TECHNICAL MANUAL

MODEL 6010B

AUTOMATIC DC RESISTANCE BRIDGE

6010B.TM Rev.6

98-04-20

INTRODUCTION

This manual contains Installation instructions, Software Protocol, Technical information and drawings for the Model 6010B Automated Resistance Bridge.

GENERAL DESCRIPTION

The Model 6010B is an automated precision DC resistance bridge employing the principle of the Direct Current Comparator. Measurements International has extended this technology into a bridge that will operate as a stand alone device for the measurement of resistance ratio. As a remote controlled automated system the direct reading of the measured resistance and/or temperature is possible. The Model 6010B can make ratio measurements of 1:1 to 10:1. System resolution is 25 bits, which is uncertainty of better than 1 part per million. Being a ratio device, the 6010B can do a "TRUE" self calibration.

This instrument provides an easy means of establishing resistor to resistor, or resistor to resistance thermometer ratios. Measurement functions are selected by front panel push buttons or via an IEEE-488 bus. Measurement selections, results and calibration data are displayed on the front panel. This information can also be transmitted over the IEEE-488 bus.

Two 4-terminal resistors can be connected to the rear panel inputs. These are designated Rs (standard) and Rx (unknown). Greater flexibility in resistor comparisons can be achieved with the addition of Measurement International's Model 4220A Four terminal Matrix Scanner.

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PHYSICAL

The Model 6010B is thoroughly inspected and tested before shipment. However, damage could result from shipping. Do a visual check of the equipment and packaging materials, both should be free of mars or dents. The shipping case should be kept until the instrument can be thoroughly checked for mechanical and electrical damage.

ELECTRICAL

LINE VOLTAGE

The Model 6010B is tested and shipped with the AC voltage selected for the destination country. However, the system should be checked to insure that the setting is correct. AC voltage settings are on the back of the system in the power entry module (figure 1).

INPUT VOLTAGE SELECTOR

Remove the power cord before attempting to change the AC input selection. Locate the small square notch in the left-hand side of the fuse cover (figure 1). Use a small screw driver to gently pry the fuse cover off. The power selector is a small printed circuit board located on the right-hand end of the power entry module. Use a small pair of pliers to remove this board from the module. Reinstall the PCB into the power entry module, with the new voltage value to the inside and the indicator to the outside see figure 2 and 3.

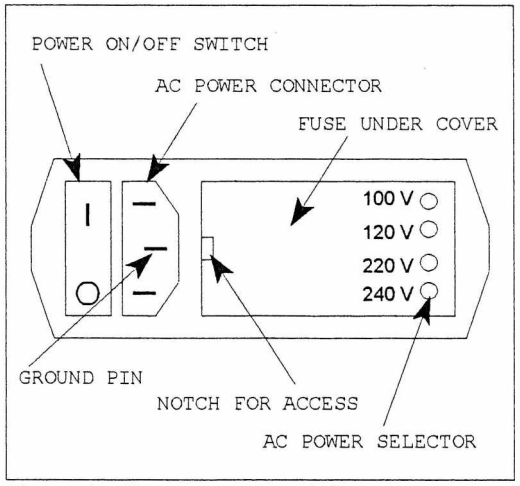


Figure 1... Power entry module

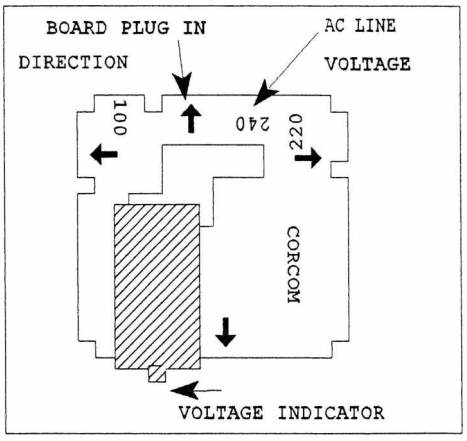


Figure 2... Power selector 240 volts

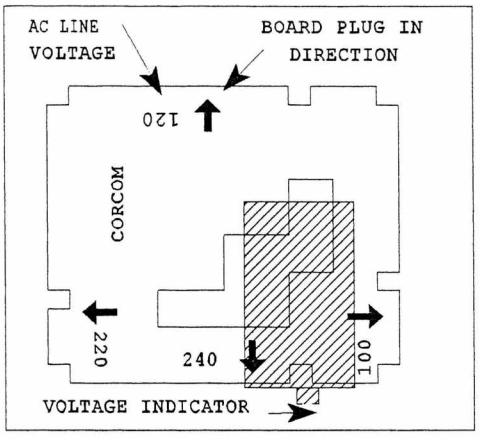


Figure 3... Power selector 120 volts

WARNING:

If the voltage selection was incorrect the **FUSE** should be checked for correct rating.

FUSE INSPECTION/REPLACEMENT

The fuse is inside the power entry module located on 6010B rear panel. Refer to figure 1 and the **INPUT VOLTAGE SELECTOR** section (page 1) for instructions on how to remove the cover.

WARNING:

Remove the power cord from the 6010B before attempting to change the fuse.

FUSE REQUIREMENTS

AC LINE VOLTAGE	FAST BLOW FUSE
100	1 AMP. 250 VOLT
120	1 AMP. 250 VOLT
220	0.5 AMP. 250 VOLT
240	0.5 AMP. 250 VOLT

INSTALLATION

ENVIRONMENTAL

The 6010B will operate over a temperature range of 18° C to 32° C at less than 75% relative humidity.

LOCATION

The 6010B is best installed on a flat clean surface (bench mount) or in a standard 19" instrument rack (optional rack mounting adapters are available). The 6010B should be installed in a location that prevents the remote resistor leads from coming in contact (or near) sources of electrical noise.

When mounting the 6010B in an instrument rack install the bottom screws first. This will hold the unit while the other screws are being installed.

GROUND

The 6010B is supplied with a three-conductor AC cord that plugs into the AC power module at the rear of the frame. To reduce the hazard of electrical shock always ensure that this cable is plugged into an approved three contact grounded electrical outlet (figure 1).

Above the power entry module there are three connections to internal ground. The recommended configuration is all connected, but if ground loop problems occur then they may be connected individually.

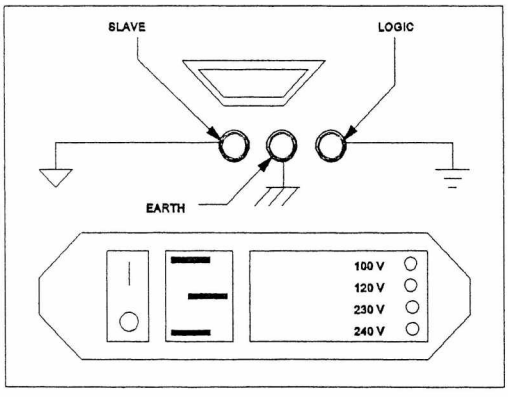


Figure 4...External ground

RESISTOR CONNECTIONS

Two 4-terminal resistors, designated Rs (standard) and Rx (unknown) can be connected to the Model 6010B.

The 6010B produces current that flows to and from the resistors. Terminals designated **C1** and **C2** are for current. This current produces and electrical potential across the resistors thus the designation **P1** and **P2**. Resistor current terminals connect to the 6010B terminals designated **Rs C1** and **Rs C2**. Resistor potential terminals are connected to the 6010B terminals **P1** and **P2**. **Rx** is connected to the Terminals designated **Rx C1, Rx P1, Rx P2** and **Rx C2** (figure 5).

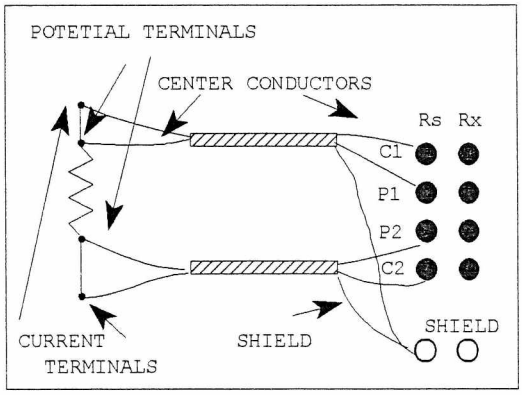


Figure 5... Resistor connections

NOTE:
Resistors must use shielded leads for connections. Connect the shield wires to the shield terminals on the rear of the 6010B.

POWER SWITCH

The power on/off switch is in the power entry module. Illumination of the front panel LCD display is the power on indication. For detailed operational instructions refer to the **OPERATORS MANUAL.**

REMOTE CONTROL

GENERAL INFORMATION

The 6010B can be operated via an IEEE 488 bus under the control of a remote computer. Software can do automatic measurements, such as scaling from 1 ohm to 10,000 ohms and also the measurement and calibration of PRT's.

IEEE-488 COMMANDS

The single-character commands tabulated here are accepted and handled by the 6010B when received over the GPIB interface.

Upon receipt of a command, the 6010B responds with an ANSWER message or an ERROR message. The ANSWER reply is the 3-character reply sent on response to the Query (Q) command (see table below). The ERROR reply consists of the character 'E', then the first character of the received command, and finally a one or two digit error number that describes the reason for the error (- see error number table below).

COMMAND NAME	FORMAT	ACTION
Local Lockout	K	Disables the 'remote' key on the 6010B. This key has an LED that is lit while the 6010B is under remote control. Unless the Local Lockout command has been received, this key may be pressed to take local control of the 6010B.
Local Unlock	U	Enables the 'remote' key on the 6010B. This key has an LED that is lit while the 6010B is under remote control. Unless the Local Lockout command has been received, this key may be pressed to take local control of the 6010B. By default, the remote key is unlocked.
Standby	S	This command is used to switch standby ON to stop a measurement or calibration sequence.
Calibrate	C	The 6010B starts its calibration procedure, or replies with an error message. Reported are descriptions (see

		D below) of upcoming reports, turn numbers (see # below), error values (see * below), error uncertainties (see @ below), a zero balance value (see below) and a zero balance uncertainty (see $ below). If the 6010B receives a Standby (S) command while a calibration sequence is in progress, the calibration is stopped and the 6010B switches standby on.
Query	Q	A 3-character reply is sent by the 6010B. The first character is R. The second character is S if standby is ON, and s if standby is OFF. The third character is Q if the 'remote' key has been pressed by the 6010B operator (while LED lit) and q if it has not.
Set Current	Ixxx	Sets the 6010B primary current to the value xxx (0-100mA). The value xxx may be any floating point number (in the allowed range) composed of up to 25 characters.
Set Delay Time	Tnnn	Sets the 6010B reversal delay time to nnn seconds (4-1000s). The integer value nnn may consist of 1 to 4 digits.
Set # of Measurements	Mnnn	The 6010B performs nnn measurements (1 to 1000000000).
Set # of Statistics	Ynn	If the measurement starts successfully, the 6010B will report a measurement description (see D below), measurement numbers (see # below) and ratio values (see & below). If the 6010B detects a problem during a measurement, it will send an error message (11 to 25 - see error number table below), stop the measurement and switch standby on. If the 6010B receives a Standby 'S' command while a measurement is in progress, one final ratio value (or a measurement error) is sent, then the 6010B switches standby on.
Local	L	The 6010B switches to local control.

Remote	R	The 6010B switches to remote control. Now each character coming switches it to remote. Except when the 6010 is performing local measurements or local calibrations. In this case an error would be reported.
Rs Value	Axxx	Send Rs value to the bridge.
Rx Value	Bxxx	Send Rx value to the bridge.
Extender 6011 (or 6011 & 6012)	E	Informs the bridge that the extender 6011 is present in the bridge system. (or 6011 & 6012)
Bridge 6010 Alone	H	Informs the bridge that no extender is present. (6011 or 6011 & 6012)
Stop Waiting (Used only if an extender is in the system)	W	When the extender (6011 or 6011 & 6012) is in the system, the bridge must often wait with doing a next step until the extender is ready. "W" sent to the bridge causes it to stop waiting. Used also to inform the bridge that the rough resistor measurement will be at full current (when the extender current is less than 1 Amp)
Used when with 6011 extender (or 6011& 6012)	V	Informs the bridge that the rough resistor measurement will be at 1/10 of the full current.
Set the amount SQR(2) * former value	Z	Causes the measurement current to increase SQR(2) times even when sent while remote measurements are running. Error message (ERS) is sent to the unit with local measurements running.
Set the amount 1/SQR(2) * former value	X	Exactly like Z but except the current is not multiplied instead it is divided by SQR(2).

ERROR MESSAGE

If a command received by the 6010B is illegal, an error message is sent as a reply. This ensures that all known commands receive a response. The error message syntax is as follows:

FORMAT	MEANING
Ecccnnn	The received command can not be handled at this time for the reason described by the error number. The single character ccc is the first character of the received command that caused the error. The 1 or 2 digit number nnn is the error number that describes the error that took place. Only error numbers 2 to 15 are sent in response to external commands. See the error Number table below for a description of error numbers. This error message is sent INSTEAD of an expected response.

6010B REPORTS

The reports tabulated here are all sent over the GPIB interface by the 6010B during either a measurement sequence or calibration sequence EXCEPT 'Talk Off' and 'To Local'. 'Talk Off' and 'To Local' are reported anytime a 6010B operator switches GPIB reporting off or presses the 'remote' key (while under remote control) respectively.

The 6010B sends reports over the GPIB interface using the following steps:

1) The 6010B asserts the GPIB control line 'SRQ'. This says to the GPIB controller that a device has made a serial request. The 6010B writes the 'serial request value' that describes the pending report to its GPIB serial port register. These 'serial request values' are tabulated below.

2) The 6010B waits until the 'SRQ' line is de-asserted by a serial poll by the GPIB controller. The 6010B responds to this serial poll with the contents of its serial poll register (the 'serial request value'), then the register is cleared.

3) The 6010B sends the report message over the GPIB interface in the format tabulated below.

REPORT NAME	FORMAT	MEANING
Measurement Description	Dsss	String sss (up to 25 characters) describes the total number of measurements to be taken (and reported) in the upcoming sequence. Serial request value is 1.
Calibration Description	Dsss	String sss (up to 35 characters) describes the subset of results to be reported by the upcoming section of a calibration. Serial request value is 1.
Turns Number	#nnn	The number nnn (1-4 digits) is the turns or partial turns to be reported on by the upcoming calibration result. Serial request value is 3.
Measurement Number	#nnn	The number nnn (0 to 99, 1-2 digits) is the number of the upcoming measurement. This number wraps to 0 each time it reaches 100. Serial request value is 3.
Ratio	&xxx	The floating point value xxx (up to 25 characters) is the measured ratio. Serial request value is 4.
Calibration Error Value	*xxx	The floating point value xxx (up to 25 characters) is the calibration error value. Serial request value is 5.
Calibration Zero Balance	(xxx	The floating point value xxx (up to 25 characters) is the measure balance at zero turns. Serial request value is 6.

Calibration Uncertainty	@xxx	The floating point value xxx (up to 25 characters) is uncertainty in the calibration error value. Serial request value is 7.
Calibration Zero Uncertainty	$xxx	The floating point value xxx (up to 25 characters) is the uncertainty in the measure balance at zero turns. Serial request value is 8.
Measurement Error	Ecccnnn	An error is reported when the 6010B detects a problem during a ratio measurement. The single character ccc is the first character of the command to the 6010B that caused the error (M in this case). The 1 or 2 digit number nnn is the error number that describes the error that took place. Only error numbers 11 to 25 are possible during a measurement. See the error Number table below for a description of error numbers. This error message is sent INSTEAD of the ratio being measured. Serial request value is the same as nnn.
	Rxxx	Measured value of Rx. The floating point value. (up to 25 characters)
	Sxxx	Measured value of Rs.
Instruction	Nsss	The message sss (up to 35 characters) contains an instruction from the 6010B that must be read and cleared by an OK (O) command to the 6010B. Note: After sending an Instruction report, the 6010B waits until it receives an OK external command before continuing. Serial request value is 9.

To Local	A	This one character report is sent by the 6010B to report that the 'remote' key (lit LED key) was pressed while the 6010B was under remote control. Serial request value is 10.

ERROR NUMBERS SENT BY THE 6010B

This table describes the error numbers sent as part of error reports and error replies. Note that error numbers 1 to 13 are used by the 6010B in replies to external commands and error numbers 11 to 15 are used by the 6010B to indicate an error during measurement. If there is an error during measurement, the measurement is stopped and standby is switched on.

NAME	NUMBER	MEANING
VALUE_OUT_RANGE	2	The value sent as part of a GPIB command is outside of the range of allowed values.
VALUE_MISSING	3	No value was sent as part of a GPIB command with which a value is expected.
ILLEGAL_NOW	5	A GPIB command was received at the 6010B at a time at which the command cannot be executed (because of ongoing activity).
TERM_EXPECTED	6	No terminator was sent at the end of a GPIB command.
VAL_INVALID_CHAR	7	The value string sent with a GPIB command contains a non-numeric ("+-.0123456789EeDd") character.
NOT_REMOTE_CTRL	8	A GPIB command was received that can only be performed while the 6010B is under remote control - and the 6010B is under local control.
VALUE_TOO_LONG	9	The value string sent as part of a GPIB command contains too many characters.

VAL_BAD	10	The value string sent with a GPIB command cannot be decoded into a number (although it consists of legal characters).
NEED_STANDBY_OFF	11	A GPIB command was received that cannot be performed while standby is on at the 6010B - and the standby is on at the 6010B.
NEED_IX_ON	12	A GPIB command was received that cannot be performed while the 6010B has no primary current - and the 6010B has zero primary current.
CHECK_CONNS	13	During a measurement, a failure has occurred that is likely caused by loose or intermittent connections.
LOW_VOLT	14	During a measurement, a failure has occurred that is likely caused by a too low primary current setting.
RATIO_RANGE	15	During a measurement, a failure has occurred that is likely caused by a resistor ratio that exceeds the specifications of the 6010B.
ERROR_UNKNOWN	25	An error was reported that is not one of the above set.

HARDWARE INSTALLATION

PLATINUM RESISTANCE THERMOMETERS (PRT) CONNECTIONS

These devices replace the **Rx** resistor and connect to the **Rx C1, Rx P1, Rx P2** and **Rx C2** terminals. A PRT must have a corresponding value of **Rs** see table 1.

TABLE 1

PRT ICE POINT	Rs OHMS
0.2	0.1
25	10*
25	100
100	100

* RECOMMENDED VALUE

NOTE: Temperature equations and software are based on a paper by H. Presto Thomas titled: "THE INTERNATIONAL TEMPERATURE SCALE OF 1990 (IPTS-90)." A copy of this paper will be supplied on request.

INTERFACE CONNECTIONS

Interface connection is made via a 24 pin D type connector located on the rear panel (figure 6). One end of the IEEE 488 bus cable plugs into this and the other into the interface connector on the , remote control computer.

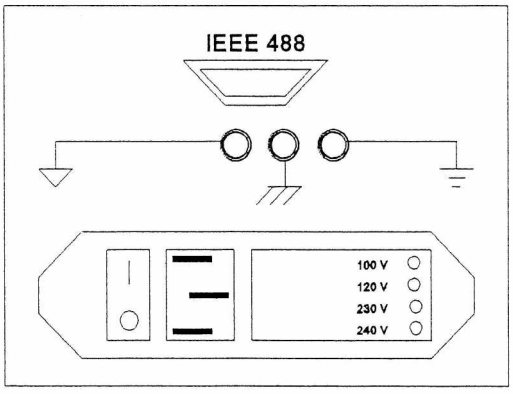


Figure 6...IEEE connector

FUNCTIONAL DESCRIPTION

Figure 7 is a functional block diagram of the 6010B. Refer to this drawing while reading this description (also system schematic drawing 610). Dotted lines outline the individual printed circuit boards (PCB's). The drawing number of the circuit boards is in the bottom left corner of the dotted line. Heavy black lines are the data lines to and from the Micro controller and the lighter solid lines are the connections between the PCB's. This description assumes that the 4 terminal resistors have been connected, measurement data entered and the measurement just started.

The "Master Current Source" (top left of figure 7) is a constant current source that produces the measurement current (Ix). This current is sent to the "Real Turns Switch" PCB (top centre of figure 7) and then to the "partial Turns Switch" PCB. The turns are set at 800 times and the loop is closed(Rx/Rs). The current then connects to the comparator switch on the "Nanovolt Amplifier PCB". The comparator switch connects Ix to Rs. This produces a voltage across Rs. The measurement switch passes this voltage to the Microvolt Detector, then to an analogue to digital (A/D) converter on the "Slave Current Source" PCB (top left of figure 7). Rs voltage and Is current are used to calculate the rough value of Rs. Ix and the Rx voltage are used to find the rough value of Rx. The first (rough) Rx/Rs ratio is then calculated.

The Micro Controller then calculates the number of primary turns and sends the information to the turn select PCB's. Secondary current (Is) required to balance the comparator is calculated and the information is sent to the Slave Current Source. The comparator selects Is to Rs and Ix to Rx. Ix is routed from Rx back to the Master Current Source. This is done to include the primary winding and switching contacts in the current source feedback circuit, thus eliminating thermal voltages and contact resistance problems.

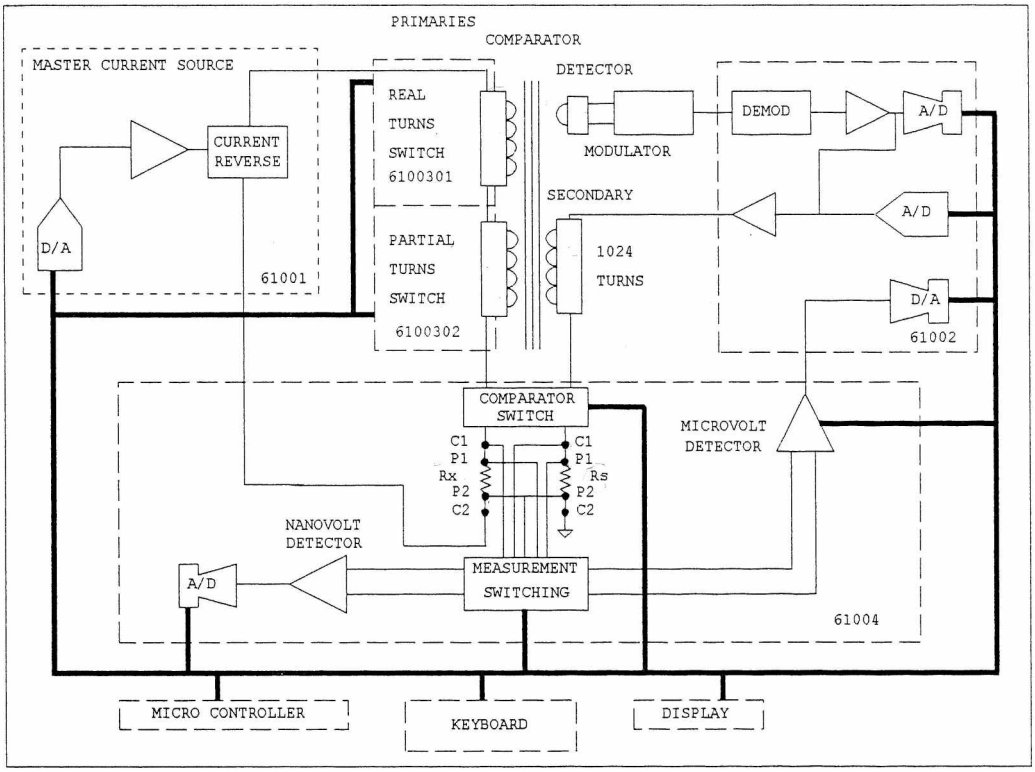


FIGURE 7... Functional Block Diagram

Equal and opposite current in the primary and secondary of a transformer will balance and produce zero flux, unequal current will produce flux, which can be detected by additional windings (detector). This allows the use of a transformer as a comparator. The output of the detector windings is modulated to allow amplification and detection of any unbalance condition then connected to the demodulator/decoder on the Slave Current Source PCB. Decoder output is routed to the secondary current source to increase/decrease the output and sent via the A/D to the Micro Controller as the balance measurement (balance 1).

The switching circuit then directs the Rx and Rs voltage to the input of the Microvolt Detector. This output is combined with the number of turns to find the Rx/Rs ratio (delta 1). Current flow is reversed and a second balance measurement is made. This is averaged with balance 1 and the results used to adjust the secondary current.

The Microvolt detector output and the turns information is combined to arrive at a second Rx/Rs ratio (delta 2). This ratio is averaged with delta 1 to readjust the turns and be displayed as the first measurement. This process is repeated until the delta is reduced to a range that can be measured by the Nanovolt detector. The Nanovolt detector continues the same process but with an increase in resolution of 10^3.

Current reversal is necessary to eliminate any offsets in the electronic circuitry. Using the principal, if current flowing in one direction develops an offset, current flowing in the opposite direction will develop an equal and opposite offset.

MEASUREMENT SEQUENCE SUMMARY

1) First the rough value of Rx and Rs is measured and the rough ratio (delta) calculated.

2) The primary turns are calculated and set.

3) The secondary balance (tracking) is calculated and set.

4) Ratio measurement 1 is made and stored as delta 1.

5) Balance measurement 1 is made and stored as balance 1.

6) The current is reversed.

7) Balance measurement 2 is made and averaged with balance 1.

8) Balance is adjusted using the average of the forward and reverse current measurements.

9) Ratio measurement 2 is made and averaged with delta 1. The result is displayed and used to adjust the turns.

10) If all the measurements have been completed the measurement process is over. If there are still measurement to complete go to the next step.

11) Repeat the ratio measurement and store the result as delta 1.

12) Repeat the balance measurement and store the result as balance 1.

13) Return to step 6 and continue until the last measurement is done.

CIRCUIT DESCRIPTION

GENERAL COMMENTS

This document uses a functional block approach to the individual circuit boards. Each circuit board description will contain, an outline of the PCB function, a block diagram of the PCB and an explanation of the function of each block.

MASTER CURRENT SOURCE 6010T0101 PCB

Refer to the block diagram (figure 8) and the 61001 schematic.

This circuitry preforms the following functions:

- stabilized programmable current source
- current ranging circuit
- high impedance output circuit
- current reversing circuit
- control, decode and interface circuits

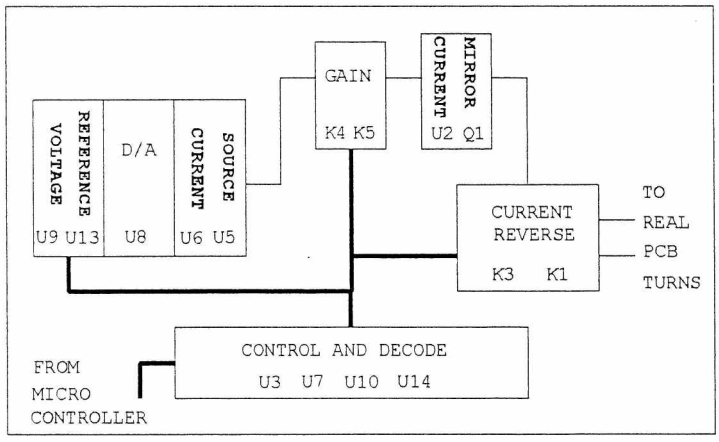


FIGURE 8...Master Current Source

Voltage regulator U9 and operational amplifier (Opamp) U13 supply a stable reference voltage for the 12 bit digital to analogue (D/A) converter U8. U6 acts as a buffer for the D/A and is connected to the Howland constant current source U5.

Gain is controlled in steps of 1, 10, 100 by Relays K5 and K4.

A current mirror (U2 and Q1) provide a high output impedance.

Current reversal is controlled by relays K1 and K3.

Circuits U3, U7, U10 and U14 are the digital decode and interface between the Micro Controller and the PCB circuits.

SLAVE CURRENT SOURCE 6100201 PCB

Refer to the block diagram (figure 9) and the 61002 schematic.

This circuity preforms the following functions:

- comparator decoder and balance measurement circuit

- current source for the comparator secondary windings

- analogue to digital converter for the Microvolt detector

- control, decode and interface circuits

The output of comparator detector circuit is decoded by diodes D1, D2, D3 and D4. Opamp U15 produces a signal that is summed with the secondary winding current source to act as a balance trim. U15 is also connected to Opamp U24 that feeds analogue to digital (A/D) converter U27. The digital balance information is sent to the Micro controller where it is processed as the balance measurement.

Balance measurement information is processed and returned to the PCB to control the D/A converter U9. The analogue output is buffered by U16, summed with U15's output and connected to Opamp U1 to generate the secondary current.

The Microvolt detector output is converted to digital in A/D converter U28. This information is

used to calculate the rough resistor and ratio values.

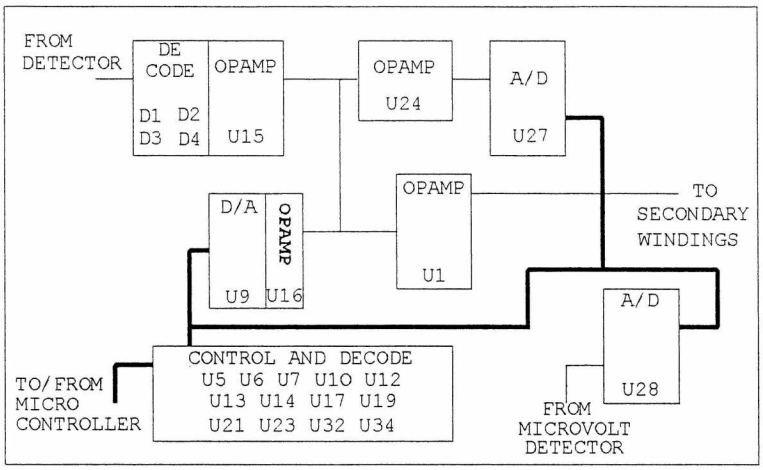


FIGURE 9... Slave Current Source

Interface between the Micro controller and the PCB circuits is handled by U5, U6, U7, U10, U12, U13, U14, U17, U19, U21, U23, U32 AND U34,

REAL TURNS SELECT 6100301 PCB

Refer to the block diagram (figure 10) and the 6100301 schematic.

This circuit preforms the following functions:

- real turn select relays

- control, decode and interface circuits

The relays select the real turn windings and the direction of the current in these windings.

RELAY OPERATION

- both relays set current forward

- both relays reset current reverse for calibration only

- one relay set and the other reset no current through turns.

Decode and control functions are handled by U1, U2, U3, U4, U5, U6, U7, U8 and U9.

This PCB can select from 0 to 11263 turns in one turn steps. There are two single turn windings the second is for calibration.

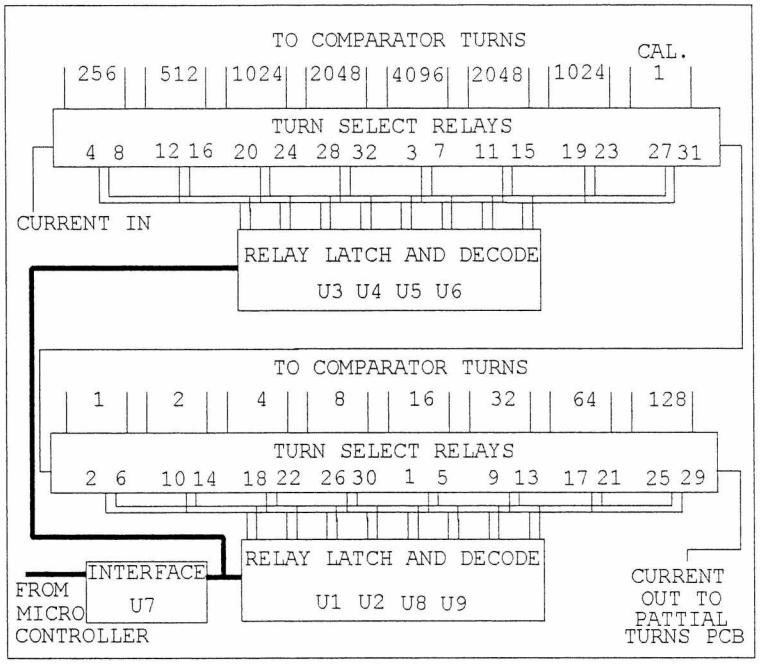


FIGURE 10... Real Turn Select

PARTIAL TURNS SELECT 6100302 PCB

Refer to the block diagram (figure 11) and the 6100302 schematic.

This PCB operation and control are identical to the Real Turns Select PCB. Differences are in the number of turns that can be selected. The addition of a current splitter and the splitting of the PCB into 1/128 weight turns and 1/16384 weight turns.

1/128 WEIGHT TURNS

The current splitter for this section of the PCB has the effect of making each turn equal 1/128 of a turn. Selecting all 127 of these turns will equal 127/128 of one turn on the Real Turns Select PCB. There is a 1/128 turn for calibration purposes.

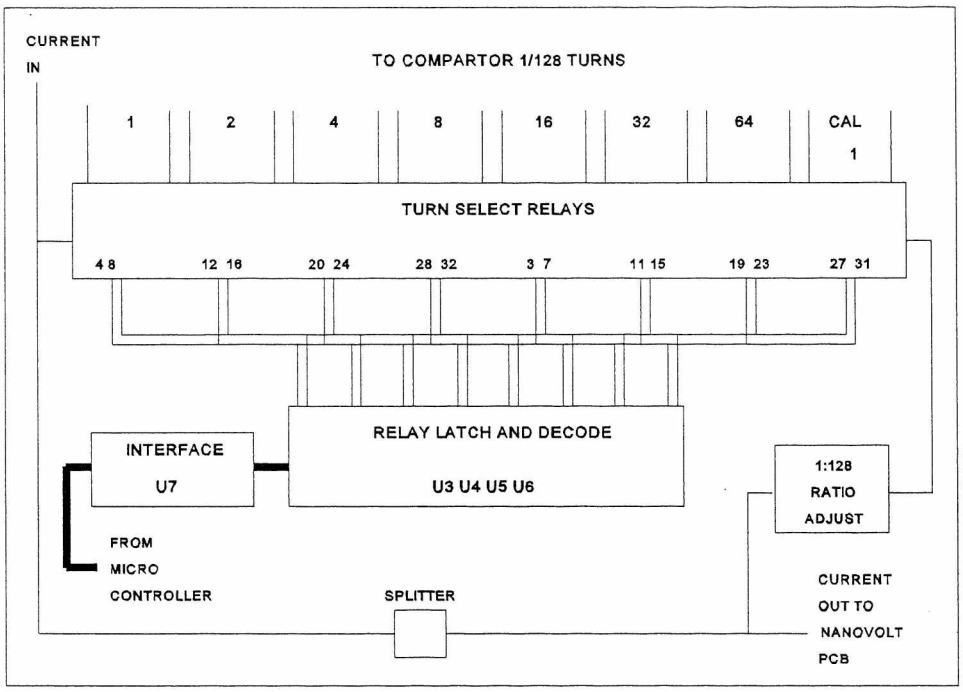


FIGURE 11... Partial Turn Select

NANOVOLT AMPLIFIER 6100401 PCB

Refer to the block diagram (figure 12) and the 61004 schematic

This circuit preforms the following functions:

- routing primary and secondary current
- routing Rs and Rx potentials to the detectors.
- Microvolt detector
- Nanovolt detector

Relays K1 and K2 control the current path for the various steps in the measurement process. K3 and K4 direct the current to either the standby resistors (Rs standby and Rx standby) or Rx and Rs for the measurement. Rx ground for the standby and rough measurement is supplied through K6. The delta select relays K5, K10, K11, K12 and K9 direct

the resistor potentials to the Microvolt or Nanovolt detectors.

K9 grounds the inputs to the Microvolt detector when it is not in the measurement circuit or for calibration purposes.

K10 applies the Rx potential to the Microvolt detector for the rough measurement.

K11 applies the Rs potential to the Microvolt detector for the rough measurement.

K12 applies the Rx and Rs potentials to the Microvolt detector for the initial ratio (delta) measurement.

K5 shorts the inputs to the Nanovolt detector until it is required for the measurement process, then Rx and Rs potentials are switched to the input.

The voltage drop across a resistor or the difference in voltage across 2 resistors is routed to the Microvolt amplifier (U23) which amplifies the difference between input signals. Amplifier gain is selected in steps of 1, 10, 100 and 1000 to allow the detection of input differences. The output of this circuit is connected to an A/D converter on the Slave Current Source PCB.

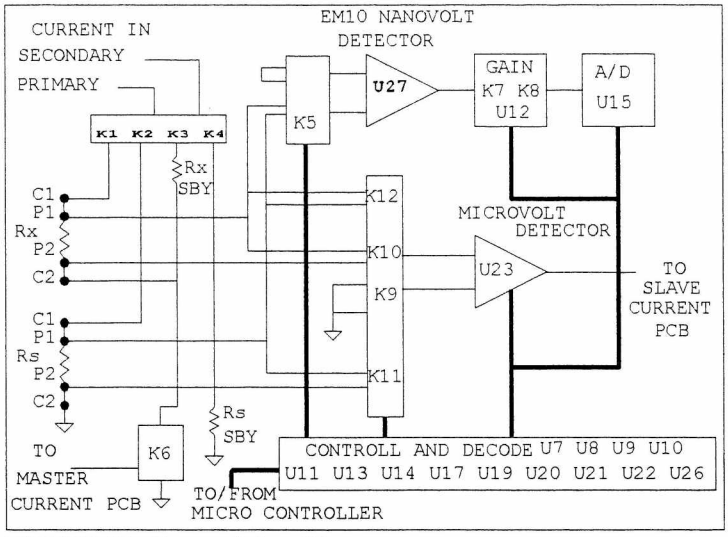


FIGURE 12...Nanovolt Amplifier

The Nanovolt detector (EM10 U27) is a modular circuit with a gain of 1000 feeding a gain control circuit (K7 and K8). These relay select additional gains of 1, 10 or 100 that give a total gain of 1000, 10,000 or 100,000. A/D converter (U15) translates the analogue information to digital. The Micro controller combines the Nanovolt detector output with the turn information to calculate the final ratio (delta).

Interface between the Micro controller and the PCB circuit is handled by U7, U8, U9, U10, U11, U13, U14, U16, U17, U19, U20, U21, U22, and U26.

OSCILLATOR/MODULATOR 6100601 ASSEMBLY

Refer to the 61006 schematic

This assembly is enclosed in a circular magnetic shield and fastened to the inside bottom of the 6010B frame. It is the smaller of the two metal cans.

This circuit modulates a DC pulse and the output of the comparator detector windings. The signal is then amplified by transformer action and passed to the demodulator/decoder on the Slave Current Source.

V25 MICRO CONTROLLER 6100701 ASSEMBLY

Refer to the 61007 schematic

This PCB handles all the control and Calculation functions of the 6010B. U4 is an NEC V25 8 bit Micro Processor operating at 10 MHz. Random access memory is in U5 and the program memory (firmware) is in U3. Serial communication with the Keyboard is done via U12 and connector PS. IEEE communication to the Micro controller is via connector PIE and integrated circuits U9, U10 and U11. Connector PIO and circuit U8 provide the communication between this PCB and the rest of the 6010B.

KEYBOARD CONTROLLER

Refer to the 61008 schematic.

The keyboard is setup as a X/Y pattern. Pressing any switch will send the keyboard controller chip (U1) a 1 of 4 X signal and a 1 of 4 Y signal. The keyboard control circuit decodes this information and sends parallel control signals to the display and serial controls to the Micro controller via U2.

POWER SUPPLY

The 6010B power supply is 3 individual circuit boards each with a different output isolated from the others. The power supply name is marked on the individual PCB's.

PSA 00101 +5, +18, and +/-30 VDC

PSB 00101 +15, -15, and +/-15 VDC

PSC 00101 +/-18 VDC

SERVICE INFORMATION

INTRODUCTION

This section contains information on self calibration, disassembly and alignment of the Model 6010B Automated Resistance Thermometer Bridge.

SELF CALIBRATION

The self calibration mode is entered from either Remote control or front panel selection. Refer to the operators manual for information on starting this procedure.

NOTE: The calibration data is stored only, when in the remote mode of operation. Local mode operation requires manual recording of results.

CALIBRATION SEQUENCE

The calibration first does a zero turn balance measurement to check the Nanovolt detector. Then checks the comparator turns.

Refer to the real and partial turns select schematics.

All the 1/16384 (including the calibrate turn) weight turns plus all the 1/128 weight turns (excluding the calibrate turn) are selected and the total this is compared with 1 real turn.

128/16384 turn + 127/128 turn = 1 real turn

All the 1/16384 (including the calibrate turn) weight turns are selected and compared with 1 1/128 weight turn.

128/16384 turns = 1/128 turn

The calibrate turn on the real turn PCB is compared to 1 real turn.

1 real turn = 1 real turn calibrate

Two 1 turns are then added and compared to the 2 turn winding.

1 turn + 1 turn calibrate = 2 turns

This combination is then added and compared with the 4 turn winding.

1 + 1 + 2 = 4

This sequence continues until the 4096 turn winding is checked.

1 + 1 + 2 + 4 + 8 + 16 + 32 + 64 + 128
+ 256 + 512 + 1024 + 2048 = 4096

At this point the total turns selected is dropped back to 2048 to check the remaining 2048 winding. Then dropped back again to check the remaining 1024 winding.

The next step is to compare the 1/16384 calibrate winding with the 1/16384 winding. These two are then used to check the 2/16384 winding. This process is continued until all the 1/16384 windings are checked.

The 1/128 turn windings are then checked in the same manner.

DISASSEMBLY

The Model 6010B is engineered to provide an easy means of disassembly for alignment and trouble shooting. The case of the 6010B is made up from two modular 5½ inch enclosures with a 10 inch front panel and back panel.

WARNING

TO AVOID ELECTRIC SHOCK, REMOVE THE POWER CORD AND RESISTOR LEADS BEFORE DISASSEMBLING THE INSTRUMENT.

The following paragraphs present the disassembly procedure for the 6010B. The top panel and back panel are removed to gain access to the printed circuit boards and power supplies.

The front panel is removed to gain access to the key board, display, power supply, interconnection harness, comparator windings and the oscillator circuit.

REMOVING THE TOP PANEL

1) Remove the screws labelled # 1 and # 2 (see figure 13).

2) Slide the top panel to the back of the system.

The printed circuit boards, looking from the rear of the instrument from left to right are as follows:

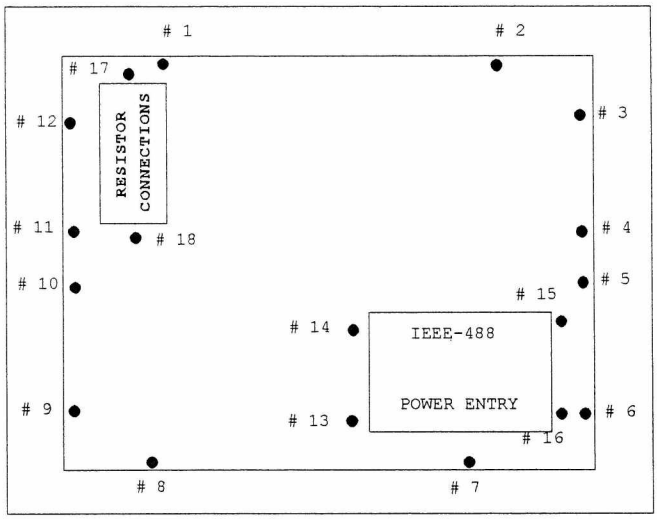


Figure 13... Back panel

1) Nanovolt PCB
2) Real Turns PCB.
3) Partial Turns PCB
4) Master Current PCB.
5) Slave Current PCB.
6) Vertical metal divider
7) Microprocessor PCB, mounted on the divider.
8) Power Supplies, mounted on top of each other.

REMOVING THE FRONT PANEL

1) Remove the four screws labelled # 1 and # 2 located in the front corners of the left and right side panels (see figure 14).

2) The front panel can then be pulled away from the chassis.

NOTE: The top and bottom bezel (blue) are connected to the front panel.

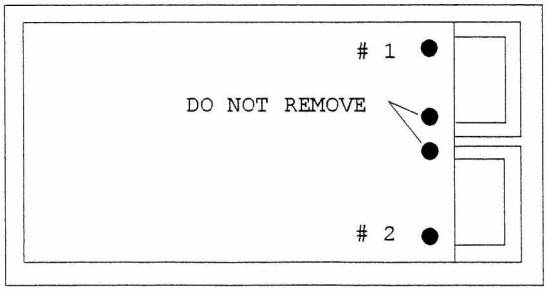


Figure 14... Side view

3) Pull the front panel top from the chassis and then the bottom.

NOTE: Do not pull to hard as the front panel Channel Indicator and Keyboard are connected to the micro printed circuit board via ribbon cables.

4) To completely remove the front panel disconnect the ribbon cable from the Keyboard and Indicator board.

REMOVING THE BACK PANEL

1) Remove the top panel.

2) Remove the all the remaining screws from the back panel (see figure 13 # 1 to # 17).

3) The top of the back panel can then be lifted up and pulled away from the chassis.

NOTE: Do not pull to hard as the back panel is connected to the internal circuit boards.

6) To completely remove the back panel very carefully remove all connections.

SERVICE MODE

The 6010B has service mode to allow user alignment of the system circuit boards.

To enter the service mode:

Press the F5 key

Input 111559111 from the keyboard.

The main menu for the Service mode will now appear. Different boards have difference menu selections that are with the board procedure.

To exit the main menus of the service mode press QUIT and *CST*. When Exiting from a sub menu of the service mode press QUIT; MORE and *CST*

A second method is to turn the power off wait 15 seconds and turn the power back on.

WARNING

When using the service mode only make the selections shown in this manual. Damage to the system could result from a wrong entry. If a menu selection in the instructions is not on the display a wrong selection has been made. Press the QUIT key to step back to the previous menu and remake the selection.

Before removing any circuit board from the system **THE POWER SWITCH POWER MUST BE IN THE OFF POSITION.**

Refer to the schematic and layout drawings for location of adjustments.

MASTER CURRENT SOURCE 61001

This alignment procedure is in two parts. The first part is the procedure for checking the existing alignment followed by the instructions for complete alignment.

CHECKOUT

1) Using the four terminal method measure the value of a 100 ohm resistor.

Record the value.

2) Connect the 100 ohm resistor between Rx-C2 & Rx-C1. Do not connect this resistor to the Rx-P1 or Rx-P2 terminals. Disconnect the Rs resistor.

3) Connect a Fluke model 8842A DVM (or equivalent) across the 100 ohm resistor

4) Enter the service mode and make the following selections:

OTHER; MORE; nVDET; BRIDG; BYPAS; NO; STDBY; Rx&Rs; QUIT; QUIT; MORE; I SCR; SET I; 4095; ENTER; +/-/0; +POS; RANGE; 1;

The DVM should read the a voltage (+/- 0.2%) equal to the measured value of R (recorded in step 1) times 1 mA current. If the DMM reading is correct continue to the next step, if not see the alignment procedure following.

5) Select RANGE; 100;

The DVM should read the a voltage +/- 0.2% equal to the measured value of R (recorded in step 1) times 100 mA current. If the reading is correct go to step 7, if not see the alignment procedure following.

6) Select RANGE; 10;

Check for a DMM reading of the voltage +/- 0.2% equal to the measured value of R (recorded in step 1) times 10 mA current.

If all the steps are within specification there is no need to align the circuit.

ALIGNMENT

1) Temporarily install the decade box in R20 with 40K of resistance.

2) Measure a 10 ohm resistor, using the four terminal method.

3) Connect the 10 ohm resistor between Rx-C2 & Rx-C1

4) Connect the FLUKE 8842A DVM across the 10 ohm resistor.

5) From main menu of unit press F5 key and input 111559111 press ENTER.

6) Select OTHER; MORE; NVDET; BYPAS; NO; STDBY; Rx&Rs; QUIT; QUIT; MORE; I SCR; SET I; 0; ENTER.

7) Adjust P2 for 0V across resistor.

8) Select SET I; 2048; ENTER; RANGE; 100; Adjust p1 and R1 for a reading of 100mA * R +/- 0.2%. Should have about 2V at TP3.

8) Select +/- NEG; Adjust P5 for 100mA * R +/- 0.2%.

9) Select RANGE; 10; Adjust P3 for a reading of 10mA * R +/- 0.2%

10) Then select range 1.

11) Adjust decade box for a reading of 1mA * R +/-0.2%.

13) Install resistor MRS25F value determined by decade box in R20.

PARTIAL TURNS 6100302

CHECKOUT

1) From the operation menu select Calib. The 6010B will first do a zero turn calibration to check the sensitivity of the peak detector.

2) Calibration results are displayed on the 6010B (see note). DMM readings are used to check for open turns in the comparator (see note). The DMM will read either 100 mV +/- 5% or 1 mV +/- 5% depending on the step in the calibration sequence. The DMM will read near 0 mV if the turn is open, because the open turn condition causes DMM input to float the exact reading cannot be predicted.

NOTES:

Specification for the turns calibration is <0.02 ppm.

The first thing seen is the calibration that is being done.

0 TURN BAL= ...10

The 10 is a count down timer when it reaches 0 the result will be displayed. (DMM 100 mDC during count down)

0 TURN BAL = 0.000??+/-0.00??

1 REAL TURN VERSUS 128 PTS
ERROR:...05 05 is the countdown
(DMM 100 mDC during count down)

REAL TURN COMPARISON

T1 ERROR:...05 (DMM 1 mDC)
T1 ERROR:..0.00?? +/-0.00?? PPM

This continues for all the real turns.

HIGH PARTIAL TURN COMPARISON
PT 1/128: ERROR:...05 (DMM 100 mDC)
PT 1/128: ERROR:0.00?? +/-0.00?? PPM

This continues for all the 128 part turns.

If the calibration and DMM reading are within specification there is no alignment necessary.

ALIGNMENT

1) Enter the service mode and make the following selections:

CALIB;

2) While looking at 1 of the 1/128 turns versus 128 of the 1/16384 turns (display 1/128 Pt versus 128/16K pts). Adjust P1 on partial turn PCB for an error of less than 0.005. The sequence will repeat to allow time to make this adjustment. The best results are achieved when 3 to 5 readings are averaged. When finished select DONE.

3) Select STDBY; OK; OK;

4) Repeat step 2 until the parameters are met.

SLAVE CURRENT SOURCE 61002

CHECKOUT and ALIGNMENT

TRACKING VOLTAGE

1) Turn off power and remove the Slave Current Source PCB from the 6010B. Remove U15 and temporarily link TP3 to analogue GND (pin 4 of U2 or U26). Reinstall the PCB and turn on power.

2) Enter the service mode and select:

OTHER; SLAVE; TRACK; 0; ENTER

3) Connect a high quality DMM to TP2 and Analogue ground . If necessary adjust P2 to obtain a 0 VDC reading (+/-0.05 mV).

4) Move the DMM lead from TP2 to TP1. If necessary adjust P3 to obtain a 0 VDC reading (+/- 0.5 mV).

5) Select TRACK ; 24.5 ; ENTER.

Note the DMM reading.

6) Select TRACK; -24.5; ENTER.

Note the DMM reading.

7) If the voltage readings in steps 5 and 6 are not positive and negative 24.5 VDC +/- 2 mVDC re select the SOT resistor across R36.

8) Switch off 6010B, Remove the slave current source from the system, reinstall U15, remove the ground link.

PEAK DETECTOR ADJUSTMENT

1) Install 10 ohm resistor on Rx

2) Enter the service mode and select:

Ix; SET I; 0.1; ENTER; QUIT; OTHER; MORE;
nVDET; BRIDG; STDBY; Rx & Rs; BYPASS; NO;
QUIT; QUIT; TURNS; REAL; 1; ENTER;

3) With an oscilloscope measure the DC shift at TP3 it should be -100 mVDC +/- 5 mVDC. To adjust this level either R15 or R16 will have a "SOT" resister selected in parallel.

4) Turn off the power and link the circuit board analogue ground to case ground.

5) Turn on power monitor TP3 with an oscilloscope and adjust P1 to minimize the AC signal.

6) Measure the DC voltage a TP3, if it is not 0.0 VDC +/- 20 mVDC shunt R3 and R4 to make this voltage correct.

7) Enter the service mode and select:

OTHER; SLAVE; BAL=?;

8) The 6010B display should -100mVDC +/- 5 mVDC, if not the alignment has to be redone.

NANOVOLT DETECTOR 61004

CHECKOUT

MICROVOLT DETECTOR

1) Install good quality stable 10 ohm resistors to the Rx and Rs terminals.

2) Enter the service mode and select:

Ix; SET I; 1; ENTER; QUIT; OTHER; MORE; nVDET; BRIDGE; STDBY; Rx&Rs; QUIT; QUIT; uVDET; CALIB; INPUT; Rs; MEAS?;

3) The display should read 10 mV +/- 0.2 mV.

DELTA=1.???????+/-X.XXXXXXmV
It is the ? section of the display to should look at.

4) Select:

QUIT; nVDET; BRIDG; BYPASS; NO; QUIT; QUIT; uVDET; INPUT; Rx; MEAS?;

5) The display should read 10 mV +/- 0.2 mV.

DELTA=1.???????+/-X.XXXXXXmV
It is the ? section of the display to should look at.

6) Select:

QUIT; MORE; QUIT; Ix; SET I; 0: ENTER; QUIT; OTHER; TURNS; REAL; 1024; ENTER; QUIT; SLAVE; TRACK; 0.125; ENTER; QUIT; QUIT; Ix; SET I; 1; ENTER; QUIT; OTHER; MORE; UDET; INPUT; RX; MEAS;

7) The display should read 10 mV +/- 0.2 mV. Record the display reading.

DELTA=1.???????+/-X.XXXXXXmV
It is the ? section of the display to should look at.

8) Select:

INPUT; Rs; MEAS?;

9) The display should read 10 mV +/- 0.2 mV. Record the display reading.

DELTA=1.???????+/-X.XXXXXXmV
It is the ? section of the display to should look at.

10) Select:

INPUT; Rx-Rs: MEAS?;

11) The display should read the difference between the results in step 7 and 8 +/- 0.01 mV.

NANOVOLT DETECTOR

1) Install good quality stable 10 ohm resistors to the Rx and Rs terminals.

2) Enter the service mode and select:

QUIT; MORE; QUIT; Ix; SET I; 50; ENTER; QUIT; MEAS; FULL; *infinity* (Note: this is displayed as the sign - not the word);

3) Wait until the Nanovolt starts measuring, and the measurement has stabilised (12 readings). Record the displayed result.

4) Introduce an error into the system by connecting a 1M resistor parallel to Rx. This must be a good quality stable resistor. Do not turn off power or change any of the system setting while adding this resistor.

5) Wait until the measurement has stabilised again (12 readings). Record the reading.

6) The value recorded in step 5 above, should be the same as that recorded in step 3 minus 1 ppm +/- 0.2 ppm.

ALIGNMENT

MICROVOLT DETECTOR

1) Enter the service mode and select:

OTHER; MORE; uVDET; CALIB; INPUT; MORE; GND; GAIN; 1000; MEAS?

2) Adjust P2 until the display is all zeros.

NANOVOLT DETECTOR

1) Enter the service mode and select:

OTHER; MORE; nVDET; INPUT; GND; MEAS?

2) Adjust P1 until the display is zero to the first 5 decimal points. 0.00000???.

SPECIFICATIONS

ELECTRONIC

RANGE:
0.001 ohm to 10 kilohms

RESOLUTION:
+/-0.01 ppm of full scale

RATIO:
0 to 13

LINEARITY:
< ± 0.01 ppm

RATIO ACCURACY: < 0.1 ppm
For all ratios from 1:1 to 13:1
(Rs max of 1000 ohms)
< ± 1 x 10^{-7} 2 Sigma

For range 10 kilohm to 10 kilohm
< ± 2 x 10^{-7} 2sigma

INSULATION RESISTANCE
> 10^{11} typically 10^{12}

GENERAL

POWER:
110/120/220/240 VAC 50/60 Hz 40 VA

WARM-UP-TIME:
10 minutes to full rated accuracy

AMBIENT TEMPERATURE:
18^0 C to 32^0 C

SIZE:
10.5 inches (266 mm) high
17.7 inches (451 mm) wide
12 inches (306 mm) deep

WEIGHT:
50 lbs. (22.7 kg)

APPENDIX

6010B

Name : General Assembly
Doc # : 6010B.PL
DCR # :
Instuctions : ☑

Rev. : 14
Date : 97-12-18
Approved :
Date Created : 91-03-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B01	Assembly	Master Current Source	
1	MIL	6010B02	Assembly	Slave Current Source	
1	MIL	6010B03	Assembly	Turns Switching Assembly	
1	MIL	6010B04	Assembly	Nanovolt Amplifier	
1	MIL	6010B05	Assembly	Comparator Assembly	
1	MIL	6010B06	Assembly	Oscillator Assembly	
1	MIL	6010B07	Assembly	Microprocessor Assembly	
1	MIL	6010B09	Assembly	Power Supply Assembly	
1	MIL	6010B11	Assembly	Front Panel Assembly	
1	MIL	6010B12	Assembly	Rear Panel Assembly	
1	MIL	6010B13	Assembly	Separator Assembly	
1	MIL	6010B17	Assembly	Keyboard/Micro Harness	
1	MIL	6010B18	Assembly	Display/Keyboard Harness	
1	MIL	6010B21	Assembly	GPIB Socket Assembly	
1	MIL	6010B22	Assembly	Power Harness Assembly	
1	MIL	6010B23	Assembly	Turns Isolation Circuit	
1	MIL	6010B24	Assembly	I/O Harness Assembly	
1	MIL	6010B26	Assembly	Wire Hookup Assembly	
1	MIL	4020A10 Rev 1	Box	Shipping Box	
5	Harting	0903-164-6823	Connector	Din Type C, 64 pin	
7	Panduit	CT156F22-4	Connector	Through, 4 pin, Female	PSA-J1,4,6,PSB-J1,4,6,PSC-J6
1	MIL	6010B19 Rev 1	Cover	6010B Terminal Cover	
1	MIL	6010B25 Rev 2	Cover	6010B Ventilated Cover	
5	Panduit	TC100F-4	Cover	4 pin, CT100F22-4	
8	Panduit	TC156F-4	Cover	4 pin, CT156F22-4	
2	Tracewell	R517-12	Enclosure	19", Lt. Blue	
2	MIL	6010B10 Rev 2	Hardware	Bracket, PCB Mounting	
10	MIL	616-220-303	Hardware	Guide, PCB Rail	
4	Keystone	620	Hardware	Brack1.156x.656" Rt Angle	

6010B

Name : Master Current Source
Doc # : 6010B01.PL
DCR # :
Instuctions : ☑

Rev. : 12
Date : 97-12-18
Approved :
Date Created : 91-05-22

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	Bourns	3006P-1-203	Potentiom'r	20k, Cermet, 10%	P4
1	Bourns	3006P-1-501	Potentiom'r	500, Cermet, 10%	P1
1	Bourns	3006P-1-502	Potentiom'r	5k, Cermet, 10%	P2
3	Aromat	DS2E-SL2-DC5V	Relay	2C, Latching, 5V, 2A	K2-4
2	Philips	MRS25F10K0	Resistor	10k, Film, 1%, .5W	R4,5
6	Philips	MRS25F1K00	Resistor	1k, Film, 1%, .5W	R21,23,25,31,34,35
4	Philips	MRS25F270R	Resistor	270, Film, 1%, .5W	R27-29,33
2	Philips	MRS25F2R00	Resistor	2.0, Film, 1%, .5W	R8,9
1	Philips	MRS25F383K	Resistor	383k, Film, 1%, .5W	R10
1	Philips	MRS25F3K92	Resistor	3.92k, Film, 1%, .5W	R37
4	Philips	MRS25F750R	Resistor	750, Film, 1%, .5W	R22,24,26,32
1	Vishay	S102K 100R0	Resistor	100, Foil, .1%, .6W	R17
5	Vishay	S102K 10K00	Resistor	10k, Foil, .1%, .6W	R3,7,11,12,30
4	Vishay	S102K 10R00	Resistor	10, Foil, .1%, .6W	R13-16
1	Vishay	S102K 1K000	Resistor	1k, Foil, .1%, .6W	R19
2	Vishay	S102K 2K000	Resistor	2k, Foil, .1%, .6W	R2,36
1	Vishay	S102K 5R000	Resistor	5, Foil, .1%, .6W	R18
7	Augat	508-AG11D-ESL	Socket	8 pin, DIP, Machined	U2,3,5,8-10,17
2	Augat	516-AG11D-ES	Socket	16 pin, DIP, Machined	U4,16
1	Augat	8059-2G6	Socket	T05-8	U7
1	AMP	ICT-183X-TG	Socket	18 pin, Dip, Machined	U12
1	Superior	BP21B	Terminal	Binding Post, Black	J2-2
1	Superior	BP21R	Terminal	Binding Post, Red	J2-1

6010B

Name : Slave Current Source
Doc # : 6010B02.PL
DCR # :
Instuctions : ☑

Rev. : 13
Date : 98-03-27
Approved :
Date Created : 94-07-12

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	Philips	368-25104	Capacitor	0.1uF, Polyes, 10%, 100V	C3
3	Philips	368-25105	Capacitor	1uF, Polyes, 10%, 100V	C4,5,7
1	Philips	368-25335	Capacitor	3.3uF, Polyes, 10%, 100V	C9
1	Philips	373-21106	Capacitor	10uF, Polyes, 10%, 63V	C6
2	Philips	680-10479	Capacitor	47pF, Ceramic, 2%, 100V	C13,14
42	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C.1 (Decoupling)
2	Philips	CN20A102J	Capacitor	1000pF, Ceramic, 5%, 100V	C11,12
2	Mallory	SKR470M15F11V	Capacitor	47uF, Electr, 20%, 63V	C1,2
24	Farnell	TAP10M35	Capacitor	10uF, Tantalum, 10%, 35V	C1T (Decoupling)
1	Harting	0903-164-6921	Connector	Din Type C, 64 pin	J1
6	Panduit	MFSS100-1	Connector	Header, 1 pin, Male	TP1-TP4,2 x GND
1	Panduit	MLSS100-4	Connector	Header, 4 pin, Male	J2
1	MTRON	MP-1-1.000	Crystal	1.000 MHz	Y1
4	Motorola	1N4148	Diode	Sig-Switch, 100V, 10mA	D5,6,13,14
2	Motorola	1N459A	Diode	Lo-Leak, 200V, 25nA	D1,2
2	Motorola	1N746A	Diode	Zener, 3.3V, 20mA	D9,10
4	Siliconix	JPAD5	Diode	Ultra low leakage	D7,8,11,12
2	AAVID	576802B03100	Heat Sink	TO-220	U3,4
1	Apex	HS02	Heat Sink	8 pin, TO-3	U1
10	Quality Tech	6N139	IC	Isolator, Opto	U5-7,12-14,19,21-23
1	T.I.	74HCT04N	IC	Gate, Hex Inverter	U18
2	Philips	74HCT595N	IC	Register, 8 bit, p/o	U10,17
1	Texas	74LS00N	IC	Gate, Quad 2, NAND	U16
2	T.I.	74LS05N	IC	Gate, Hex Inverter	U11,20
1	Nat. Semi.	7805CT	IC	Regulator, 5V	U4
1	Nat. Semi.	7905CT	IC	Regulator, -5V	U3
1	Analog	AD569JN	IC	Converter, 16 Bit D-A	U9
3	Analog	AD584JH	IC	Reference, Precision	U2,26,29
2	Analog	AD7701BN	IC	Converter, 16 Bit	U27,28

6010B

Name : Slave Current Source
Doc # : 6010B02.PL
DCR # :
Instuctions : ☑

Rev. : 13
Date : 98-03-27
Approved :
Date Created : 94-07-12

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
6	P.M.I.	OP-177FP	IC	Op Amp	U8,15,24,25,31,32
1	Apex	PA07	IC	Op Amp, Power	U1
2	MIL	Jumper	Jumper	Link	D, L1
1	MIL	6100201 Rev 8	PCB	6010B Slave Current	
1	Vishay	1280G 10K	Potentiom'r	10k, Metal Foil, 10%	P3
1	Vishay	1280G 20K	Potentiom'r	20k, Metal Foil, 10%	P1
1	Hamlin	HE721C0510	Relay	SPDT, Reed	K1
3	Bourns	4606X-101-102	Resistor	1k, Bussed, 5%, .25W	RN2,6,9
3	Bourns	4606X-101-271	Resistor	270, Bussed, 5%, .25W	RN1,5,8
3	Bourns	4606X-101-681	Resistor	680, Bussed, 5%, .25W	RN3,4,7
1	Philips	MRS25F100R	Resistor	100, Film, 1%, .5W	R10
4	Philips	MRS25F10K0	Resistor	10k, Film, 1%, .5W	R15,16,18,19
5	Philips	MRS25F10R0	Resistor	10.0, Film, 1%, .5W	R24-28
1	Philips	MRS25F118K	Resistor	118k, Film, 1%, .5W	R17
3	Philips	MRS25F1K00	Resistor	1k, Film, 1%, .5W	R35,38,39
2	Philips	MRS25F24K9	Resistor	24.9k, Film, 1%, .5W	R14,20
1	Philips	MRS25F383K	Resistor	383k, Film, 1%, .5W	R5
3	Philips	MRS25F4K99	Resistor	4.99k, Film, 1%, .5W	R8,29,32
1	Philips	MRS25F560R	Resistor	560, Film, 1%, .5W	R22
2	Philips	MRS25F75K0	Resistor	75k, Film, 1%, .5W	R3,4
2	Philips	PR02J2R2	Resistor	2.2, Film, 5%, 2W	R1,2
2	Philips	PR02J47R5	Resistor	47.5, Film, 5%, 2W	R6,7
2	Vishay	S102K 10K00	Resistor	10k, Foil, .1%, .6W	R11,12
2	Vishay	S102K 5K000	Resistor	5k, Foil, .1%, .6W	R9,13
5	MIL	SOT Resistor	Resistor	Select On Test	R30,31,36,37,40
8	MIL	0327015013427100	Socket	PCB pins for TO-5 package	U1
19	AMP	2-641260-3	Socket	8 pin, DIP, Low Profile	U2,5-8,12-15,19,21-26,29,31,32
2	AMP	544196-3	Socket	20 pin, DIP, Machined	U27,28
1	Augat	ICA-286-S-T-G	Socket	28 pin, DIP, Machined	U9

6010B

Name : Turns Switching Assembly
Doc # : 6010B03.PL
DCR # :
Instuctions : ☐

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 91-09-30

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B0301	Assembly	Real Turns Selection	
1	MIL	6010B0302	Assembly	Partial Turns Selection	

6010B

Name : Real Turns Selection
Doc # : 6010B0301.PL
DCR # : ECN00016
Instuctions : ☑

Rev. : 4
Date : 97-12-22
Approved : MJL
Date Created : 92-10-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
6	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	Decoupling C.1
1	Farnell	TAP100K16	Capacitor	100uF, Tantalum, 10%, 16V	C1T
1	Harting	0903-164-6921	Connector	Din Type C, 64 pin	J1
5	Panduit	MFSS100-1	Connector	Header, 1 pin, Male	TP1-5
1	T.I.	74HCT04N	IC	Gate, Hex Inverter	U7
8	Allegro	UCN5841A	IC	Driver, 8 Bit Serial	U1-6,8,9
5	MIL	Jumper	Jumper	Link	R1,2,7,P1,2
1	MIL	610030001 Rev 1	PCB	6010B Real Turns Board	
32	Aromat	S2EB-L2-5V	Relay	2A 2B, Latching, 5V	K1-32

6010B

Name : Partial Turns Selection
Doc # : 6010B0302.PL
DCR # :
Instuctions : ☑

Rev. : 7
Date : 97-12-22
Approved :
Date Created : 92-10-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
3	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C2-4
1	Farnell	TAP100K16	Capacitor	100uF, Tantalum, 10%, 16V	C1
1	Harting	0903-164-6921	Connector	Din Type C, 64 pin	J1
3	Panduit	MFSS100-1	Connector	Header, 1 pin, Male	TP2,4,5
1	Wakefield	680-.5A	Heat Sink	1/2 ", Anodized Heat Sink	
1	T.I.	74HCT04N	IC	Gate, Hex Inverter	U7
5	Allegro	UCN5841A	IC	Driver, 8 Bit Serial	U2-6
1	MIL	Jumper	Jumper	Link	R6
1	MIL	6010B030201 Rev 1	PCB	6010B Partial Turns Board	
1	Vishay	1280G 10R	Potentiom'r	10, Metal Foil, 10%	P2
5	Aromat	S2EB-L2-5V	Relay	2A 2B, Latching, 5V	K24,27,28,31,32
11	Aromat	S2EB-L2-5V	Relay	2A 2B, Latching, 5V	K3,4,7,8,11,12,15,16,19,20,23,
1	Vishay	S102K 3K700	Resistor	3.7k, Foil, .1%, .6W	R7
1	Vishay	VHP-3 30R000	Resistor	30, VHP-3, .01%, 10W	R4

6010B

Name : Nanovolt Amplifier
Doc # : 6010B04.PL
DCR # :
Instuctions : ☑

Rev. : 12
Date : 98-01-19
Approved :
Date Created : 91-05-22

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
2	Mallory	160474K63D	Capacitor	0.47uF, Polyes, 10%, 63V	C5,6
1	Philips	344-25154	Capacitor	0.15uF, Polyes, 10%, 100V	C7
2	Philips	368-25105	Capacitor	1uF, Polyes, 10%, 100V	C8,11 (on back)
1	Philips	373-21106	Capacitor	10uF, Polyes, 10%, 63V	C9
3	Philips	680-10479	Capacitor	47pF, Ceramic, 2%, 100V	C2,3,12
22	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C.1 Decoupling
1	Kemet	CK05BX103K	Capacitor	0.01uF, Ceramic, 10%,100V	C4
1	Philips	CN20A102J	Capacitor	1000pF, Ceramic, 5%, 100V	C1
29	Farnell	TAP10M35	Capacitor	10uF, Tantalum, 10%, 35V	C1T Decoupling
1	Harting	0903-164-6921	Connector	Din Type C, 64 pin	J1
7	Panduit	MFSS100-1	Connector	Header, 1 pin, Male	TP1-4, NV GND, 2 x A GND
2	Panduit	MLSS100-4	Connector	Header, 4 pin, Male	J2,4
1	MTRON	MP-1-1.000	Crystal	1.000 MHz	Y1
2	Motorola	1N4148	Diode	Sig-Switch, 100V, 10mA	D4,5
6	Siliconix	JPAD5	Diode	Ultra low leakage	D1-3
6	Keystone	3049	Hardware	Washer, #4, Nylon	U1-6
16	MIL	4100206 Rev	Hardware	Washer, Q200, #8,Shoulder	
6	Keystone	4673	Hardware	InsulatorTO220,MicaWasher	U1-6
2	Keystone	619	Hardware	Bracket,.687" Right Angle	
2	Keystone	619	Hardware	Bracket,.687" Right Angle	
1	MIL	6010B0402 Rev 1	Heat Sink	Regulator Heat Sink	U1-6
10	Quality Tech	6N139	IC	Isolator, Opto	U8-10,13,14,16,19,20,24,25
2	T.I.	74LS05N	IC	Gate, Hex Inverter	U7,17
2	Nat. Semi.	7805CT	IC	Regulator, 5V	U1,6
1	Nat. Semi.	7815CT	IC	Regulator, 15V	U2
2	Nat. Semi.	7905CT	IC	Regulator, -5V	U3,4
1	Nat. Semi.	7915CT	IC	Regulator, -15V	U5
1	EM Electr.	A10	IC	Op Amp, Nanovolt	A9
1	Analog	AD584JH	IC	Reference, Precision	U18

6010B

Name : Nanovolt Amplifier
Doc # : 6010B04.PL
DCR # :
Instuctions : ☑

Rev. : 12
Date : 98-01-19
Approved :
Date Created : 91-05-22

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	Analog	AD7703CN	IC	Converter, 20 Bit	U15
1	Lin Tech	LT1028	IC	Op Amp, Low Noise	U12
1	P.M.I.	OP-177FP	IC	Op Amp	U27
1	Burr Brown	PGA200AG	IC	Op Amp, Prog. Gain	U23
4	Allegro	UCN5841A	IC	Driver, 8 Bit Serial	U11,21,22,26
1	MIL	6100401 Rev 5	PCB	6010B Nanovolt Amplifier	
1	MIL	6010B0403 Rev 1	Plate	RS/RX Terminal Mounting	
1	Vishay	1280G 200R	Potentiom'r	200, Metal Foil, 10%	P1
1	Bourns	3006P-1-104	Potentiom'r	100k, Cermet, 10%	P2 (angled off board)
3	Aromat	S2EB-L2-5V	Relay	2A 2B, Latching, 5V	K1,2,5
7	Aromat	S4EB-L2-5V	Relay	4A, Latching, 5V	K6-12
1	Bourns	4606X-101-102	Resistor	1k, Bussed, 5%, .25W	RN3
2	Bourns	4606X-101-271	Resistor	270, Bussed, 5%, .25W	RN2,5
3	Bourns	4606X-101-681	Resistor	680, Bussed, 5%, .25W	RN1,4,6
1	Philips	MRS25F100R	Resistor	100, Film, 1%, .5W	R20
2	Philips	MRS25F10K0	Resistor	10k, Film, 1%, .5W	R16,17
1	Philips	MRS25F10M0	Resistor	10M, Film, 1%, .5W	R28
3	Philips	MRS25F10R0	Resistor	10.0, Film, 1%, .5W	R19,21,22
1	Philips	MRS25F15K0	Resistor	15k, Film, 1%, .5W	R32
4	Philips	MRS25F1K00	Resistor	1k, Film, 1%, .5W	R10,11,23,24
2	Philips	MRS25F270R	Resistor	270, Film, 1%, .5W	R5,6
2	Philips	MRS25F2K94	Resistor	2.94k, Film, 1%, .5W	R25,30
1	Philips	MRS25F2M00	Resistor	2M, Film, 1%, .5W	R29
1	Philips	MRS25F2R21	Resistor	2.21, Film, 1%, .5W	R18
2	Philips	MRS25F470R	Resistor	470, Film, 1%, .5W	R7,8
2	Philips	MRS25F4K99	Resistor	4.99k, Film, 1%, .5W	R26,27
2	Philips	MRS25F750R	Resistor	750, Film, 1%, .5W	R9,12
2	Philips	PR02J100R	Resistor	100, Film, 5%, 2W	R1,3
2	Philips	PR02J10R	Resistor	10, Film, 5%, 2W	RrS,RxS

6010B

Name : Nanovolt Amplifier
Doc # : 6010B04.PL
DCR # :
Instuctions : ☑

Rev. : 12
Date : 98-01-19
Approved :
Date Created : 91-05-22

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
2	Philips	PR02J1R0	Resistor	1.0, Film, 5%, 2W	R2,4
1	Vishay	S102K 100R0	Resistor	100, Foil, .1%, .6W	R13
1	Vishay	S102K 101R0	Resistor	101, Foil, .1%, .6W	R34
1	Vishay	S102K 10K00	Resistor	10k, Foil, .1%, .6W	R15
1	Vishay	S102K 10R00	Resistor	10, Foil, .1%, .6W	R31
1	Vishay	S102K 1K111	Resistor	1.111k, Foil, .1%, .6W	R33
1	Vishay	S102K 9K990	Resistor	9.99k, Foil, .1%, .6W	R14
11	Augat	508-AG11D-ESL	Socket	8 pin, DIP, Machined	U8-10,12-14,16,19,20,24,25
1	AMP	544196-3	Socket	20 pin, DIP, Machined	U15
1	AMP	545118-2	Socket	14 pin, DIP, Machined	U23
16	R.P. Screw M	4100205 Rev A	Spacer	Low Thermal Spacer	
8	MIL	4100203A Rev B	Terminal	Low Thermal, Screw, Short	
8	MIL	4100204 Rev C	Terminal	Terminal Head	
1	Motorola	2N2222A	Transistor	NPN, Signal	Q1

6010B

Name : Comparator Assembly
Doc # : 6010B05.PL
DCR # :
Instuctions : ☑

Rev. : 2
Date : 97-08-14
Approved : MS
Date Created : 91-03-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B0501	Assembly	Comparator Sub-Assembly	
1	MIL	2000502 Rev A	Shield	Can, Large, Mumetal Mag.	

6010B

Name : Comparator Sub-Assembly
Doc # : 6010B0501.PL
DCR # :
Instuctions : ☐

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 91-03-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B050105	Assembly	Detector Assembly	
5	MIL	6010B050101 Rev 1	Shield	Bottom Ring	
5	MIL	6010B050102 Rev 1	Shield	Top Ring	
1	MIL	6010B050103 Rev 1	Shield	Outer, Mumetal	
1	MIL	6010B050104 Rev 1	Shield	Inner, Mumetal	

6010B

Name : Detector Assembly
Doc # : 6010B050105.PL
DCR # :
Instuctions : ☑

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 91-03-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
2	Magnetic Inc	18A8002	Core	Matched Pair	

6010B

Name : Oscillator Assembly
Doc # : 6010B06.PL
DCR # :
Instuctions : ☐

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 91-03-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B0601	Assembly	Oscillator / Modulator	
1	MIL	6010B0602	Assembly	Oscillator Toroid	
1	MIL	2000602 Rev A	Shield	Can, Small, Mumetal Mag.	

6010B

Name : Oscillator / Modulator
Doc # : 6010B0601.PL
DCR # :
Instuctions : ☑

Rev. : 4
Date : 97-08-14
Approved :
Date Created : 91-05-21

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	Philips	DD-102	Capacitor	1000pF, Ceramic,10%,1000V	C1
2	Motorola	1N4148	Diode	Sig-Switch, 100V, 10mA	D1,2
1	MIL	6010B060102 Rev 2	Heat Sink	Osc/Mod Heat Sink	
1	MIL	610060101 Rev 0	PCB	6010B Osc/Mod Board	
1	Philips	MRS25F10K0	Resistor	10k, Film, 1%, .5W	R3
4	Philips	MRS25F1K00	Resistor	1k, Film, 1%, .5W	R4-7
2	Philips	MRS25F470R	Resistor	470, Film, 1%, .5W	R1,2
2	Motorola	D45H11	Transistor	PNP, Power	Q1,2

6010B

Name : Oscillator Toroid
Doc # : 6010B0602.PL
DCR # :
Instuctions : ☑

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 94-03-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	Magnetic Inc	01-52035-1A	Core	2.9,4.7,1.6, Sq. Orthonol	

6010B

Name : Microprocessor Assembly
Doc # : 6010B07.PL
DCR # : ECN00041
Instuctions : ☐

Rev. : 3
Date : 97-08-14
Approved :
Date Created : 91-12-28

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
2	Philips	678-10189	Capacitor	18pF, Ceramic, 2%, 100V	C1,2
15	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C.1
5	Farnell	TAP10M35	Capacitor	10uF, Tantalum, 10%, 35V	C3-6,10
1	AMP	102153-6	Connector	Latch, 26 pin, M	PIE
1	AMP	102159-2	Connector	14 pin, Right Angle	PS
1	AMP	102159-6	Connector	Latch, 26 pin, M	PIO
1	Panduit	MLAS100-4	Connector	Header, 4 pin, Male	PP
1	MTRON	MP-1-10.000	Crystal	10.000 MHz	X1
1	Microchip	27C512 Q150	IC	EPROM, 512K, 64Kx8	U3
1	T.I.	74HCT02N	IC	Gate, Quad NOR	U1
2	T.I.	74HCTLS138AN	IC	Decoder	U2,6
1	Dallas Semi.	DS1231-020	IC	Controller, Reset	U7
1	Hitachi	HM62256LP-10	IC	RAM, Static, 256K, 32Kx8	U5
1	Maxim	MAX232CPE	IC	Receiver, RS-232 Transmit	U12
1	Nat. Semi.	NAT9914APD	IC	Controller, GPIB	U9
1	T.I.	SN75160AN	IC	Tranceiver, GPIB	U10
1	T.I.	SN75162AN	IC	Driver, GPIB	U11
1	N.E.C.	UPD70320L-5	IC	Microprocessor, V25, 5MHz	U4
1	N.E.C.	UPD71055C	IC	Parallel Port	U8
1	MIL	Jumper	Jumper	Link	A15
1	MIL	6100701 Rev 2	PCB	6010B Micro Board	
3	Bourns	4610X-101-103	Resistor	10k, Bussed, 5%, .25W	RN2-4
2	Philips	MRS25F10K0	Resistor	10k, Film, 1%, .5W	R1,2
2	AMP	2-641268-3	Socket	40 pin, DIP, Low Profile	U8,9
1	AMP	2-644018-3	Socket	32 pin, DIP, Low Profile	U3
1	AMP	821573-1	Socket	84 Pin, PLC, Square	U4
1	Dallas Semi.	DS1213D	Socket	32 pin, Smart K	U5

6010B

Name : Power Supply Assembly
Doc # : 6010B09.PL
DCR # :
Instuctions : ☐

Rev. : 3
Date : 97-08-14
Approved :
Date Created : 91-04-09

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B0901	Assembly	(+/- 15V, +/- 30V) Supply	
1	MIL	6010B0902	Assembly	+5V, +18V, +/- 30V Supply	
1	MIL	6010B0903	Assembly	(+/-18V) Supply	

6010B

Name : (+/- 15V, +/- 30V) Supply
Doc # : 6010B0901.PL
DCR # :
Instuctions : ☑

Rev. : 4
Date : 97-08-14
Approved :
Date Created : 91-04-09

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
4	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C1,4,8,11
2	Mallory	LP103M035E7P3	Capacitor	10000uF, Electr, 20%, 35V	C3,6
2	Mallory	LP222M050A5P3	Capacitor	2200uF, Electr, 20%, 50V	C10,14
4	Mallory	SKR470M15F11V	Capacitor	47uF, Electr, 20%, 63V	C7,9,12,13
2	Farnell	TAP10M35	Capacitor	10uF, Tantalum, 10%, 35V	C2,5
3	Panduit	MLSS100-4	Connector	Header, 4 pin, Male	J2,5,7
3	Panduit	MLSS156-4	Connector	Header, 4 pin, Male	J1,4,6
2	Motorola	1.5KE30A	Diode	Transorb, 30V, 1500W	D1,2
2	Motorola	1.5KE51A	Diode	Transorb, 51V, 1500W	D4,6
2	Diode Inc.	1N4004	Diode	Regulator, 100V, 4.7mA	D3,5
3	Diode Inc.	RS102	Diode	Bridge, 100V, 1A	DB1,2,3
4	AAVID	529802B02500	Heat Sink	TO-220 / TO-218	U1-4
1	Nat. Semi.	7815CT	IC	Regulator, 15V	U1
1	Nat. Semi.	7915CT	IC	Regulator, -15V	U2
1	Lin Tech	LM317T	IC	Regulator, 3 Term. Pos.	U4
1	Lin Tech	LM337T	IC	Regulator, 3 Term. Neg.	U3
1	MIL	00101 Rev 1	PCB	Power Supply Board	
2	Philips	MRS25F249R	Resistor	249, Film, 1%, .5W	R2,4
2	Philips	MRS25F5K62	Resistor	5.62k, Film, 1%, .5W	R1,3
6	Keystone	2131	Spacer	6-32 Threaded, Hex 1" M/F	

6010B

Name : +5V, +18V, +/- 30V Supply
Doc # : 6010B0902.PL
DCR # :
Instuctions : ☑

Rev. : 4
Date : 97-08-14
Approved :
Date Created : 91-04-09

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
4	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C1,4,8,11
3	Mallory	LP222M050A5P3	Capacitor	2200uF, Electr, 20%, 50V	C6,10,14
1	Mallory	LP223M016E7P3	Capacitor	22000uF, Electr, 20%, 16V	C3
4	Mallory	SKR470M15F11V	Capacitor	47uF, Electr, 20%, 63V	C7,9,12,13
2	Farnell	TAP10M35	Capacitor	10uF, Tantalum, 10%, 35V	C2,5
1	Panduit	MLSS100-4	Connector	Header, 4 pin, Male	J7
5	Panduit	MLSS156-4	Connector	Header, 4 pin, Male	J1,2,4-6
1	Motorola	1.5KE16A	Diode	Transorb, 16V, 1500W	D1
1	Motorola	1.5KE30A	Diode	Transorb, 30V, 1500W	D2
2	Motorola	1.5KE51A	Diode	Transorb, 51V, 1500W	D4,6
2	Diode Inc.	1N4004	Diode	Regulator, 100V, 4.7mA	D3,5
1	Diode Inc.	RS102	Diode	Bridge, 100V, 1A	DB3
2	Diode Inc.	RS404L	Diode	Bridge, 400V, 4A	DB1,2
4	AAVID	529802B02500	Heat Sink	TO-220 / TO-218	U1-4
1	Nat. Semi.	7818CT	IC	Regulator, 18V	U2
1	Lin Tech	LM317T	IC	Regulator, 3 Term. Pos.	U4
1	Lin Tech	LM337T	IC	Regulator, 3 Term. Neg.	U3
1	Lin Tech	LT1085CT-5	IC	Regulator, 5V, 3A	U1
1	MIL	00101 Rev 1	PCB	Power Supply Board	
2	Philips	MRS25F249R	Resistor	249, Film, 1%, .5W	R2,4
2	Philips	MRS25F5K62	Resistor	5.62k, Film, 1%, .5W	R1,3
4	Keystone	2131	Spacer	6-32 Threaded, Hex 1" M/F	

6010B

Name : (+/-18V) Supply
Doc # : 6010B0903.PL
DCR # :
Instuctions : ☑

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 91-04-09

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
2	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C8,11
2	Mallory	LP822M050H9P3	Capacitor	8200uF, Electr, 20%, 50V	C10,14
2	Farnell	TAP10M35	Capacitor	10uF, Tantalum, 10%, 35V	C9,13
1	Panduit	MLSS100-4	Connector	Header, 4 pin, Male	J7
1	Panduit	MLSS156-4	Connector	Header, 4 pin, Male	J6
2	Motorola	1.5KE30A	Diode	Transorb, 30V, 1500W	D4,6
1	Diode Inc.	RS102	Diode	Bridge, 100V, 1A	DB3
2	AAVID	529802B02500	Heat Sink	TO-220 / TO-218	U3,4
1	Nat. Semi.	7818CT	IC	Regulator, 18V	U4
1	Nat. Semi.	7918CT	IC	Regulator, -18V	U3
1	MIL	00101 Rev 1	PCB	Power Supply Board	

6010B

Name : Front Panel Assembly
Doc # : 6010B11.PL
DCR # :
Instuctions : ☐

Rev. : 5
Date : 97-08-14
Approved :
Date Created : 91-07-31

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B1101	Assembly	Silkscreened Front Panel	
1	MIL	6010B1103	Assembly	Keyboard / Controller	
1	AMP	4-102944-0	Connector	80 pin,	
1	A.N.D.	AND711AST-30	Display	240x64, Super Twist TRNSF	
1	MIL	BL711-2.5	Hardware	Fiber Optic Backlight	
1	MIL	6010B1102 Rev 2	Plate	6010B Keyboard Mounting	
4	Keystone	Spacer3	Spacer	#4*3/16-1/4 O.D., Round	

6010B

Name : Silkscreened Front Panel
Doc # : 6010B1101.PL
DCR # :
Instuctions : ☐

Rev. : 1
Date : 98-03-03
Approved :
Date Created : 97-06-20

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B110101 Rev 1	Panel	6010B Front Panel	

6010B

Name : Keyboard / Controller
Doc # : 6010B1103.PL
DCR # :
Instuctions : ☑

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 91-05-22

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
2	Philips	681-10339	Capacitor	33pF, Ceramic, 2%, 100V	C4,5
1	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C.1
5	Farnell	TAP10M35	Capacitor	10uF, Tantalum, 10%, 35V	C2,3,6-8
1	Farnell	TAP22M16	Capacitor	22uF, Tantalum, 20%, 16V	C1
1	AMP	102159-3	Connector	Latch, 16 pin, M	J1
1	AMP	102159-4	Connector	Latch, 20 pin, M	J2
1	MTRON	MP-1-11.0592	Crystal	11.0592 MHz	Y1
1	Motorola	1N4148	Diode	Sig-Switch, 100V, 10mA	D2
1	Cybernetic	CY325B	IC	Controller, Display	U1
1	Maxim	MAX232CPE	IC	Receiver, RS-232 Transmit	U2
1	MIL	6100801 Rev 0	PCB	6010B Keyboard/Contr	
1	Vishay	1280G 10K	Potentiom'r	10k, Metal Foil, 10%	P1
1	Aromat	DS2E-S-DC5V	Relay	2C, Single Side, 5V, 2A	K1 (Optional)
2	Philips	MRS25F10K0	Resistor	10k, Film, 1%, .5W	R1,2
1	Philips	MRS25F20K0	Resistor	20k, Film, 1%, .5W	R4
1	Philips	MRS25F332R	Resistor	332, Film, 1%, .5W	R3
1	AMP	2-641268-3	Socket	40 pin, DIP, Low Profile	U1
10	C & K	MP01R09CBE	Switch	Pushbutton, Grey	S1,8-16
1	C & K	MP01R193CBE	Switch	Pushbutton, Grey, Red LED	S7
5	C & K	MP01S09CBE	Switch	Pushbutton, Grey	S2-6
1	Motorola	2N2222A	Transistor	NPN, Signal	Q1

6010B

Name : Rear Panel Assembly
Doc # : 6010B12.PL
DCR # :
Instuctions : ☐

Rev. : 3
Date : 97-08-14
Approved :
Date Created : 93-06-10

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B1201	Assembly	Silkscreened Rear Panel	
2	Johnson	1482-103	Terminal	Binding Post, Black	

6010B

Name : Silkscreened Rear Panel
Doc # : 6010B1201.PL
DCR # :
Instuctions : ☐

Rev. : 0
Date : 97-06-20
Approved :
Date Created : 97-06-20

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B120101 Rev 0	Panel	6010B Rear Panel	

6010B

Name : Separator Assembly
Doc # : 6010B13.PL
DCR # :
Instuctions : ☐

Rev. : 6
Date : 97-12-18
Approved :
Date Created : 88-11-24

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B1302	Assembly	Silked Power Entry Panel	
1	BUSS	AGC-1	Fuse	1A, Non-Delay, 250V	
1	BUSS	AGC-1/2	Fuse	0.5A, Non-Delay, 250V	
4	Keystone	619	Hardware	Bracket,.687" Right Angle	
1	MIL	6010B1301 Rev 4	Plate	6010B Seperator	
1	Aerovox	A05PM4FD94	Socket	Power Entry Module	
4	Keystone	1903C	Spacer	1/2" Nylon, 6-32 Thread	
3	Superior	BP21GN	Terminal	Binding Post, Green	

6010B

Name : Silked Power Entry Panel
Doc # : 6010B1302.PL
DCR # :
Instuctions : ☐

Rev. : 0
Date : 97-11-01
Approved :
Date Created : 97-11-01

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	MIL	6010B130201 Rev 0	Panel	6010B Power Entry	

6010B

Name : Keyboard/Micro Hamess
Doc # : 6010B17.PL
DCR # :
Instuctions : ☑

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 91-04-05

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	AMP	746285-2	Connector	Ribbon, 14 pin, IDC	
1	AMP	746285-3	Connector	Ribbon, 16 pin, IDC	

6010B

Name : Display/Keyboard Harness
Doc # : 6010B18.PL
DCR # :
Instuctions : ☑

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 91-04-05

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
2	AMP	746285-4	Connector	Ribbon, 20 pin, IDC	

6010B

Name : GPIB Socket Assembly
Doc # : 6010B21.PL
DCR # :
Instuctions : ☑

Rev. : 2
Date : 97-08-14
Approved :
Date Created : 90-09-05

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	3M	3549-1000	Connector	Ribbon, 24 pin, IDC	
1	AMP	553636-3	Connector	IEEE-488 Jack	
1	AMP	746285-6	Connector	Ribbon, 26 pin, IDC	

6010B

Name : Power Harness Assembly
Doc # : 6010B22.PL
DCR # :
Instuctions : ☑

Rev. : 1
Date : 97-08-14
Approved :
Date Created : 96-06-11

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
5	Panduit	CT100F22-4	Connector	Through, 4 pin, Female	
2	Panduit	CT156F22-4	Connector	Through, 4 pin, Female	

6010B

Name : Turns Isolation Circuit
Doc # : 6010B23.PL
DCR # :
Instuctions : ☑

Rev. : 3
Date : 97-12-18
Approved :
Date Created : 96-07-23

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	Kemet	C322C104M5u5cA	Capacitor	0.1uF, Ceramic, 20%,	C2
1	Mallory	LP182M035A1P3	Capacitor	1800uF, Electr, 20%, 35V	C1
1	Farnell	TAP10M35	Capacitor	10uF, Tantalum, 10%, 35V	C3
3	Panduit	MLSS100-2	Connector	Header, 2 pin, Male	J1,2
1	Motorola	1.5KE16A	Diode	Transorb, 16V, 1500W	D1
1	Diode Inc.	RS102	Diode	Bridge, 100V, 1A	DB2
1	AAVID	576802B04000	Heat Sink	TO-220	U1
5	Quality Tech	6N139	IC	Isolator, Opto	U3-7
2	T.I.	74HCT04N	IC	Gate, Hex Inverter	U2,8
1	Nat. Semi.	7805CT	IC	Regulator, 5V	U1
1	MIL	6010T2301 Rev 1	PCB	6010B Turns Isolation	
5	Philips	MRS25F1K00	Resistor	1k, Film, 1%, .5W	R2,5,8,11,14
5	Philips	MRS25F270R	Resistor	270, Film, 1%, .5W	R1,4,7,10,13
5	Philips	MRS25F750R	Resistor	750, Film, 1%, .5W	R3,6,9,12,15
4	Keystone	1903C	Spacer	1/2" Nylon, 6-32 Thread	

6010B

Name : I/O Harness Assembly
Doc # : 6010B24.PL
DCR # :
Instuctions : ☑

Rev. : 1
Date : 97-08-14
Approved :
Date Created : 96-08-13

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
1	AMP	746285-6	Connector	Ribbon, 26 pin, IDC	

6010B

Name : Wire Hookup Assembly
Doc # : 6010B26.PL
DCR # :
Instuctions : ☑

Rev. : 1
Date : 97-08-14
Approved :
Date Created : 97-07-07

Measurements International Limited

Quantity	Manufacturer	Part Number	Name	Description	Reference
0	Sycor	9999 /4	Wire	#18/4, Shielded, Silver	

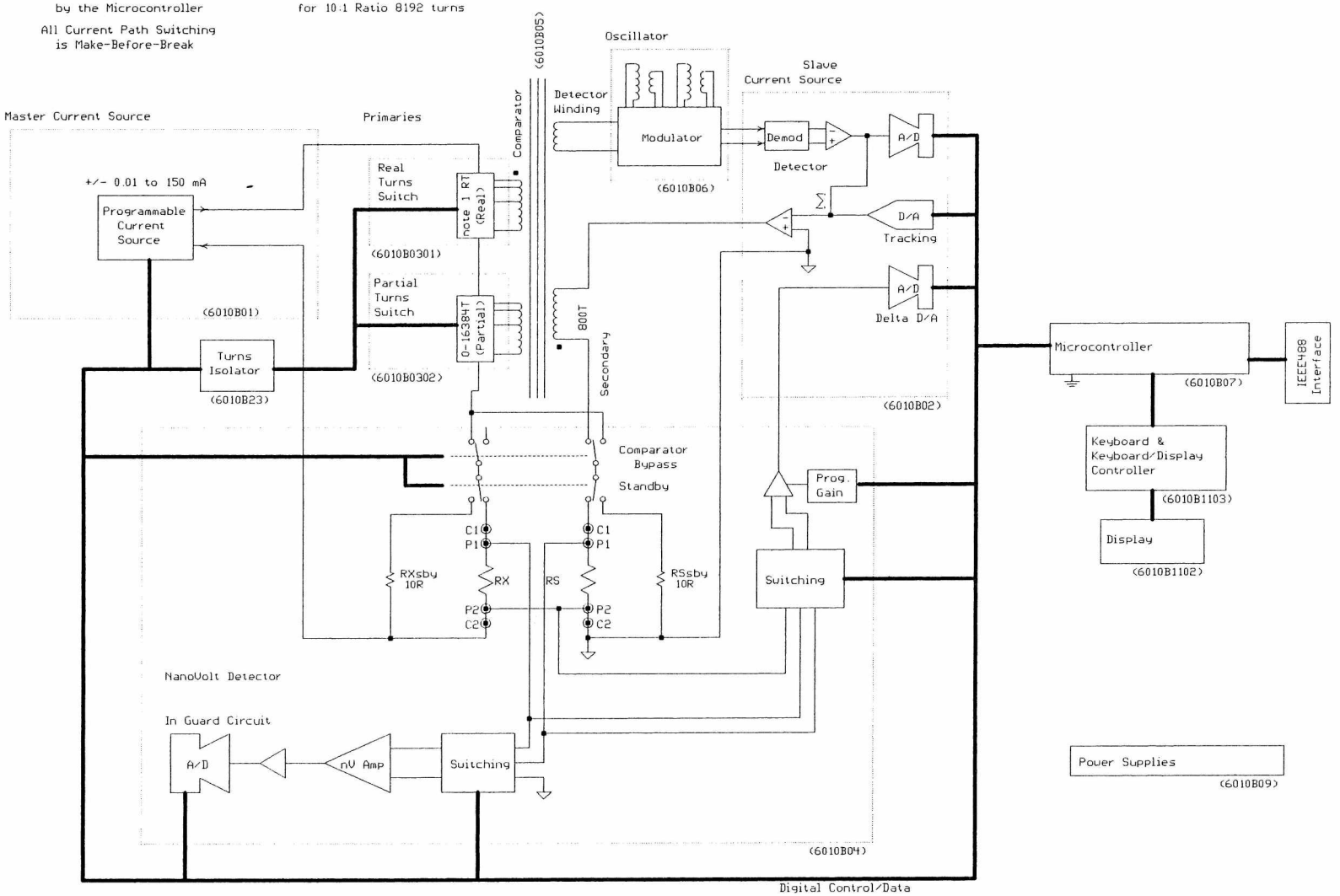
Revisions

#	description	date	app'd
1	Add R Sec	26/09/91	DB
3	Add bipolar Ix	96/02/05	LB
4	Add Turns Isolator (61023)	96/02/05	LB
5	Changed Doc# to new format	97/10/28	

All Switching is Controlled by the Microcontroller

All Current Path Switching is Make-Before-Break

Note: 1 RT for 13:1 Ratio 11264 turns
for 10:1 Ratio 8192 turns



dru.	NW	91/02/01
appd.	DB	91/02/01
eng.	DB	91/02/01

MEASUREMENTS INTERNATIONAL LIMITED

TITLE **RESISTANCE BRIDGE SYSTEM**

DCR | rev. 5 | doc# 6010B.SCH

sheet 1 of 1

revisions			
ltr	description	date	app'd
A	Prototype Release	21/02/91	
1	Fix Pos Adj Reg Pinout	09/08/91	

Transformer Ratings

Secondary Ratings (@ nom 115VAC)

FOR CIRCUITS A&B: O/P VDC	VAC(RMS)	FOR CIRCUITS C&D: O/P VDC	VAC(RMS) (each wdg.)
5	8.3 (7.6)	15	15.6
6	9	16.5	16.7
12	13.5	18	18
15	15.3	21.5	20.3
18	19	30	28

IAC(RMS)=1.8*O/PAmps

Primary Rating
Input: 100/115/230 VAC(RMS) - 2 115V windings, 1 tapped @ 100V
VA Rating = VA*IA + VB*IB + VC*IC + VD*ID (All RMS)

Diode Bridge Selection

IAC RMS	DBn P/N
<1.5A	KBP02
>1.5A	KBL02

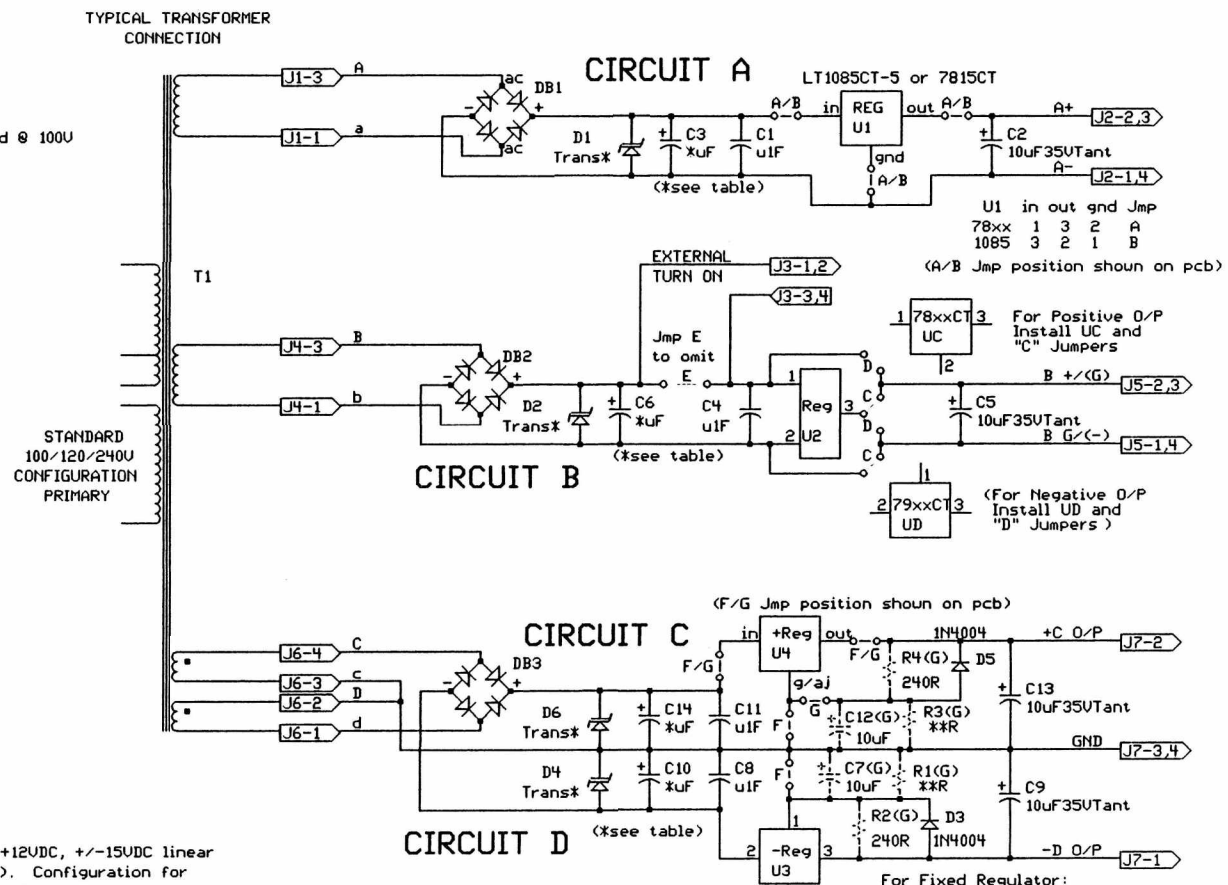
Transorb Selection

VAC RMS	VAC (pk)	Trans* NomVb	P/N
8.5	12	16	1.5KE16
11	16	20	1.5KE20
17	24	30	1.5KE30
18.5	26	30	1.5KE30
20	28	33	1.5KE33
21.5	30	39	1.5KE39
23	33	39	1.5KE39
33.5	47	51	1.5KE51

Capacitor Selection

Value	Mallory P/N
2700uF25uv	LP272S025A1P3
8200uF16uv	LP822S016E1P3
15000uF16uv	LP153S016H3P3
22000uF16uv	LP223S016E9P3
1800uF35uv	LP182S035A1P3
10000uF35uv	LP103S035E9P3
2200uF50uv	LP222S050E1P3
8200uF50uv	LP822S050H9P3
6800uF63uv	LP682S063H9P3

This circuit is nominally designed as a +5VDC, +12VDC, +/-15VDC linear regulated power supply (3 circuits independent). Configuration for different models is shown in table.



For Fixed Regulator:
+Reg = 78xxCT
-Reg = 79xxCT
Omit all RG's & CG's,
Install "F" Jumpers

For Adjustable Regulator:
+Reg = LM317U
-Reg = LM337U
Install "G" Jumpers
Install all RG's & CG's,
**R = (188 * Vo) - 235 OHMS

Supply Configuration

CIRCUIT / Model	A O/P	A Amp	A (* cap.) (value)	A Reg	B O/P	B Amp	B (* cap.) (value)	B Reg	C O/P	C Amp	C (* cap.) (value)	C Reg	D O/P	D Amp	D (* cap.) (value)	D Reg	Note
4XX0	+5	.5	8200uF16uv	7805	+12	.1	1800uF35uv	7812	none				none				
6000	+5	.5	8200uF16uv	7805	+12	.1	1800uF35uv	7812	+21.5	.1	2200uF50uv	7815	-21.5	.1	2200uF50uv	7915	
8000	+5	.5	8200uF16uv	7805	+12	.1	1800uF35uv	7812	+15	.1	1800uF35uv	7815	-15	.1	1800uF35uv	7915	
2000	+5	.5	8200uF16uv	7805	+12	.1	1800uF35uv	7812	none				none				
2010	+5	.1	2700uF25uv	7805	-6	.1	2700uF25uv	7906	+15	.5	10000uF35uv	7815	-15	.5	10000uF35uv	7915	
2500	+5	1	15000uF16uv	1085-5	+12	.1	1800uF35uv	7812	+15	.5	10000uF35uv	7815	-15	.5	10000uF35uv	7915	&+/-200PS
2600	+5	.5	8200uF16uv	7805	+12	.1	1800uF35uv	7812	+16.5	.5	8200uF50uv	7818	-16.5	.5	8200uF50uv	7918	
6010	+5	2	22000uF16uv	1085-5	+18	1	2200uF50uv	7818	+30	.3	2200uF50uv	LM317	-30	.3	2200uF50uv	LM337	PSA] Xfmr1
	+15	.5	10000uF35uv	7815	-15	.5	10000uF35uv	7915	+15	.1	2200uF50uv	7815	-15	.1	2200uF50uv	7915	PSB]
									+18	.2	8200uF50uv	7818	-18	.2	8200uF50uv	7918	PSC Xfmr2

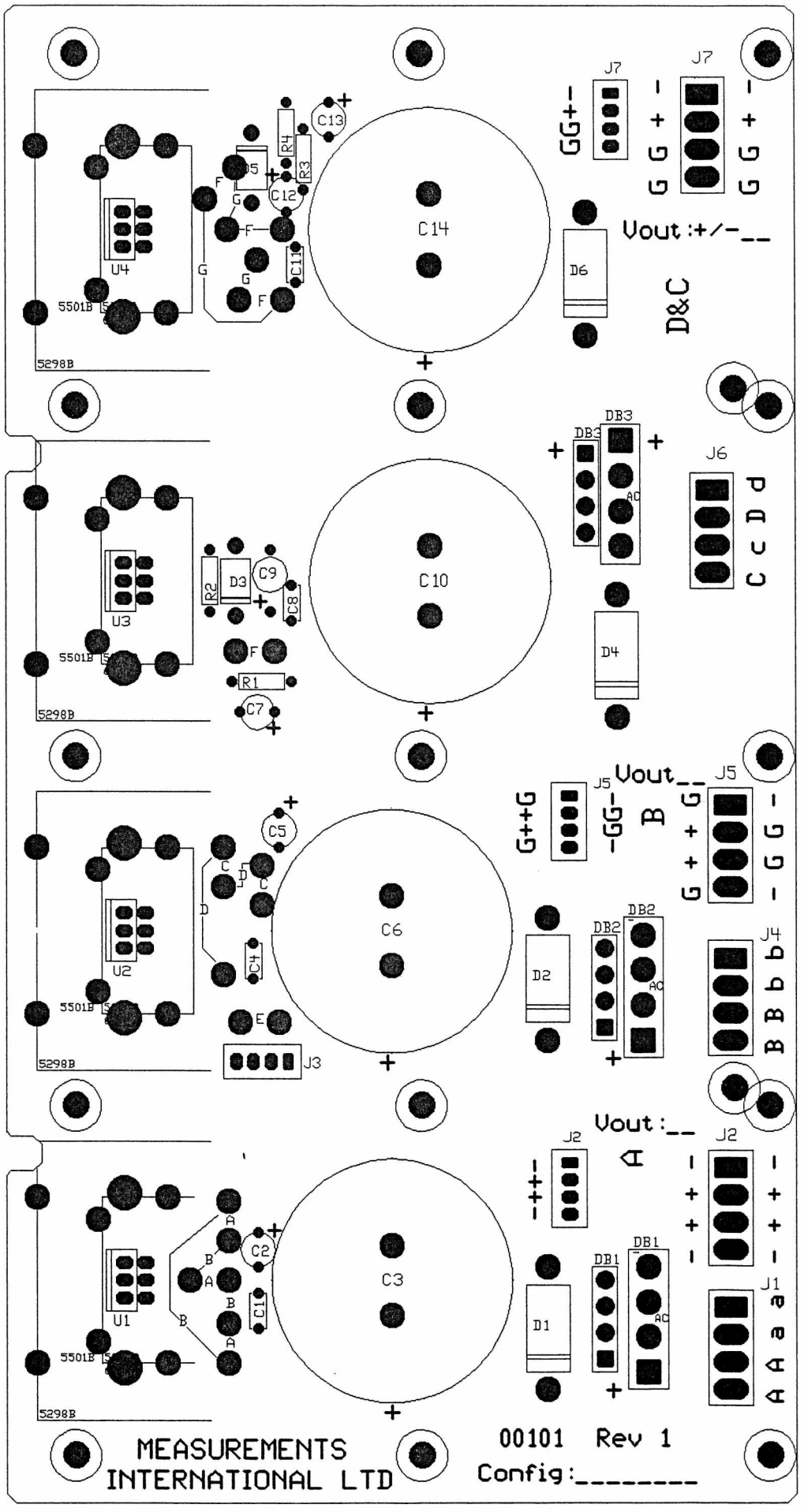
MEASUREMENTS INTERNATIONAL LTD.

DC Regulated Power Supply Module

dru.	nu	21/02/91
appd.		
eng.	nu	Feb. 91

size C | rev. 1 | drawing no. 00101

date 09/08/91 | sheet 1 of 1


J7
GG+-
J7
G G + -
G G + -
Vout :+/-__
D&C
D6
C14
C13
R4
R3
C12
C11
D5
U4
5501B
5298B
DB3
DB3
AC
J6
C c D d
D4
C10
R2
D3
C9
C8
U3
R1
C7
Vout__
J5
G++G
-GG-
B
J5
G + + G
- G G -
D2
DB2
DB2
AC
J4
B B b b
C6
C5
C4
U2
J3
Vout :__
J2
-++-
A
J2
- + + -
- + + -
DB1
DB1
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C3
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MEASUREMENTS
INTERNATIONAL LTD
00101 Rev 1
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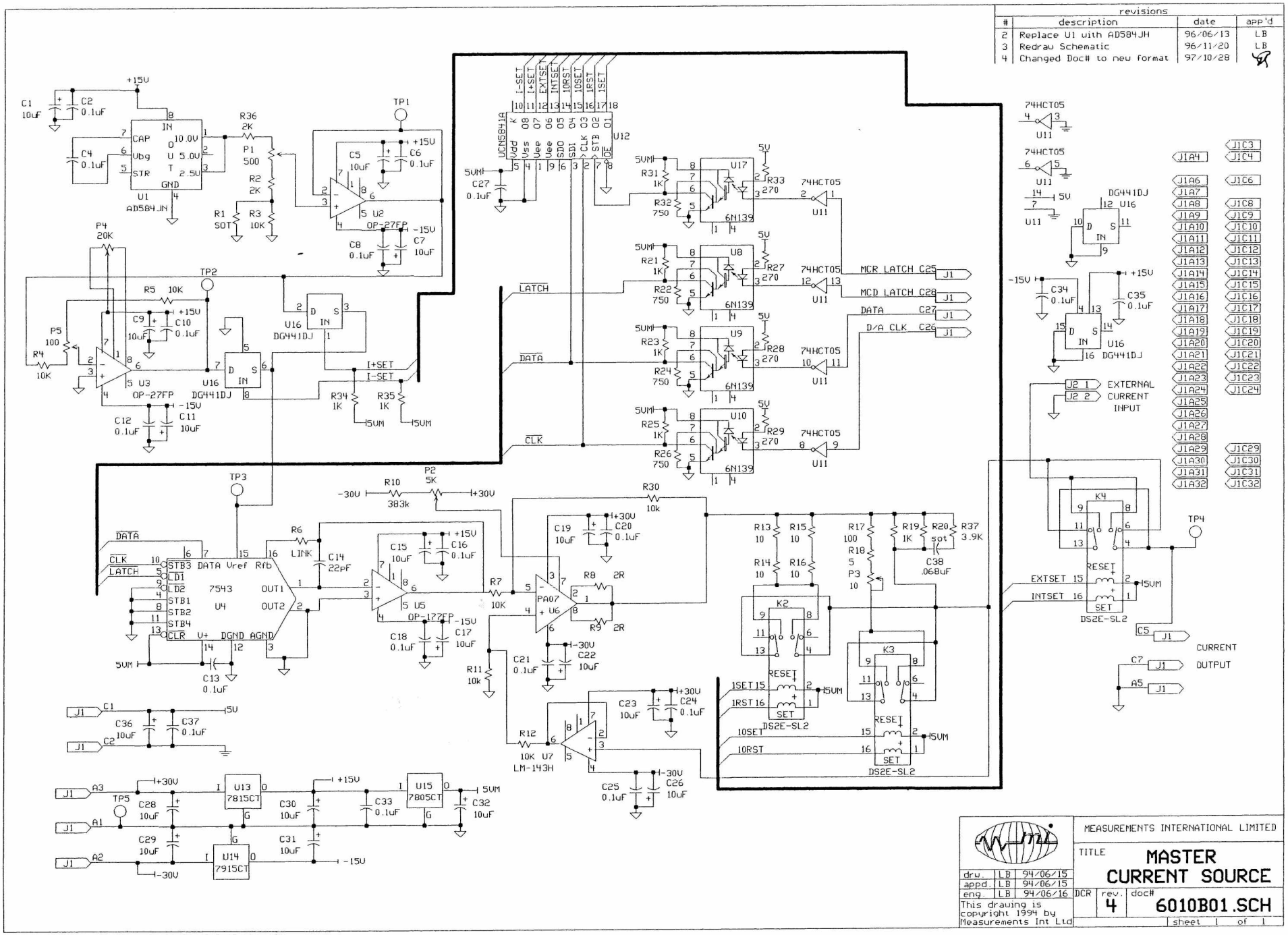
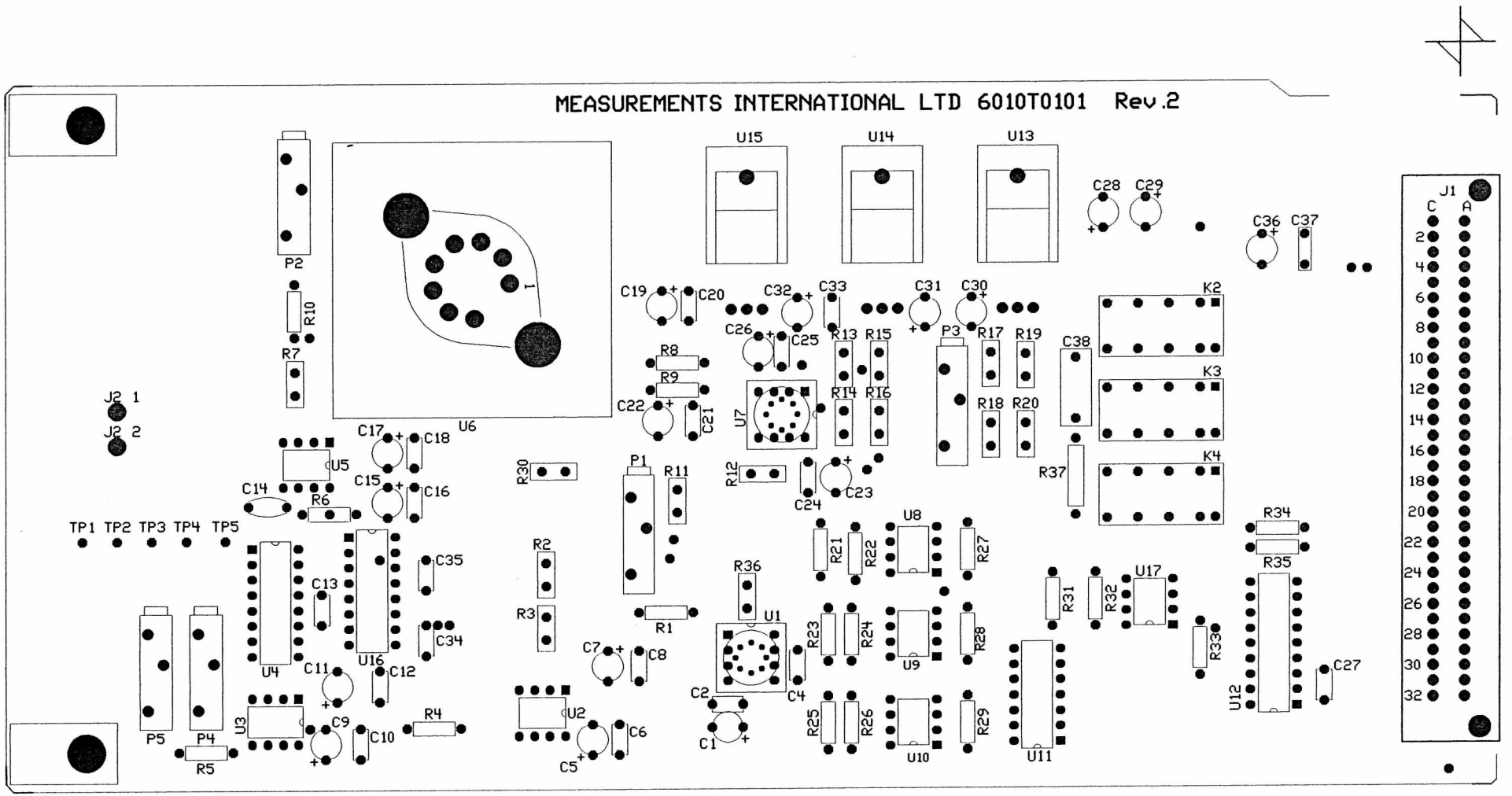


Form MI 35, Rev. 2, Dated 96-06-24 (QAP 19, App."I")


MEASUREMENTS INTERNATIONAL LTD 6010T0101 Rev.2
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U14
U13
C28
C29
C36
C37
J1
C
A
P2
R10
R7
U6
C19
C20
C32
C33
C31
C30
K2
K3
K4
C26
C25
R13
R15
P3
R17
R19
C38
R8
R9
C22
C21
U7
R14
R16
R18
R20
R37
J2 1
J2 2
C17
C18
U5
C14
C15
C16
R6
R30
P1
R11
R12
C24
C23
U8
R34
TP1 TP2 TP3 TP4 TP5
R2
R21
R22
R27
R35
C35
C13
R36
R31
R32
U17
R3
U1
R23
R24
R28
R33
C34
C7
C8
U9
U12
C27
C11
C12
U4
U16
C4
R1
C2
R25
R26
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C9
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P4
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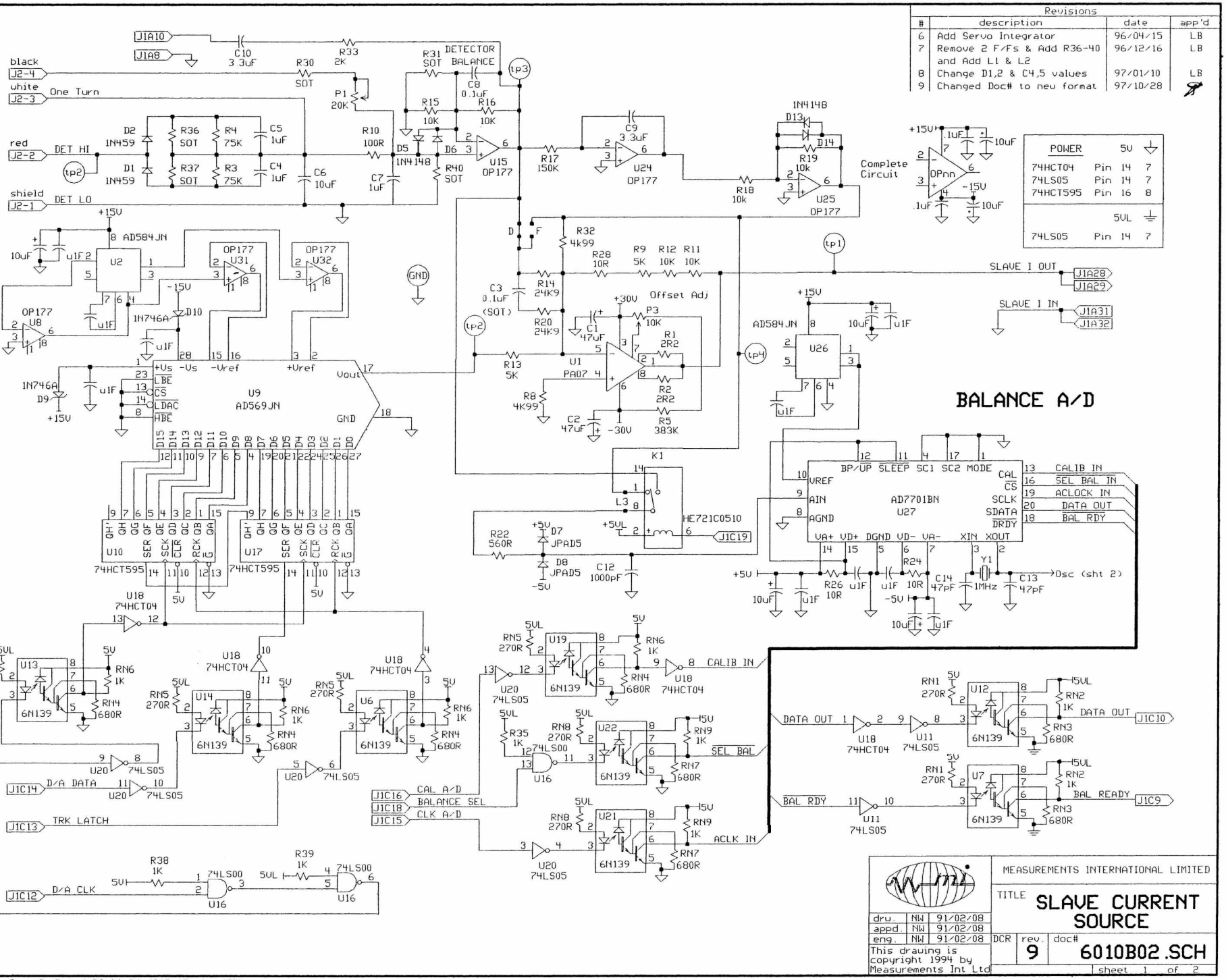
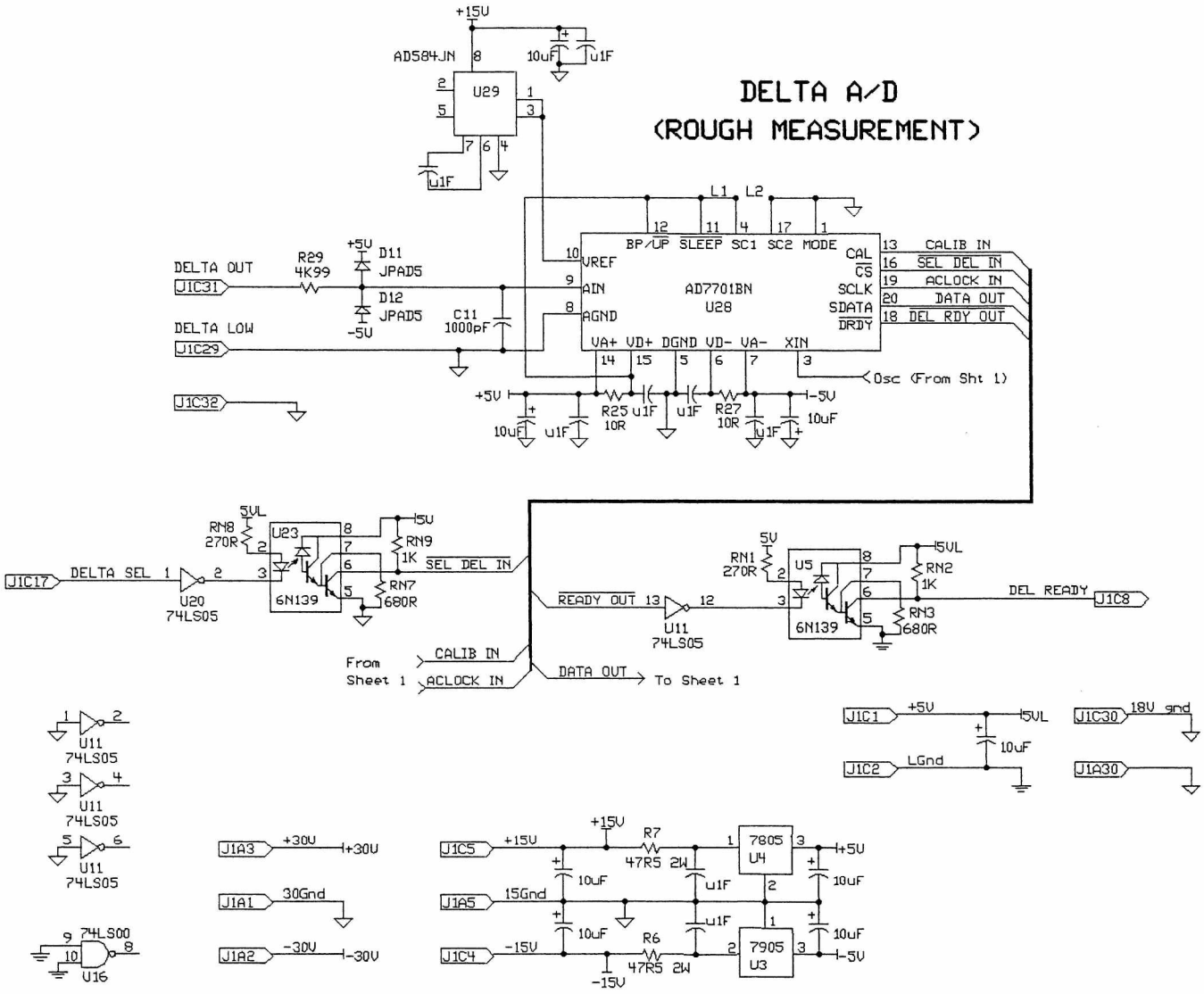
C1



Form MI 35, Rev. 2, Dated 96-06-24 (QAP 19, App."I")

Revisions			
#	description	date	app'd
6	Add Servo Integrator	96/04/15	LB
7	Remove 2 F/Fs, Add R36-40 and Add L1 & L2	96/12/16	LB
8	Change D1,2 & C4,5 values	97/01/10	LB
9	Changed Doc# to new format	97/10/28	

DELTA A/D
(ROUGH MEASUREMENT)



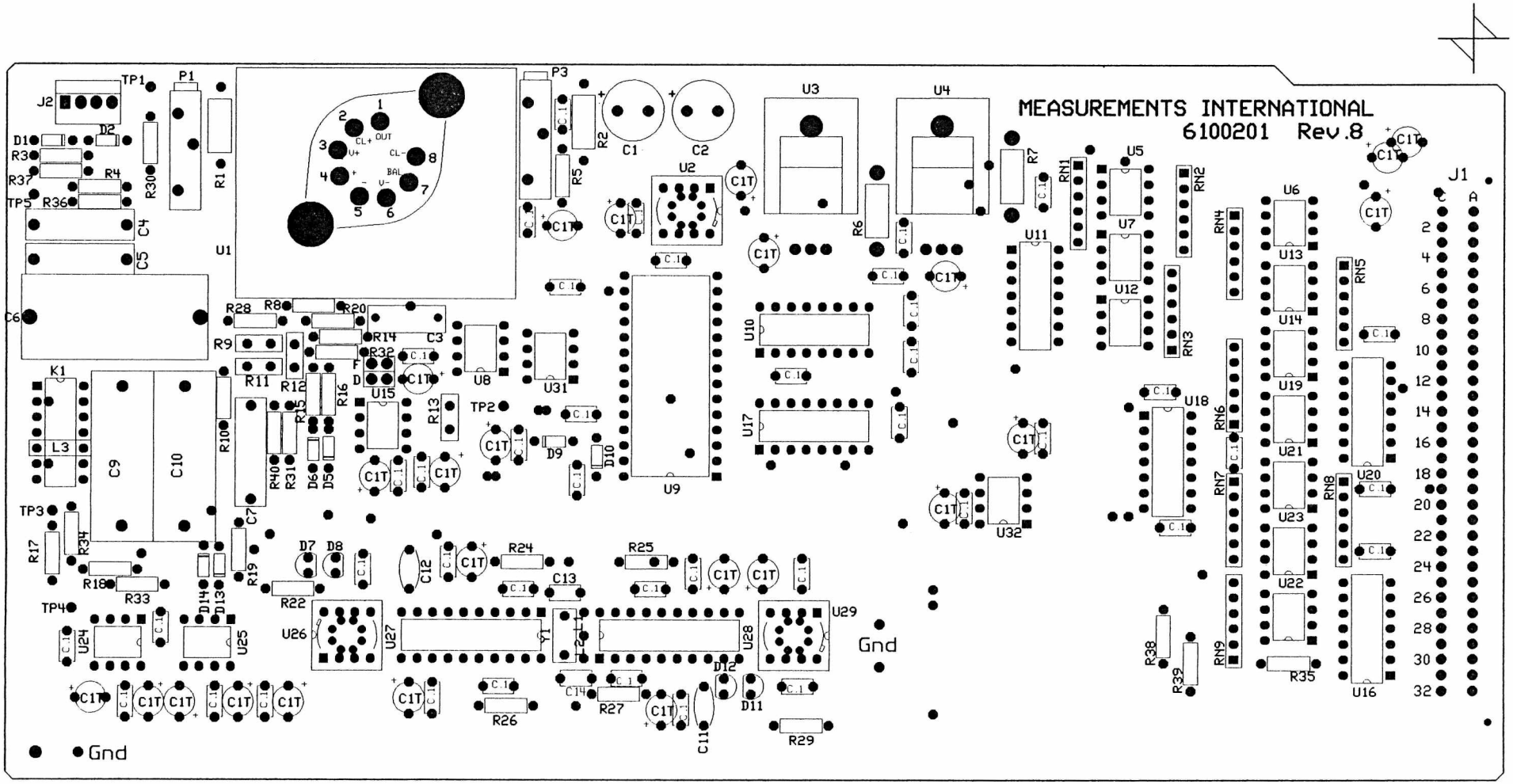
dru.	NW	91/02/08	
appd.	NW	91/02/08	
eng.	NW	91/02/08	

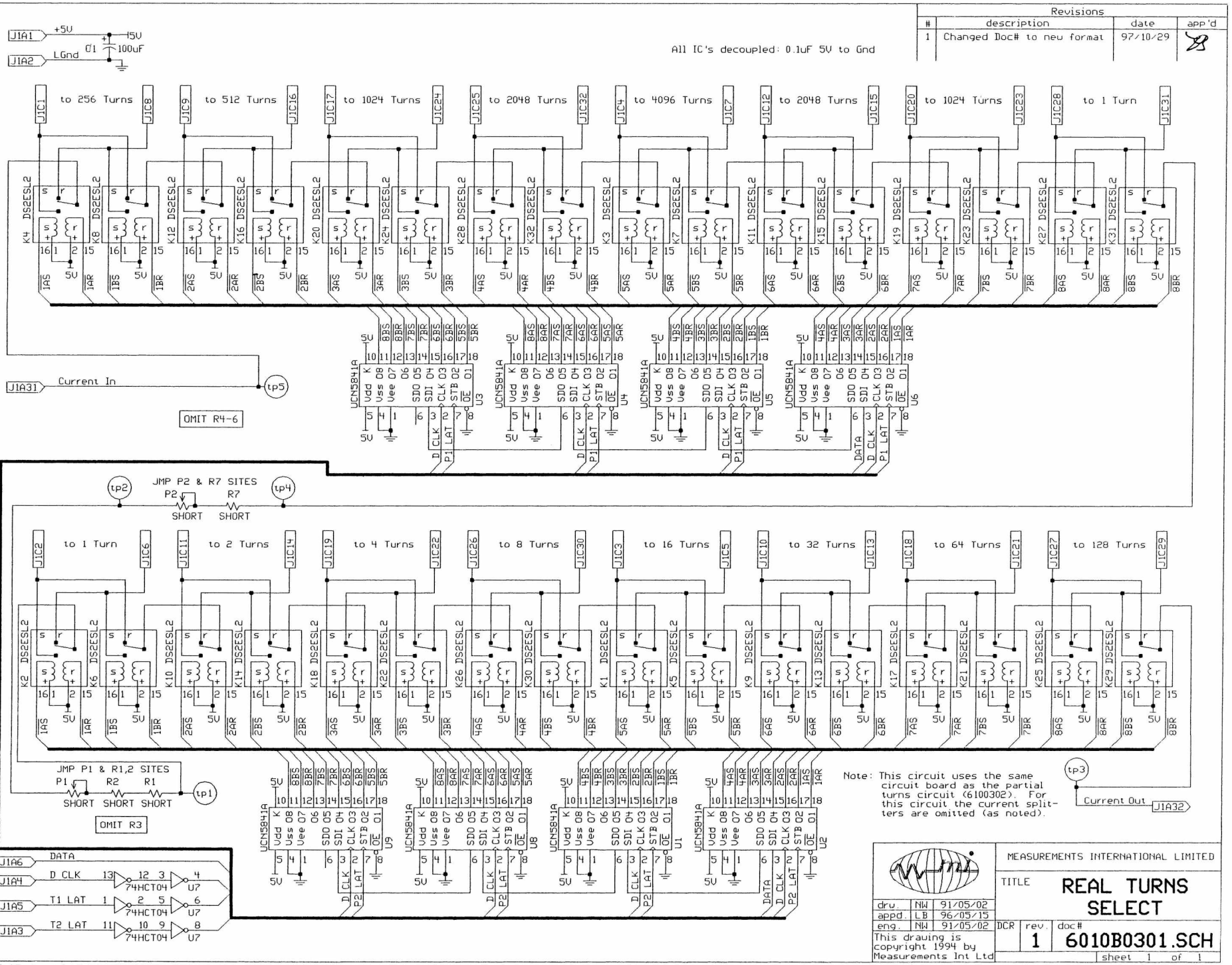
MEASUREMENTS INTERNATIONAL LIMITED

TITLE: SLAVE CURRENT SOURCE

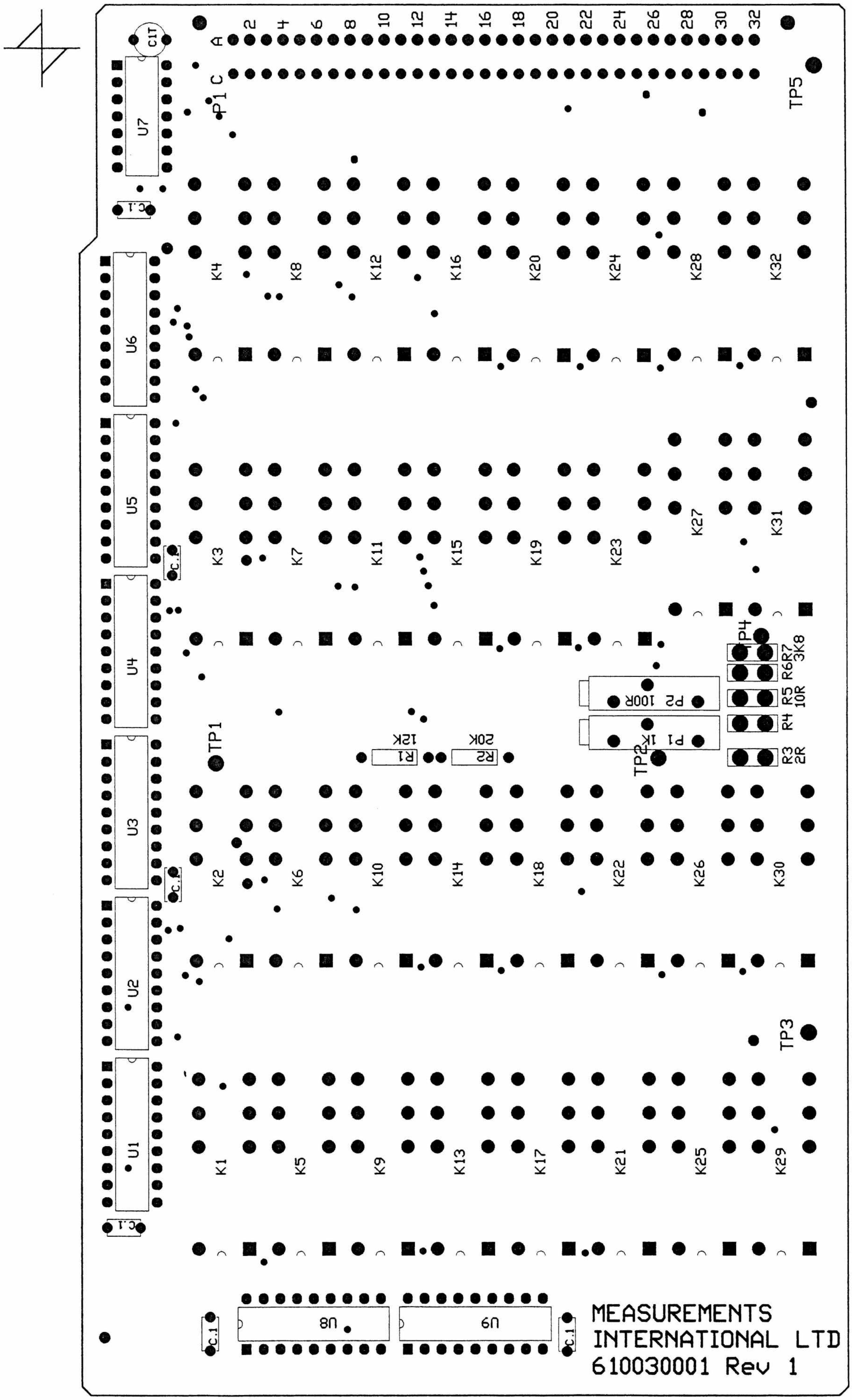
DCR | rev. 9 | doc# 6010B02.SCH

sheet 2 of 2


MEASUREMENTS INTERNATIONAL
6100201 Rev.8
Gnd
Gnd



Form MI 35, Rev. 2, Dated 96-06-24 (QAP 19, App."I")


MEASUREMENTS
INTERNATIONAL LTD
610030001 Rev 1
P1
A
C
TP1
TP2
TP3
TP4
TP5
U1
U2
U3
U4
U5
U6
U7
U8
U9
C1T
C.1
R1 12K
R2 20K
P1 1K
P2 100R
R3 2R
R4
R5 10R
R6
R7 3K8
K1
K2
K3
K4
K5
K6
K7
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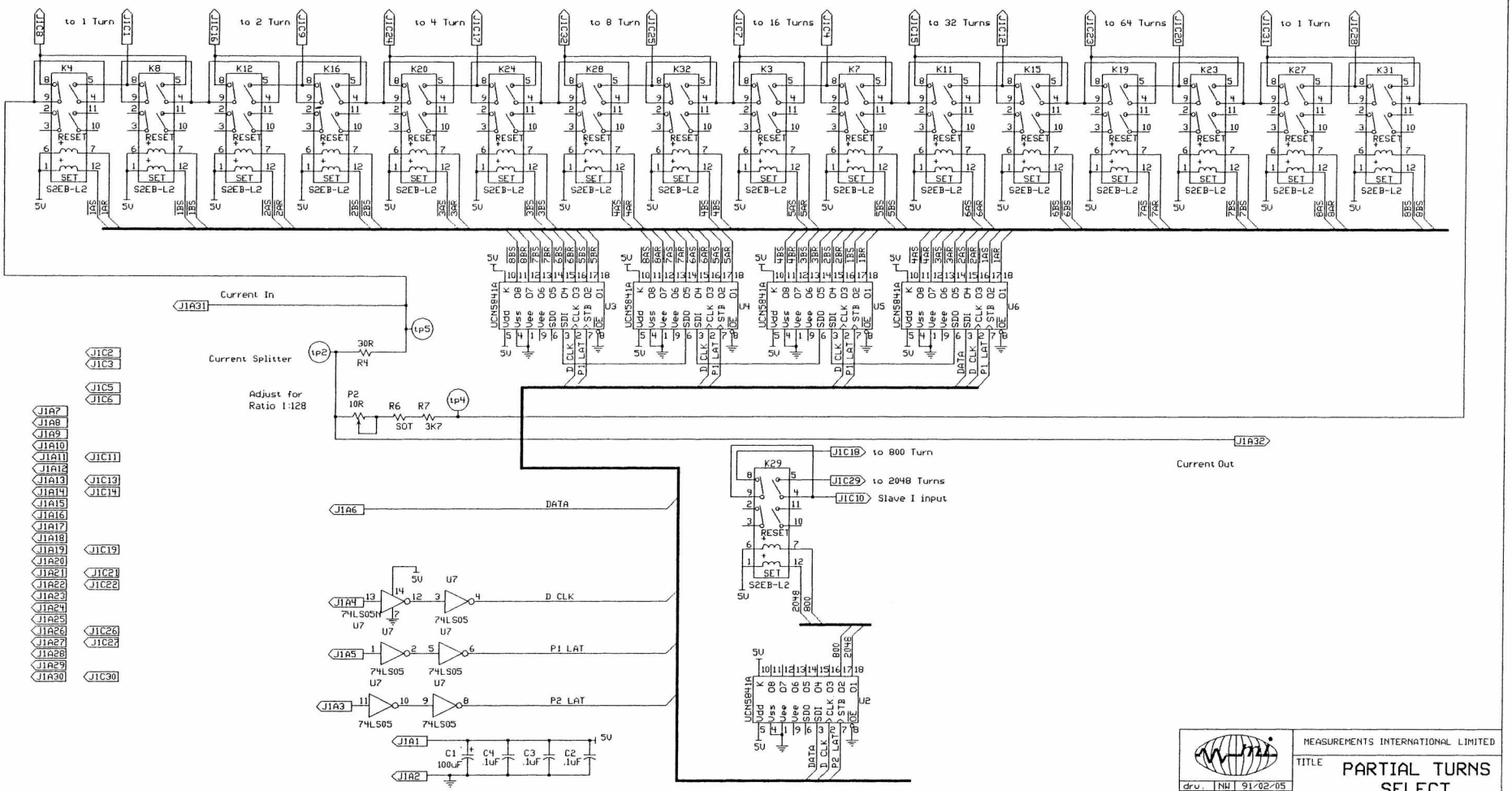
K18
K19
K20
K21
K22
K23
K24
K25
K26
K27
K28
K29
K30
K31
K32
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32

1/128 Weight Turns

Revisions			
#	description	date	app'd
1	Add Res. in series with P2 Remove 1/16384 weight turns	96/11/26	LB
2	Replace DS2ESL2 with S2EB-L2 Add S2EB-L2 & UCN5841A	97/02/19	LB
3	Changed Doc# to new format	97/10/29	



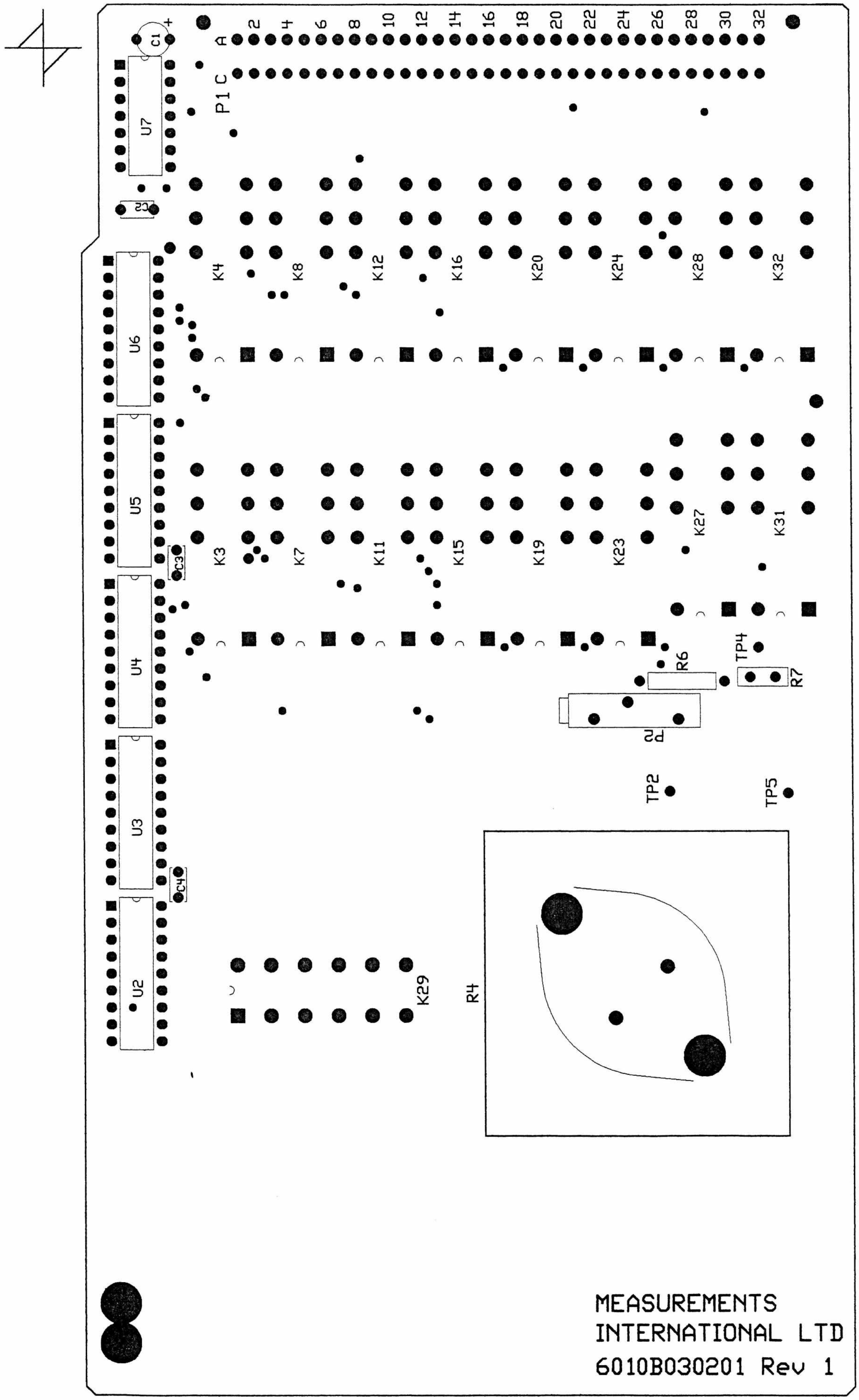
drv.	NW	91/02/05
appd.	LB	96/08/15
eng.	NW	91/02/05

MEASUREMENTS INTERNATIONAL LIMITED

TITLE: PARTIAL TURNS SELECT

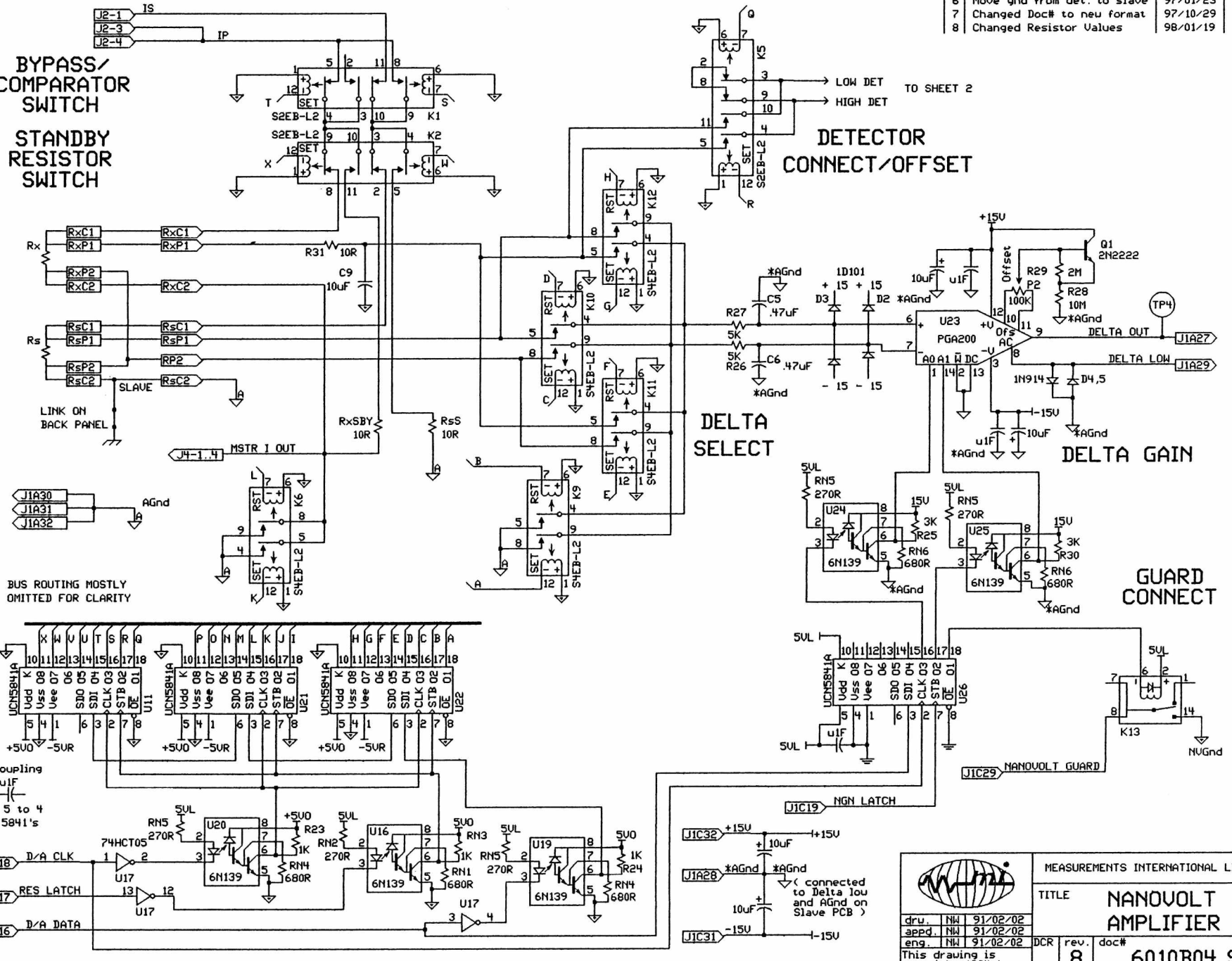
DCR | rev. 3 | doc# 6010B0302.SCH

date | sheet 1 of 1



P1
A
C
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
C1
U7
C2
U6
U5
U4
U3
U2
C3
C4
K4
K8
K12
K16
K20
K24
K28
K32
K3
K7
K11
K15
K19
K23
K27
K31
R6
TP4
R7
P2
TP2
TP5
R4
K29
MEASUREMENTS
INTERNATIONAL LTD
6010B030201 Rev 1

Revisions			
#	description	date	app'd
5	Replace Relays	96/09/27	LB
6	Move gnd from det. to slave	97/01/23	MS
7	Changed Doc# to new format	97/10/29	LB
8	Changed Resistor Values	98/01/19	



dru.	NW	91/02/02
appd.	NW	91/02/02
eng.	NW	91/02/02

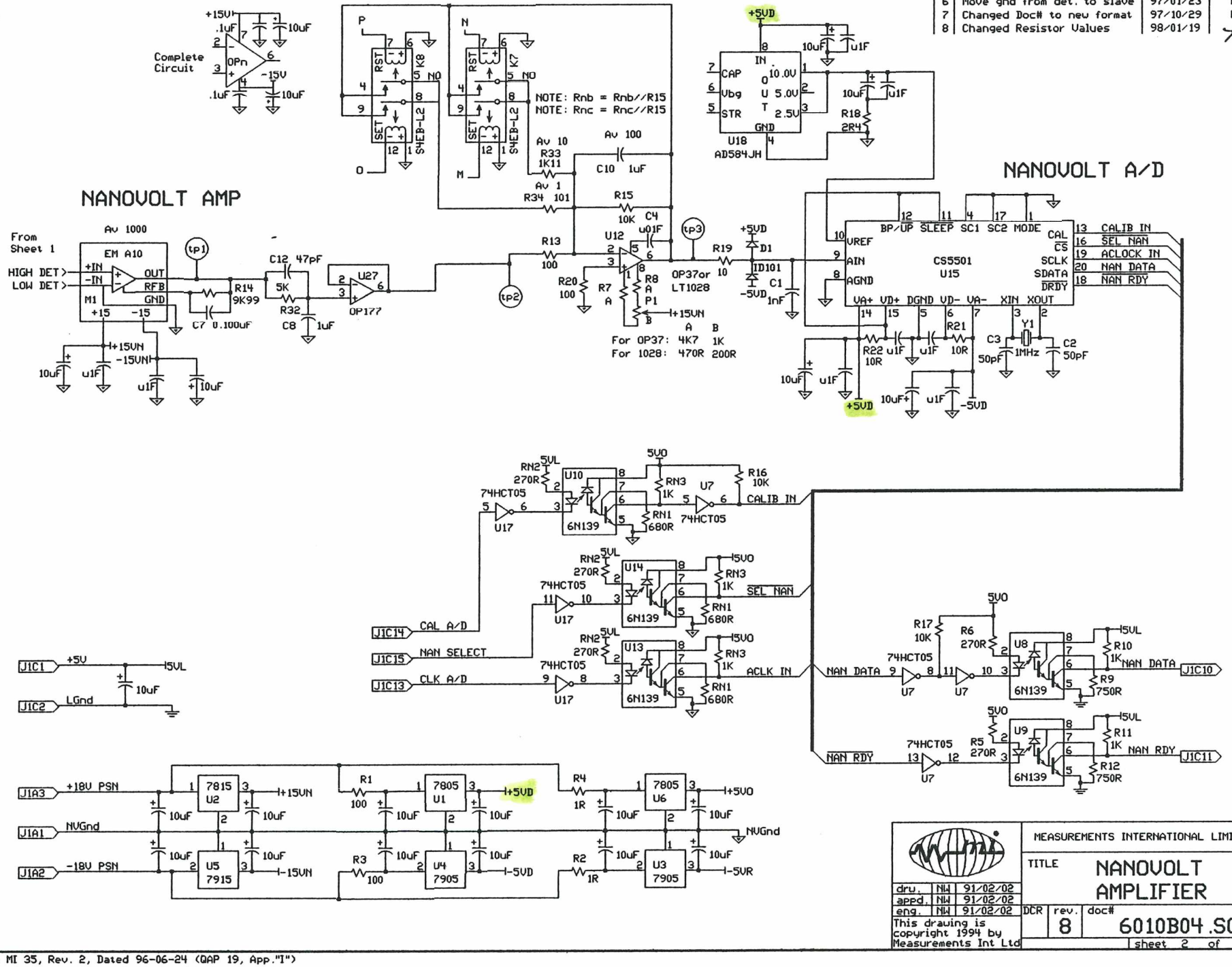
MEASUREMENTS INTERNATIONAL LIMITED

TITLE: NANOVOLT AMPLIFIER

DCR | rev. 8 | doc# 6010B04.SCH

sheet 1 of 2

Revisions			
#	description	date	app'd
5	Replace Relays	96/09/27	LB
6	Move gnd from det. to slave	97/01/23	MS
7	Changed Doc# to new format	97/10/29	LB
8	Changed Resistor Values	98/01/19	

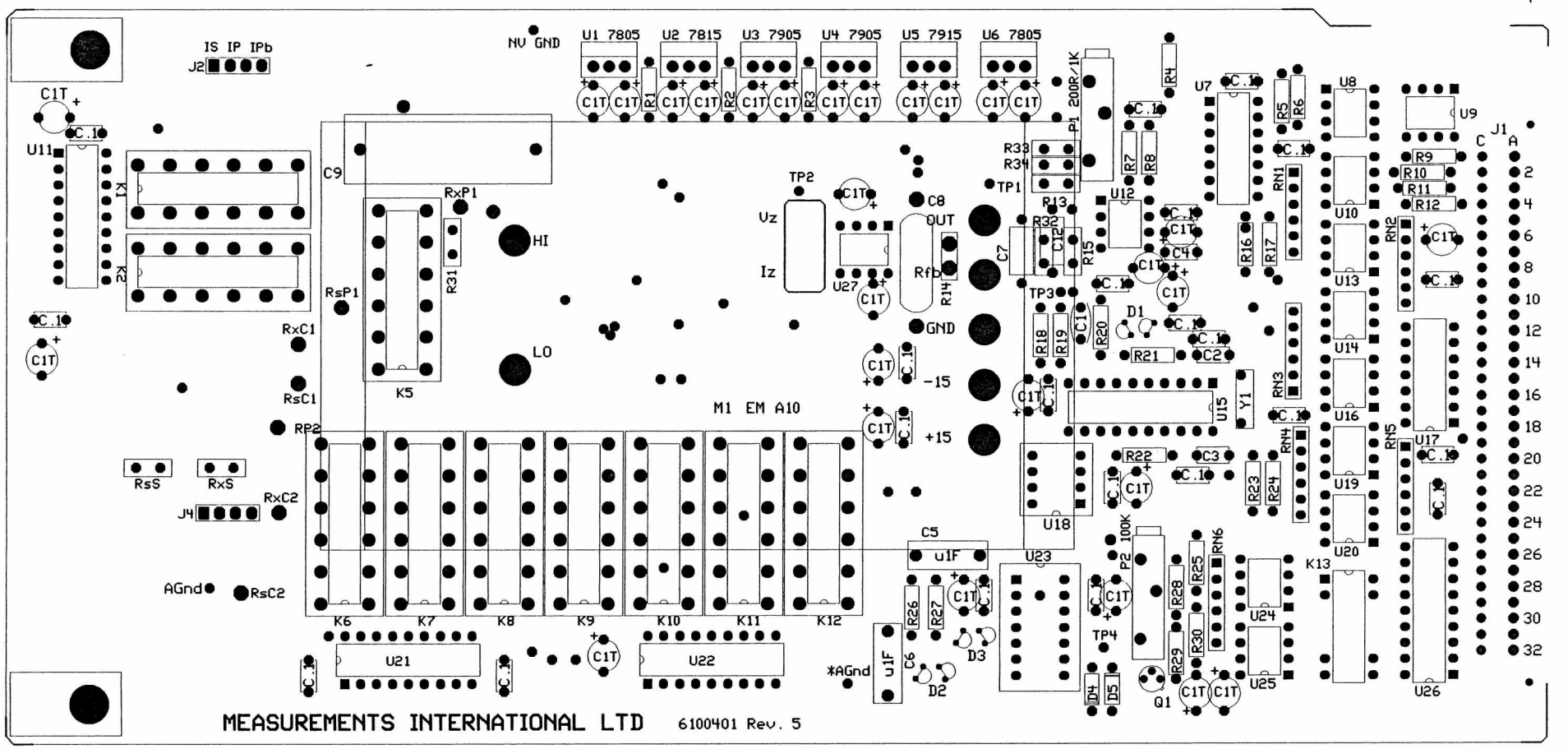


MEASUREMENTS INTERNATIONAL LIMITED

TITLE: NANOVOLT AMPLIFIER

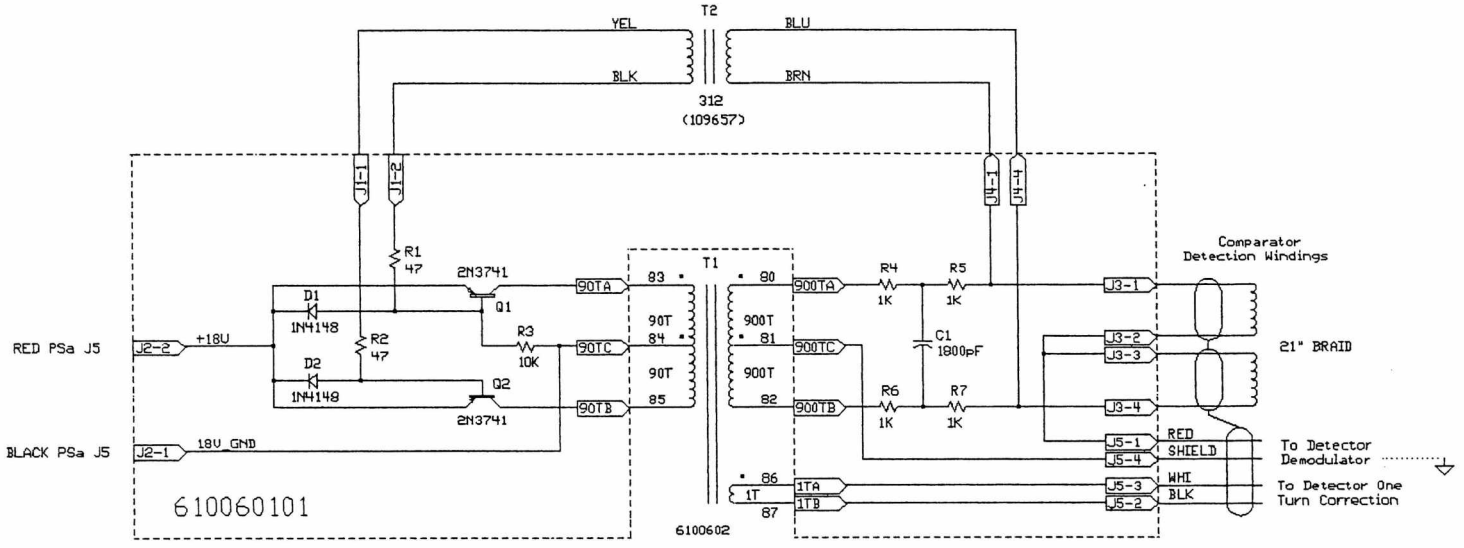
dru.	NW	91/02/02
appd.	NW	91/02/02
eng.	NW	91/02/02

DCR | rev. 8 | doc# 6010B04.SCH | sheet 2 of 2



MEASUREMENTS INTERNATIONAL LTD 6100401 Rev. 5

Revisions			
#	description	date	app'd
1	Wiring Identification	91/09/26	DB
2	Changed Doc# to new format	97/09/02	



Notes: 6010B0601 Assembly consists of
610060101 Oscillator Cct Bd and
6010B060102 Oscillator Toroid housed
in Magnetic Shield can 2000602

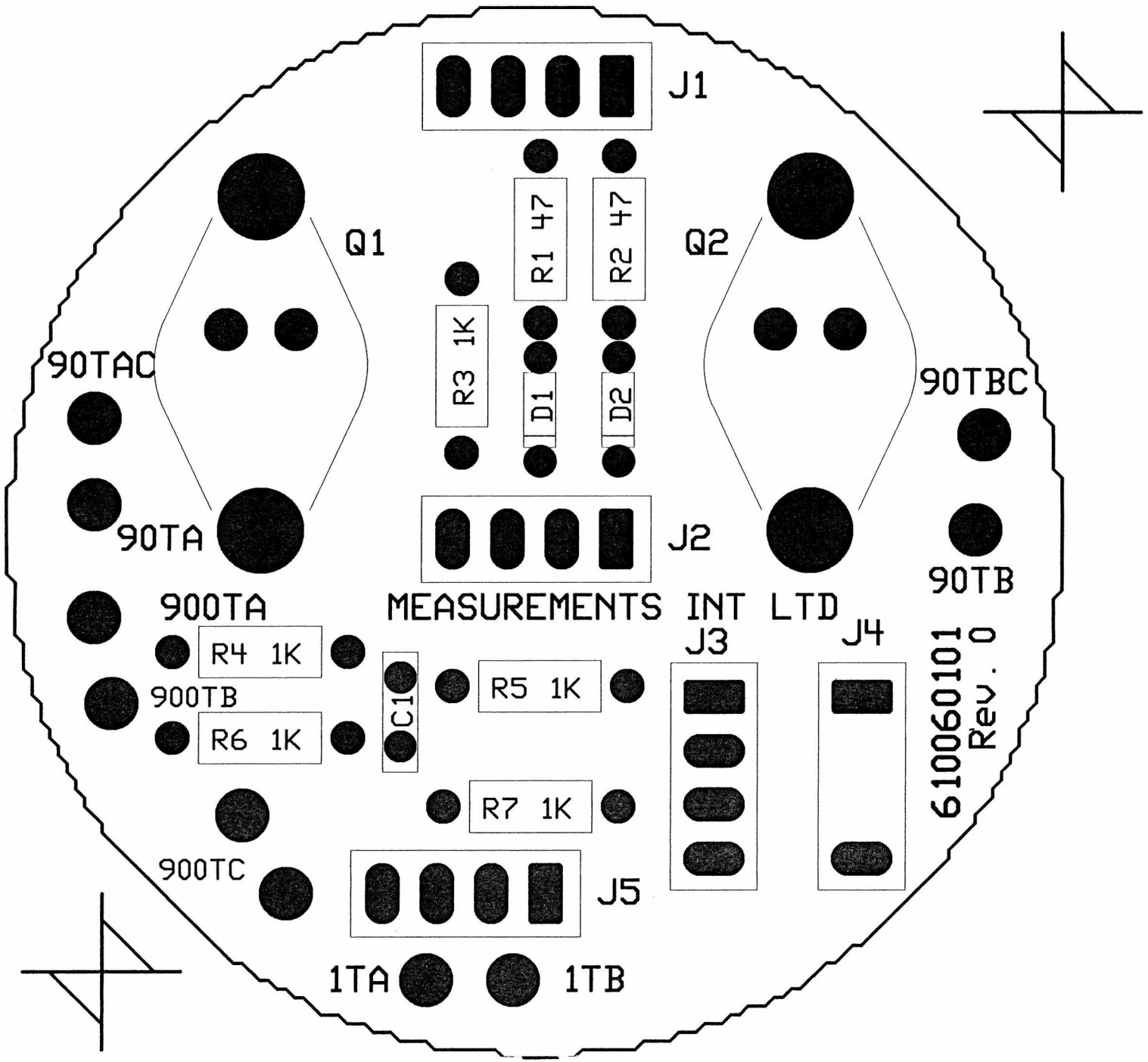
drw.	DB	91/02/14
appd.	DB	91/09/26
eng.	DB	91/09/26

MEASUREMENTS INTERNATIONAL LIMITED

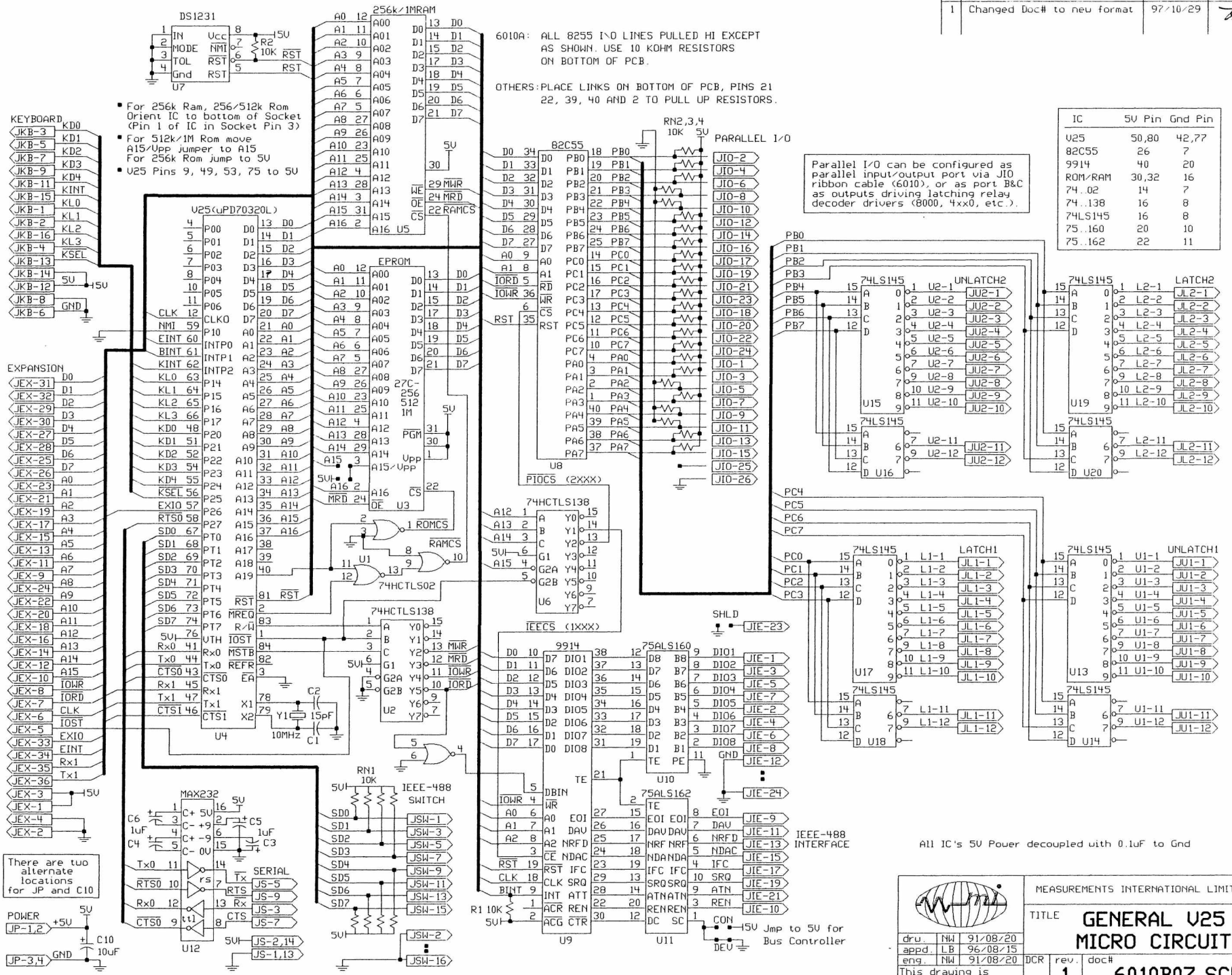
TITLE OSCILLATOR/ MODULATOR

DCR	rev.	doc#
	2	6010B06.SCH

sheet 1 of 1


J1
Q1
Q2
R1 47
R2 47
R3 1K
D1
D2
90TAC
90TBC
90TA
90TB
J2
900TA
MEASUREMENTS INT LTD
J3
J4
R4 1K
900TB
R6 1K
C1
R5 1K
R7 1K
900TC
J5
1TA
1TB
610060101
Rev. 0

Revisions			
#	description	date	app'd
1	Changed Doc# to new format	97/10/29	



IC	5V Pin	Gnd Pin
V25	50,80	42,77
82C55	26	7
9914	40	20
ROM/RAM	30,32	16
74..02	14	7
74..138	16	8
74LS145	16	8
75..160	20	10
75..162	22	11

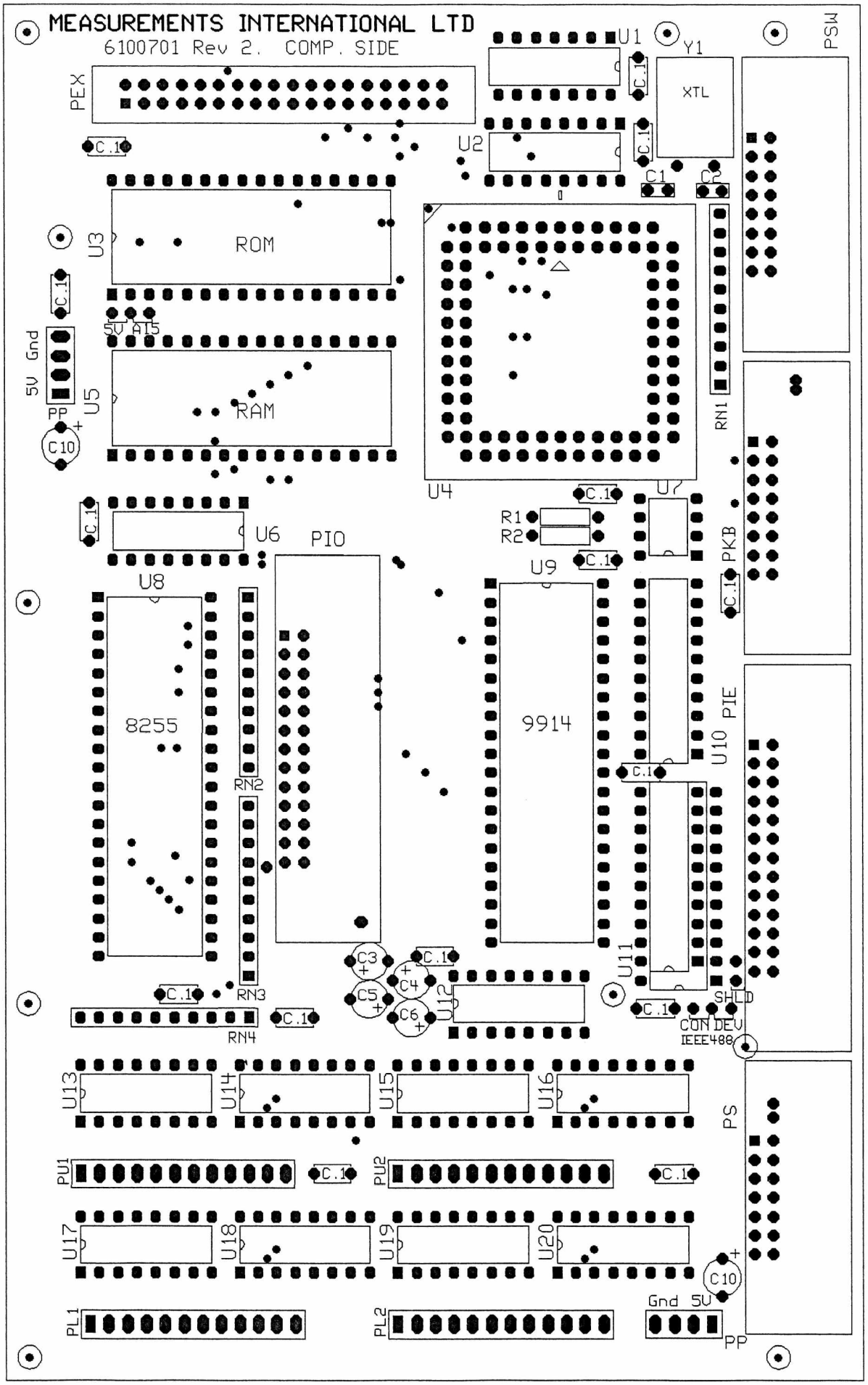
dru.	NW	91/08/20
appd.	LB	96/08/15
eng.	NW	91/08/20

MEASUREMENTS INTERNATIONAL LIMITED

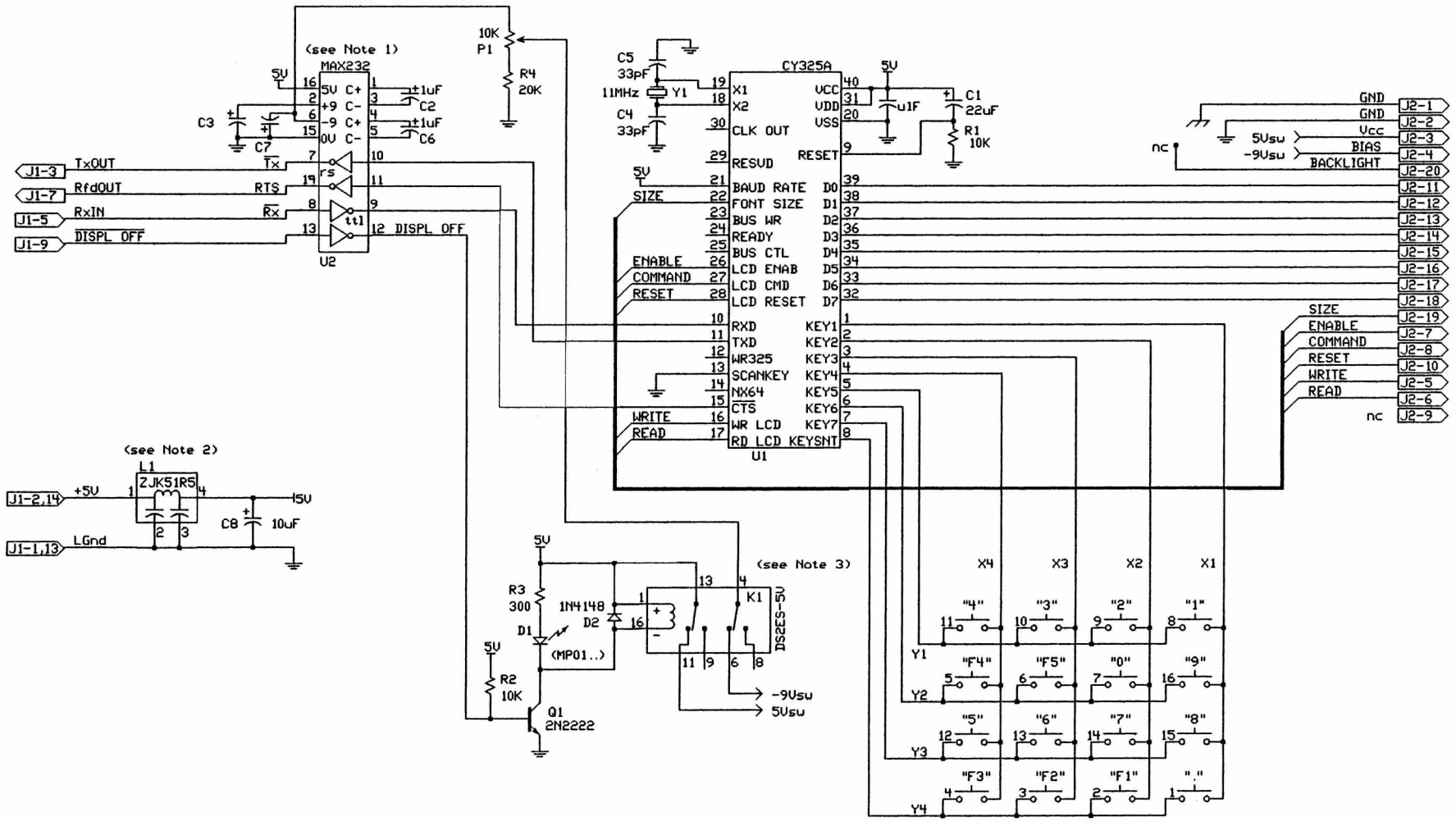
TITLE **GENERAL V25 MICRO CIRCUIT**

DCR | rev. 1 | doc# 6010B07.SCH

sheet 1 of 1


MEASUREMENTS INTERNATIONAL LTD
6100701 Rev 2. COMP. SIDE
PEX
U1
Y1
XTL
PSW
C.1
U2
C1
C2
U3
ROM
5V AT5
5V Gnd
PP
U5
RAM
C10
U4
RN1
R1
R2
U7
U6
PIO
PKB
U9
U8
8255
9914
U10
PIE
RN2
RN3
RN4
C3
C4
C5
C6
U12
U11
SHLD
CON DEV
IEEE488
PS
U13
U14
U15
U16
PU1
PU2
U17
U18
U19
U20
Gnd 5V
PL1
PL2
PP

Revisions			
#	description	date	app'd
1	U2, L1, K1 notes, R4	91/09/26	LB
2	Changed Doc# to new format	97/10/29	



NOTES: 1. U2 (MAX232) Must be Maxim part, NO other Mfg's or substitutes (due to too lou -9V for LCD)
2. If L1 is not available, Omit and Jump pin 1 to pin 4
3. In normal board do not install K1, instead jump K1 pins as follous: pin 11 to 13, and 4 to 6

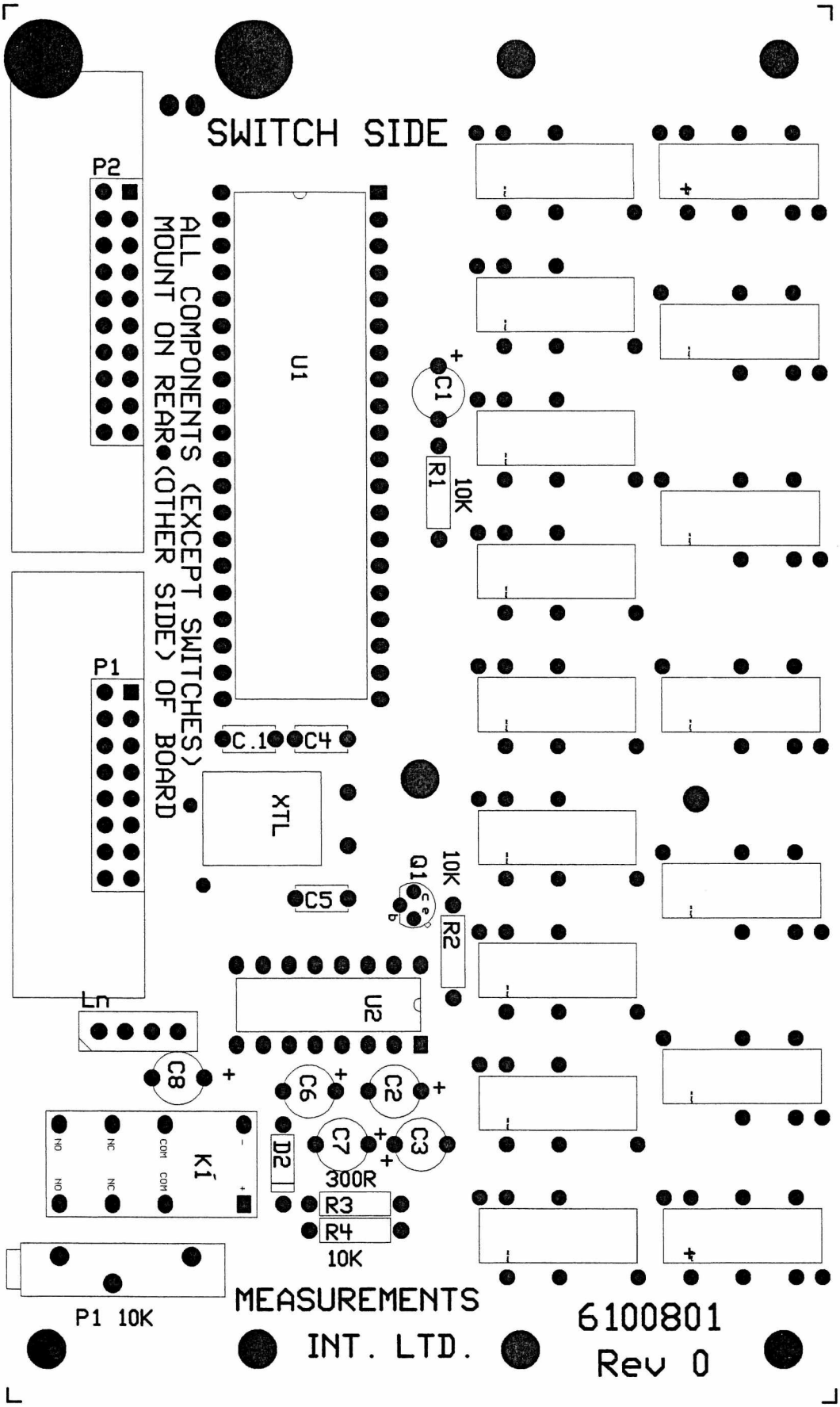
drv.	NW	91/02/01
appd.	NW	91/02/01
eng.	NW	91/09/26

MEASUREMENTS INTERNATIONAL LIMITED

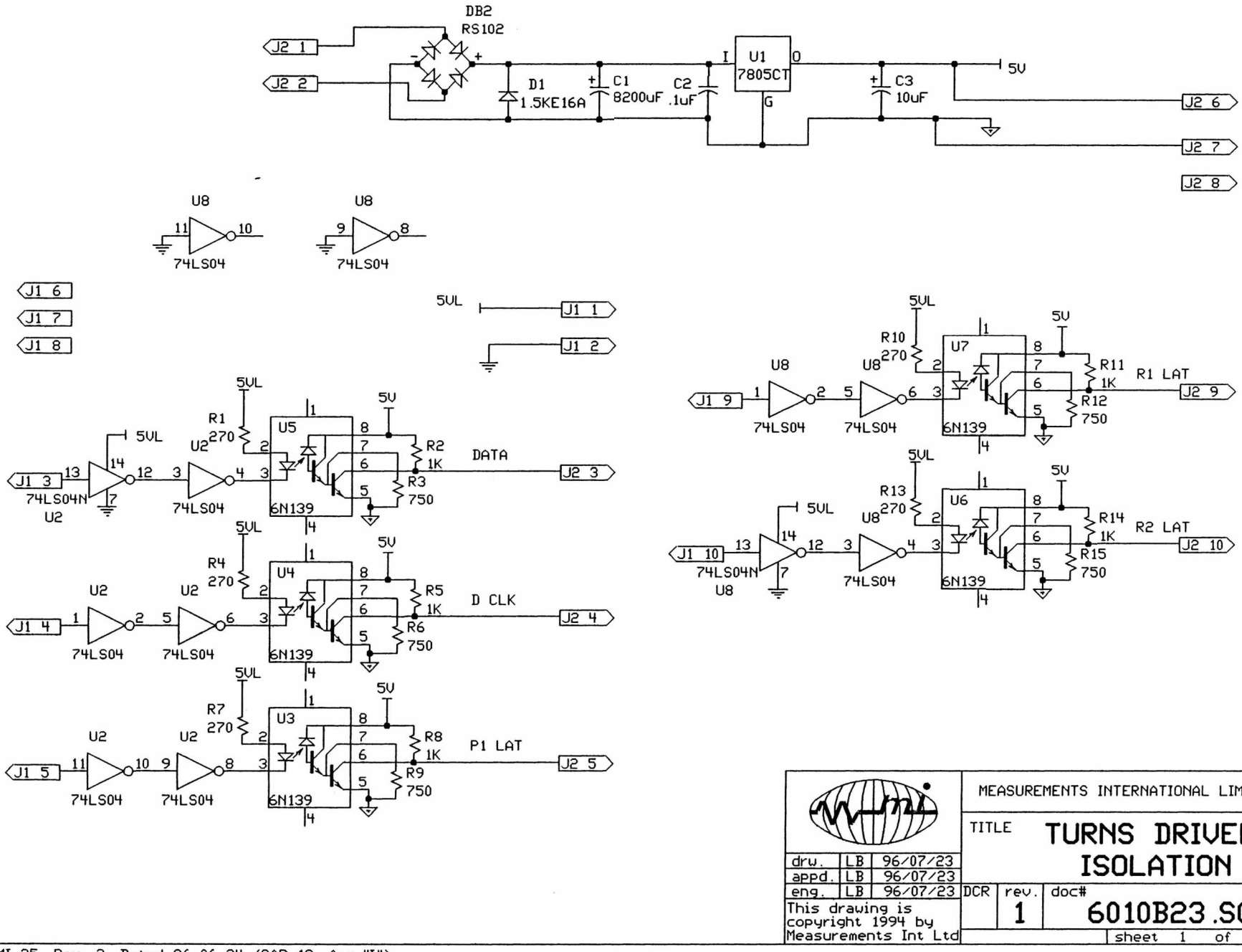
TITLE KEYBOARD/ CONTROLLER

DCR | rev. 2 | doc# 6010B08.SCH

sheet 1 of 1


SWITCH SIDE
P2
P1
U1
ALL COMPONENTS (EXCEPT SWITCHES)
MOUNT ON REAR (OTHER SIDE) OF BOARD
C1
R1
10K
C.1
C4
XTL
C5
Q1
10K
R2
U2
C8
C6
C2
C7
C3
D2
300R
R3
R4
10K
K1
NO
NC
COM
P1 10K
MEASUREMENTS
INT. LTD.
6100801
Rev 0

Revisions			
#	description	date	app'd
1	Changed Doc# to new format	97/10/29	



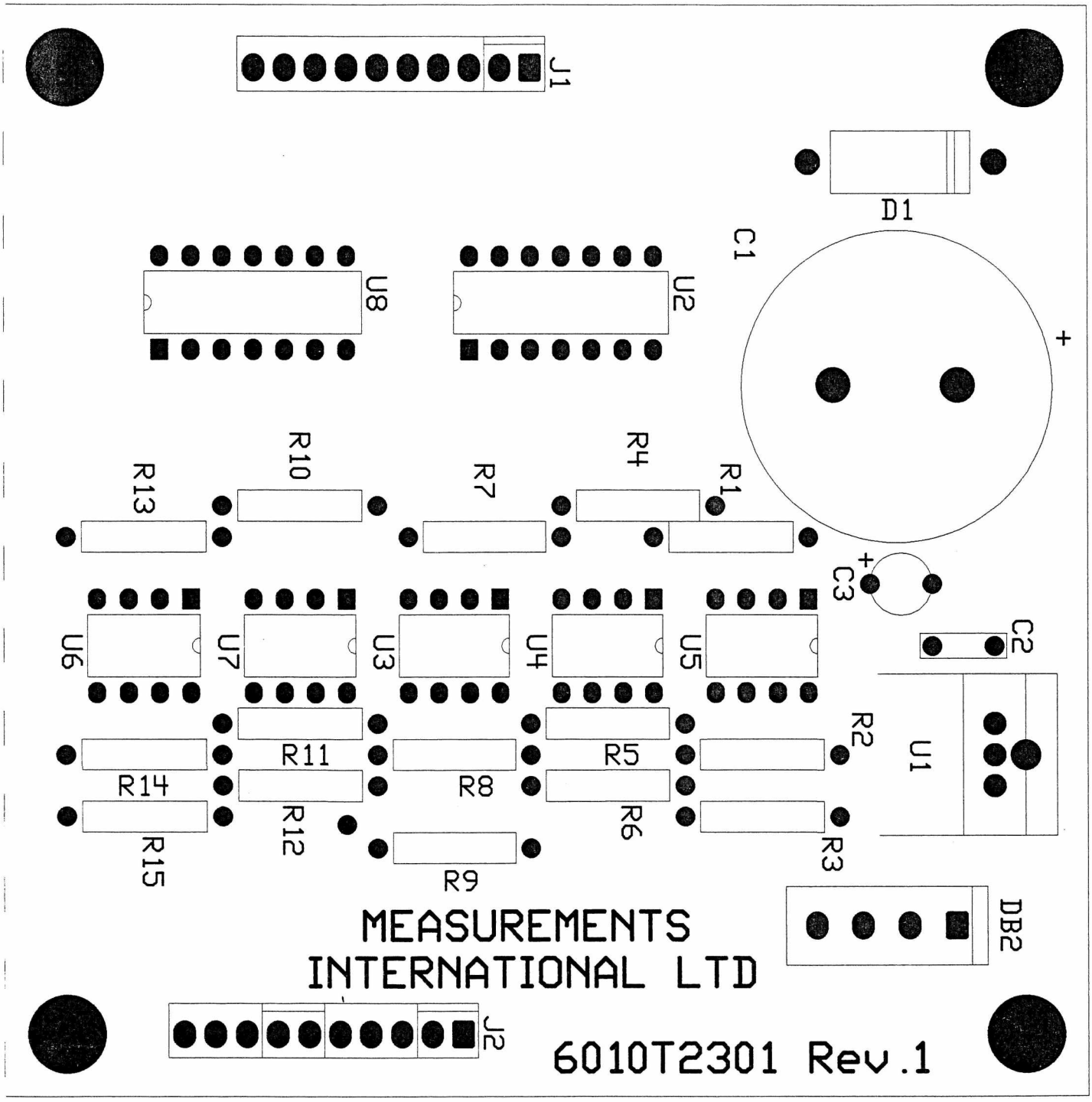
MEASUREMENTS INTERNATIONAL LIMITED

TITLE **TURNS DRIVER ISOLATION**

drw.	LB	96/07/23
appd.	LB	96/07/23
eng.	LB	96/07/23

DCR | rev. 1 | doc# 6010B23.SCH

sheet 1 of 1


J1
D1
C1
+
U8
U2
R13
R10
R7
R4
R1
+
C3
C2
U6
U7
U3
U4
U5
R2
U1
R14
R11
R8
R5
R6
R12
R15
R9
R3
DB2
MEASUREMENTS
INTERNATIONAL LTD
J2
6010T2301 Rev.1