | R1219 | C4 | R1601 | B2 | TP221 | C1 |
| C1321 | A2 | D1205 | E2 | R1220 | E2 | R1602 | E3 | TP222 | A2 |
| C1322 | C1 | D1206 | B2 | R1221 | A3 | R1603 | E4 | TP223 | B4 |
| C1323 | B2 | D1207 | D1 | R1222 | B3 | T1301 | D1 | TP224 | F1 |
| C1324 | H1 | D1208 | C1 | R1223 | A3 | V1201 | B1 | TP225 | C1 |
| C1326 | H4 | D1209 | D2 | R1224 | B2 | V1203 | E2 | TP227 | B1 |
| C1327 | C4 | D1210 | C1 | R1225 | A4 | V1204 | B5 | TP233 | E3 |
| C1328 | G1 | D1301 | F2 | R1226 | C4 | V1205 | E2 | TP234 | E2 |
| C1329 | C2 | D1401 | H4 | R1227 | C4 | V1206 | A2 | TP235 | F2 |
| C1330 | G3 | D1402 | H2 | R1228 | B2 | V1207 | A2 | TP237 | E3 |
| C1331 | E4 | D1403 | H1 | R1229 | B3 | V1210 | F4 | TP239 | B3 |
| C1332 | B2 | D1404 | G2 | R1230 | C4 | V1215 | E2 | TP244 | E2 |
| C1333 | F2 | D1406 | G3 | R1231 | B1 | V1220 | C2 | TP244 | F1 |
| C1334 | F2 | D1407 | F3 | R1232 | C4 | V1304 | E1 | TP246 | C1 |
| C1335 | F3 | D1408 | F1 | R1301 | A2 | V1305 | D1 | TP247 | B1 |
| C1336 | D4 | D1409 | F1 | R1302 | A2 | V1306 | E1 | TP248 | E4 |
| C1337 | D3 | D1410 | F1 | R1309 | E1 | V1307 | E1 | TP249 | B2 |
| C1338 | D3 | D1601 | B2 | R1311 | E1 | V1308 | E2 | | |
| C1339 | D2 | D1601 | B1 | R1312 | E1 | V1309 | E2 | | |


A
B
C
D
1
2
3
4
5
+12V PROGRAMMING
VOLTAGE CONTACT
KERNEL
TEST
217
216
219
227
221
225
247
214
246
213
241
249
222
239
223
0V PROGRAMMING
VOLTAGE CONTACT
C1203
R1204
V1201
R1231
D1202
C1322
V1405
V1202
T1301
R1210
C1216
R1213
R1217
R1216
D1601
N1301
R1601
D1210
D1208
D1207
C1214
C1321
R1302
C1332
C1343
C1329
V1220
C1339
V1206
R1215
R1301
D1602
V1207
C1501
R1228
D1206
D1204
C1302
C1305
R1503
V1502
V1501
R1502
C1323
R1224
D1209
C1312
R1506
C1344
V1503
J3
R1222
C1502
V1506
R1507
R1229
C1347
C1401
R1223
R1501
R1504
C1317
L1201
C1345
C1316
C1319
R1221
C1220
C1202
R1206
R1207
D1201
D1203
C1327
R1208
R1209
D1606
R1219
R1226
C1205
C1201
R1401
V1401
R1212
R1230
L1202
R1227
C1336
R1408
C1213
C1212
C1348
R1232
C1215
C1349
R1218
C1211
C1221
G1201
C1503
C1204
C1318
C1340
C1208
R1225
R1214
V1204
X1201
R1211


C
D
E
F
G
225
V1405
T1301
H1201
H1202
202
V1202
R1202
R1203
V1305
C1217
R1201
R1311
R1312
R1309
D1409
D1410
D1408
C1407
C1404
214
246
213
224
C1303
C1352
C1351
V1304
C1353
R1316
V1307
R1319
V1314
V1316
V1319
D1200
D1207
C1304
V1306
D1301
C1314
R1333
V1313
V1312
V1317
R1220
238
V1308
V1309
V1311
V1318
C1309
D1404
V1203
244
234
C1334
V1220
236
R1412
C1311
C1339
R1205
V1205
R1402
R1414
D1205
N1401
R1411
235
C1302
V1215
R1403
R1407
1204
R1404
R1406
R1409
C1346
D1209
C1312
D1603
R1413
C1333
C1406
237
C1335
R1602
233
C1401
C1409
C1347
C1338
C1316
C1319
D1604
C1342
D1407
R1206
C1403
R1207
R1603
R1422
C1327
C1337
D1406
R1208
R1423
R1209
V1406
D1606
R1418
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C1331
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V1402
C1402
R1424
C1205
R1227
R1226
L1202
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C1336
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V1404
R1419
R1417
C1215
C1349
C1206
V1210
C1348
R1232
V1403
C1411
248
C1503
C1204
C1318
C1340
C1208
C1207
C1209
X1201

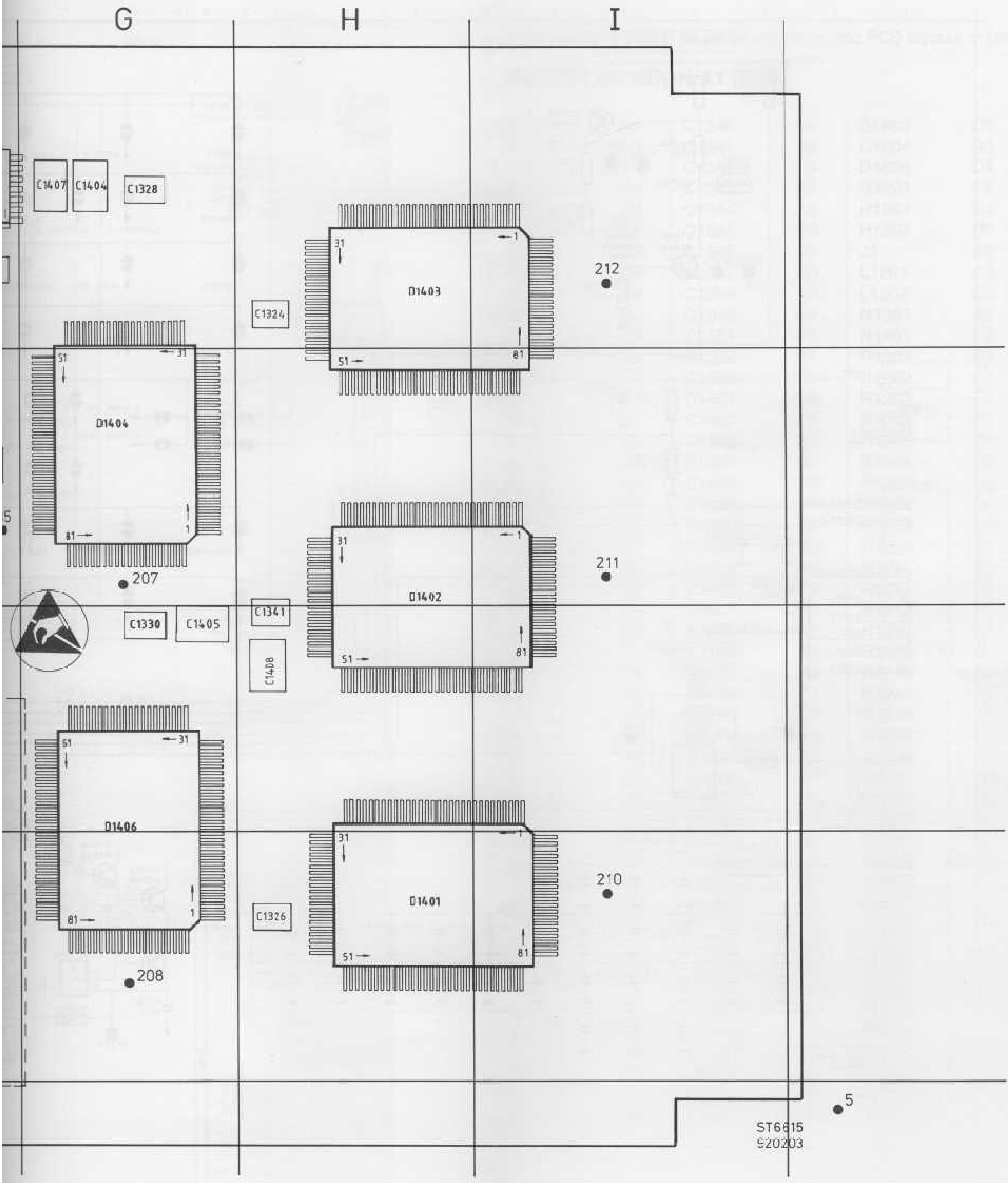
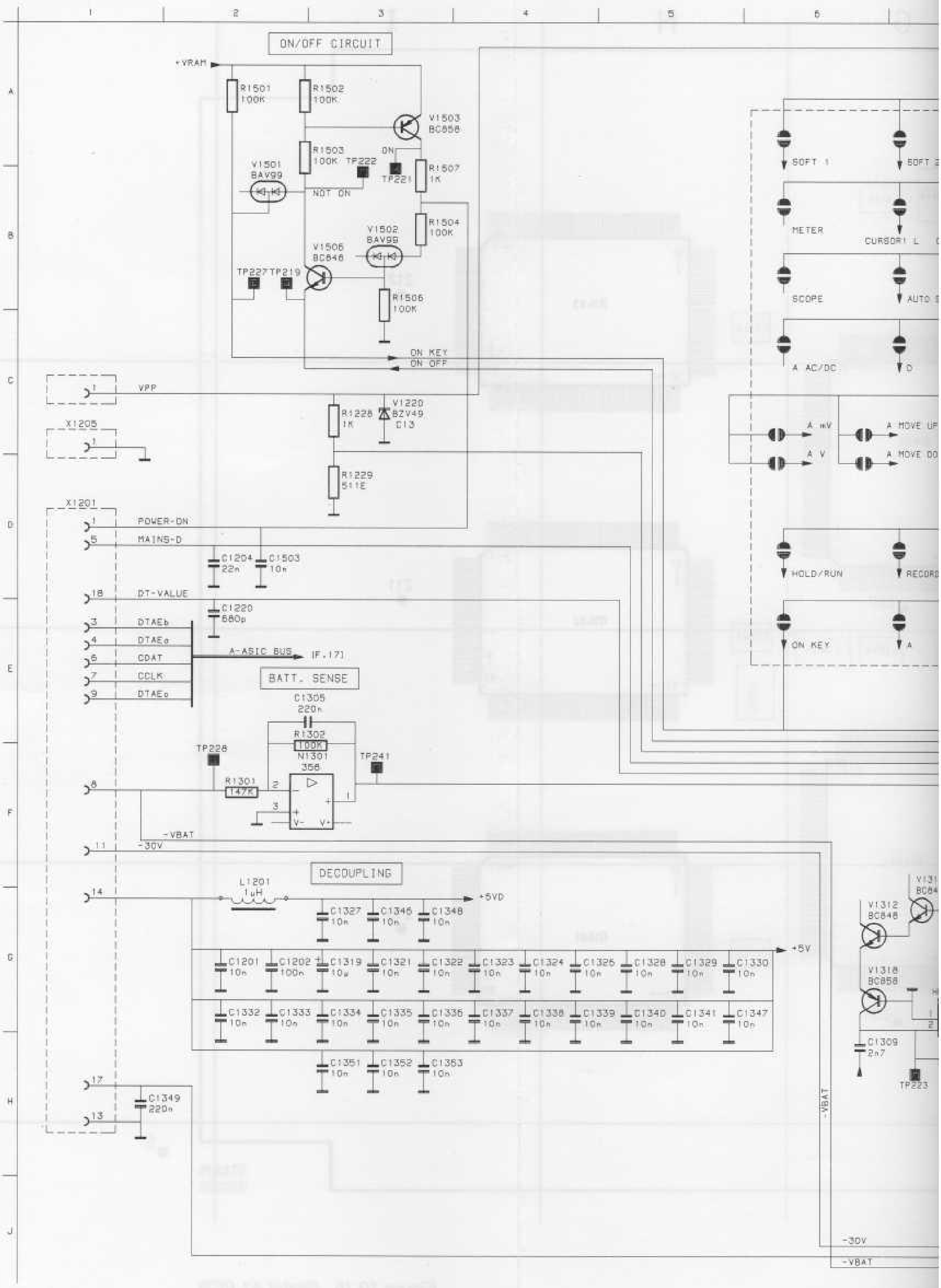
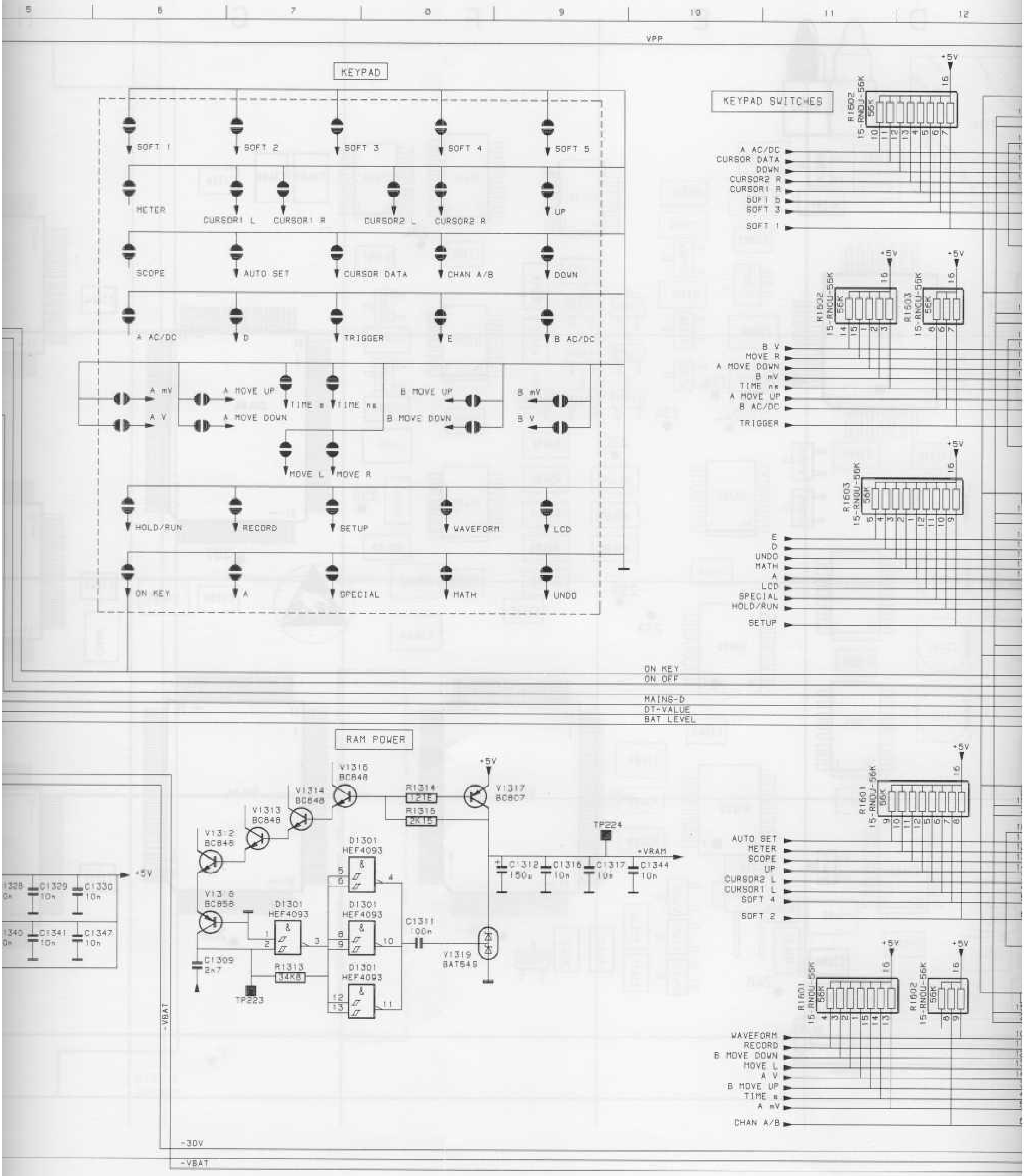
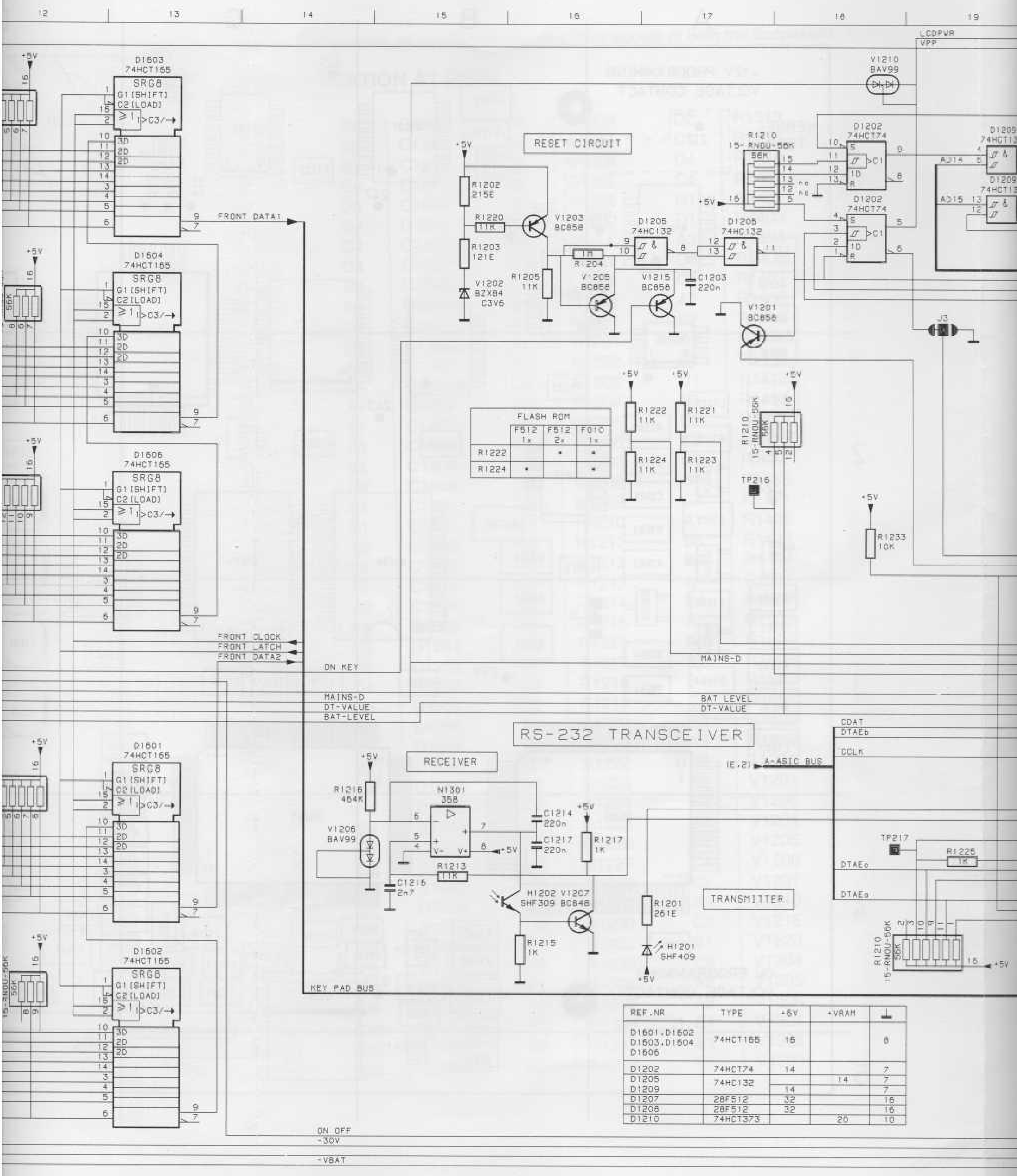



*Figure 10.1b Digital A1 PCB*


ON/OFF CIRCUIT
+VRAM
R1501 100K
R1502 100K
V1503 BC858
R1503 100K
TP222
ON
TP221
R1507 1K
V1501 BAV99
NOT ON
R1504 100K
V1502 BAV99
V1505 BC848
TP227 TP219
R1506 100K
ON KEY
ON OFF
VPP
X1205
R1228 1K
V1220 BZV49 C13
R1229 511E
X1201
POWER-ON
MAINS-D
C1204 22n
C1503 10n
DT-VALUE
C1220 680p
DTAEb
DTAEa
CDAT
CCLK
DTAEc
A-ASIC BUS
[F.17]
BATT. SENSE
C1305 220n
R1302 100K
N1301 358
TP228
TP241
R1301 147K
-VBAT
-30V
DECOUPLING
L1201 1uH
+5VD
+5V
C1201 C1202 C1319 C1321 C1322 C1323 C1324 C1325 C1328 C1329 C1330
C1332 C1333 C1334 C1335 C1336 C1337 C1338 C1339 C1340 C1341 C1347
C1327 C1346 C1348
C1351 C1352 C1353
C1349 220n
SOFT 1
SOFT 2
METER
CURSOR1 L
SCOPE
AUTO S
A AC/DC
D
A mV
A V
A MOVE UP
A MOVE DO
HOLD/RUN
RECORD
ON KEY
A
V1312 BC848
V1318 BC858
C1309 2n7
TP223
-30V
-VBAT



KEYPAD
SOFT 1
SOFT 2
SOFT 3
SOFT 4
SOFT 5
METER
CURSOR1 L
CURSOR1 R
CURSOR2 L
CURSOR2 R
UP
SCOPE
AUTO SET
CURSOR DATA
CHAN A/B
DOWN
A AC/DC
D
TRIGGER
E
B AC/DC
A mV
A V
A MOVE UP
A MOVE DOWN
TIME s
TIME ns
B MOVE UP
B MOVE DOWN
B mV
B V
MOVE L
MOVE R
HOLD/RUN
RECORD
SETUP
WAVEFORM
LCD
ON KEY
A
SPECIAL
MATH
UNDO
KEYPAD SWITCHES
R1602
15-RNOU-56K
R1603
R1601
56K
+5V
VPP
ON KEY
ON OFF
MAINS-D
DT-VALUE
BAT LEVEL
RAM POWER
V1316
BC848
V1314
BC848
V1313
BC848
V1312
BC848
V1318
BC858
R1314
121E
R1316
2K15
V1317
BC807
D1301
HEF4093
C1311
100n
V1319
BAT54S
C1309
2n7
R1313
34K8
TP223
TP224
+VRAM
C1312
150µ
C1316
10n
C1317
10n
C1344
10n
C1329
10n
C1330
10n
C1341
10n
C1347
10n
-VBAT
-30V




| | FLASH ROM | | |
|---|---|---|---|
| | F512 1x | F512 2x | F010 1x |
| R1222 | | * | * |
| R1224 | * | | * |

| REF.NR | TYPE | +5V | +VRAM | ⊥ |
|---|---|---|---|---|
| D1601, D1602<br>D1603, D1604<br>D1606 | 74HCT165 | 16 | | 8 |
| D1202 | 74HCT74 | 14 | | 7 |
| D1205 | 74HC132 | | 14 | 7 |
| D1209 | | 14 | | 7 |
| D1207 | 28F512 | 32 | | 16 |
| D1208 | 28F512 | 32 | | 16 |
| D1210 | 74HCT373 | | 20 | 10 |

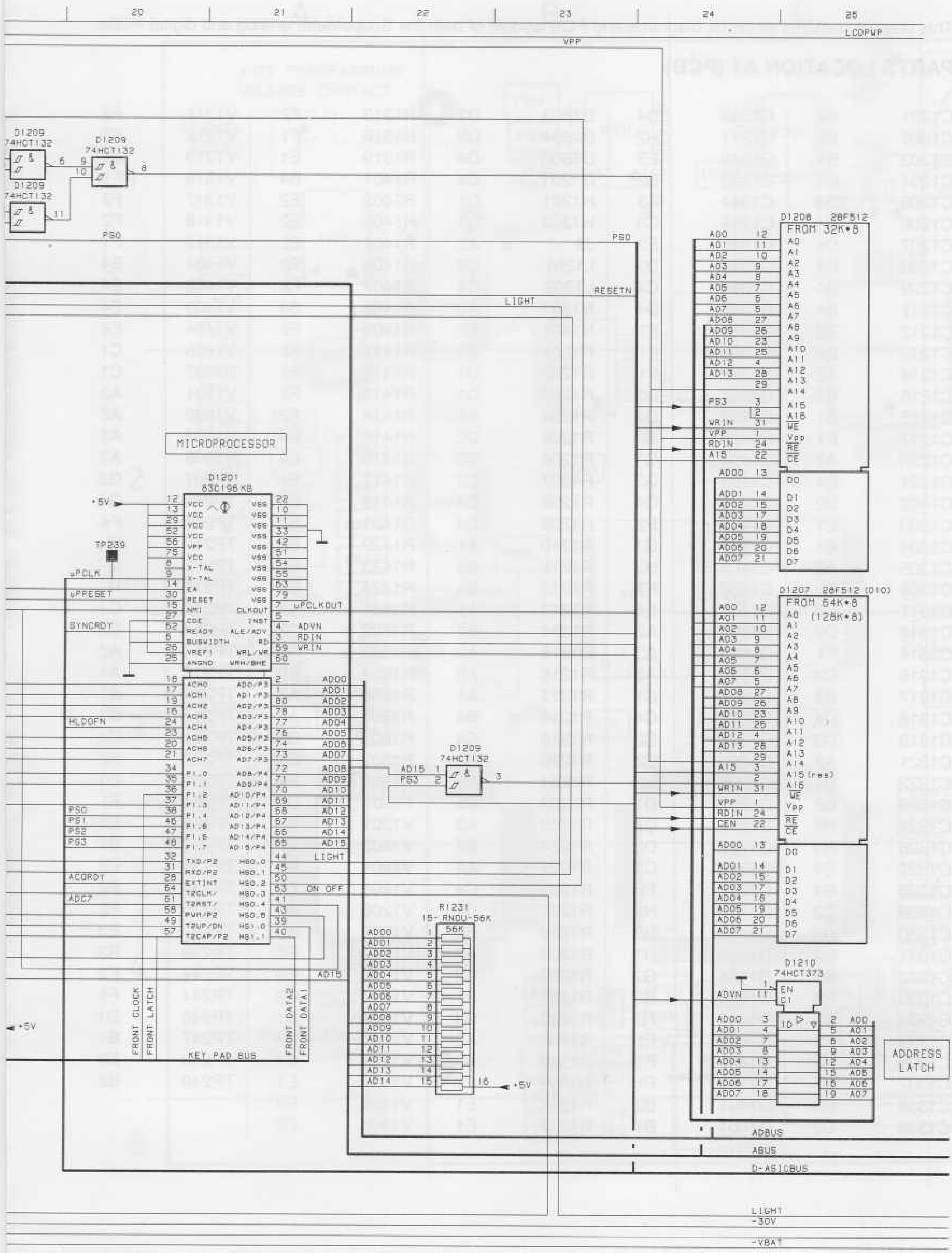



Figure 10.2a Digital A1 circuit diagram (part a)

## PARTS LOCATION A1 (CIRCUIT DIAGRAM)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | E7 | C1335 | G3 | D1604 | B13 | R1231 | G22 | TP222 | A3 |
| A MOVE UP | C7 | C1336 | G3 | D1606 | D13 | R1301 | F2 | TP223 | H7 |
| A MOVE DN | C7 | C1338 | G4 | DOWN | B9 | R1302 | E2 | TP224 | G9 |
| A AC/DC | C6 | C1339 | G4 | E | C8 | R1313 | H7 | TP228 | F2 |
| A mV | C6 | C1340 | G5 | G1337 | G4 | R1314 | F8 | TP239 | D20 |
| AUTOSET | B7 | C1341 | G5 | H1201 | G17 | R1316 | F8 | TP241 | F3 |
| B MOVE DN | C8 | C1346 | G3 | H1202 | G16 | R1501 | A2 | TRIGGER | C6 |
| B MOVE UP | C8 | C1347 | G5 | HOLD/RUN | D6 | R1502 | A3 | UNDO | E8 |
| B V | C9 | C1348 | G3 | J3 | C19 | R1503 | A3 | UP | B9 |
| B mV | C9 | C1349 | H1 | L1201 | G2 | R1504 | B3 | V1201 | C17 |
| B AC/DC | C9 | C1350 | H2 | LCD | D8 | R1506 | B3 | V1202 | B15 |
| B1209 | B19 | C1351 | H3 | MATH | E8 | R1507 | A3 | V1203 | B16 |
| C1201 | G2 | C1352 | H3 | METER | B6 | R1601 | H11 | V1205 | B16 |
| C1202 | G2 | C1353 | H3 | MOVE L | D7 | R1601 | F11 | V1206 | G14 |
| C1203 | B17 | C1503 | D2 | MOVE R | D7 | R1602 | C11 | V1207 | G16 |
| C1204 | D2 | CHAN A/B | B8 | N1301 | F2 | R1602 | A11 | V1210 | A18 |
| C1214 | F16 | CURSOR DA | B7 | N1301 | F15 | R1602 | H12 | V1215 | B17 |
| C1217 | G16 | CURSOR1 L | B7 | ON KEY | E6 | R1602 | C12 | V1220 | C3 |
| C1305 | E2 | CURSOR1 R | B7 | R1201 | G17 | R1603 | D11 | V1301 | G7 |
| C1309 | H6 | CURSOR2 L | B8 | R1202 | B15 | R210 | G18 | V1312 | G6 |
| C1311 | G8 | CURSOR2 R | B8 | R1203 | B15 | RECORD | D7 | V1313 | G7 |
| C1312 | G9 | D | C6 | R1204 | B16 | SCOPE | B6 | V1314 | F7 |
| C1316 | G9 | D1201 | D21 | R1205 | B16 | SETUP | D7 | V1316 | F7 |
| C1317 | G9 | D1202 | A18 | R1210 | A17 | SOFT1 | A6 | V1317 | F8 |
| C1319 | G3 | D1202 | B18 | R1210 | D17 | SOFT2 | A7 | V1318 | G6 |
| C1321 | G3 | D1205 | B17 | R1213 | G15 | SOFT3 | A7 | V1319 | G8 |
| C1322 | G3 | D1207 | E25 | R1215 | G16 | SOFT4 | A8 | V1501 | A3 |
| C1323 | G4 | D1208 | B25 | R1216 | F14 | SOFT5 | A9 | V1501 | B2 |
| C1324 | G4 | D1209 | F16 | R1217 | G16 | SPECIAL | E7 | V1502 | B3 |
| C1326 | G4 | D1209 | A20 | R1221 | C17 | TEST1 | D17 | V1506 | B3 |
| C1327 | G3 | D1209 | A19 | R1222 | C17 | TEST12 | G18 | WAVEFORM | D8 |
| C1328 | G5 | D1210 | G25 | R1223 | D17 | TIME ns | C7 | X1201 | D1 |
| C1329 | G5 | D1301 | G7 | R1224 | D17 | TIME s | C7 | X1205 | C1 |
| C1330 | G5 | D1301 | H7 | R1225 | G19 | TP216 | D17 | | |
| C1332 | G2 | D1601 | F13 | R1226 | C9 | TP217 | G18 | | |
| C1333 | G2 | D1602 | H13 | R1228 | C3 | TP219 | B2 | | |
| C1334 | G3 | D1603 | A13 | R1229 | D3 | TP221 | A3 | | |

## PARTS LOCATION A1 (CIRCUIT DIAGRAM)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C1205 | C9 | D1205 | A3 | R1206 | A6 | R1409 | E14 | TP234 | H14 |
| C1207 | A7 | D1205 | B3 | R1207 | B6 | R1411 | F14 | TP237 | G14 |
| C1207 | B7 | D1206 | A2 | R1211 | E9 | R1412 | F14 | TP244 | B4 |
| C1208 | B7 | D1230 | D5 | R1212 | E9 | R1413 | G14 | TP246 | A2 |
| C1209 | B7 | D1401 | C12 | R1214 | E9 | R1414 | H14 | TP247 | F4 |
| C1211 | R9 | D1401 | A17 | R1218 | E9 | R1416 | G11 | TP248 | H14 |
| C1212 | E9 | D1402 | A18 | R1219 | C9 | R1417 | H13 | TP249 | D14 |
| C1213 | E9 | D1403 | A20 | R1220 | E8 | R1418 | G13 | V1304 | G19 |
| C1215 | C9 | D1404 | C16 | R1220 | E7 | R1419 | F14 | V1306 | H19 |
| C1221 | E10 | D1406 | D16 | R1226 | C9 | R1421 | H11 | V1307 | G20 |
| C1302 | H19 | D1407 | F16 | R1227 | C9 | R1422 | H12 | V1308 | J20 |
| C1303 | G20 | D1408 | A13 | R1230 | E9 | R1423 | G12 | V1309 | J20 |
| C1304 | J19 | D1408 | B13 | R1232 | C9 | R1424 | G12 | V1311 | J19 |
| C1318 | H11 | D1409 | A12 | R1309 | G19 | T1301 | H20 | V1401 | D13 |
| C1401 | E12 | D1409 | B12 | R1311 | H20 | T1301 | H19 | V1402 | H12 |
| C1402 | H13 | D1410 | B14 | R1312 | H18 | TP207 | C17 | V1403 | G12 |
| C1403 | G11 | G1201 | E9 | R1319 | H19 | TP208 | D17 | V1405 | E12 |
| C1404 | E14 | H1401 | D19 | R1401 | D12 | TP209 | F17 | V1406 | H14 |
| C1405 | E14 | J1401 | C11 | R1402 | E13 | TP210 | B18 | V1503 | H18 |
| C1406 | F14 | L1202 | C8 | R1403 | E13 | TP211 | B18 | X1201 | A22 |
| C1407 | F14 | N1401 | G13 | R1404 | F14 | TP212 | B18 | X1202 | H22 |
| C1409 | H14 | N1401 | E14 | R1406 | G13 | TP213 | D2 | | |
| C1411 | G12 | N1401 | F14 | R1407 | G13 | TP214 | D2 | | |
| D1204 | E2 | N1404 | G12 | R1408 | D14 | TP233 | D14 | | |

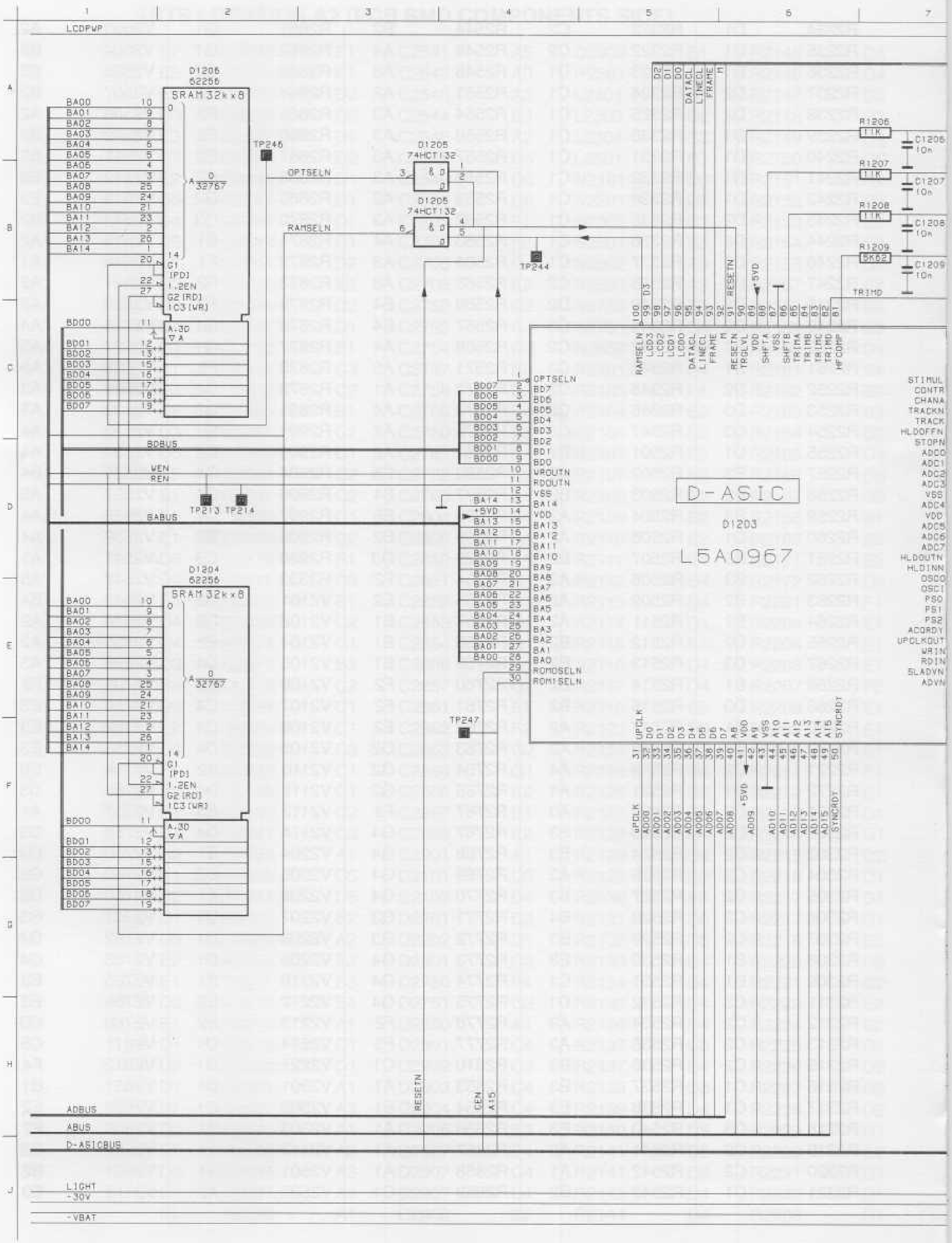
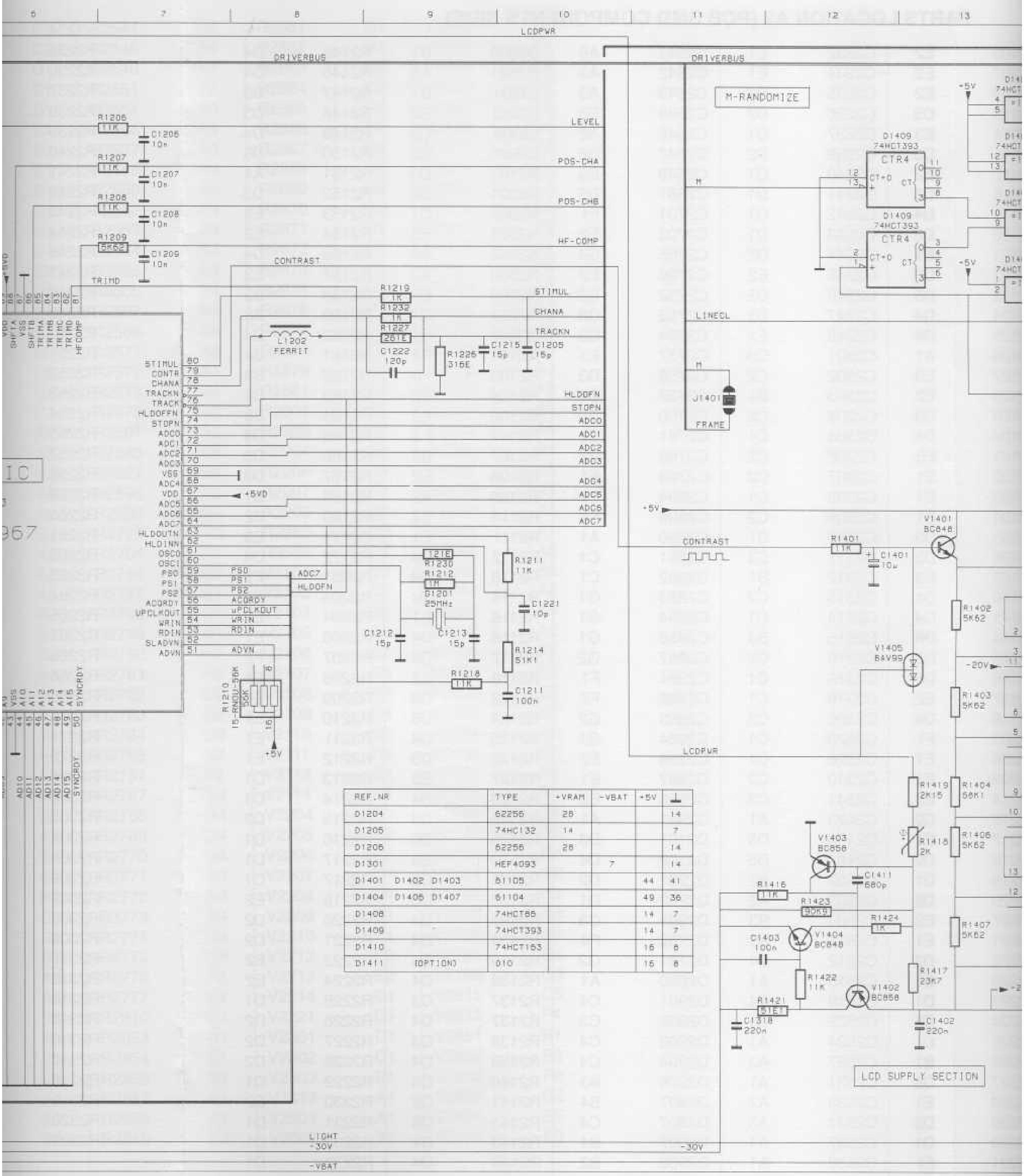
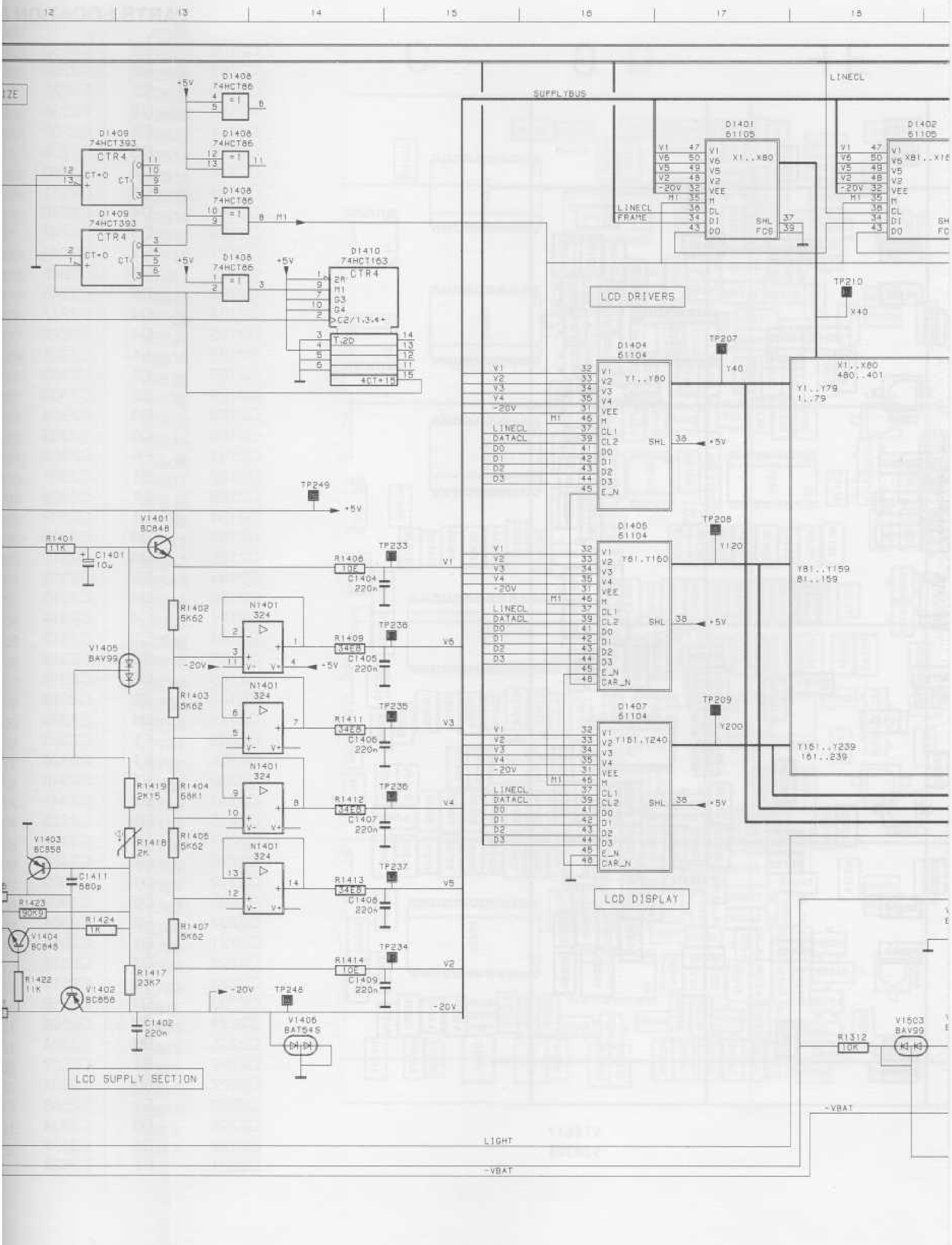



Figure 10.2b Digital A1 circuit diagram (part b)

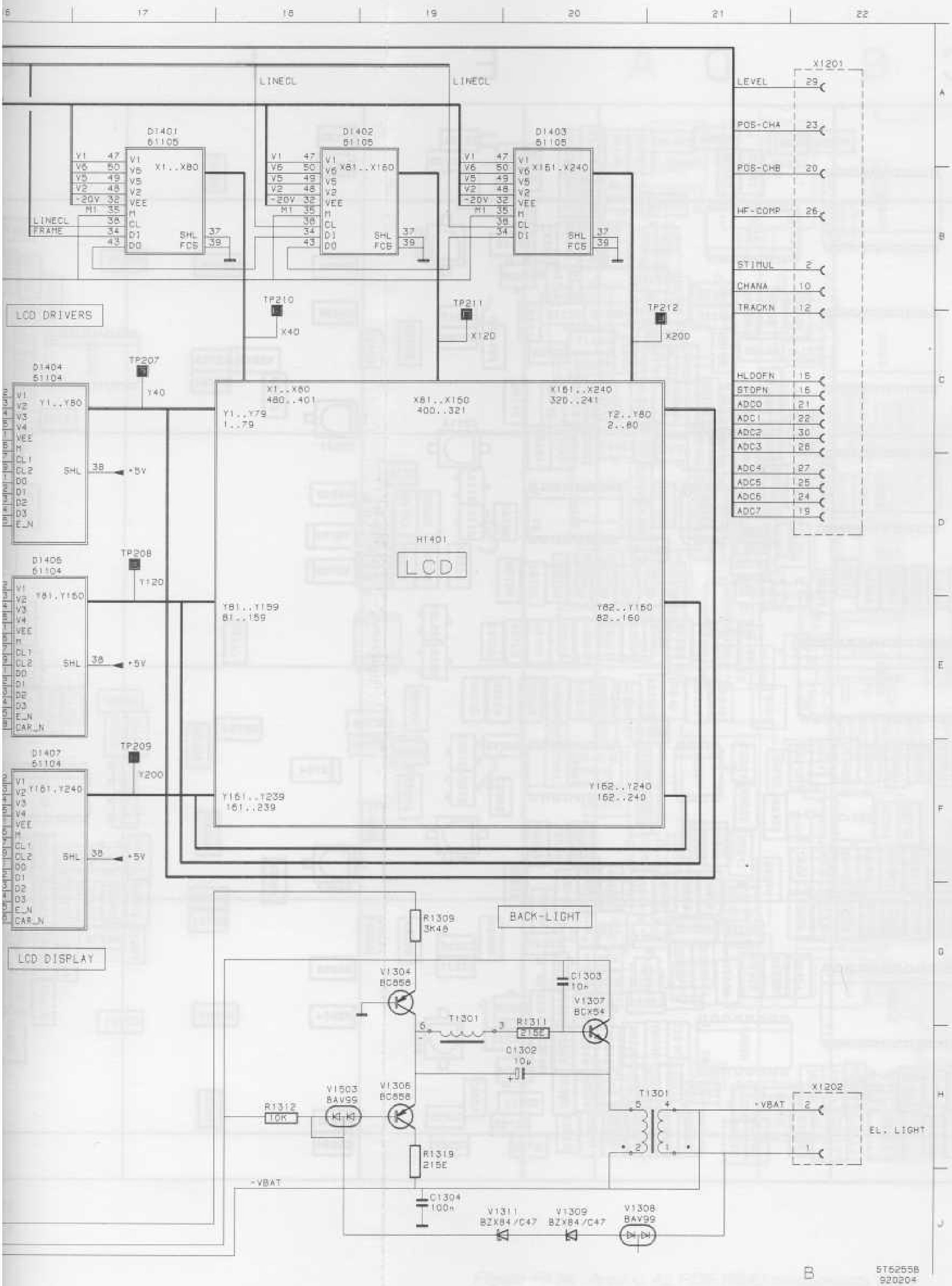



| REF.NR | TYPE | +VRAM | -VBAT | +5V | ⊥ |
|---|---|---|---|---|---|
| D1204 | 62256 | 28 | | | 14 |
| D1205 | 74HC132 | 14 | | | 7 |
| D1206 | 62256 | 28 | | | 14 |
| D1301 | HEF4093 | | 7 | | 14 |
| D1401 D1402 D1403 | 61105 | | | 44 | 41 |
| D1404 D1405 D1407 | 61104 | | | 49 | 36 |
| D1408 | 74HCT86 | | | 14 | 7 |
| D1409 | 74HCT393 | | | 14 | 7 |
| D1410 | 74HCT163 | | | 16 | 8 |
| D1411 (OPTION) | 010 | | | 16 | 8 |

*gram (part b)*



12
13
14
15
16
17
18
SUPPLYBUS
LINECL
IZE
D1408
74HCT86
D1409
74HCT393
CTR4
CT=0
D1410
74HCT163
M1
+5V
D1401
61105
X1..X80
D1402
61105
X81..X16
V1
V6
V5
V2
-20V
VEE
LINECL
FRAME
SHL
FCS
TP210
X40
LCD DRIVERS
TP207
Y40
D1404
61104
Y1..Y80
X1..X80
480..401
Y1..Y79
1..79
LINECL
DATACL
D0
D1
D2
D3
E_N
CAR_N
TP249
V1401
BC848
R1401
11K
C1401
10µ
TP233
R1408
10E
C1404
220n
D1405
61104
Y81..Y160
TP208
Y120
Y81..Y159
81..159
R1402
5K62
N1401
324
R1409
34E8
C1405
220n
TP238
V1405
BAV99
R1403
5K62
R1411
34E8
C1406
220n
TP235
D1407
61104
Y161..Y240
TP209
Y200
Y161..Y239
161..239
R1419
2K15
R1404
68K1
R1412
34E8
C1407
220n
TP236
V1403
BC858
R1418
2K
R1405
5K62
C1411
560p
R1413
34E8
C1408
220n
TP237
LCD DISPLAY
R1423
90K9
R1424
1K
V1404
BC848
R1407
5K62
R1422
11K
R1417
23K7
R1414
10E
C1409
220n
TP234
V1402
BC858
TP248
C1402
220n
V1406
BAT54S
R1312
10K
V1503
BAV99
LCD SUPPLY SECTION
-VBAT
LIGHT


LCD DRIVERS
D1401
61105
D1402
61105
D1403
61105
LINECL
FRAME
TP210
TP211
TP212
X40
X120
X200
D1404
61104
TP207
Y40
D1405
61104
TP208
Y120
D1407
61104
TP209
Y200
H1401
LCD
X1..X80
480..401
X81..X160
400..321
X161..X240
320..241
Y1..Y79
1..79
Y2..Y80
2..80
Y81..Y159
81..159
Y82..Y160
82..160
Y161..Y239
161..239
Y162..Y240
162..240
X1201
LEVEL
POS-CHA
POS-CHB
HF-COMP
STIMUL
CHANA
TRACKN
HLDOFN
STOPN
ADC0
ADC1
ADC2
ADC3
ADC4
ADC5
ADC6
ADC7
LCD DISPLAY
BACK-LIGHT
R1309
3K48
V1304
BC858
C1303
10n
V1307
BCX54
T1301
R1311
215E
C1302
10µ
R1312
10K
V1503
BAV99
V1306
BC858
R1319
215E
C1304
100n
-VBAT
V1311
BZX84/C47
V1309
BZX84/C47
V1308
BAV99
X1202
EL. LIGHT
B
ST5255B
920204

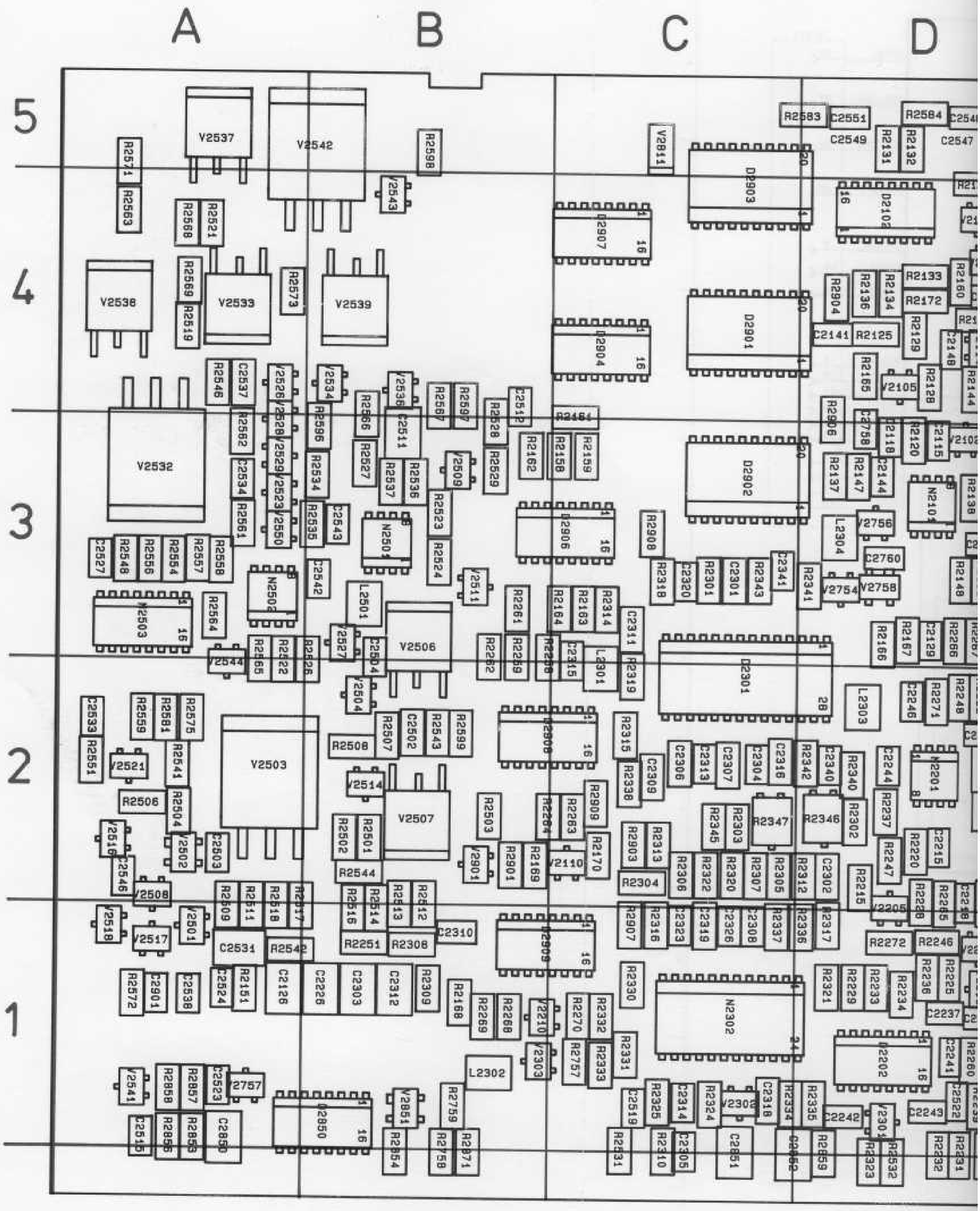
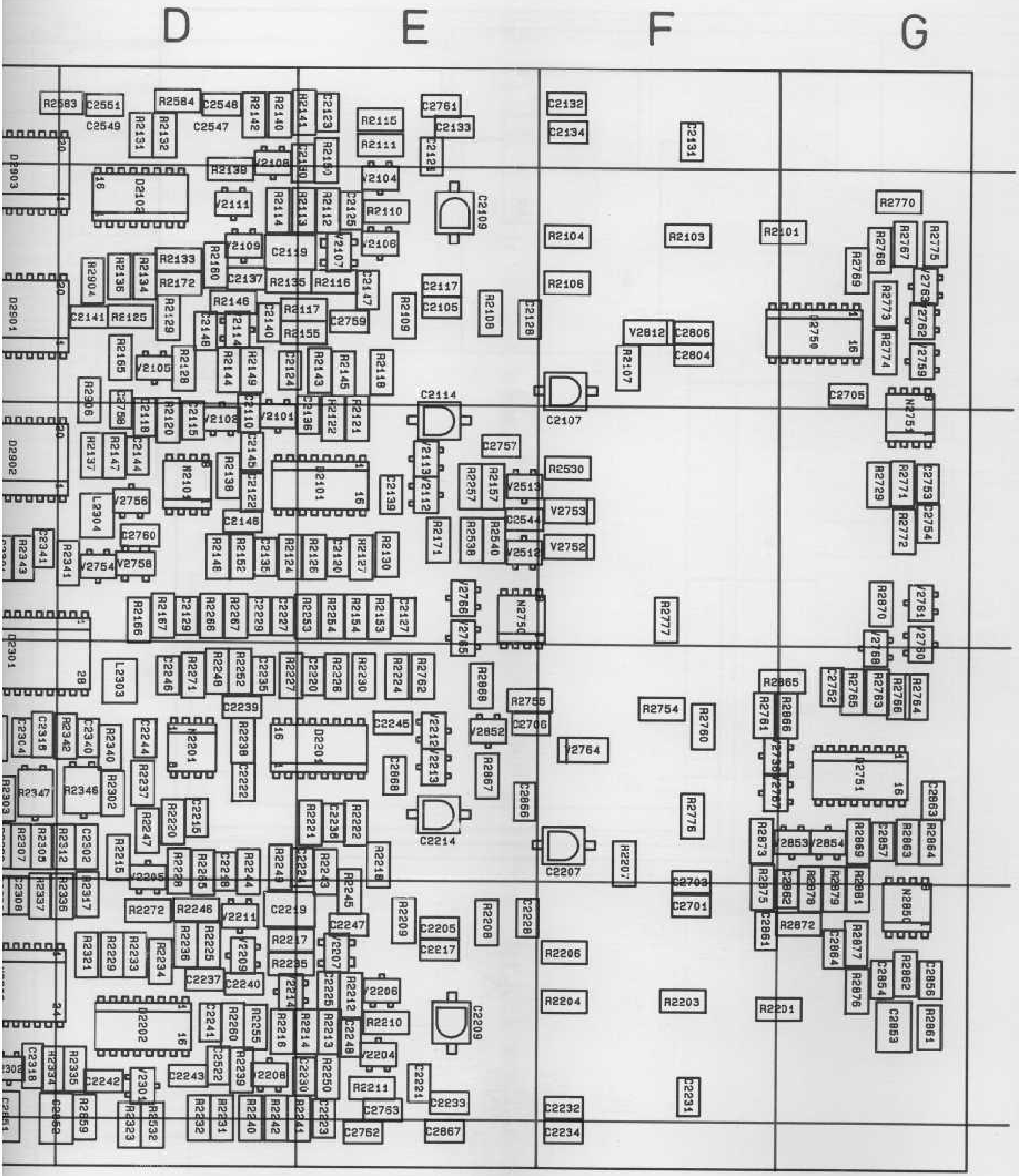



*Figure 10.3a Analog A2 PCB (SMD components side)*

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## PARTS LOCATION A2 (PCB SMD COMPONENTS SIDE)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C2105 | E2 | C2232 | E1 | C2541 | A5 | D2909 | B1 | R2145 | D4 |
| C2107 | E2 | C2234 | E1 | C2542 | A3 | H2561 | A3 | R2146 | D4 |
| C2109 | E2 | C2235 | D2 | C2543 | A3 | L2301 | B1 | R2147 | D3 |
| C2110 | D3 | C2236 | D2 | C2544 | E3 | L2303 | D2 | R2148 | D3 |
| C2114 | E3 | C2237 | D1 | C2546 | A2 | L2304 | C3 | R2149 | D4 |
| C2115 | D3 | C2239 | D2 | C2547 | D5 | L2501 | B3 | R2150 | D5 |
| C2117 | E2 | C2240 | D1 | C2549 | D5 | N2101 | D3 | R2151 | A1 |
| C2118 | D3 | C2241 | D1 | C2551 | D5 | N2201 | D2 | R2152 | D3 |
| C2119 | D4 | C2242 | D1 | C2701 | F1 | N2302 | C1 | R2153 | E3 |
| C2120 | D3 | C2243 | D1 | C2703 | F2 | N2501 | B3 | R2154 | E3 |
| C2121 | E1 | C2244 | D2 | C2705 | G4 | N2502 | A3 | R2155 | D4 |
| C2122 | D3 | C2245 | E2 | C2706 | E2 | N2503 | A3 | R2157 | E3 |
| C2123 | D5 | C2246 | D2 | C2752 | G2 | N2750 | E3 | R2158 | B3 |
| C2124 | D4 | C2247 | D1 | C2753 | G3 | N2751 | G4 | R2159 | B3 |
| C2125 | D4 | C2248 | E1 | C2754 | G3 | N2850 | G2 | R2160 | D4 |
| C2126 | A1 | C2301 | C3 | C2757 | E3 | R2101 | F4 | R2161 | B4 |
| C2127 | E3 | C2302 | C2 | C2758 | D3 | R2103 | F4 | R2162 | B3 |
| C2128 | E2 | C2303 | B1 | C2759 | D4 | R2104 | E2 | R2163 | B3 |
| C2129 | D3 | C2304 | C2 | C2760 | D3 | R2106 | E2 | R2164 | B3 |
| C2130 | D5 | C2305 | C1 | C2761 | E1 | R2107 | F3 | R2165 | D4 |
| C2131 | F5 | C2306 | C2 | C2762 | E2 | R2107 | B2 | R2166 | D3 |
| C2132 | E1 | C2307 | C2 | C2763 | E1 | R2108 | E2 | R2167 | D3 |
| C2133 | E1 | C2308 | C1 | C2804 | F4 | R2109 | E2 | R2168 | B1 |
| C2134 | E1 | C2309 | C2 | C2806 | F4 | R2110 | E2 | R2169 | B2 |
| C2135 | D3 | C2310 | B1 | C2850 | A1 | R2111 | E1 | R2171 | E3 |
| C2136 | D3 | C2311 | C3 | C2851 | C1 | R2112 | D4 | R2172 | D4 |
| C2139 | E3 | C2312 | B1 | C2852 | C1 | R2113 | D4 | R2201 | F1 |
| C2140 | D4 | C2313 | C2 | C2853 | G1 | R2114 | D4 | R2204 | E1 |
| C2141 | C4 | C2314 | C1 | C2854 | G1 | R2115 | E1 | R2204 | E1 |
| C2144 | D3 | C2315 | B3 | C2856 | G1 | R2116 | D4 | R2206 | E1 |
| C2145 | D3 | C2316 | C2 | C2857 | G2 | R2117 | D4 | R2207 | F2 |
| C2146 | D3 | C2318 | C1 | C2861 | F1 | R2118 | E2 | R2208 | E1 |
| C2147 | E2 | C2319 | C1 | C2862 | F2 | R2122 | D3 | R2209 | E1 |
| C2148 | D4 | C2320 | C3 | C2863 | G2 | R2124 | D3 | R2210 | E1 |
| C2203 | F1 | C2323 | C1 | C2864 | G1 | R2125 | D4 | R2211 | E1 |
| C2205 | E1 | C2326 | C1 | C2866 | E2 | R2126 | D3 | R2212 | E1 |
| C2209 | E1 | C2340 | C2 | C2867 | E1 | R2127 | E3 | R2213 | D1 |
| C2214 | E2 | C2341 | C3 | C2868 | E2 | R2128 | D4 | R2214 | D1 |
| C2215 | D2 | C2423 | A1 | C2901 | A1 | R2129 | D4 | R2215 | D2 |
| C2217 | E1 | C2458 | D5 | D2101 | D3 | R2129 | D3 | R2216 | D1 |
| C2218 | D2 | C2484 | D5 | D2102 | D4 | R2130 | E3 | R2217 | D1 |
| C2219 | D1 | C2502 | B2 | D2201 | D2 | R2131 | D5 | R2217 | D1 |
| C2220 | D2 | C2503 | A2 | D2202 | D1 | R2132 | D5 | R2218 | E2 |
| C2207 | E2 | C2504 | B3 | D2301 | C3 | R2133 | D4 | R2220 | D2 |
| C2221 | E1 | C2511 | B3 | D2750 | F4 | R2134 | D4 | R2221 | D2 |
| C2222 | D2 | C2512 | B4 | D2751 | G2 | R2135 | D4 | R2222 | E2 |
| C2223 | E1 | C2515 | A1 | D2850 | A1 | R2136 | D4 | R2224 | E2 |
| C2223 | D1 | C2519 | C1 | D2901 | C4 | R2137 | C3 | R2225 | D1 |
| C2224 | D2 | C2522 | D1 | D2902 | C3 | R2137 | D4 | R2226 | D2 |
| C2225 | D1 | C2524 | A1 | D2903 | C4 | R2138 | D3 | R2227 | D2 |
| C2226 | B1 | C2527 | A3 | D2904 | C4 | R2139 | D4 | R2228 | D2 |
| C2227 | D3 | C2531 | A1 | D2906 | B3 | R2140 | D5 | R2229 | D1 |
| C2228 | E1 | C2533 | A2 | D2907 | B4 | R2141 | D5 | R2230 | E2 |
| C2229 | D3 | C2534 | A3 | D2907 | C4 | R2141 | D5 | R2231 | D1 |
| C2230 | D1 | C2537 | A4 | D2907 | B4 | R2143 | D4 | R2232 | D1 |
| C2231 | F1 | C2538 | A1 | D2908 | B2 | R2144 | D4 | R2233 | D1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| R2234 | D1 | R2322 | C2 | R2544 | B2 | R2861 | G1 | V2503 | A2 |
| R2235 | D1 | R2322 | C2 | R2546 | A4 | R2862 | G1 | V2504 | B2 |
| R2236 | D1 | R2323 | D1 | R2548 | A3 | R2863 | G2 | V2506 | B3 |
| R2237 | D2 | R2324 | C1 | R2551 | A2 | R2864 | G2 | V2507 | B2 |
| R2238 | D2 | R2325 | C1 | R2554 | A3 | R2865 | F2 | V2508 | A2 |
| R2239 | D1 | R2330 | C1 | R2556 | A3 | R2866 | F2 | V2509 | B3 |
| R2240 | D1 | R2331 | C1 | R2557 | A3 | R2867 | E2 | V2511 | B3 |
| R2241 | D1 | R2332 | C1 | R2558 | A3 | R2868 | E2 | V2512 | E3 |
| R2242 | D1 | R2334 | C1 | R2559 | A2 | R2869 | G2 | V2513 | E3 |
| R2243 | D2 | R2335 | C1 | R2562 | A3 | R2870 | G3 | V2514 | B2 |
| R2244 | D2 | R2336 | C1 | R2563 | A4 | R2871 | B1 | V2516 | A2 |
| R2246 | D1 | R2337 | C1 | R2564 | A3 | R2872 | F1 | V2518 | A1 |
| R2247 | D2 | R2338 | C2 | R2565 | A3 | R2873 | F2 | V2521 | A2 |
| R2248 | D2 | R2340 | D2 | R2566 | B4 | R2875 | F2 | V2523 | A3 |
| R2249 | D2 | R2341 | C3 | R2567 | B4 | R2876 | G1 | V2526 | A4 |
| R2250 | D1 | R2342 | C2 | R2568 | A4 | R2877 | G1 | V2527 | A3 |
| R2251 | B1 | R2343 | C3 | R2571 | A5 | R2878 | F2 | V2528 | A3 |
| R2252 | D2 | R2345 | C2 | R2572 | A1 | R2879 | G2 | V2529 | A3 |
| R2253 | D3 | R2346 | C2 | R2573 | A4 | R2881 | G2 | V2532 | A3 |
| R2254 | D3 | R2347 | C2 | R2575 | A2 | R2901 | B2 | V2533 | A4 |
| R2255 | D1 | R2501 | B2 | R2581 | A2 | R2903 | C2 | V2534 | A4 |
| R2257 | E3 | R2502 | A2 | R2583 | C5 | R2904 | C4 | V2536 | B4 |
| R2258 | B3 | R2503 | B2 | R2597 | B4 | R2906 | C4 | V2537 | A5 |
| R2259 | B3 | R2504 | A2 | R2598 | B5 | R2907 | C1 | V2538 | A4 |
| R2260 | D1 | R2506 | A2 | R2599 | B2 | R2909 | B2 | V2539 | A4 |
| R2261 | B3 | R2507 | B2 | R2729 | G3 | R2980 | C3 | V2541 | A1 |
| R2262 | B3 | R2508 | A2 | R2754 | F2 | R3333 | C1 | V2542 | A5 |
| R2263 | B2 | R2509 | A2 | R2755 | E2 | V2101 | D3 | V2543 | B4 |
| R2264 | B2 | R2511 | A2 | R2757 | B1 | V2102 | D3 | V2544 | A2 |
| R2265 | D2 | R2512 | B2 | R2758 | B1 | V2104 | E2 | V2550 | A3 |
| R2267 | D3 | R2513 | B2 | R2759 | B1 | V2105 | D4 | V2596 | A3 |
| R2268 | B1 | R2514 | B2 | R2760 | F2 | V2106 | E2 | V2736 | F2 |
| R2268 | D3 | R2516 | B2 | R2761 | F2 | V2107 | D4 | V2750 | E3 |
| R2269 | B1 | R2517 | A2 | R2762 | E2 | V2108 | D4 | V2752 | E3 |
| R2270 | B1 | R2518 | A2 | R2763 | G2 | V2109 | D4 | V2753 | E3 |
| R2271 | D2 | R2519 | A4 | R2764 | G2 | V2110 | B2 | V2754 | C3 |
| R2272 | D1 | R2521 | A4 | R2766 | G2 | V2111 | D4 | V2756 | D3 |
| R2301 | C3 | R2522 | A3 | R2767 | F2 | V2112 | E3 | V2757 | A1 |
| R2302 | D2 | R2523 | B3 | R2767 | G4 | V2114 | D4 | V2758 | D3 |
| R2303 | C2 | R2524 | B3 | R2768 | G4 | V2204 | E1 | V2759 | G4 |
| R2304 | C2 | R2526 | A3 | R2769 | G4 | V2205 | D2 | V2760 | G3 |
| R2305 | C2 | R2527 | B3 | R2770 | G4 | V2206 | E1 | V2760 | D3 |
| R2306 | C2 | R2528 | B4 | R2771 | G3 | V2207 | D1 | V2761 | G3 |
| R2307 | C2 | R2529 | B3 | R2772 | G3 | V2208 | D1 | V2762 | G4 |
| R2308 | B1 | R2530 | E3 | R2773 | G4 | V2209 | D1 | V2763 | G4 |
| R2309 | B1 | R2531 | C1 | R2774 | G4 | V2210 | B1 | V2765 | E3 |
| R2311 | C3 | R2532 | D1 | R2775 | G4 | V2212 | E2 | V2766 | E3 |
| R2312 | C2 | R2534 | A3 | R2776 | F2 | V2213 | E2 | V2768 | G3 |
| R2313 | C2 | R2535 | A3 | R2777 | F3 | V2214 | D1 | V2811 | C5 |
| R2315 | C2 | R2536 | B3 | R2810 | C1 | V2221 | D1 | V2812 | F4 |
| R2316 | C1 | R2537 | B3 | R2853 | A1 | V2301 | D1 | V2851 | B1 |
| R2317 | C1 | R2538 | E3 | R2854 | B1 | V2302 | C1 | V2852 | E2 |
| R2318 | C3 | R2540 | E3 | R2856 | A1 | V2303 | B1 | V2853 | F2 |
| R2319 | C2 | R2541 | A2 | R2857 | A1 | V2417 | A1 | V2854 | G2 |
| R2320 | C2 | R2542 | A1 | R2858 | A1 | V2501 | A1 | V2901 | B2 |
| R2321 | C1 | R2543 | B2 | R2859 | C1 | V2502 | A2 | V3113 | E3 |

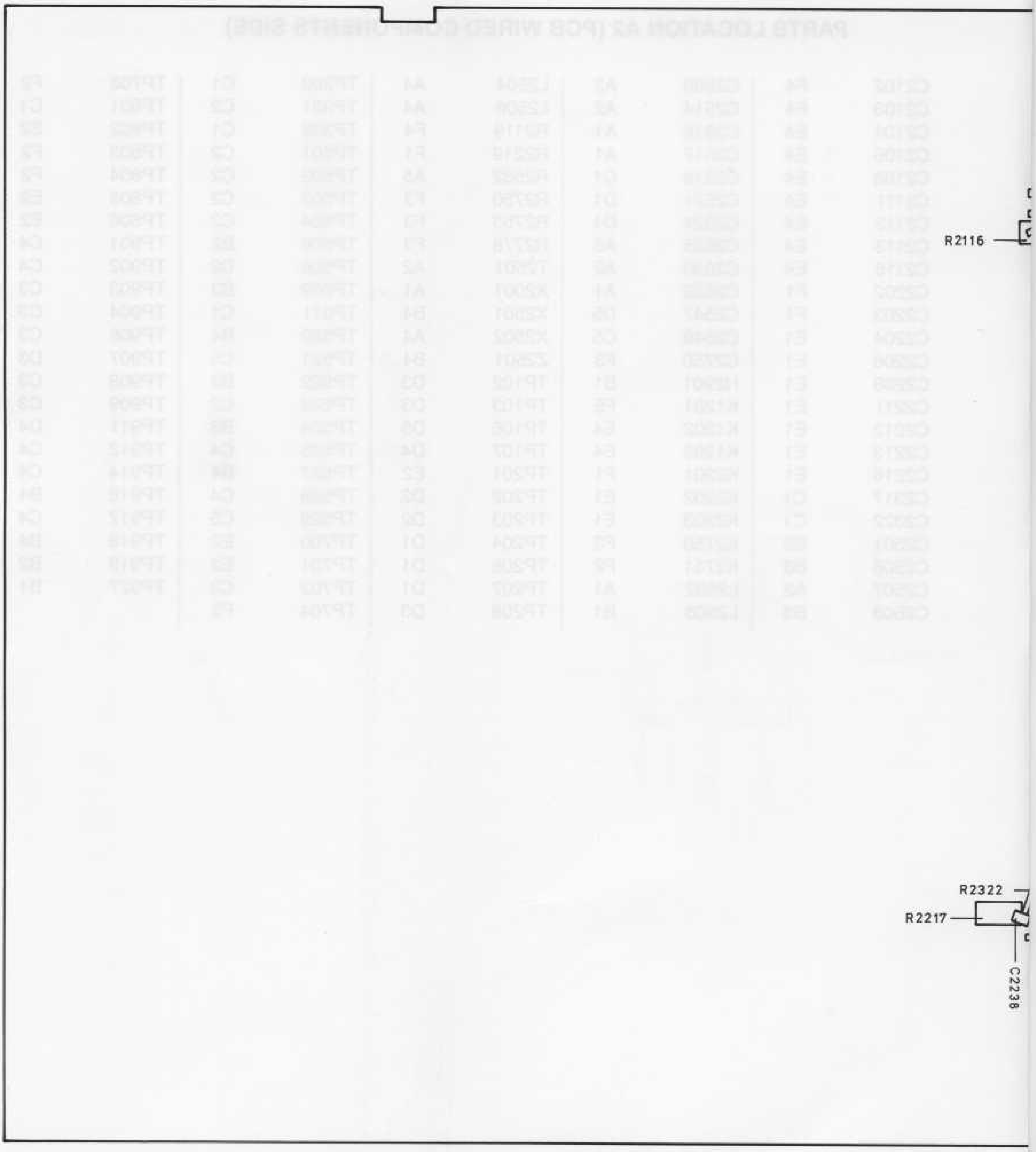
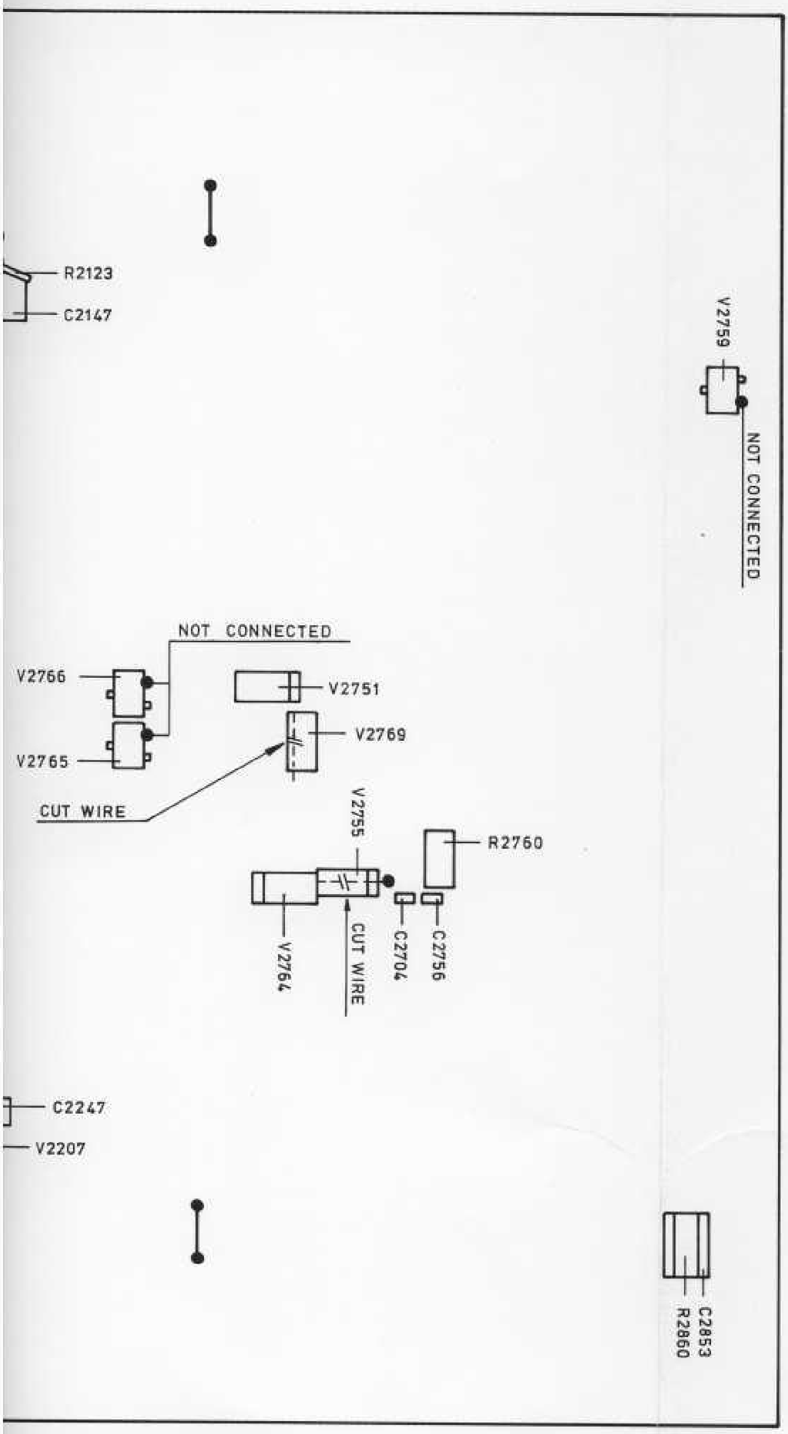



*Figure 10.3b Modifications Analog A2 PCB (SMD component side)*




ST6850
920210

## PARTS LOCATION A2 (PCB WIRED COMPONENTS SIDE)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C2102 | F4 | C2509 | A2 | L2504 | A4 | TP209 | C1 | TP706 | F2 |
| C2103 | F4 | C2514 | A2 | L2506 | A4 | TP331 | C2 | TP801 | C1 |
| C2104 | E4 | C2516 | A1 | R2119 | F4 | TP332 | C1 | TP802 | E2 |
| C2106 | E4 | C2517 | A1 | R2219 | F1 | TP501 | C2 | TP803 | F2 |
| C2108 | E4 | C2518 | C1 | R2582 | A5 | TP502 | C2 | TP804 | F2 |
| C2111 | E4 | C2521 | D1 | R2750 | F3 | TP503 | C2 | TP805 | E2 |
| C2112 | E4 | C2524 | D1 | R2753 | F3 | TP504 | C2 | TP806 | E2 |
| C2113 | E4 | C2525 | A3 | R2778 | F3 | TP506 | B2 | TP901 | C4 |
| C2116 | E4 | C2530 | A2 | T2501 | A2 | TP508 | D2 | TP902 | C4 |
| C2202 | F1 | C2532 | A1 | X2001 | A1 | TP509 | B3 | TP903 | C3 |
| C2203 | F1 | C2547 | D5 | X2501 | B4 | TP511 | C1 | TP904 | C3 |
| C2204 | E1 | C2549 | C5 | X2502 | A4 | TP520 | B4 | TP906 | C3 |
| C2206 | E1 | C2750 | F3 | Z2501 | B4 | TP521 | C5 | TP907 | D3 |
| C2208 | E1 | H2901 | B1 | TP102 | D3 | TP522 | B3 | TP908 | C3 |
| C2211 | E1 | K1201 | F5 | TP103 | D3 | TP523 | C2 | TP909 | C3 |
| C2212 | E1 | K1202 | E4 | TP106 | D5 | TP524 | B3 | TP911 | D4 |
| C2213 | E1 | K1203 | E4 | TP107 | D4 | TP526 | C4 | TP912 | C4 |
| C2216 | E1 | K2201 | F1 | TP201 | E2 | TP527 | B4 | TP914 | C4 |
| C2317 | C1 | K2202 | E1 | TP202 | D2 | TP528 | C4 | TP916 | B4 |
| C2322 | C1 | K2203 | E1 | TP203 | D2 | TP529 | C5 | TP917 | C4 |
| C2501 | B2 | K2750 | F3 | TP204 | D1 | TP700 | E2 | TP918 | B4 |
| C2506 | B3 | K2751 | F2 | TP206 | D1 | TP701 | E2 | TP919 | B2 |
| C2507 | A2 | L2502 | A1 | TP207 | D1 | TP702 | C3 | TP927 | B1 |
| C2508 | B3 | L2503 | B1 | TP208 | D3 | TP704 | F3 | | |

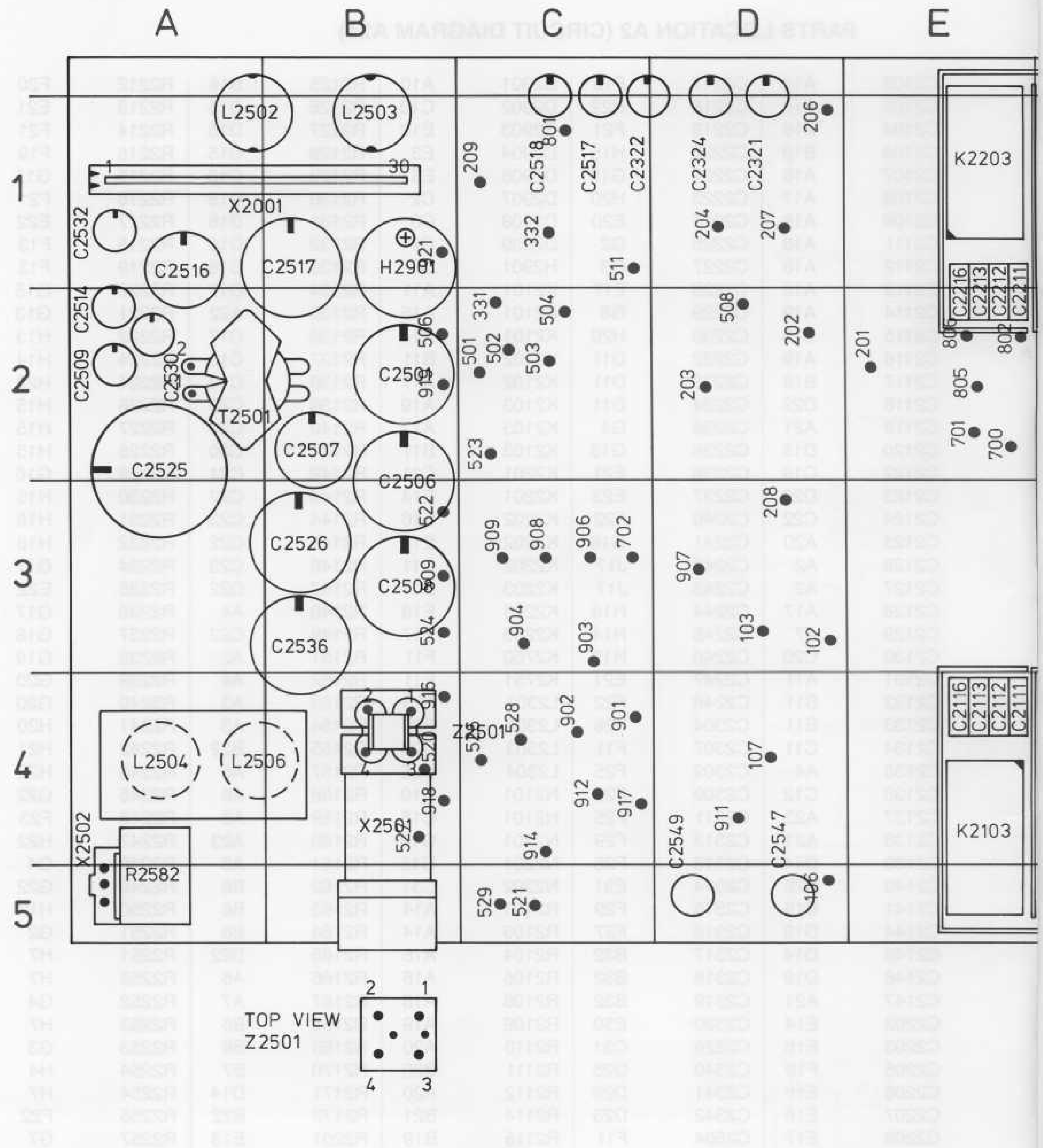
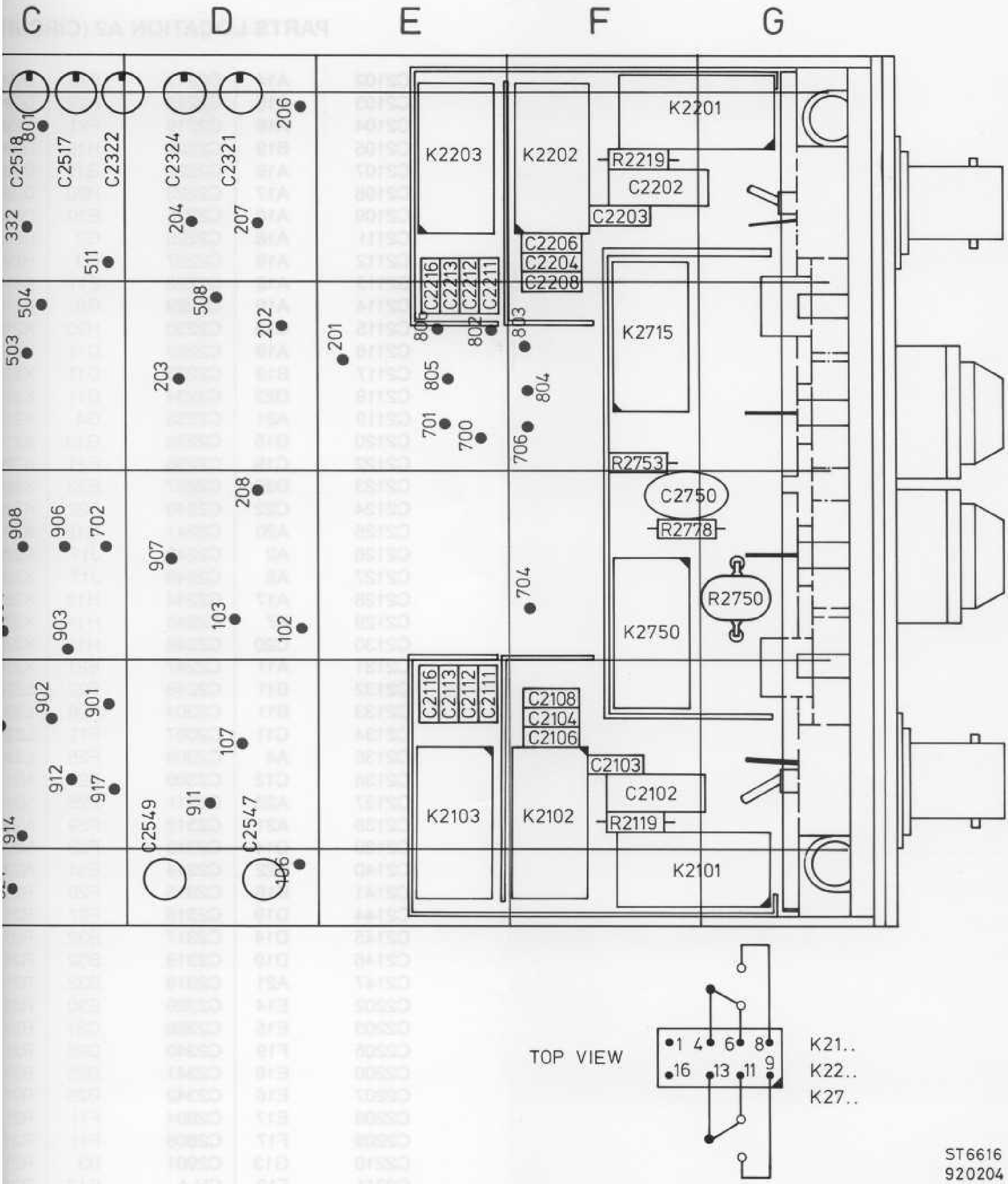


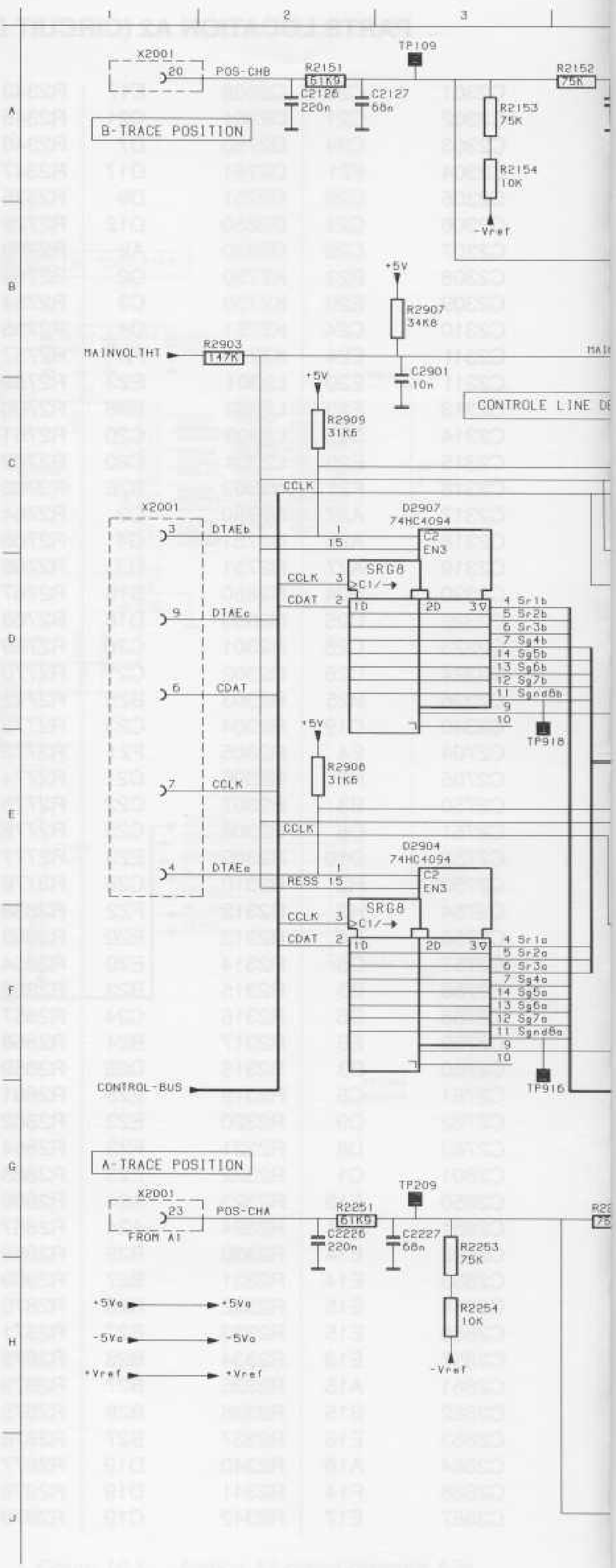

*Figure 10.4* *Analog A2 PCB (wired component side)*

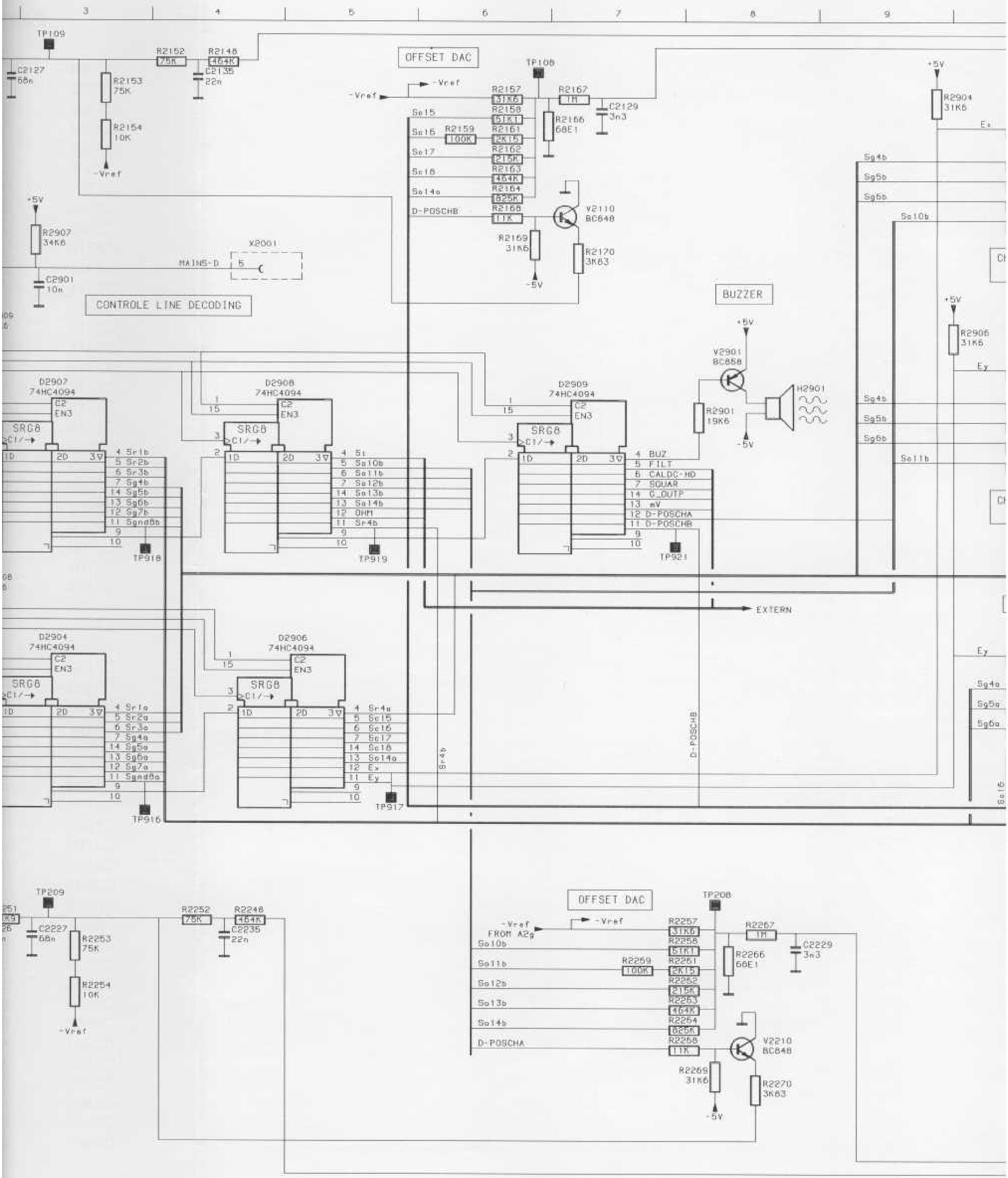

C
D
E
F
G
C2518
801
C2517
C2322
C2324
C2321
206
332
204
207
511
504
508
202
201
503
203
K2203
K2202
K2201
R2219
C2202
C2203
C2206
C2204
C2208
C2216
C2213
C2212
C2211
803
802
805
804
701
700
706
K2715
R2753
C2750
R2778
208
908
906
702
907
704
R2750
K2750
903
103
102
902
901
107
912
917
911
C2549
C2547
914
106
C2116
C2113
C2112
C2111
C2108
C2104
C2106
C2103
C2102
K2103
K2102
R2119
K2101
TOP VIEW
1 4 6 8
16 13 11 9
K21..
K22..
K27..
ST6616
920204

## PARTS LOCATION A2 (CIRCUIT DIAGRAM A2a)

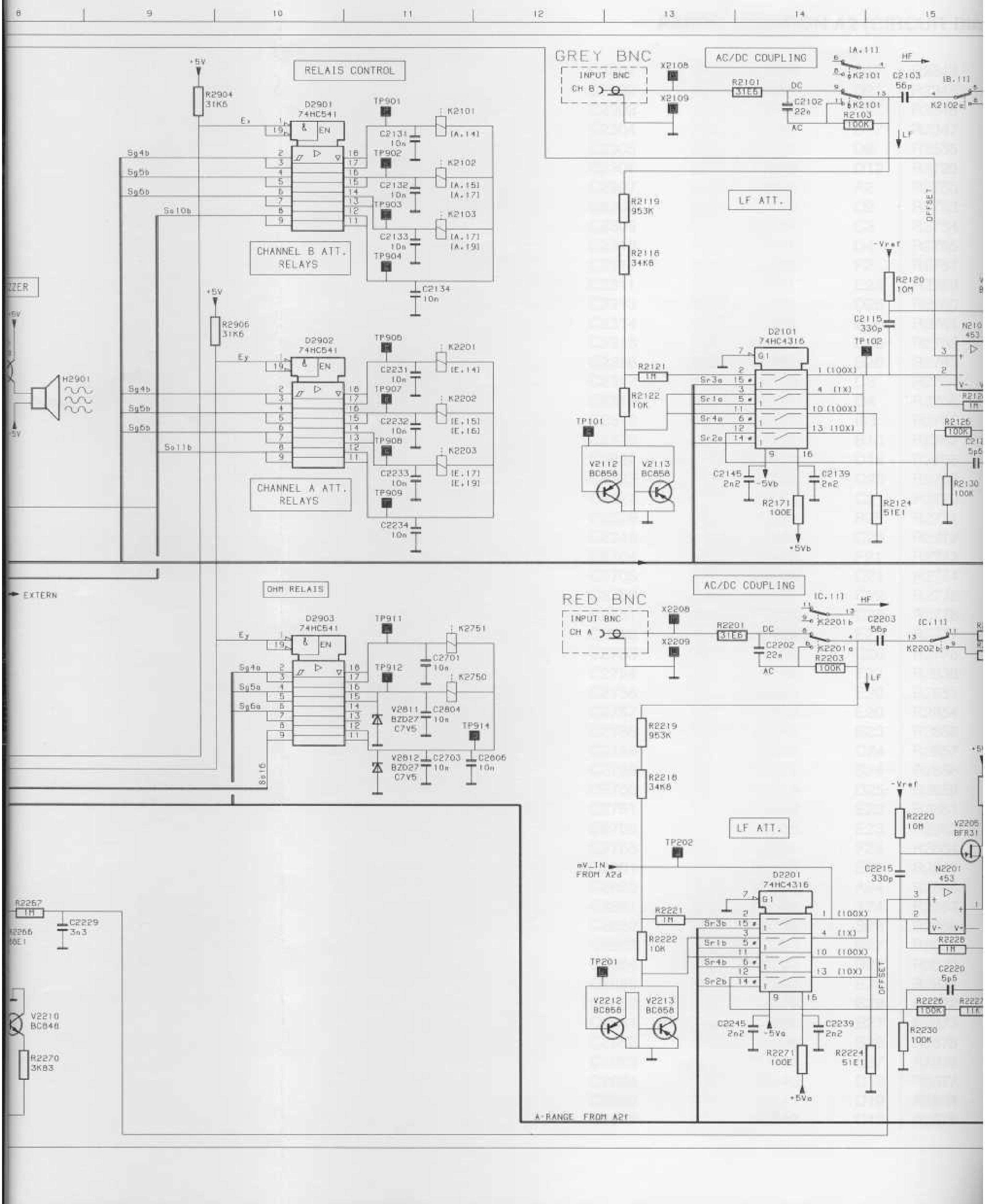
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C2102 | A14 | C2217 | F19 | D2901 | A10 | R2125 | B16 | R2212 | F20 |
| C2103 | A15 | C2218 | H22 | D2902 | C10 | R2126 | D15 | R2213 | E21 |
| C2104 | A16 | C2219 | F21 | D2903 | E10 | R2127 | D15 | R2214 | F21 |
| C2105 | B19 | C2220 | H15 | D2904 | E3 | R2128 | C15 | R2215 | F19 |
| C2107 | A16 | C2222 | G19 | D2906 | E5 | R2129 | C16 | R2215 | G15 |
| C2108 | A17 | C2223 | H20 | D2907 | C2 | R2130 | D15 | R2216 | F21 |
| C2109 | A18 | C2225 | E20 | D2908 | C3 | R2131 | D16 | R2217 | E22 |
| C2111 | A18 | C2226 | G2 | D2909 | C7 | R2132 | D16 | R2218 | F13 |
| C2112 | A18 | C2227 | G3 | H2901 | C8 | R2133 | C16 | R2219 | F13 |
| C2113 | A18 | C2228 | E17 | K2101 | A11 | R2134 | C17 | R2220 | G15 |
| C2114 | A19 | C2229 | G8 | K2101 | A15 | R2135 | A22 | R2221 | G13 |
| C2115 | C15 | C2230 | H20 | K2101 | A14 | R2136 | C17 | R2222 | H13 |
| C2116 | A19 | C2232 | D11 | K2102 | B11 | R2137 | C18 | R2224 | H14 |
| C2117 | B19 | C2233 | D11 | K2102 | A17 | R2138 | C19 | R2224 | H22 |
| C2118 | D22 | C2234 | D11 | K2103 | A19 | R2139 | C20 | R2226 | H15 |
| C2119 | A21 | C2235 | G4 | K2103 | A17 | R2140 | C20 | R2227 | H15 |
| C2120 | D15 | C2236 | G13 | K2103 | B11 | R2141 | C20 | R2228 | H15 |
| C2122 | C19 | C2238 | E21 | K2201 | C11 | R2142 | C21 | R2229 | G16 |
| C2123 | D20 | C2237 | E23 | K2201 | E14 | R2143 | C22 | R2230 | H15 |
| C2124 | C22 | C2240 | F22 | K2202 | E16 | R2144 | C23 | R2231 | H16 |
| C2125 | A20 | C2241 | G16 | K2202 | E15 | R2145 | C22 | R2232 | H16 |
| C2126 | A2 | C2242 | J17 | K2202 | C11 | R2146 | C23 | R2234 | G17 |
| C2127 | A2 | C2243 | J17 | K2203 | D11 | R2147 | D22 | R2235 | E22 |
| C2128 | A17 | C2244 | H19 | K2203 | E19 | R2148 | A4 | R2236 | G17 |
| C2129 | A7 | C2245 | H14 | K2203 | E17 | R2149 | C22 | R2237 | G18 |
| C2130 | C20 | C2246 | H19 | K2750 | F11 | R2151 | A2 | R2238 | G19 |
| C2131 | A11 | C2247 | E21 | K2751 | E11 | R2152 | A4 | R2239 | G20 |
| C2132 | B11 | C2248 | F22 | L2301 | F28 | R2153 | A3 | R2240 | G20 |
| C2133 | B11 | C2304 | F26 | L2302 | E32 | R2154 | A3 | R2241 | H20 |
| C2134 | C11 | C2307 | F11 | L2303 | D25 | R2155 | B22 | R2242 | H21 |
| C2135 | A4 | C2309 | F25 | L2304 | D25 | R2157 | A6 | R2243 | H22 |
| C2136 | C12 | C2309 | F28 | N2101 | C19 | R2158 | A6 | R2245 | G22 |
| C2137 | A23 | C2311 | F25 | N2101 | C15 | R2159 | A6 | R2246 | F23 |
| C2138 | A21 | C2312 | F29 | N2201 | G19 | R2160 | A23 | R2247 | H22 |
| C2139 | D14 | C2313 | F28 | N2201 | G15 | R2161 | A6 | R2248 | G4 |
| C2140 | B22 | C2314 | E31 | N2302 | C31 | R2162 | B6 | R2249 | G22 |
| C2141 | B16 | C2315 | F29 | R2101 | A14 | R2163 | B6 | R2250 | H19 |
| C2144 | D19 | C2316 | F27 | R2103 | A14 | R2164 | B6 | R2251 | G2 |
| C2145 | D14 | C2317 | B32 | R2104 | A16 | R2165 | D22 | R2251 | H7 |
| C2146 | D19 | C2318 | B32 | R2106 | A16 | R2166 | A6 | R2252 | H7 |
| C2147 | A21 | C2319 | B32 | R2108 | A18 | R2167 | A7 | R2252 | G4 |
| C2202 | E14 | C2320 | E30 | R2109 | A19 | R2168 | B6 | R2253 | H7 |
| C2203 | E15 | C2326 | C31 | R2110 | A20 | R2169 | B6 | R2253 | G3 |
| C2205 | F19 | C2340 | D25 | R2111 | B20 | R2170 | B7 | R2254 | H4 |
| C2206 | E16 | C2341 | D25 | R2112 | A20 | R2171 | D14 | R2254 | H7 |
| C2207 | E16 | C2342 | D25 | R2114 | B21 | R2172 | B22 | R2255 | F22 |
| C2208 | E17 | C2804 | F11 | R2115 | B19 | R2201 | E13 | R2257 | G7 |
| C2209 | F17 | C2806 | F11 | R2116 | B21 | R2203 | E14 | R2258 | H7 |
| C2210 | G13 | C2901 | B3 | R2117 | A22 | R2204 | E15 | R2258 | G7 |
| C2211 | F18 | CH A | E12 | R2118 | B13 | R2206 | E15 | R2259 | H8 |
| C2212 | E18 | D2101 | C14 | R2119 | B13 | R2207 | G16 | R2259 | G7 |
| C2213 | F18 | D2102 | C17 | R2120 | B15 | R2208 | E17 | R2260 | E23 |
| C2214 | F18 | D2201 | G14 | R2121 | C13 | R2209 | E19 | R2265 | H22 |
| C2215 | G15 | D2202 | F17 | R2122 | C13 | R2210 | E19 | R2266 | G8 |
| C2216 | E19 | D2301 | E26 | R2123 | A21 | R2211 | F20 | R2267 | G8 |

| | | | |
|---|---|---|---|
| R2270 | H8 | TP902 | B11 |
| R2271 | H14 | TP903 | B11 |
| R2272 | F22 | TP904 | B11 |
| R2301 | D25 | TP906 | C11 |
| R2303 | C30 | TP907 | C11 |
| R2305 | F26 | TP908 | D11 |
| R2312 | F27 | TP909 | D11 |
| R2313 | F25 | TP911 | E11 |
| R2314 | F25 | TP912 | E11 |
| R2315 | C28 | TP914 | F11 |
| R2316 | C29 | TP916 | F3 |
| R2317 | C29 | TP918 | D3 |
| R2318 | E31 | TP919 | D5 |
| R2319 | F28 | TP921 | D7 |
| R2320 | F28 | V2104 | B20 |
| R2321 | F28 | V2105 | B15 |
| R2322 | F28 | V2106 | A20 |
| R2323 | B29 | V2107 | A21 |
| R2324 | B29 | V2108 | C21 |
| R2325 | B30 | V2109 | A23 |
| R2330 | C33 | V2110 | B7 |
| R2331 | C32 | V2111 | C23 |
| R2332 | C33 | V2112 | D12 |
| R2333 | C32 | V2113 | D13 |
| R2334 | C33 | V2114 | B22 |
| R2335 | C32 | V2204 | F20 |
| R2336 | C33 | V2205 | G15 |
| R2337 | C32 | V2206 | E20 |
| R2338 | C28 | V2207 | E21 |
| R2340 | E24 | V2208 | G21 |
| R2341 | E24 | V2209 | E23 |
| R2343 | D25 | V2210 | H8 |
| R2345 | C29 | V2211 | G23 |
| R2346 | C29 | V2212 | H13 |
| R2901 | C8 | V2213 | H13 |
| R2903 | B2 | V2214 | F22 |
| R2904 | A9 | V2301 | B30 |
| R2906 | C10 | V2302 | B30 |
| R2907 | B3 | V2303 | E31 |
| R2908 | E2 | V2811 | F11 |
| R2909 | C2 | V2812 | F11 |
| TP101 | D12 | V2901 | C8 |
| TP103 | C16 | X2001 | G1 |
| TP104 | C14 | X2001 | A1 |
| TP104 | C16 | X2001 | B4 |
| TP106 | B20 | X2001 | B33 |
| TP107 | B22 | X2001 | C1 |
| TP108 | A6 | X2108 | A13 |
| TP109 | A3 | X2109 | A13 |
| TP202 | G13 | X2208 | E13 |
| TP206 | F20 | X2209 | E13 |
| TP207 | F23 | | |
| TP208 | G8 | | |
| TP209 | G3 | | |
| TP331 | C29 | | |
| TP332 | C29 | | |
| TP717 | F5 | | |
| TP901 | A11 | | |

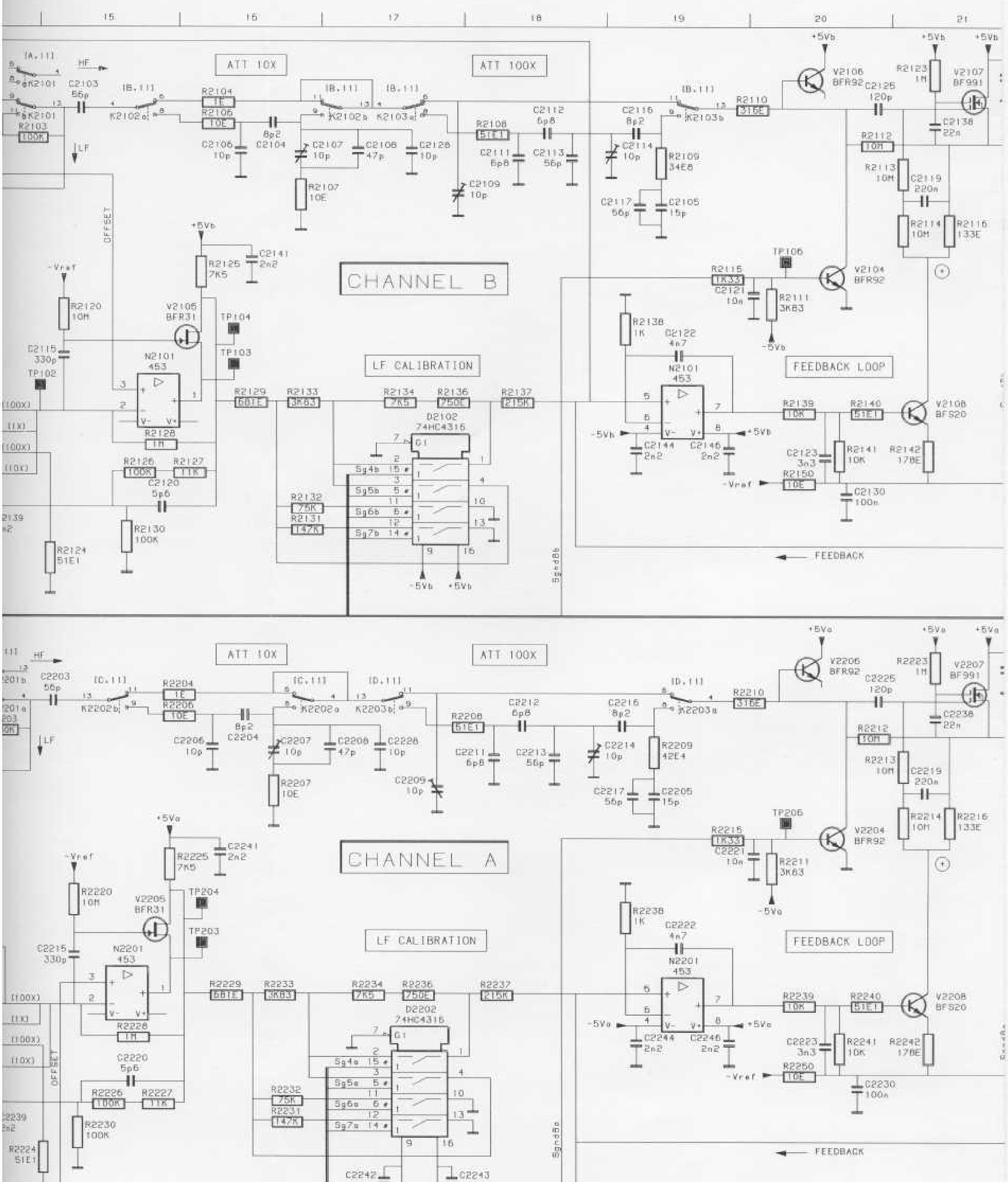




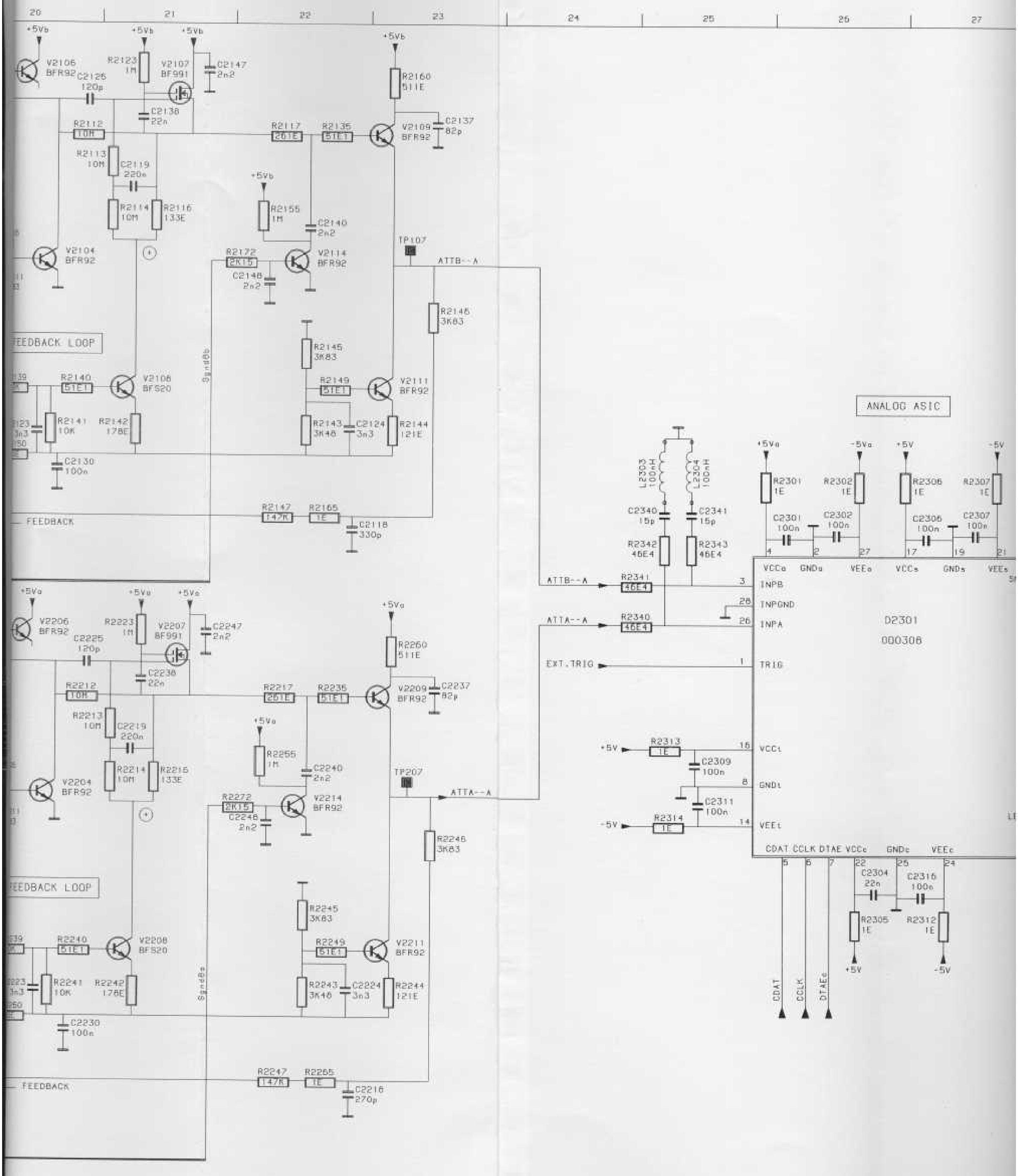
OFFSET DAC
CONTROLE LINE DECODING
BUZZER
TP109
R2152 75K
R2148 464K
C2127 68n
R2153 75K
R2154 10K
C2135 22n
-Vref
TP108
R2157 31K6
R2158 51K1
R2159 100K
R2161 2K15
R2162 215K
R2163 464K
R2164 825K
R2168 11K
R2167 1M
C2129 3n3
R2166 68E1
V2110 BC848
R2169 31K6
R2170 3K63
-5V
+5V
R2907 34K8
C2901 10n
X2001
MAINS-D
R2904 31K6
R2906 31K6
V2901 BC858
R2901 19K6
H2901
D2907 74HC4094
D2908 74HC4094
D2909 74HC4094
D2904 74HC4094
D2906 74HC4094
SRG8
EN3
BUZ
FILT
CALDC-HD
SQUAR
C_OUTP
mV
D-POSCHA
D-POSCHB
OHM
TP918
TP919
TP921
TP916
TP917
EXTERN
TP209
R2252 75K
R2248 464K
C2227 68n
R2253 75K
R2254 10K
C2235 22n
TP208
-Vref FROM A2g
R2257 31K6
R2258 51K1
R2259 100K
R2261 2K15
R2262 215K
R2263 464K
R2264 825K
R2268 11K
R2267 1M
C2229 3n3
R2266 68E1
V2210 BC848
R2269 31K6
R2270 3K63



8
9
10
11
12
13
14
15
RELAIS CONTROL
+5V
R2904
31K6
D2901
74HC541
TP901
K2101
C2131
10n
[A.14]
Sg4b
Sg5b
Sg6b
Sol0b
TP902
K2102
C2132
[A.15]
[A.17]
TP903
K2103
C2133
[A.17]
[A.19]
CHANNEL B ATT. RELAYS
TP904
C2134
R2905
31K6
D2902
74HC541
TP906
K2201
C2231
[E.14]
H2901
TP907
K2202
C2232
[E.15]
[E.16]
Sol1b
TP908
K2203
C2233
[E.17]
[E.19]
CHANNEL A ATT. RELAYS
TP909
C2234
EXTERN
OHM RELAIS
D2903
74HC541
TP911
K2751
TP912
C2701
K2750
Sg4a
Sg5a
Sg6a
V2811
BZD27
C7V5
C2804
TP914
V2812
BZD27
C7V5
C2703
C2806
Sol6
R2267
1M
C2229
3n3
R2266
V2210
BC848
R2270
3K83
A-RANGE FROM A2f
GREY BNC
INPUT BNC
CH B
X2108
X2109
AC/DC COUPLING
R2101
31E6
DC
C2102
22n
AC
K2101
C2103
56p
R2103
100K
HF
LF
K2102
LF ATT.
R2119
953K
R2118
34K8
-Vref
R2120
10M
C2115
330p
D2101
74HC4316
TP102
R2121
1M
R2122
10K
Sr3a
Sr1a
Sr4a
Sr2a
1 (100X)
4 (1X)
10 (100X)
13 (10X)
TP101
V2112
BC858
V2113
BC858
C2145
2n2
-5Vb
C2139
2n2
R2171
100E
+5Vb
R2124
51E1
R2126
100K
R2130
100K
OFFSET
N2101
453
RED BNC
INPUT BNC
CH A
X2208
X2209
AC/DC COUPLING
R2201
31E6
C2202
22n
K2201
C2203
56p
R2203
100K
K2202
R2219
953K
R2218
34K8
LF ATT.
R2220
10M
V2205
BFR31
TP202
mV_IN FROM A2d
C2215
330p
N2201
453
D2201
74HC4316
R2221
1M
R2222
10K
Sr3b
Sr1b
Sr4b
Sr2b
TP201
V2212
BC858
V2213
BC858
C2245
2n2
-5Va
C2239
2n2
R2271
100E
+5Va
R2224
51E1
R2228
1M
C2220
5p5
R2226
100K
R2230
100K



15
16
17
18
19
20
21
ATT 10X
ATT 100X
CHANNEL B
LF CALIBRATION
FEEDBACK LOOP
FEEDBACK
HF
LF
OFFSET
K2101
K2102a
K2102b
K2103a
K2103b
R2101
R2103 100K
C2103 56p
R2104 1E
R2105 10E
C2104 8p2
C2106 10p
C2107 10p
C2108 47p
C2128 10p
R2107 10E
R2108 51E1
C2109 10p
C2111 6p8
C2112 6p8
C2113 56p
C2116 8p2
C2114 10p
R2109 34E8
C2117 56p
C2105 15p
R2110 316E
V2106 BFR92
C2125 120p
R2123 1M
V2107 BF991
C2138 22n
R2112 10M
R2113 10M
C2119 220n
R2114 10M
R2116 133E
TP106
R2115 1K33
C2121 10n
R2111 3K83
V2104 BFR92
-5Vb
+5Vb
-Vref
R2120 10M
C2115 330p
TP102
R2125 7K5
C2141 2n2
V2105 BFR31
TP104
TP103
N2101 453
R2128 1M
R2126 100K
R2127 11K
C2120 5p6
R2130 100K
R2124 51E1
R2129 681E
R2133 3K83
R2134 7K5
R2136 750E
R2137 215K
D2102 74HC4316
R2132 75K
R2131 147K
R2138 1K
C2122 4n7
C2144 2n2
C2146 2n2
R2139 10K
R2140 51E1
V2108 BFS20
C2123 3n3
R2141 10K
R2142 178E
R2150 10E
C2130 100n
Sgnd8b
CHANNEL A
K2201
K2202a
K2202b
K2203a
K2203b
R2203
C2203 56p
R2204 1E
R2205 10E
C2204 8p2
C2206 10p
C2207 10p
C2208 47p
C2228 10p
R2207 10E
R2208 51E1
C2209 10p
C2211 6p8
C2212 6p8
C2213 56p
C2216 8p2
C2214 10p
R2209 42E4
C2217 56p
C2205 15p
R2210 316E
V2205 BFR92
C2225 120p
R2223 1M
V2207 BF991
C2238 22n
R2212 10M
R2213 10M
C2219 220n
R2214 10M
R2216 133E
TP206
R2215 1K33
C2221 10n
R2211 3K83
V2204 BFR92
-5Va
+5Va
R2220 10M
C2215 330p
R2225 7K5
C2241 2n2
V2206 BFR31
TP204
TP203
N2201 453
R2228 1M
R2226 100K
R2227 11K
C2220 5p6
R2230 100K
R2224 51E1
C2239 2n2
R2229 681E
R2233 3K83
R2234 7K5
R2236 750E
R2237 215K
D2202 74HC4316
R2232 75K
R2231 147K
C2242 2n2
C2243 2n2
R2238 1K
C2222 4n7
C2244 2n2
C2246 2n2
R2239 10K
R2240 51E1
V2208 BFS20
C2223 3n3
R2241 10K
R2242 178E
R2250 10E
C2230 100n
Sgnd8a


20
21
22
23
24
25
26
27
FEEDBACK LOOP
FEEDBACK
ANALOG ASIC
D2301
000308
ATTB--A
ATTA--A
EXT.TRIG
TP107
TP207
V2106 BFR92
V2107 BF991
V2109 BFR92
V2104 BFR92
V2114 BFR92
V2108 BFS20
V2111 BFR92
V2206 BFR92
V2207 BF991
V2209 BFR92
V2204 BFR92
V2214 BFR92
V2208 BFS20
V2211 BFR92
R2123 1M
R2160 511E
R2112 10M
R2117 261E
R2135 51E1
R2113 10M
R2114 10M
R2116 133E
R2155 1M
R2172 2K15
R2148 3K83
R2145 3K83
R2140 51E1
R2149 51E1
R2141 10K
R2142 178E
R2143 3K48
R2144 121E
R2147 147K
R2165 1E
C2125 120p
C2147 2n2
C2138 22n
C2137 82p
C2119 220n
C2140 2n2
C2148 2n2
C2124 3n3
C2130 100n
C2118 330p
R2223 1M
R2260 511E
R2212 10M
R2217 261E
R2235 51E1
R2213 10M
R2214 10M
R2216 133E
R2255 1M
R2272 2K15
R2246 3K83
R2245 3K83
R2240 51E1
R2249 51E1
R2241 10K
R2242 178E
R2243 3K48
R2244 121E
R2247 147K
R2265 1E
C2225 120p
C2247 2n2
C2238 22n
C2237 82p
C2219 220n
C2240 2n2
C2248 2n2
C2224 3n3
C2230 100n
C2218 270p
L2303 100nH
L2304 100nH
C2340 15p
C2341 15p
R2342 46E4
R2343 46E4
R2341 46E4
R2340 46E4
R2301 1E
R2302 1E
R2306 1E
R2307 1E
C2301 100n
C2302 100n
C2306 100n
C2307 100n
R2313 1E
R2314 1E
C2309 100n
C2311 100n
C2304 22n
C2316 100n
R2305 1E
R2312 1E
VCCa GNDa VEEa VCCs GNDs VEEs
INPB
INPGND
INPA
TRIG
VCCt
GNDt
VEEt
CDAT CCLK DTAE VCCc GNDc VEEc
CDAT
CCLK
DTAEc
+5Vb
+5Va
-5Va
+5V
-5V

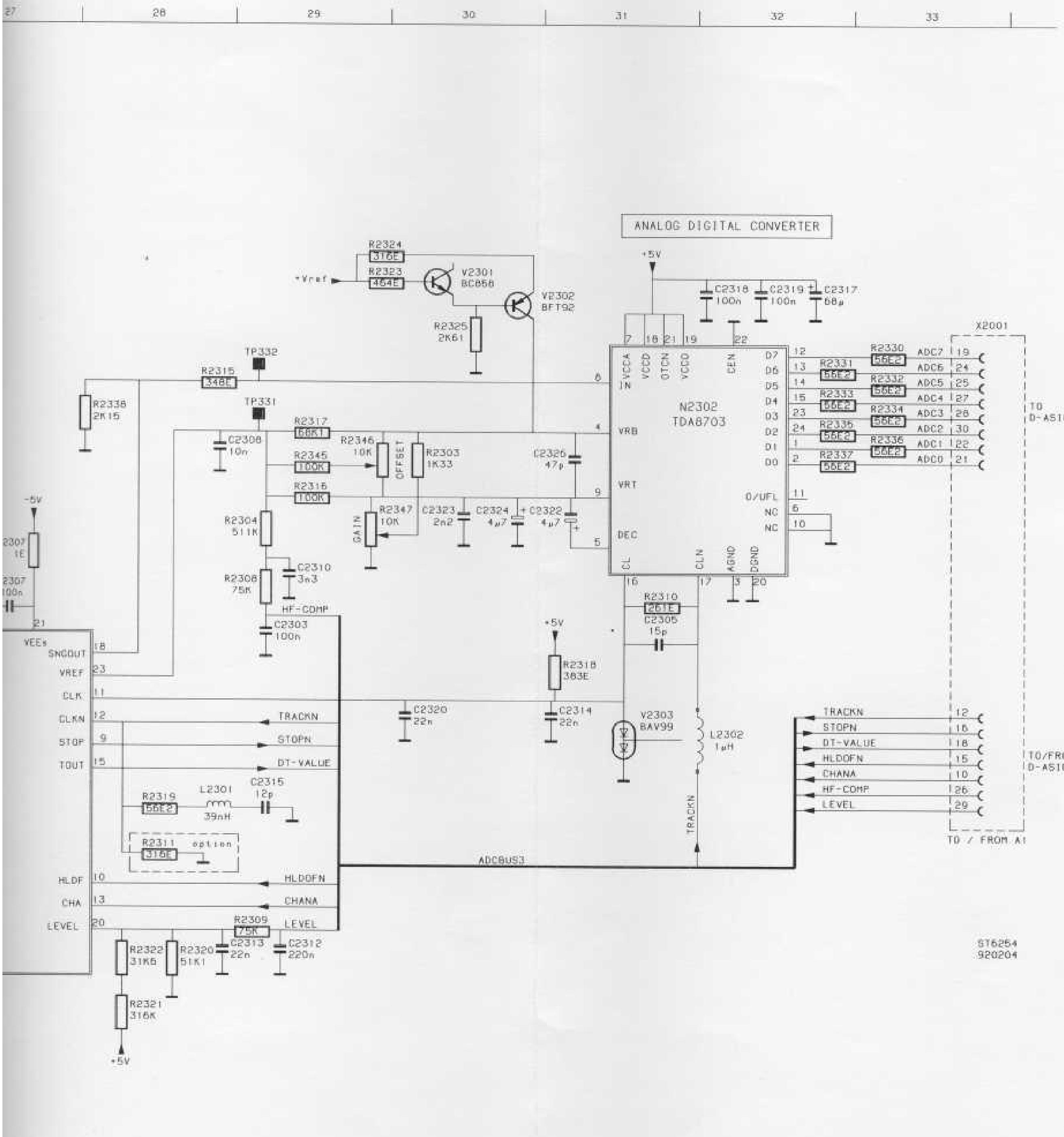



Figure 10.5 Analog A2 circuit diagram A2a

## PARTS LOCATION A2 (CIRCUIT DIAGRAM A2b)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C2301 | C20 | C2868 | E17 | R2343 | C20 | R2881 | A17 |
| C2302 | C21 | D2301 | D21 | R2345 | B24 | TP331 | B23 |
| C2303 | C24 | D2750 | D7 | R2346 | B24 | TP332 | B23 |
| C2304 | F21 | D2751 | D17 | R2347 | C24 | TP700 | D4 |
| C2305 | C26 | D2751 | D9 | R2535 | A25 | TP701 | D4 |
| C2306 | C21 | D2850 | D12 | R2729 | G3 | TP702 | B3 |
| C2307 | C22 | D2850 | A2 | R2750 | C3 | TP704 | G3 |
| C2308 | B23 | K2750 | D2 | R2753 | C4 | TP706 | G4 |
| C2309 | E20 | K2750 | C3 | R2754 | C5 | TP801 | D12 |
| C2310 | C24 | K2751 | D4 | R2755 | D3 | TP802 | F14 |
| C2311 | E24 | K2751 | F2 | R2757 | A4 | TP803 | D15 |
| C2311 | E20 | L2301 | E23 | R2759 | B3 | TP804 | E16 |
| C2313 | E23 | L2302 | D26 | R2760 | D5 | TP805 | B15 |
| C2314 | D25 | L2303 | C20 | R2761 | D7 | TP806 | A16 |
| C2315 | E23 | L2304 | C20 | R2762 | D10 | V2301 | A25 |
| C2316 | F21 | N2302 | B26 | R2763 | D5 | V2302 | A25 |
| C2317 | A27 | N2750 | C3 | R2764 | D5 | V2303 | D26 |
| C2318 | A26 | N2751 | G4 | R2766 | C5 | V2736 | D8 |
| C2319 | A27 | N2751 | G3 | R2766 | E5 | V2751 | C4 |
| C2320 | D24 | N2850 | B16 | R2767 | D6 | V2752 | D4 |
| C2322 | C25 | N2850 | D16 | R2768 | D6 | V2753 | D4 |
| C2323 | C25 | R2301 | C20 | R2769 | D7 | V2754 | C6 |
| C2324 | C25 | R2302 | C21 | R2770 | E5 | V2755 | H5 |
| C2326 | B25 | R2303 | B25 | R2771 | H3 | V2756 | C6 |
| C2340 | C19 | R2304 | C23 | R2772 | H4 | V2757 | A4 |
| C2704 | E4 | R2305 | F21 | R2773 | G4 | V2758 | B3 |
| C2705 | H3 | R2306 | C21 | R2774 | G4 | V2759 | F5 |
| C2750 | B3 | R2307 | C22 | R2775 | E5 | V2760 | F4 |
| C2751 | C5 | R2308 | C23 | R2776 | E9 | V2761 | G4 |
| C2752 | D10 | R2309 | E23 | R2777 | C4 | V2762 | F5 |
| C2753 | H3 | R2310 | C26 | R2778 | C1 | V2763 | F6 |
| C2754 | H3 | R2312 | F22 | R2838 | B22 | V2764 | H5 |
| C2756 | E4 | R2313 | E20 | R2853 | E13 | V2765 | D2 |
| C2757 | D6 | R2314 | E20 | R2854 | E13 | V2766 | D2 |
| C2758 | B3 | R2315 | B23 | R2856 | D13 | V2767 | D8 |
| C2758 | D6 | R2316 | C24 | R2857 | E13 | V2768 | E10 |
| C2759 | E6 | R2317 | B24 | R2858 | E13 | V2769 | C4 |
| C2760 | B3 | R2318 | D25 | R2859 | E14 | V2851 | E13 |
| C2761 | C6 | R2319 | E23 | R2861 | E15 | V2852 | F15 |
| C2762 | D9 | R2320 | E23 | R2862 | E15 | V2853 | B14 |
| C2763 | D8 | R2321 | F23 | R2864 | E16 | V2854 | B17 |
| C2801 | C1 | R2322 | E23 | R2865 | B14 | X2001 | F1 |
| C2850 | E13 | R2323 | A24 | R2866 | E17 | X2001 | B28 |
| C2851 | E14 | R2324 | A24 | R2867 | F14 | X2201 | F1 |
| C2852 | E14 | R2330 | B28 | R2868 | F14 | | |
| C2853 | E14 | R2331 | B27 | R2869 | F15 | | |
| C2854 | E15 | R2332 | B28 | R2870 | C14 | | |
| C2856 | E15 | R2333 | B27 | R2871 | A15 | | |
| C2857 | E13 | R2334 | B28 | R2872 | A15 | | |
| C2861 | A15 | R2335 | B27 | R2873 | B15 | | |
| C2862 | B15 | R2336 | B28 | R2875 | B15 | | |
| C2863 | E16 | R2337 | B27 | R2876 | A15 | | |
| C2864 | A16 | R2340 | D19 | R2877 | A16 | | |
| C2866 | F14 | R2341 | D19 | R2878 | B16 | | |
| C2867 | E17 | R2342 | C19 | R2879 | B16 | | |

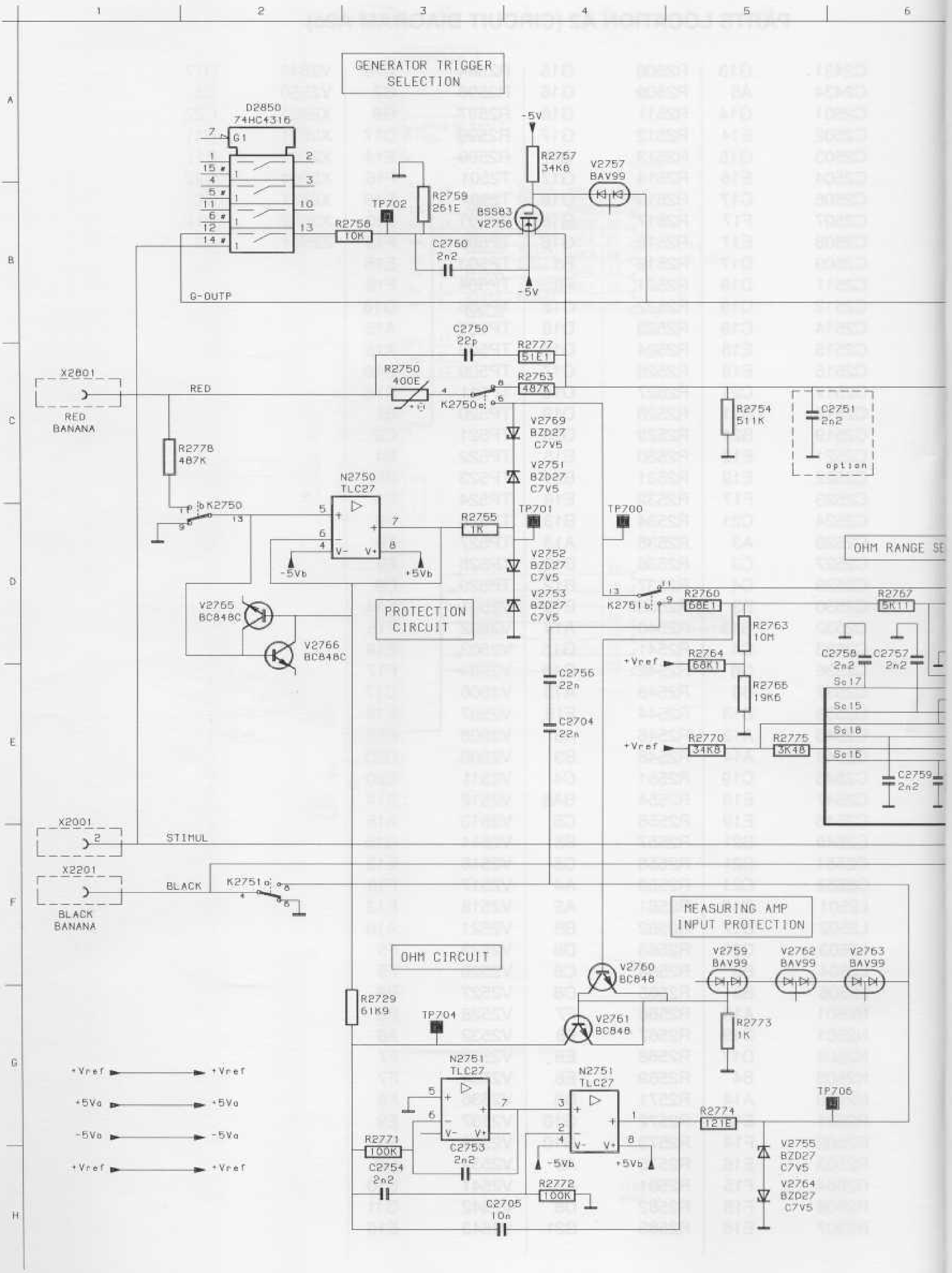
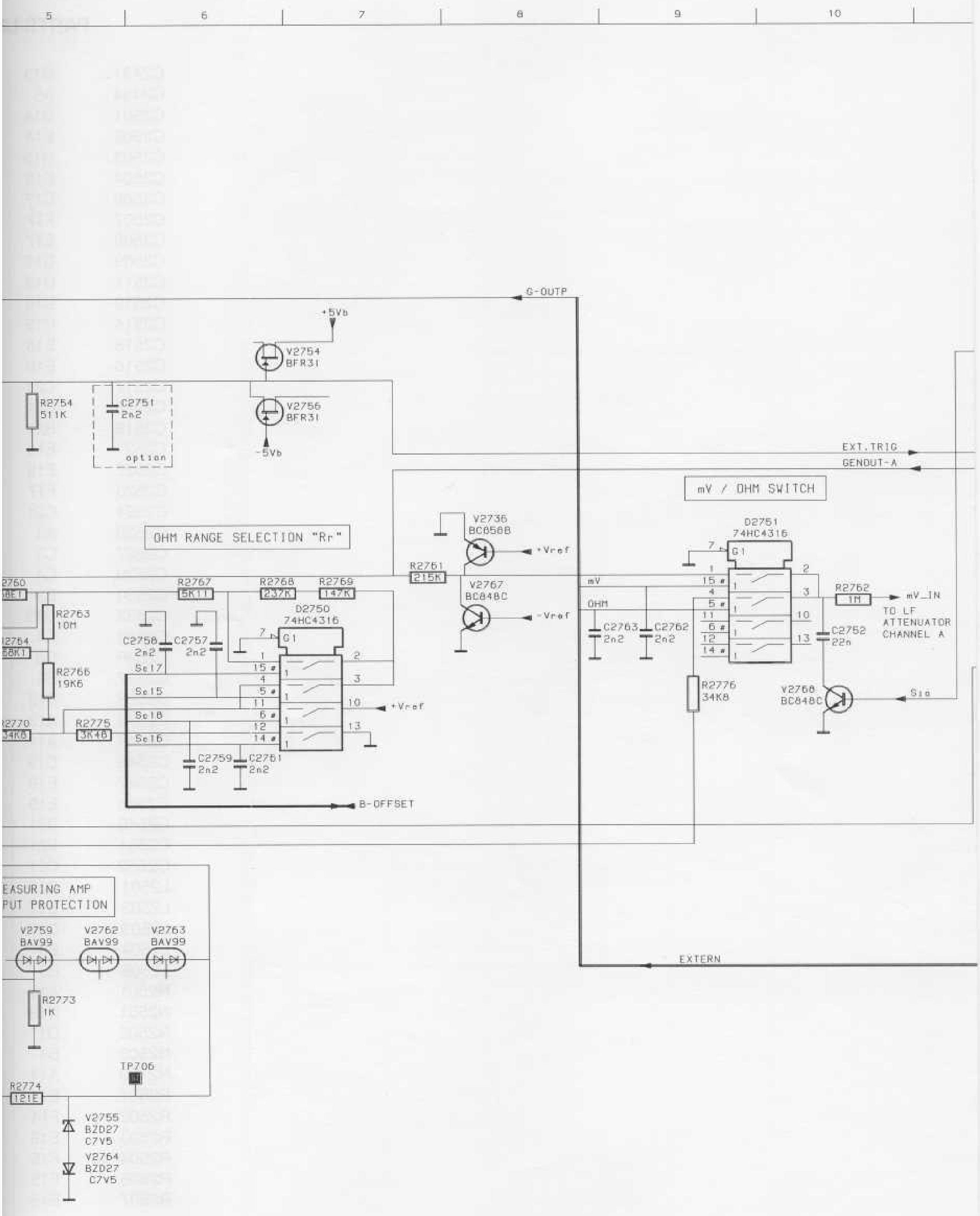
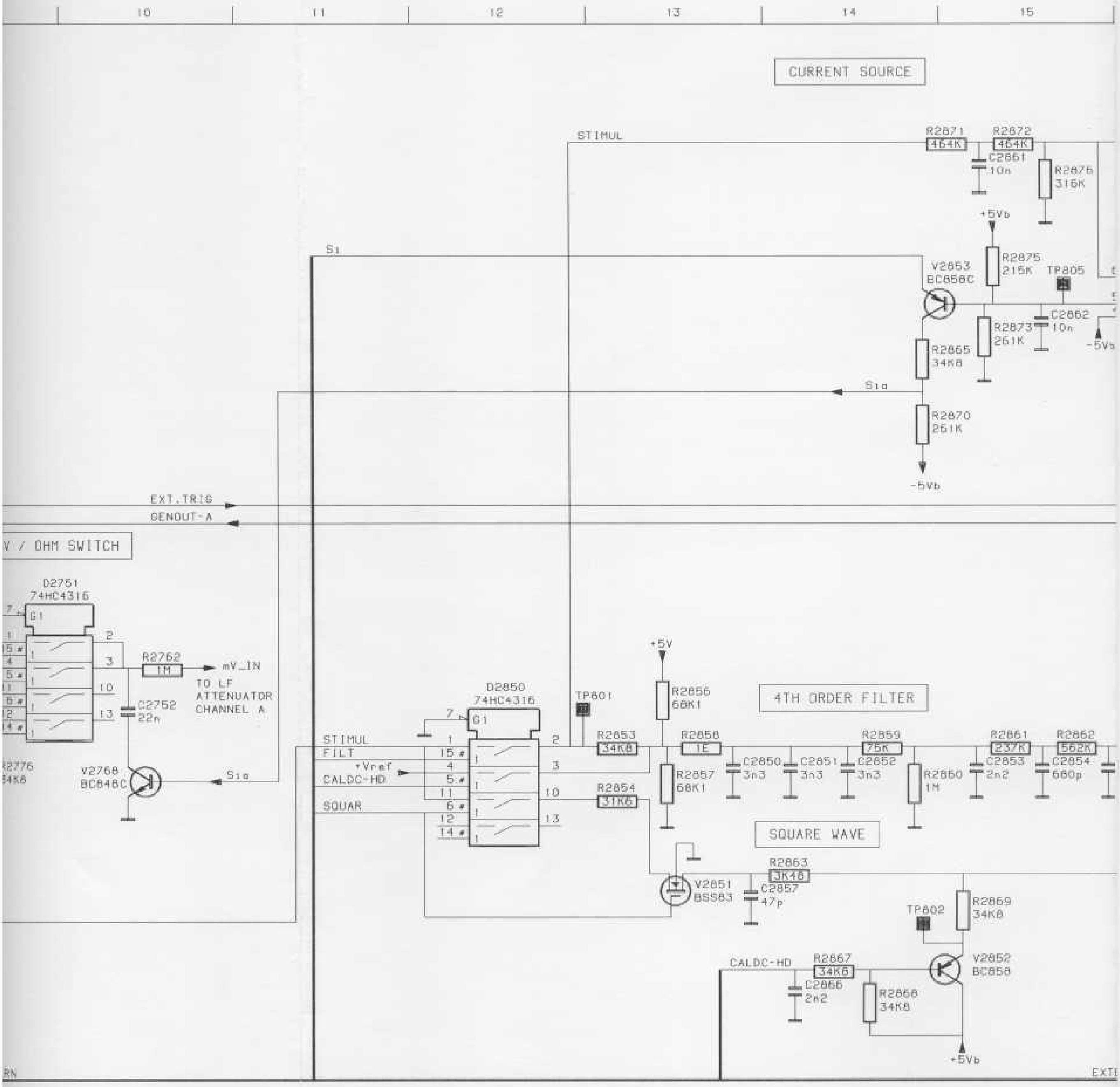


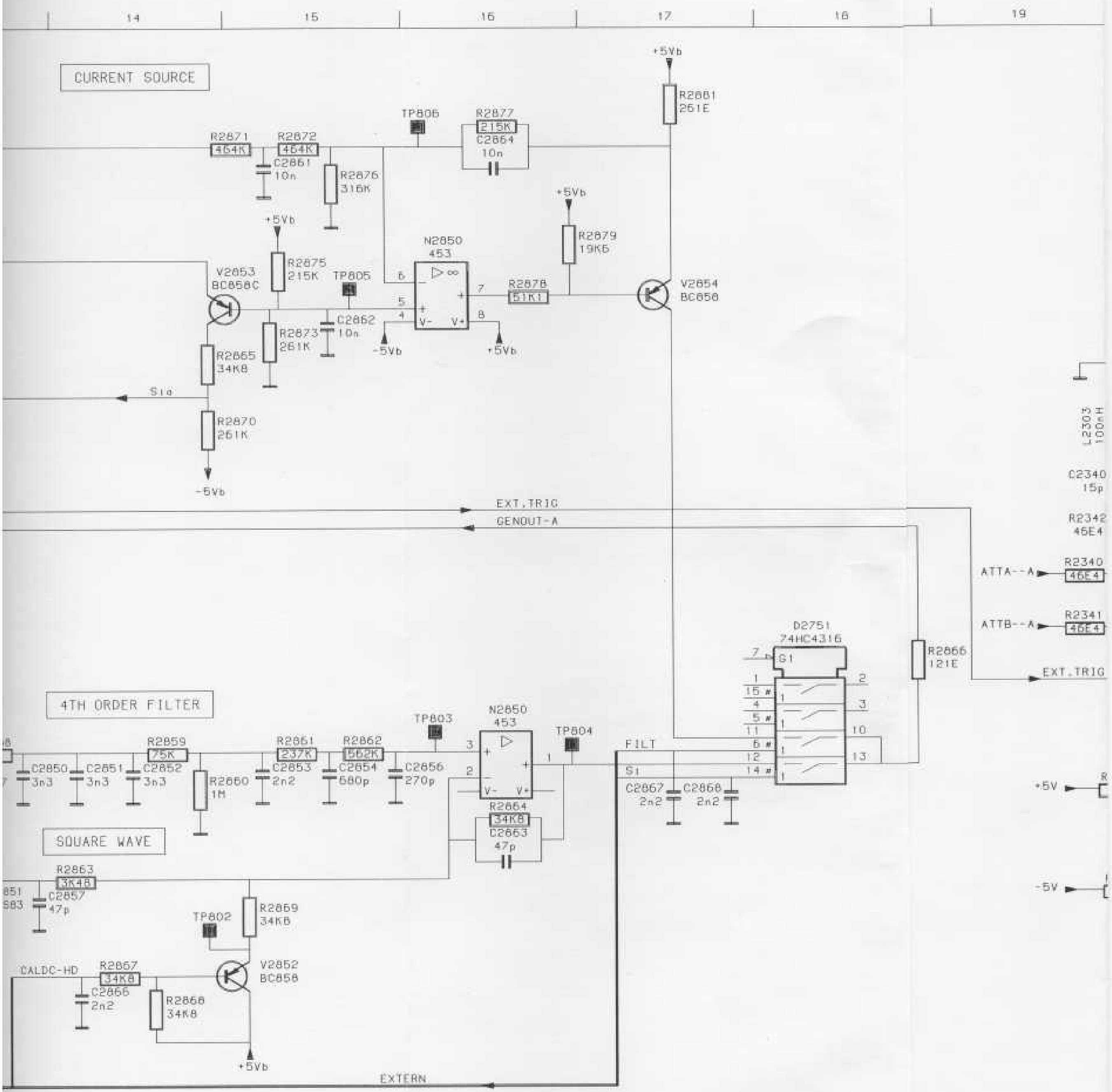

*Figure 10.6 Analog A2 circuit diagram A2b*

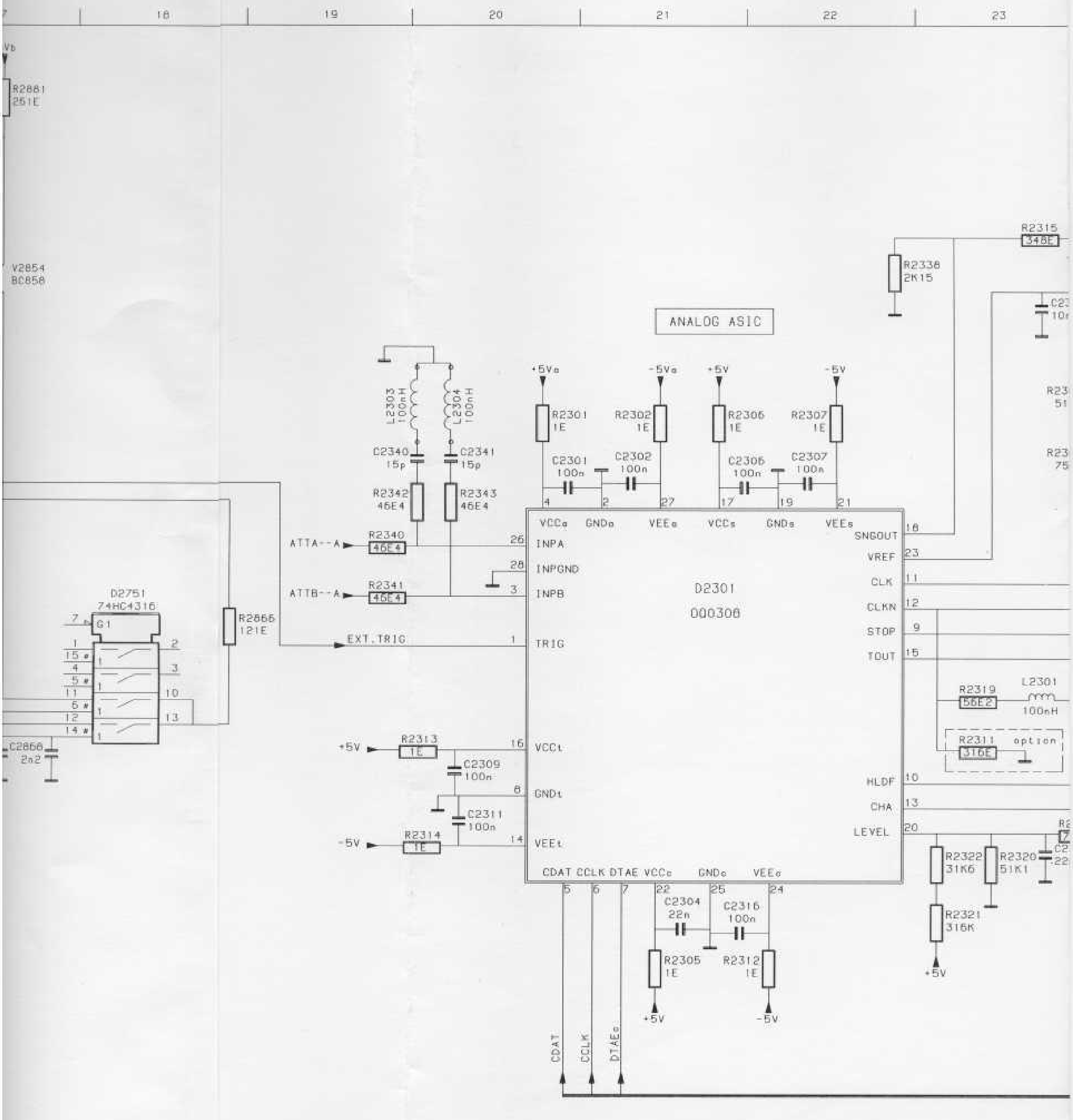


5
6
7
8
9
10
G-OUTP
+5Vb
V2754
BFR31
V2756
BFR31
-5Vb
R2754
511K
C2751
2n2
option
EXT.TRIG
GENOUT-A
mV / OHM SWITCH
OHM RANGE SELECTION "Rr"
V2736
BC858B
+Vref
V2767
BC848C
-Vref
R2761
215K
D2751
74HC4316
mV
OHM
C2763
2n2
C2762
2n2
R2762
1M
mV_IN
TO LF
ATTENUATOR
CHANNEL A
C2752
22n
R2776
34K8
V2768
BC848C
Sio
R2760
R2767
5K11
R2768
237K
R2769
147K
R2763
10M
R2764
R2765
19K6
D2750
74HC4316
C2758
2n2
C2757
2n2
Sc17
Sc15
Sc18
Sc16
R2770
34K8
R2775
3K48
C2759
2n2
C2761
2n2
B-OFFSET
EXTERN
EASURING AMP
PUT PROTECTION
V2759
BAV99
V2762
BAV99
V2763
BAV99
R2773
1K
TP706
R2774
121E
V2755
BZD27
C7V5
V2764
BZD27
C7V5

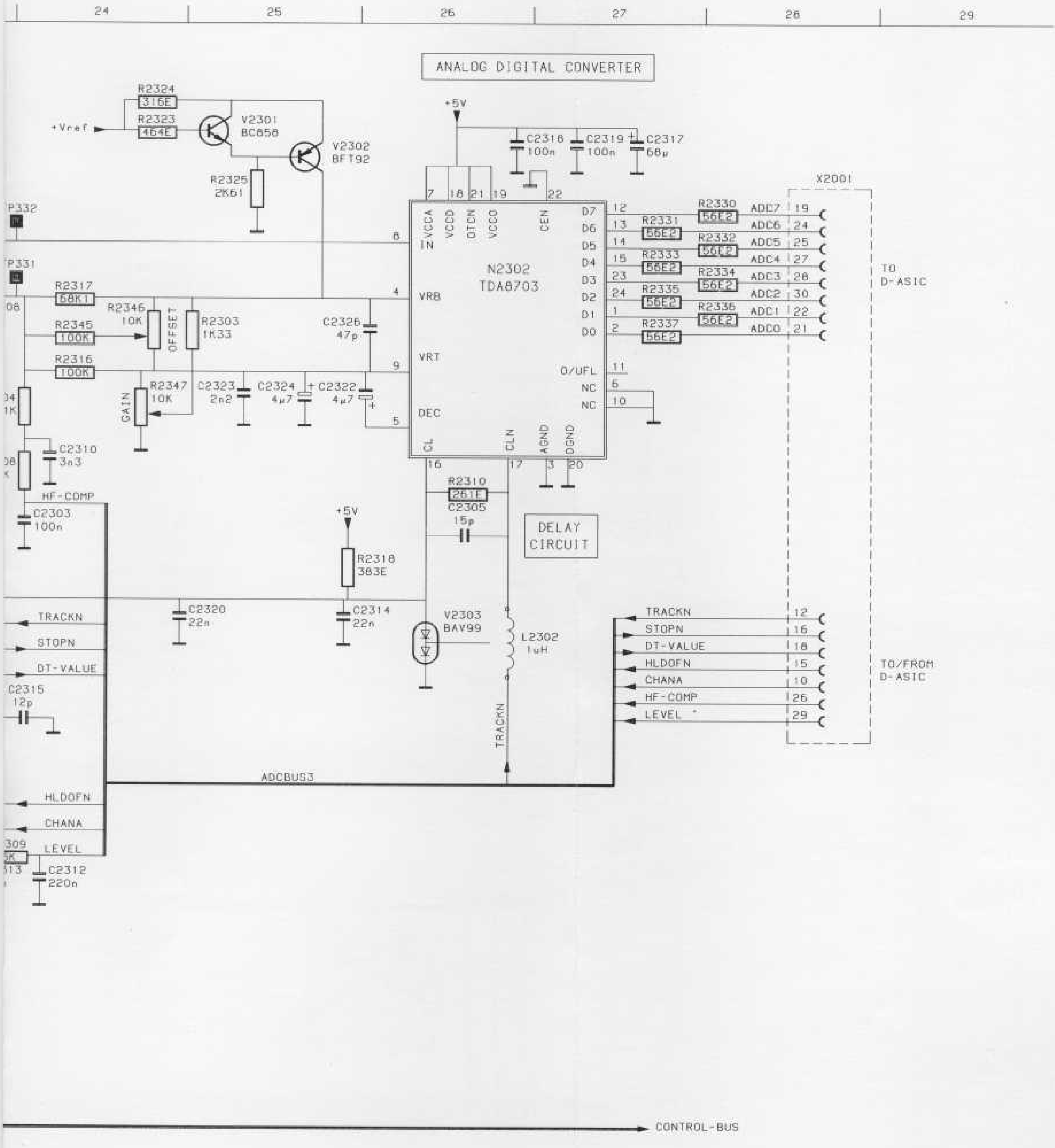


10
11
12
13
14
15
CURRENT SOURCE
STIMUL
R2871
464K
R2872
464K
C2861
10n
R2876
316K
+5Vb
S1
V2853
BC858C
R2875
215K
TP805
C2862
10n
R2873
261K
-5Vb
R2865
34K8
S1a
R2870
261K
-5Vb
EXT.TRIG
GENOUT-A
V / OHM SWITCH
D2751
74HC4316
G1
R2762
1M
mV_IN
TO LF
ATTENUATOR
CHANNEL A
C2752
22n
R2776
34K8
V2768
BC848C
S1a
+5V
R2856
68K1
TP801
4TH ORDER FILTER
D2850
74HC4316
G1
STIMUL
FILT
+Vref
CALDC-HD
SQUAR
R2853
34K8
R2858
1E
R2859
75K
R2861
237K
R2862
562K
C2850
3n3
C2851
3n3
C2852
3n3
R2860
1M
C2853
2n2
C2854
680p
R2857
68K1
R2854
31K6
SQUARE WAVE
R2863
3K48
V2851
BSS83
C2857
47p
R2869
34K8
TP802
CALDC-HD
R2867
34K8
V2852
BC858
C2866
2n2
R2868
34K8
+5Vb
RN
EXT


14
15
16
17
18
19
CURRENT SOURCE
+5Vb
R2881
261E
TP806
R2877
215K
C2864
10n
R2871
464K
R2872
464K
C2861
10n
R2876
316K
+5Vb
R2879
19K6
+5Vb
N2850
453
V2853
BC858C
R2875
215K
TP805
R2878
51K1
V2854
BC858
C2862
10n
R2873
261K
-5Vb
+5Vb
R2865
34K8
Sia
R2870
261K
-5Vb
L2303
100nH
C2340
15p
EXT.TRIG
GENOUT-A
R2342
46E4
ATTA--A
R2340
46E4
ATTB--A
R2341
46E4
D2751
74HC4316
R2866
121E
EXT.TRIG
4TH ORDER FILTER
TP803
N2850
453
TP804
R2859
75K
R2861
237K
R2862
562K
FILT
C2850
3n3
C2851
3n3
C2852
3n3
R2860
1M
C2853
2n2
C2854
680p
C2856
270p
S1
C2867
2n2
C2868
2n2
+5V
R2864
34K8
C2863
47p
SQUARE WAVE
-5V
R2863
3K48
C2857
47p
R2869
34K8
TP802
CALDC-HD
R2867
34K8
V2852
BC858
C2866
2n2
R2868
34K8
+5Vb
EXTERN



18
19
20
21
22
23
ANALOG ASIC
D2301
0Q0308
R2881
251E
V2854
BC858
D2751
74HC4316
G1
R2866
121E
C2866
2n2
L2303
100nH
L2304
100nH
C2340
15p
C2341
15p
R2342
46E4
R2343
46E4
ATTA--A
R2340
46E4
ATTB--A
R2341
46E4
EXT.TRIG
+5Va
-5Va
+5V
-5V
R2301
1E
R2302
1E
R2306
1E
R2307
1E
C2301
100n
C2302
100n
C2306
100n
C2307
100n
VCCa
GNDa
VEEa
VCCs
GNDs
VEEs
INPA
INPGND
INPB
TRIG
VCCt
GNDt
VEEt
CDAT
CCLK
DTAE
VCCc
GNDc
VEEc
SNGOUT
VREF
CLK
CLKN
STOP
TOUT
HLDF
CHA
LEVEL
R2313
1E
R2314
1E
C2309
100n
C2311
100n
C2304
22n
C2316
100n
R2305
1E
R2312
1E
R2338
2K15
R2315
348E
R2319
56E2
L2301
100nH
R2311
316E
option
R2322
31K6
R2320
51K1
R2321
316K
DTAEc


24
25
26
27
28
29
ANALOG DIGITAL CONVERTER
R2324
316E
R2323
464E
+Vref
V2301
BC858
V2302
BFT92
R2325
2K61
+5V
C2318
100n
C2319
100n
C2317
68μ
X2001
N2302
TDA8703
VCCA
VCCD
OTCN
VCCO
CEN
IN
VRB
VRT
DEC
CL
CLN
AGND
DGND
D7
D6
D5
D4
D3
D2
D1
D0
O/UFL
NC
R2330
R2331
R2332
R2333
R2334
R2335
R2336
R2337
56E2
ADC7
ADC6
ADC5
ADC4
ADC3
ADC2
ADC1
ADC0
TO
D-ASIC
TP332
TP331
R2317
68K1
R2346
10K
OFFSET
R2303
1K33
R2345
100K
R2316
100K
C2326
47p
R2347
10K
GAIN
C2323
2n2
C2324
4μ7
C2322
4μ7
C2310
3n3
HF-COMP
C2303
100n
R2310
261E
C2305
15p
DELAY
CIRCUIT
+5V
R2318
383E
C2320
22n
C2314
22n
V2303
BAV99
L2302
1uH
TRACKN
STOPN
DT-VALUE
HLDOFN
CHANA
LEVEL
C2315
12p
TO/FROM
D-ASIC
ADCBUS3
C2312
220n
CONTROL-BUS

## PARTS LOCATION A2 (CIRCUIT DIAGRAM A2c)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C2431 | G13 | R2508 | G15 | R2584 | E18 | V2544 | D17 |
| C2434 | A5 | R2509 | G16 | R2596 | G7 | V2550 | G5 |
| C2501 | G14 | R2511 | G16 | R2597 | G8 | X2001 | C22 |
| C2502 | E14 | R2512 | G17 | R2598 | D17 | X2001 | G11 |
| C2503 | G15 | R2513 | G17 | R2599 | E14 | X2001 | E11 |
| C2504 | E15 | R2514 | G17 | T2501 | F16 | X2001 | C22 |
| C2506 | C17 | R2516 | G18 | T2501 | E16 | X2501 | B1 |
| C2507 | F17 | R2517 | G18 | TP501 | F13 | X2502 | H11 |
| C2508 | E17 | R2518 | G18 | TP502 | F13 | Z2501 | A2 |
| C2509 | D17 | R2519 | F8 | TP503 | E15 | | |
| C2511 | D19 | R2521 | F8 | TP504 | F18 | | |
| C2512 | D19 | R2522 | C18 | TP506 | G18 | | |
| C2514 | C19 | R2523 | D18 | TP507 | A15 | | |
| C2515 | E18 | R2524 | D18 | TP508 | A15 | | |
| C2516 | E18 | R2526 | C17 | TP509 | D19 | | |
| C2517 | C21 | R2527 | D18 | TP511 | E18 | | |
| C2518 | B21 | R2528 | D19 | TP520 | B1 | | |
| C2519 | B21 | R2529 | D20 | TP521 | C2 | | |
| C2521 | E19 | R2530 | B15 | TP522 | B4 | | |
| C2522 | E19 | R2531 | B21 | TP523 | B5 | | |
| C2523 | F17 | R2532 | E18 | TP524 | C5 | | |
| C2524 | C21 | R2534 | B13 | TP526 | B8 | | |
| C2526 | A3 | R2535 | A13 | TP527 | F9 | | |
| C2527 | C3 | R2536 | B12 | TP528 | F9 | | |
| C2529 | C4 | R2537 | B12 | TP529 | D9 | | |
| C2530 | B3 | R2538 | B13 | V2501 | E14 | | |
| C2532 | G13 | R2540 | A14 | V2502 | F15 | | |
| C2533 | C4 | R2541 | G15 | V2503 | E16 | | |
| C2536 | G6 | R2542 | G13 | V2504 | F17 | | |
| C2537 | B6 | R2543 | A13 | V2506 | C17 | | |
| C2538 | B13 | R2544 | F15 | V2507 | E16 | | |
| C2543 | A13 | R2546 | A8 | V2508 | F13 | | |
| C2544 | A14 | R2548 | B3 | V2509 | D20 | | |
| C2546 | C19 | R2551 | C4 | V2511 | E20 | | |
| C2547 | E19 | R2554 | BA5 | V2512 | B14 | | |
| C2548 | E19 | R2556 | C5 | V2513 | A15 | | |
| C2549 | B21 | R2557 | B5 | V2514 | G15 | | |
| C2551 | B21 | R2558 | C5 | V2516 | E13 | | |
| C2552 | C21 | R2559 | A4 | V2517 | F13 | | |
| L2501 | C18 | R2561 | A5 | V2518 | E13 | | |
| L2502 | E17 | R2562 | B6 | V2521 | A10 | | |
| L2503 | C20 | R2563 | D8 | V2523 | F5 | | |
| L2504 | B8 | R2564 | C8 | V2526 | F5 | | |
| L2506 | B8 | R2565 | C8 | V2527 | B6 | | |
| N2501 | A13 | R2566 | F7 | V2528 | B6 | | |
| N2501 | D19 | R2567 | F8 | V2532 | A8 | | |
| N2502 | D17 | R2568 | E8 | V2533 | F7 | | |
| N2503 | B4 | R2569 | E8 | V2534 | F7 | | |
| N2750 | A14 | R2571 | D8 | V2536 | F8 | | |
| R2501 | E14 | R2572 | G10 | V2537 | E9 | | |
| R2502 | F14 | R2573 | G10 | V2538 | F9 | | |
| R2503 | E16 | R2575 | A9 | V2539 | G9 | | |
| R2504 | F15 | R2581 | A9 | V2541 | E10 | | |
| R2506 | F15 | R2582 | D8 | V2542 | G11 | | |
| R2507 | E15 | R2583 | B21 | V2543 | E10 | | |

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Tel: 0711-5204150*

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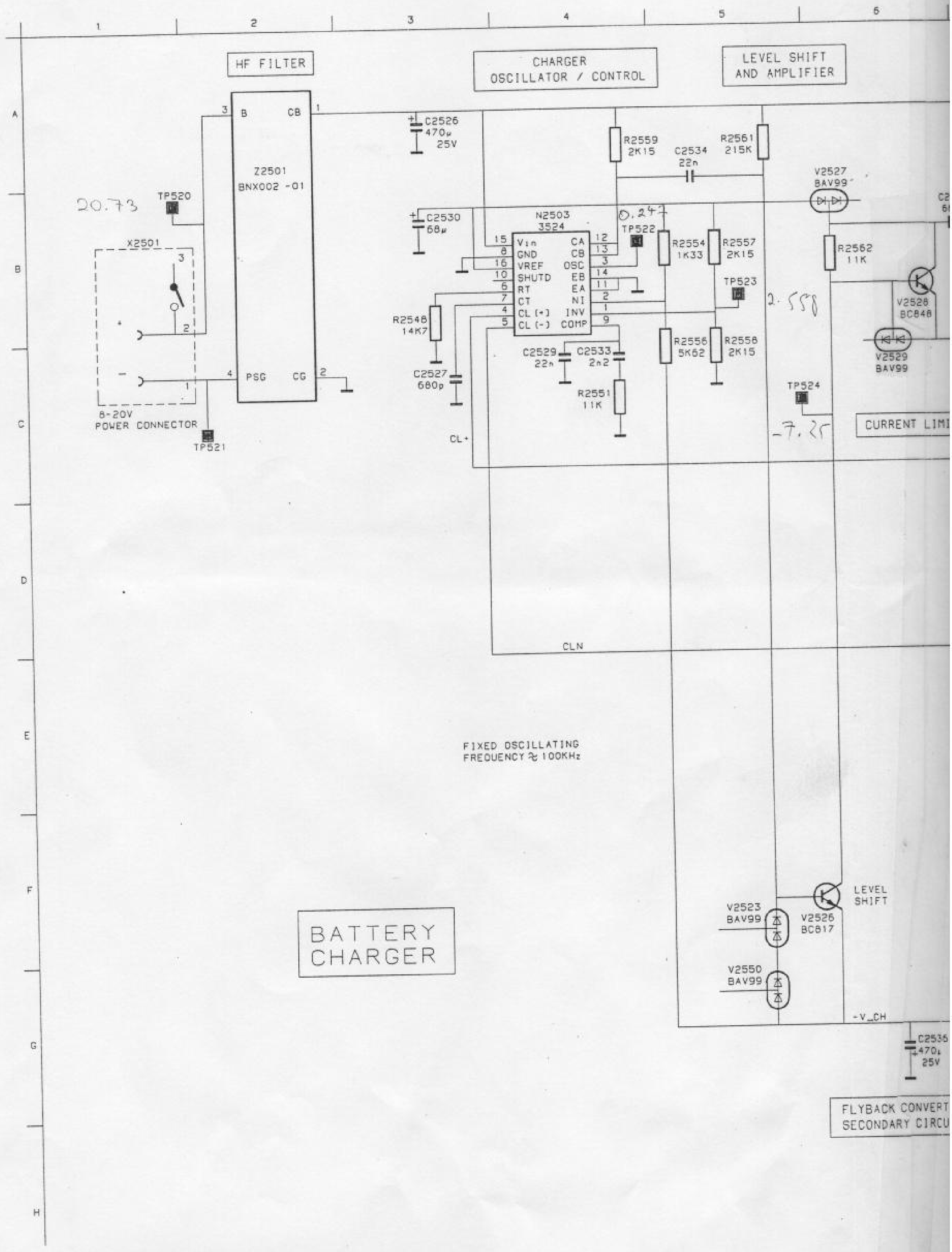
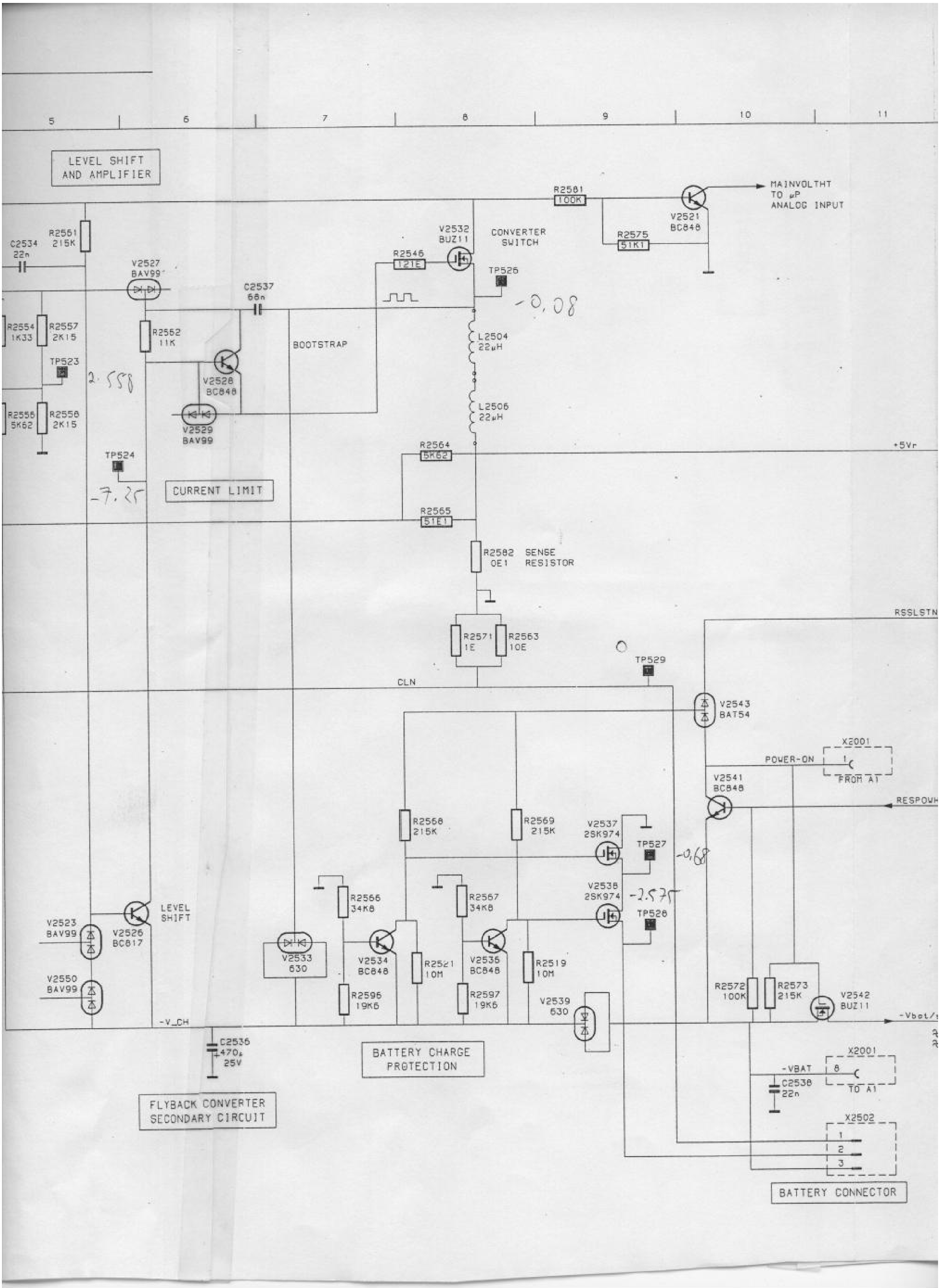



*Figure 10.7 Analog A2 circuit diagram A2c*



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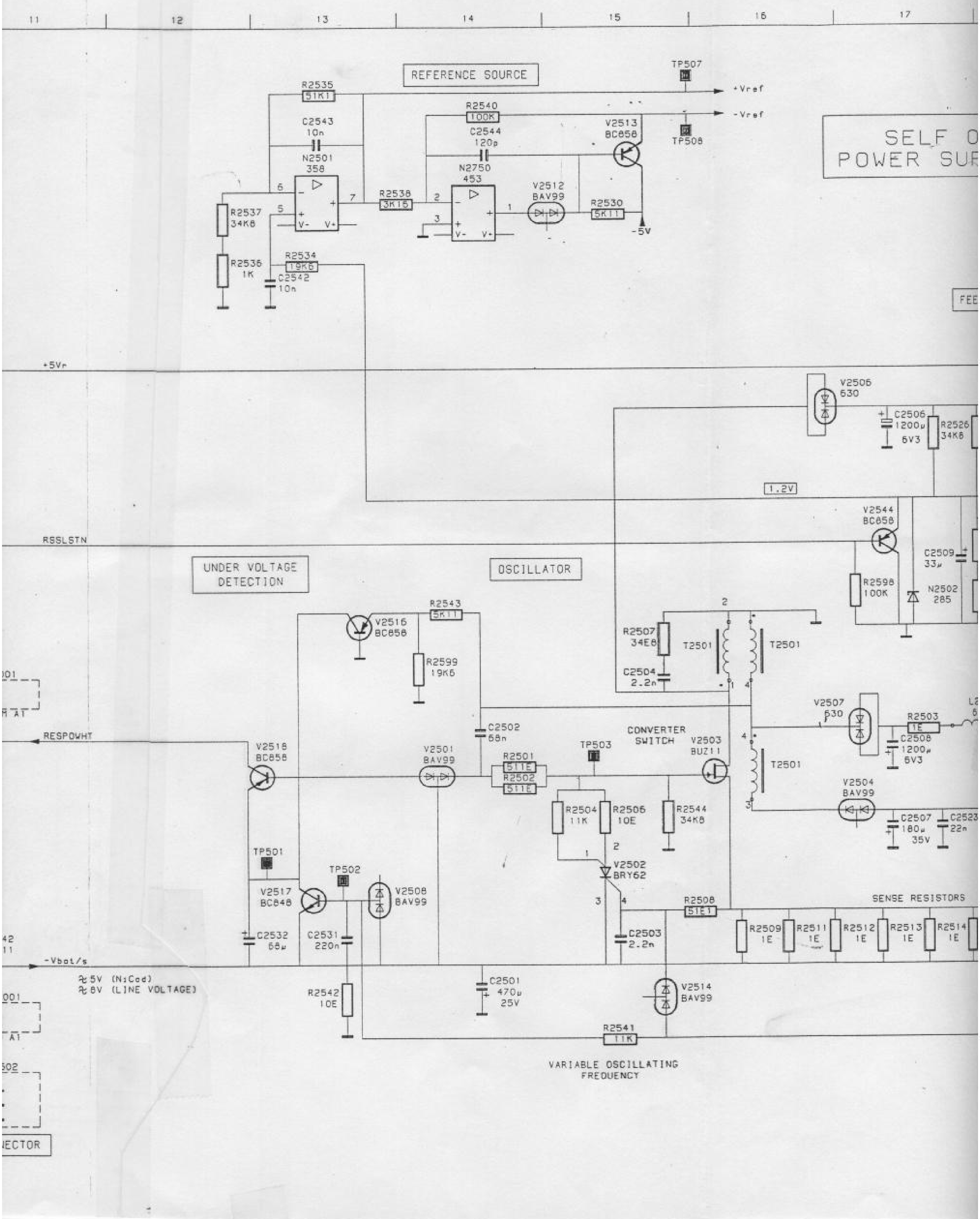
11
LEVEL SHIFT AND AMPLIFIER
R2581 100K
MAINVOLTHT TO µP ANALOG INPUT
V2521 BC848
R2575 51K1
V2532 BUZ11
CONVERTER SWITCH
R2546 121E
TP526
-0,08
R2551 215K
C2534 22n
V2527 BAV99
C2537 68n
R2554 1K33
R2557 2K15
R2552 11K
BOOTSTRAP
L2504 22µH
TP523
2.558
V2528 BC848
L2505 22µH
R2555 5K62
R2558 2K15
V2529 BAV99
R2564 5K62
+5Vr
TP524
-7.25
CURRENT LIMIT
R2565 51E1
R2582 0E1
SENSE RESISTOR
RSSLSTN
R2571 1E
R2563 10E
TP529
CLN
V2543 BAT54
X2001
POWER-ON
FROM A1
V2541 BC848
RESPOWH
R2568 215K
R2569 215K
V2537 2SK974
TP527
-0,68
R2566 34K8
R2567 34K8
V2538 2SK974
-2.575
TP528
V2523 BAV99
LEVEL SHIFT
V2526 BC817
V2533 630
V2534 BC848
R2521 10M
V2535 BC848
R2519 10M
V2550 BAV99
R2596 19K6
R2597 19K6
V2539 630
R2572 100K
R2573 215K
V2542 BUZ11
-V_CH
-Vbat/
C2536 470µ 25V
BATTERY CHARGE PROTECTION
-VBAT
C2538 22n
TO A1
FLYBACK CONVERTER SECONDARY CIRCUIT
X2502
BATTERY CONNECTOR



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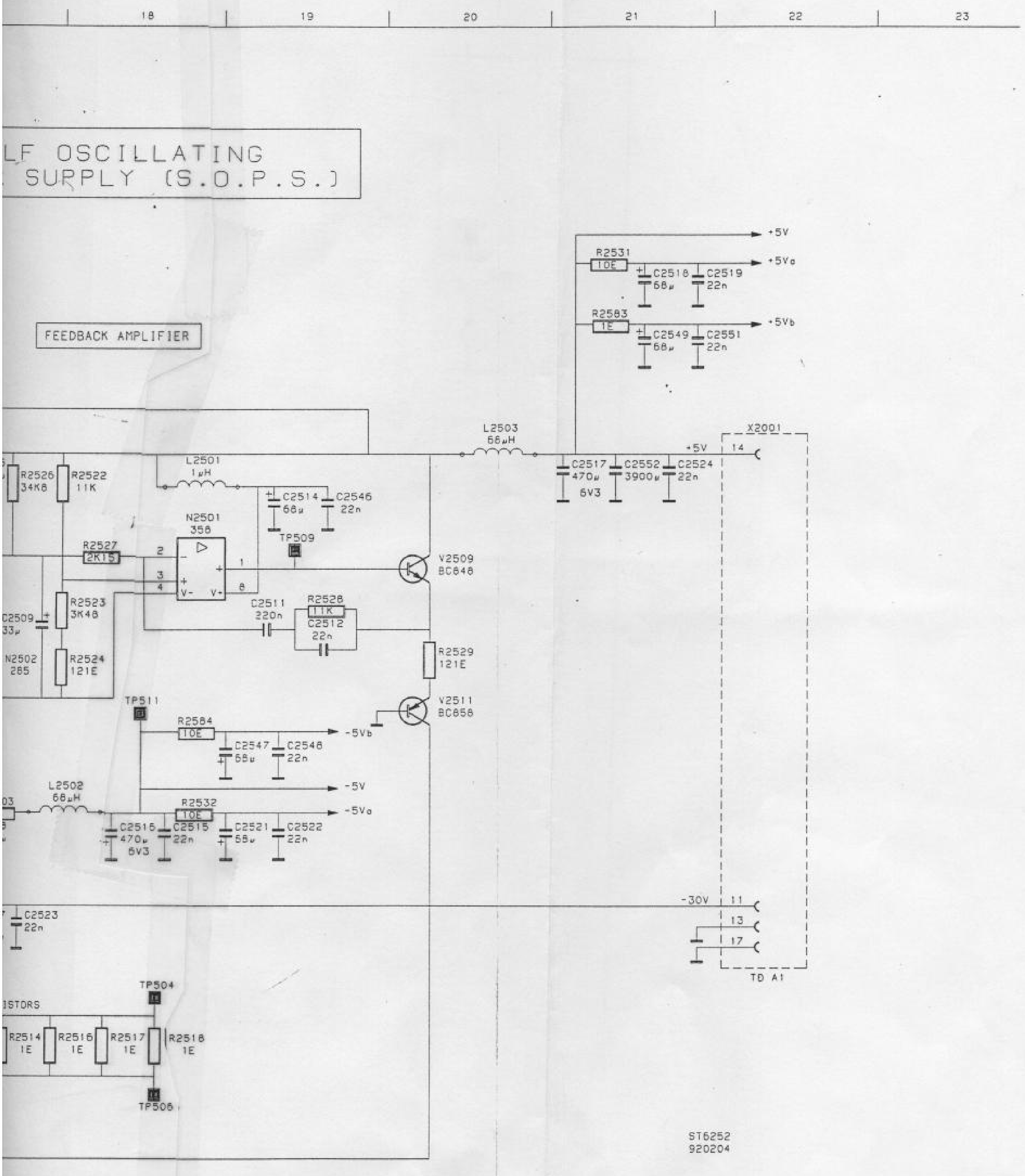
REFERENCE SOURCE
SELF O
POWER SUR
UNDER VOLTAGE DETECTION
OSCILLATOR
CONVERTER SWITCH
SENSE RESISTORS
VARIABLE OSCILLATING FREQUENCY
+Vref
-Vref
+5Vr
RSSLSTN
RESPOWHT
-Vbat/s
≈5V (NiCad)
≈8V (LINE VOLTAGE)
R2535 51K1
R2540 100K
C2543 10n
C2544 120p
N2501 358
N2750 453
V2513 BC858
TP507
TP508
R2537 34K8
R2536 1K
R2534 19K6
C2542 10n
R2538 3K16
V2512 BAV99
R2530 5K11
-5V
V2506 630
C2506 1200μ 6V3
R2526 34K8
1.2V
V2544 BC858
C2509 33μ
R2598 100K
N2502 285
R2543 5K11
V2516 BC858
R2599 19K6
R2507 34E8
C2504 2.2n
T2501
V2507 630
R2503 1E
C2508 1200μ 6V3
C2502 68n
V2518 BC858
V2501 BAV99
R2501 511E
R2502 511E
TP503
V2503 BUZ11
R2504 11K
R2505 10E
R2544 34K8
V2504 BAV99
C2507 180μ 35V
C2523 22n
TP501
TP502
V2517 BC848
V2508 BAV99
V2502 BRY62
R2508 51E1
C2503 2.2n
R2509 1E
R2511 1E
R2512 1E
R2513 1E
R2514 1E
C2532 68μ
C2531 220n
C2501 470μ 25V
R2542 10E
V2514 BAV99
R2541 11K
NECTOR


18
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LF OSCILLATING
SUPPLY (S.O.P.S.)
FEEDBACK AMPLIFIER
R2531
10E
C2518
68µ
C2519
22n
+5V
+5Va
R2583
1E
C2549
68µ
C2551
22n
+5Vb
L2503
68µH
X2001
+5V
14
C2517
470µ
6V3
C2552
3900µ
C2524
22n
R2526
34K8
R2522
11K
L2501
1µH
C2514
68µ
C2546
22n
N2501
358
TP509
R2527
2K15
V2509
BC848
R2523
3K48
C2509
33µ
C2511
220n
R2528
11K
C2512
22n
N2502
285
R2524
121E
R2529
121E
TP511
V2511
BC858
R2584
10E
C2547
68µ
C2548
22n
-5Vb
-5V
L2502
68µH
R2532
10E
-5Va
C2516
470µ
6V3
C2515
22n
C2521
68µ
C2522
22n
-30V
11
13
17
C2523
22n
TD A1
TP504
R2514
1E
R2516
1E
R2517
1E
R2518
1E
TP506
ST6252
920204