Service Manual

PAT4DV and PAT4DVF

Covers Mk 1 Mk2 and Mk3 Models.

Edition 3.1 10th February 2004

Warning: **Only suitably trained and qualified persons should undertake servicing this product and they must read the section entitled "Safety Precautions"**

Contents

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Safety Precautions.

(1) While servicing PAT4 instruments they should be powered from a mains supply protected using a 15mA RCD. For improved safety an isolation transformer fitted in line should be employed.

(2) **High Voltages** are generated within the PAT4, which must be treated with great care. This comment is particularly relevant in the case of the PAT4DVF where **3000 Volts** are present with a short circuit current of 6mA. Capacitors within the instrument may under fault conditions remain charged after the instrument is disconnected from the mains supply.

(3) Before dismantling the PAT4 observe the position of all cable fastenings and any insulators etc. that need removal prior to the repair. **To maintain product safety** all wire positions **must** be reinstated after service and all insulation sheets must be replaced exactly as originally fitted.

(4) All replacement components must be of a type approved by “Megger Ltd.” to maintain product safety.

(5) Before a repaired PAT4 is returned to the user the service personnel must thoroughly test the instrument and be certain that it is completely safe to operate without a risk of electric shock. All protective devices fitted to the unit by the manufacturer must be present and fully operational.

(6) A full PAT test should be performed on the completed unit including a 500 V Insulation Test and 25A Earth Bond test.

Static Sensitivity Precautions.

The PAT4 models contain Static Sensitive Devices (SSD) which require correct handling. In particular service personnel should operate using an Earthed wrist strap in a correctly configured service area with conductive matting over the floor area around the workbench.

Technical Specifications.

Circuit test: Open circuit voltage: 12V ac
Short circuit current: 100mA.

Insulation test: Range: 0-50MΩ Accuracy: 5.0% ±100kΩ Compliance: 500V @ 0.5MΩ
Pass Band Options: 0.5MΩ, 1MΩ , 2MΩ , 5MΩ , 7MΩ , 10MΩ , 20MΩ ,

Earth Bond Test: Range: 0 - 999mΩ Resolution 1 mΩ 1000 - 1999mΩ Resolution 10 mΩ.
Accuracy: 0 <R> 499mΩ 5.0% ±5mΩ …..500 <R> 1999mΩ 5.0% ±50mΩ
Open circuit voltage: 10V ac
Test Current: 10A or 25A into 0.1Ω Typical.
Pass Band Options: 50m , 100m , 200m , 500m , 750m , 1.0 , 1.5 , 2.0

Continuity Test: Range: 0 - 999mΩ Resolution 1 mΩ & 1.00 - 9.99Ω Resolution 10 mΩ .
Accuracy: 0 <R> 999mΩ 5.0% ± 5m & 1.00 <R> 9.99Ω 5.0% ± 10mΩ.
Open circuit voltage: 200mV, Short circuit Current: 4.0V (PAT4DV Mk2 & 3).
Open circuit voltage: 100mV, Short circuit Current: 100mA. (PAT4DV Mk 1).
Pass Bands: 100mΩ , 500mΩ , 750mΩ , 1.0Ω , 1.5Ω , 2.0Ω , 5.0Ω , 10 Ω,

Operation Test (230V).
Range: 0 - 3.0 kVA. Accuracy: 0 <VA> 99VA 5.0% ± 5VA

100 <VA> 999VA : 5.0% ± 10VA, 1.0 <kVA> 3.0kVA : 5.0% ± 100VA
Reference: Reading corrected to 230V
Pass Bands (VA): 50, 200, 500, 1000, 1500, 2000, 2500, and 3000.

Operation Test (110V).
Range: 0 - 1.6 kVA. (3.0 kVA. Short Term)
Accuracy: 0 <VA> 99VA 5.0% ± 5VA
100 <VA> 999VA: 5.0% ± 10VA, 1.0 <kVA>1.6kVA: 5.0% ± 100VA
Reference: Reading corrected to 110V
Pass Bands (VA): 50, 200, 500, 1000, 1500, 2000, 2500, and 3000.

Earth Leakage Test.
Range: 0 - 15mA. Accuracy: 5.0% ± 100 μA (Readings corrected to 253V).
Pass Band: 0.5mA, 1.0mA, 2.0mA, 3.0mA, 5.0mA, 7.5mA, 10mA, 15mA,

Flash Test.
Range: 0 - 3.5mA. Accuracy: 5.0% ± 100 μA.
Output Voltage: Class 1: 1500Volt ac….Class 2: 3000Volt ac
Output Current: < 3.5mA @254V.
Pass Bands:0.2mA, 0.5mA, 0.75mA, 1.0mA, 1.5mA, 2.0mA, 2.5mA, 3.0mA

Fuse Test. Open circuit voltage: 5V dc Test Current: 100 mA short circuit .
Indication: Audible using internal buzzer.

Extension Lead Test.
Open circuit voltage: 5V dc 1mA short circuit current.
Indications: Lead Short Circuit (Live to Neutral).
Lead Open Circuit. (Live or Neutral)
Live / Neutral Transposed.
Lead OK.
Bond Test and Insulation Tests follow OK condition.

Section (i) Circuit Descriptions.

1.0 General Introduction.

1.1 Introduction.

PAT4DVF / PAT4DV are Portable Appliance Testers, designed for the testing of electrical appliances and equipment found in industrial, office or domestic situations.

1.2 Model Variations:

PAT4DVF: This model performs Class 1 and Class 2 Flash tests.
PAT4DV: As above without Flash test.

Sub Variations:

PAT4DVFe / PAT4DVe: Standard PAT4DVF with custom software for "ElectraTest."

1.3 Model History:

Mk1 PAT4 Models created **October 1997**
Mk2 PAT4 Models created **August 1998**. To allow use in Europe where the Mains Supply can be reversed. These units can be identified by having two Black Panel mounted fuse holders on the front panel as opposed to the original singe fuse.

The **Earth Continuity** Range was changed to provide a higher output:
Mk 2 /3: 4 Volts O/C or 200mA S/C.
Mk 1: 100mV O/C or 100mA S/C.
This opportunity was used to improve the Following :

Earth Bond Test Range simplified.
Circuit Load Test Range improved.
Mains inlet filter was relocated for improved performance.
Larger EPROM fitted allowing integral Calibration routines.
Mk3 PAT4 Models created **July 2001**. To comply with latest IEE code of practice for in service testing. Additionally an LCD backlight is fitted and a separate reference earth terminal is fitted. Up rated relay now fitted on metal bracket rather than on PCB.

1.4 Instrument Block Diagram. Refer to *Figure 1a & 1b*.

Individual elements will be described in detail later in this document but comprise:

Microprocessor 8 Bit Hitachi 6303Y running at 12Mhz (8Mhz in PAT4 Mk 1 models)
Relay switching using Peripheral Interface Adapter (IC 8).
Memory map decoding via custom PLD (IC 32).
LCD contrast and digital adjustment system.
Analogue switches for measurement channel selection.
Precision Differential Amplifier / Full wave rectifier.
12 bit Analogue to Digital converter with mains synchronised conversion.
EEPROM storage for calibration constants.
Bond Test current selection control electronics.
Continuity test / Fuse test electronics.
Flash Test high voltage transformer & current limiting networks.
Full QWERTY rubber mat keyboard with decode logic.
LCD display 2 line by 20 character text module
RS232 serial ports (used by barcode scanner and PC link).
Parallel printer port (used by barcode printer option).
Software Watchdog timer.
All power supplies required for PAT4DVF operation are derived from a standard linear system with automatic hardware for 110 to 230V changeover.

1.5 General Arrangement.

Refer to ***figure 1b*** which illustrates the general electrical arrangement of PAT4DVF components. All internal elements are built up from the front panel. This front panel is retained in the main instrument case using Four M4 screws fitted in deep recesses within the main case moulding. Mechanical arrangements are shown on Figure 31.

Fixed directly to the front panel moulding are all input and output connectors including the Parallel printer port and Serial Port. Four PCBs are screwed directly to this front moulding these are:

Keyboard PCB containing a conductive rubber key mat.
LCD Display module 2 Lines by 20 Characters (and backlight on Mk3).
IEC PCB continuing:- IEC connector used for testing extension leads, connections to both 4mm binding terminals used for Bond test and Continuity test and two connections to the Fuse Test pads.
Mains Filter PCB containing the mains inlet filter.

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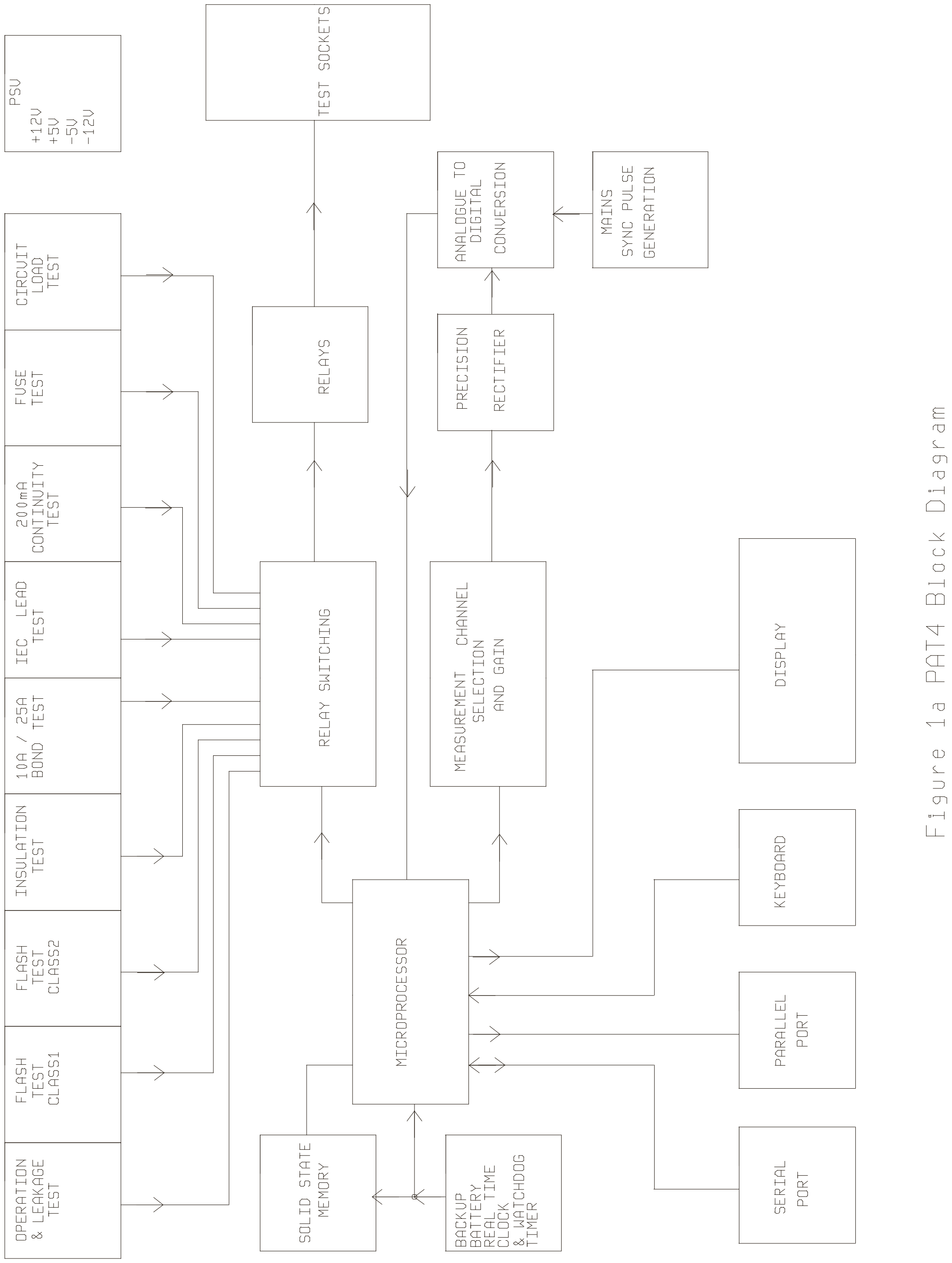


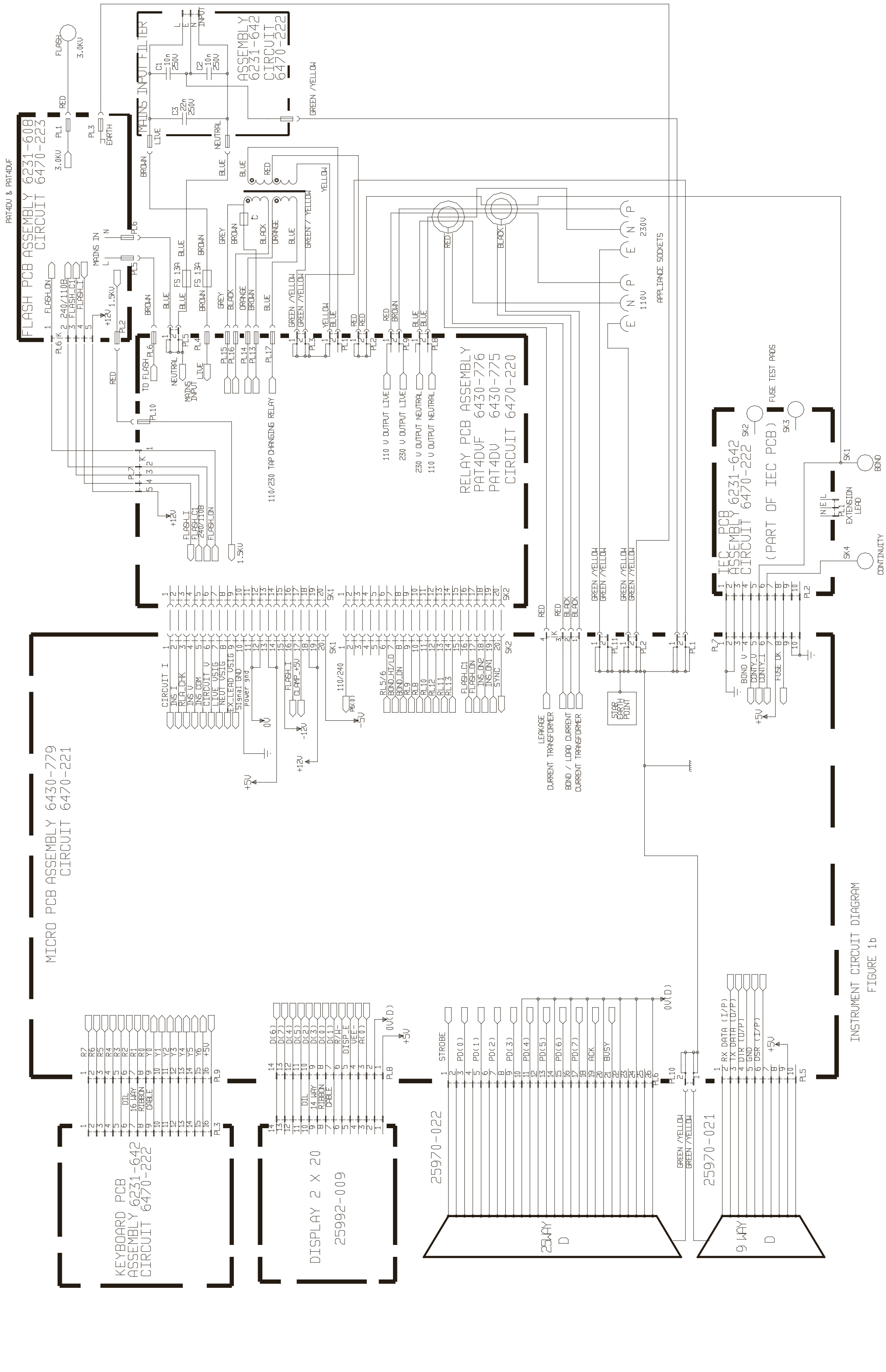
Figure 1a

Two main PCBs contain most of the PAT4 electronic components. These two boards are electrically and mechanically fixed together in a "Back to Back" format. Electrical connections between the boards is via Two, Twenty way inter-board connectors. Mechanically the boards are joined using Seven nylon "snap-fixing" pillars. These Two PCBs are screwed to Six 45mm pillars moulded to the front panel. The Four fixings nearest the Appliance Test sockets are retained using Four threaded 57mm nylon pillars while the remaining Two fixings are M4 screws. On PAT4DV models the 57mm pillars are not fitted and Four M4 screws retain the PCBs. The board nearest the front panel contains the "Microprocessor" and all analogue measurement components and is referred to throughout this documentation as the "**Microprocessor PCB**". The larger board contains all the high voltage elements including all relays, the mains transformer and Bond Transformer. It is referred to throughout this documentation as the **"Relay PCB**".

On PAT4DVF models a final PCB is located on the Four threaded 57mm nylon pillars securing the Relay PCB as described above and an additional pillar to support the middle of this PCB. This single sided PCB, referred to throughout this documentation as the "**Flash PCB**" contains all components relating to generation of the Flash Test voltages.

2.0 Software Data.

PAT4DVF data files are stored within a 512k x 8 SRAM. This is permanently retained via the on board Lithium backup battery contained within the real time clock module. This data includes all Asset information, Location data, User information, PAT4DVF set-up values, Client Information and a copy of PAT4DVF calibration constants.


FLASH PCB ASSEMBLY 6231-608
CIRCUIT 6470-223
MAINS INPUT FILTER
ASSEMBLY 6231-642
CIRCUIT 6470-222
RELAY PCB ASSEMBLY
PAT4DVF 6430-776
PAT4DV 6430-775
CIRCUIT 6470-220
APPLIANCE SOCKETS
IEC PCB
ASSEMBLY 6231-642
CIRCUIT 6470-222
(PART OF IEC PCB)
FUSE TEST PADS
BOND
EXTENSION LEAD
CONTINUITY
MICRO PCB ASSEMBLY 6430-779
CIRCUIT 6470-221
KEYBOARD PCB
ASSEMBLY 6231-642
CIRCUIT 6470-222
DISPLAY 2 X 20
25992-009
25970-022
25WAY D
25970-021
9 WAY D
INSTRUMENT CIRCUIT DIAGRAM
FIGURE 1b

3.0 Analogue to Digital Conversion.

3.1 Conversion.

Reference should be made to ***figure 2*** for Analogue To Digital Converter (ADC) circuits. IC27 is a 12Bit ADC. The 12 data bits are interfaced to the 8 Bit PC bus in two write operations. This is achieved using the Low Byte Enable (LBEN) pin (pin 18) and the High Byte Enable (HBEN) pin (pin 19)..

The analogue input range for the ADC is governed by the voltage supplied to the reference input pins" Ref. in +" and " Ref. in -" , as shown in ***figure 2***. The reference voltage is approximately 2.048Volts. This reference results in 4096 bits of ADC output corresponding to 4.096 Volts presented at the analogue input pin "IN high" pin 35.

An external 102khz clock is supplied to the ADC via "OSC In" pin 22.
This clock is derived from the incoming mains supply frequency via resistor R18 and diode D5 to transistor TR4. This transistor simply provided a 50Hz (or mains frequency equivalent) 5Volt positive square wave which is fed via inter board connector SK2 to phase locked loop IC4 on the microprocessor board.

The Phase Locked Loop (PLL) chip consists of two parts. The 50hz signal is fed to pin 14, which is the input to a phase sensitive detector. A reference signal is supplied to the comparator input at pin 3.
The comparator action is as follows. If the input frequency (pin 14) is higher than the comparator input (pin3) frequency, the comparator output is low for most of the clock period. If the input frequency (pin 14) is lower than the comparator input (pin 3) frequency, the comparator output is high for most of the clock period.

The error signal generated is fed to the second section of the PLL, the Voltage Controlled Oscillator (VCO) pin 9 via a filter R30, R34, C16, and R37. The voltage presented to the VCO input (pin 9) in conjunction with the internal VCO oscillator generates a fixed frequency at the VCO output pin 4. C12, R25 and R26 set the internal oscillator frequency. By connecting divider chip IC5 between the VCO output (pin 4) and the comparator input (pin 3) it becomes possible to generate higher frequencies with respect to the input signal. The PAT4 uses the Q10 output .A mains frequency of 50Hz generates a locked output of 102.4khz.

The ICL7109 ADC chip is operated in processor controlled single shot mode. RUN/HOLD (pin 26) being the "Start a conversion" command from the processor IC27 P2(7). After the signal has been received the ADC during the conversion drives the “STATUS” control line (pin 2) high. The processor via P5 (7) awaits the negative going transition of RUN/HOLD, which indicates valid data is available. Two further control lines the Low Byte Enable (LBEN) pin 18 controlled by A0 and the High Byte Enable (HBEN) pin 19 which is controlled by A1 connect the respective byte to their output pins.

Analogue signal amplification and precision full wave rectification are implemented using amplifiers IC12 and IC37 before connection to the ADC analogue input.

3.2 Differential Amplifier.

Amplifier IC37 consists of a dedicated differential instrumentation amplifier with a gain of six. This value of gain results in 666mV of signal (peak) corresponding to 4.0Volts and a digital value of 4095 bits at the analogue to digital converter.

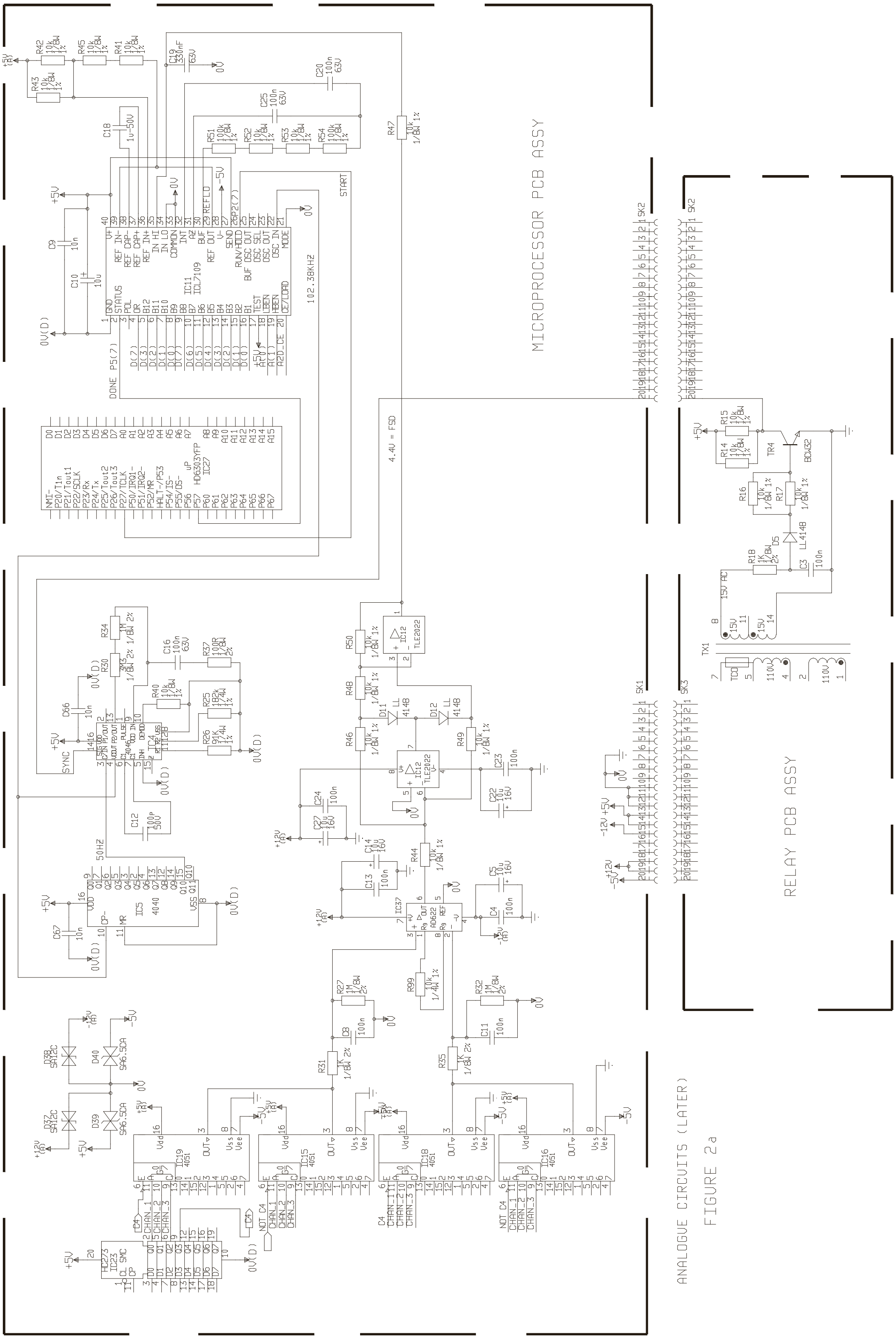

MICROPROCESSOR PCB ASSY
RELAY PCB ASSY
ANALOGUE CIRCUITS (LATER)
FIGURE 2a

Figure 2a

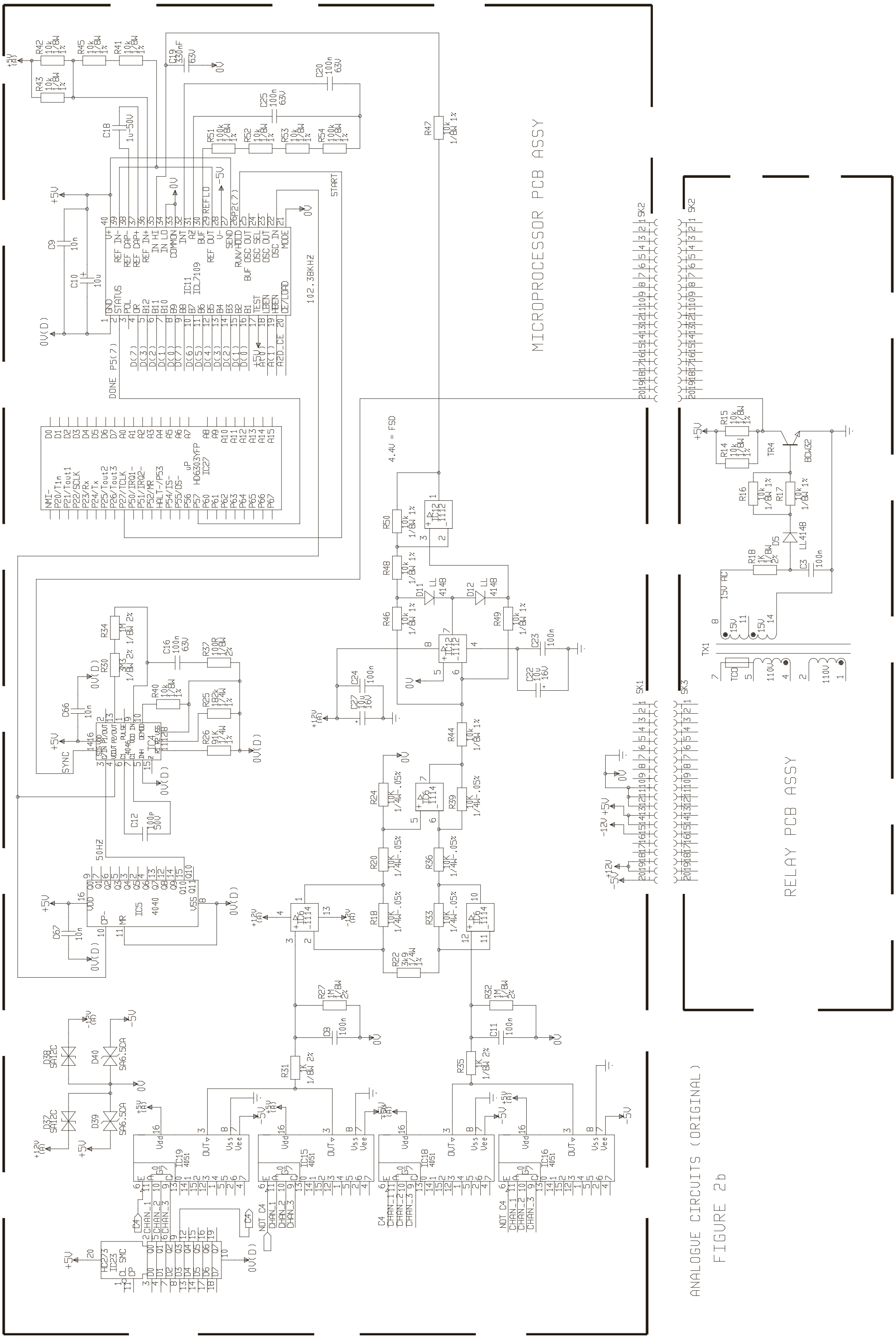


Figure2b

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For earlier PAT4 instruments refer to ***figure 2b*** which illustrates a discrete "Three Op Amp" differential amplifier IC6. Differential input being applied between Pins 3 and 12and single ended output from Pin 7 with a gain of Six.

3.3 Rectification.

Amplifiers IC12 act as a full wave precision rectifier. During positive input polarity, diode D11 conducts and resistor R46 becomes the feedback element while R49 is effectively disconnected due to reverse bias on diode D12.
During negative input polarity diode D12 conducts and resistor R49 becomes the feedback element while R46 is effectively disconnected due to reverse bias on diode D11. Therefore the output voltage is always positive.
For earlier PAT4 instruments refer to ***figure 2b,*** where an alternative Op amp (IC 12) was used.

3.4 Analogue channel selection.

Measurement channel selection uses Four Multiplexer (IC15, IC16, IC18 & IC19). To maintain a switchable differential input for all channel selections, the Multiplexer are arranged in pairs such that one Multiplexer switches Input High while Input Low is selected by a second Multiplexer. Analogue measurement channels are designated for software purposes Channel (0) to Channel (15) these are tabulated below for reference.

Using Multiplexer IC19 and IC18

(00) = 100mA Continuity Test Current (Differential measurement)
(01) = Operation Test Current and Bond Test Current.
(02) = Leakage Current.
(03) = Live 230 V Voltage Measurement.
(04) = Not used.
(05) = Insulation Test Current .
(06) = Relay welded contact test.
(07) = Insulation Test Voltage.

Using Multiplexer IC15 and IC16

(08) = Flash Test Current.
(09) = Circuit / Load Test Current.
(10) = Circuit / Load Test Voltage.
(11) = Extension Lead Test.
(12) = Bond Test Voltage.
(13) = 100mA Continuity Test Voltage Measurement.
(14) = Mains Neutral Voltage Measurement.
(15) = Cold / Warm start detector.

Individual channel selection is from Latch IC23 which connect to Multiplexer address lines (A,B,C). and Multiplexer *enable* lines which are coupled in pairs generating complementary signals *mux_enable* and *mux_enable-*. The selected channel are internally connected to the Multiplexer output pins (pin 3). The Multiplexer outputs feed the differential amplifier described in section 3.2.

4.0 PAT4DVF General circuits.

Reference should be made to ***figure 3***.

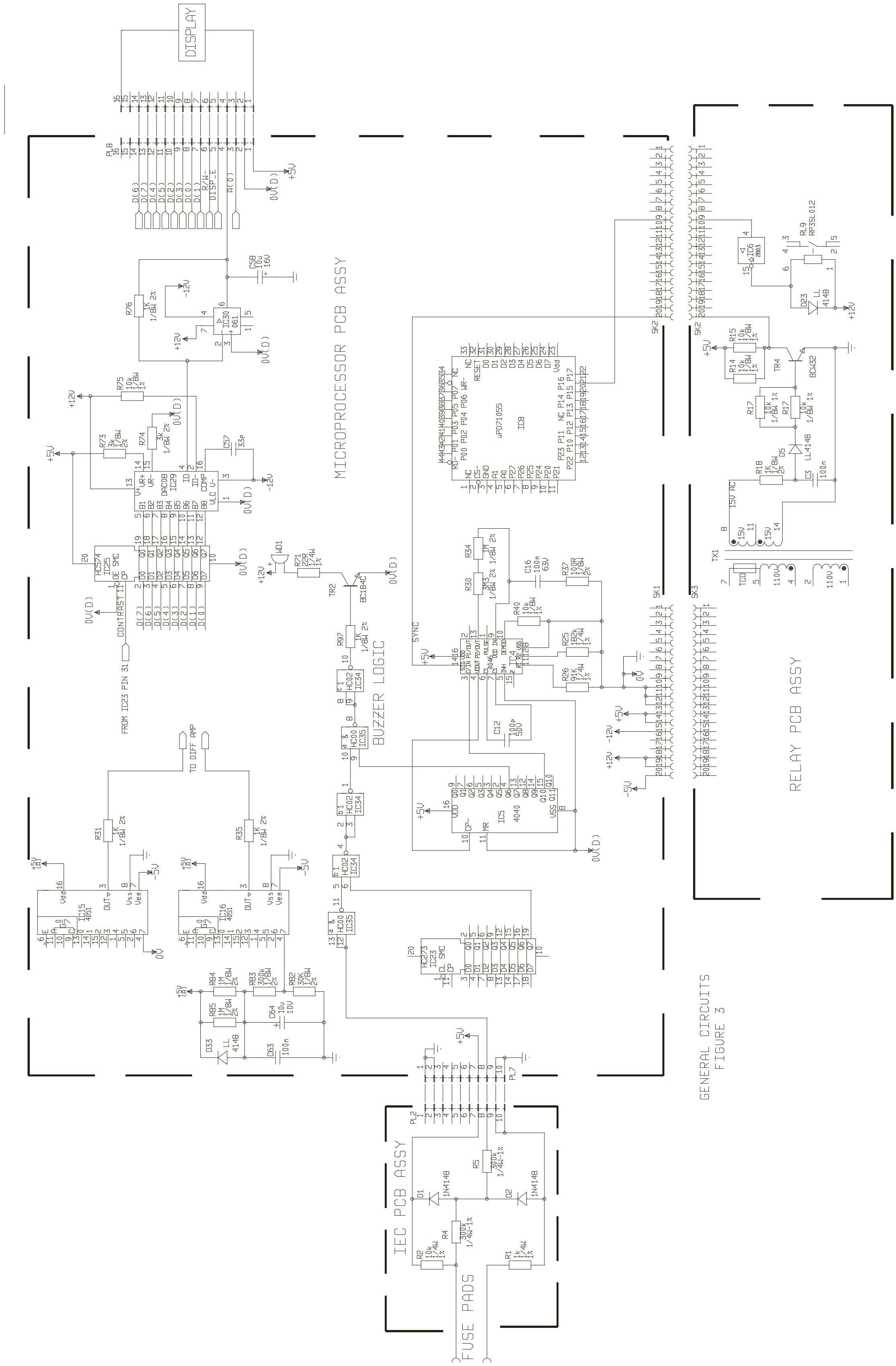

Figure 3

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4.1 Peripheral Interface Adapter (PIA).

All relay functions, and the parallel port are implemented on PAT4DVF using a PIA chip IC8. Type UPD71055 is employed. This chip provides 12 Lines of I/O and provides on board the necessary control, latching, buffering and handshaking of the data presented to or from the data bus. The chip has an individual memory address for each Port. When the required address appears on the address bus the Chip Select (*CS*) input to the PIA device is set LOW. Whilst the CS signal is derived from higher order address lines, the two Least Significant Bits of the address bus are fed to pins *A0* and *A1* to provide sequential memory location address decoding. Data direction to / from the data bus from / to the PIA is controlled by the inputs referred to as Read (*RD*) and Write (*WR*), when PIA input *RD* is LOW the processor can Read the PIA for data. Similarly when *WR* is low the processor can Write to the PIA registers. The final control line present on the PIA chips is *Reset* this is normally held LOW. When taken HIGH all I/O Ports are switched to input mode and all latches are cleared, control of this line is via the bus *Reset* line. The operating mode and direction of all PIA Ports is configured by software.

4.2 Relay Drive configuration.

All PAT4DVF relays are driven from one Bit of a PIA port. Since the PIA ports are not capable of supplying large currents and their outputs are limited to +5 Volts, relay coils are driven using two octal Darlington driver chips IC12 and IC13 which provided increased drive current and level shifting to +12 Volt supply. An example relay drive arrangement is shown on **Figure 3** which illustrates the arrangement for relay RL9 (all other relays are identical using a different PIA pin). To energise a given relay the respective PIA port is driven HIGH. The Darlington driver chips are located on the relay board except on PAT4 Mk 1 models where they were placed on the Microprocessor PCB.

4.3 Fuse Test and Buzzer circuitry.

The buzzer employed on the PAT4 is of the non-self exciting type i.e. it must be supplied with a source of a.c. at or near its resonant frequency. Using a divided output from the PLL (IC 4 & IC5) provides this signal at 6.4khz. (See section 3.1).
Current drive to the buzzer WD1 is provided by transistor TR2. This transistor is gated via IC35b & IC34c (which form an "AND" gate) with the a.c. signal (at approximately 6.4khz.) and a control signal produced by ("OR" configured) gates IC34a & IC34b. At IC34b pin 10 a logic high will result in the a.c. signal on pin 9 commutating to the output and thus the buzzer will sound.
The gates IC34a & IC34b allow both software (via latch IC5) & hardware (via IC35a) to control the buzzer.

For software control a logic high generated by latch IC5 will activate the buzzer. Hardware operation is required for the Fuse Test. With no fuse (or a defective fuse) across Fuse Pads, PL7 pin 8 will be pulled High by the action of Resistor R2, R4 & R5 (located on IEC PCB). This high signal is therefore inverted by the action of IC35a resulting in no buzzer. With a good fuse across the fuse pads the situation is reversed as PL7 pin 8 will be pulled Low by the action of Resistor R1, R4 & R5 and hence the buzzer will operate.

4.4 Warm Start detection circuitry.

Channel (15) IC15 & IC16 pin 4 monitors the warm / cold start detection circuit. If a corruption occurs the microprocessor will try to continue the test that was in progress from the point where it stopped. However, it needs to be able to distinguish between an error and the instrument having been turned off in which case it should make no attempt to continue with the test. R82, R83, R84, R85, C63, C34 and D33 achieve this. The ADC measures the voltage across R82 (2V under steady state conditions). C64 produces a time constant of approximately 2s.

After an error, Channel (15) is measured and if it is approximately 2V, an error has occurred and the test will be re started. If however the instrument has just been turned on (i.e. a cold start), the microprocessor, which measures Channel (15) early on during its initialisation process, will find less than 1V and realise that it should perform a cold start.

4.5 Display Contrast circuitry.

An 8 bit Multiplying D/A converter (DAC08) IC29 is employed on the PAT4 to provide digital control of LCD contrast voltage. As the DAC08 contains no input latches a separate latch IC25 is added to maintain the digital input to the D/A converter. The D/A converter used provides on analogue output current based on the digital value of the input. The current from pin 4 is fed to the current / voltage converter formed from IC30.
The output voltage presented to the display contrast pin is: 0 to + 1.7 Volts

5.0 PAT4 Microprocessor and associated circuits.

Reference should be made to ***figure 4***.

IC27 is an 8 bit microprocessor which has built in timers, serial communication interface and latched i/o ports. It has a 16-bit address bus and therefore a 64k-address range. It is used with a 12Mhz crystal, giving a 3Mhz system clock, which appears on pin 57 (the **E** signal).

Address decoding is provided using PLD IC32 and gates IC31.
The PLD also generates the bank switching hardware for both RAM and EPROM, which extends the addressable memory beyond the address range of the processor.

5.1 Address Map

0000-0027	6303 Internal ports
0040-013F	6303 Internal scratchpad RAM (volatile)
0140-1FC0	Scratchpad RAM and stack area (battery backed ext. RAM)
1FC1-1FC2	Analogue to Digital Converter
1FC4-1FC7	Keyboard
1FC8-1FCB	PIA
1FCC-1FCF	Latch
1FD0-1FD3	Liquid Crystal Display
1FE0-1FEF	Real time Clock
2000-3FFF	Banked RAM blocks (battery backed) (x15)
4000-9FFF	Banked EPROM blocks (x8)
A000-FFFF	Non-banked EPROM

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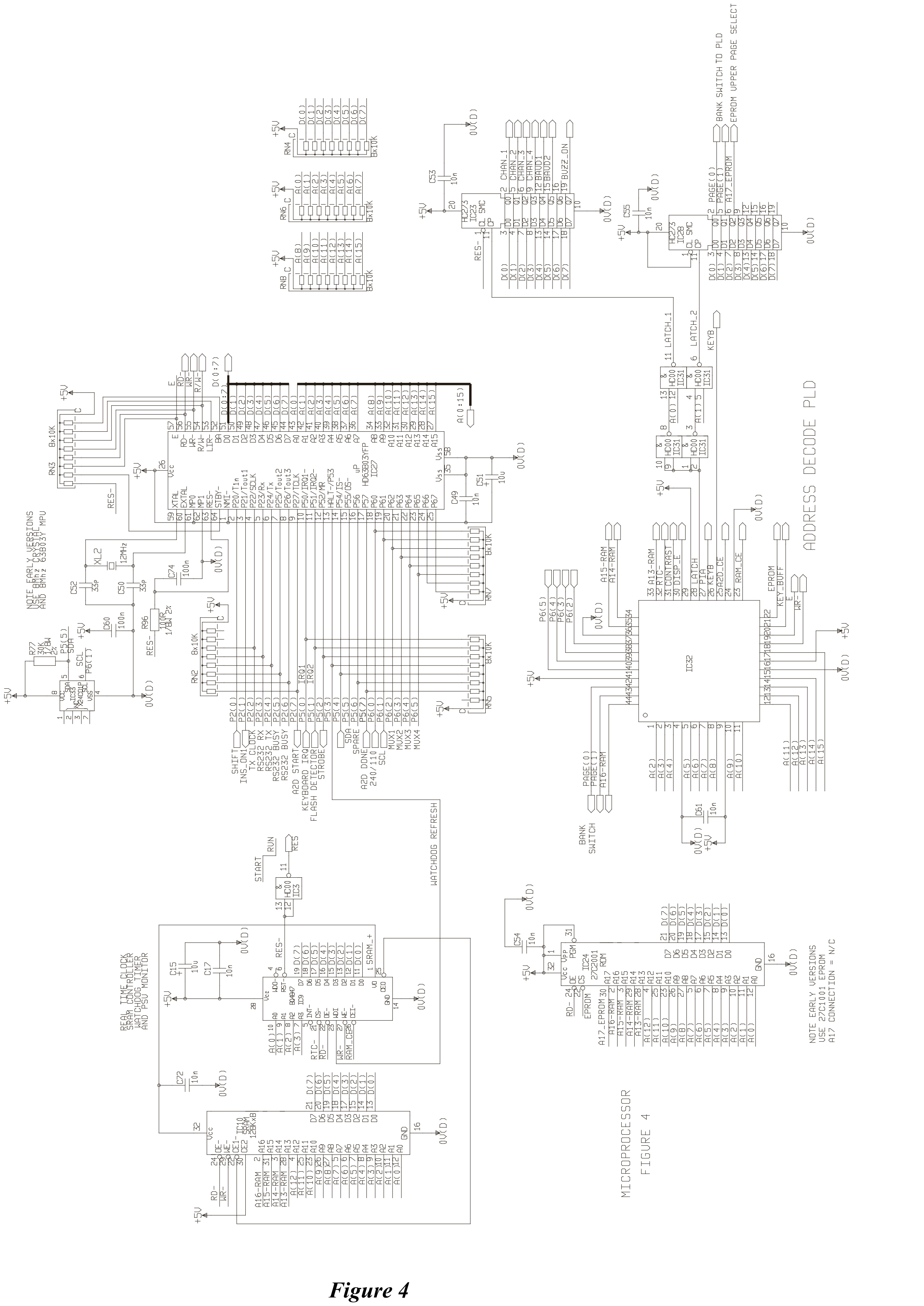

Figure 4

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5.2 Microprocessor port functions.

Port 2 P2(0) to P2(7)

Bit	Direction	Function.
0	I	Keyboard SHIFT key/Flash enable key
1	O	Insulation test - HV generator enable
2	I	Serial comms. baud rate clock input
3	I	Serial comms RXD
4	O	Serial comms TXD
5	O	Serial comms DTR
6	I	Serial comms DSR
7	O	A2D converter start

Port 5 P5(0) to P5(7)

Bit	Direction	Function.
0	I	Keyboard IRQ
1	I	Flash breakdown Detector
2	O	Printer Strobe
3	O	Watchdog refresh
4	I	Not Used
5	I/O	E2prom serial data in/out
6	I	Spare
7	I	A2D converter Done

Port 6 P6 (0) to P6 (7)

Bit	Direction	Function.
0	I	230/110 voltage discriminator
1	O	E2prom data clock
2	O	Mux selection line 1
3	O	Mux selection line 2
4	O	Mux selection line 3
5	O	Mux selection line 4
6	O	Spare
7	O	Spare

5.3 Electrically Erasable Memory (EEPROM).

All PAT4DVF calibration constants are stored in EEPROM (IC 15). This device (X24C01) is a CMOS 1024bit with serial interface chip. Data in to or out from the device is present on the Serial Data (SD) pin that is therefore bi-directional. Data control is achieved using the Serial Clock (SLC) pin. 32.

5.4 Memory mapped Latches.

Two latches provide additional memory mapped Output Ports.

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Latch IC 23

Bit	Direction	Function.
0	O	Analogue Multiplexer Selection line 1
1	O	Analogue Multiplexer Selection line 2
2	O	Analogue Multiplexer Selection line 3
3	O	Analogue Multiplexer Selection line 4
4	O	Baud Rate Select 1 *
5	O	Baud Rate Select 2 *
6	O	Spare
7	O	Sound Buzzer

* Baud rate changes are not user selectable but change between scanner input at 2400 Baud and Upload / Download which are pre-set to 9600 Baud within the software.

Latch IC 28

Bit	Direction	Function.
0	O	Page Switching to PLD Page (0).
1	O	Page Switching to PLD Page (1).
2	O	EPROM A17 Line *
3	O	Spare
4	O	Spare
5	O	Spare
6	O	Spare
7	O	Spare

* Early PAT4s used a smaller 27C1001 EPROM therefore A17 is not available.

5.5 Memory, Watchdog and Real Time clock module.

The Real Time Clock (RTC) module IC9 contains a Lithium Battery power crystal controlled Clock / calendar module. This clock integrates, a time of day, 100 year calendar, CPU supervisor watchdog, a battery and timing crystal .

The watchdog functions by expecting the microprocessor IC27 to regularly toggle the watchdog input pin 23. If for any reason the microprocessor stops toggling the watchdog within the internally programmed time out period (set to 1.5 seconds by software) IC9 pulls the reset line at pin 6 low causing the microprocessor to respond with a reset.

The supervisor section contains a temperature compensated reference and comparator that monitors the status of the +5 Volt rail. When an out of tolerance condition is detected a full reset signal is generated.

Memory power is obtained via the Lithium battery circuits that will write protect the SRAM memory device IC10 during out of specification conditions.

5.6 EPROM

The EPROM operates in page mode as described in section 5.1. Page selection is achieved via software using PLD IC32 and latch IC28.

N.B. Earlier PAT4 models use a 27C1001 (128Kx8) EPROM while later units use a 27C2001 (256Kx8) EPROM.
The software contained within the EPROM is not interchangeable between models.

6.0 Keyboard circuit.

Reference should be made to ***figure 5a***.

The keyboard comprises a rubber mat with conductive "Pills" it each key position. These conductive "pills" are positioned above a pair of gold plated fingers etched into the Keyboard PCB below each rubber key. When a given key is pressed, the conductive “Pill” bridges the two parts of the gold fingers.
The keyboard is arranged as shown on figure 5 in an 8 x 5 matrix with an isolated "shift key". The processor-using latch IC26 sequentially enables the Rows labelled R0 to 7. The key status is read from columns labelled C0 to C5 using memory-mapped latch IC22. A software lookup table translates the individual keys into their ASCII equivalent for use by the software.

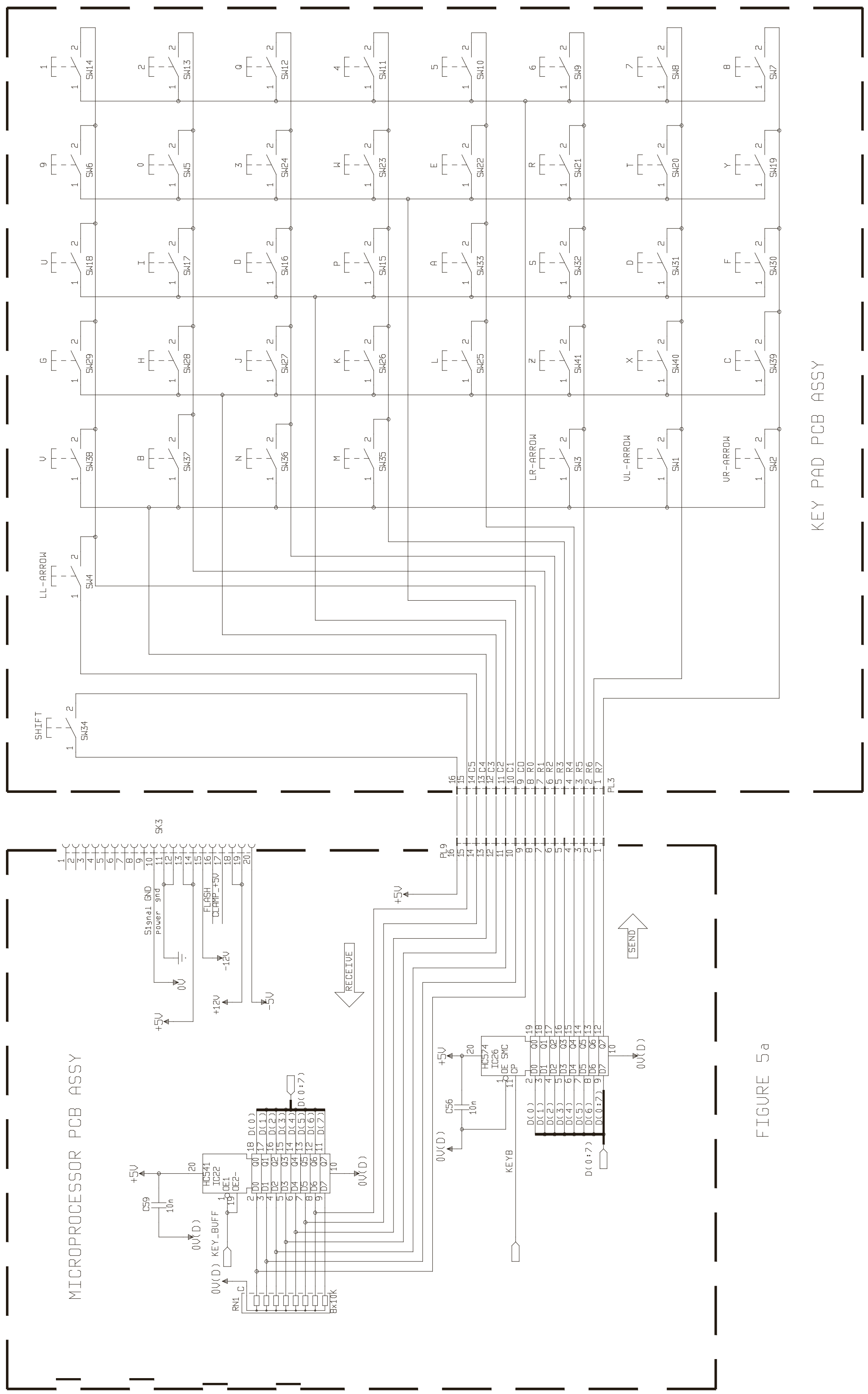

Figure 5a

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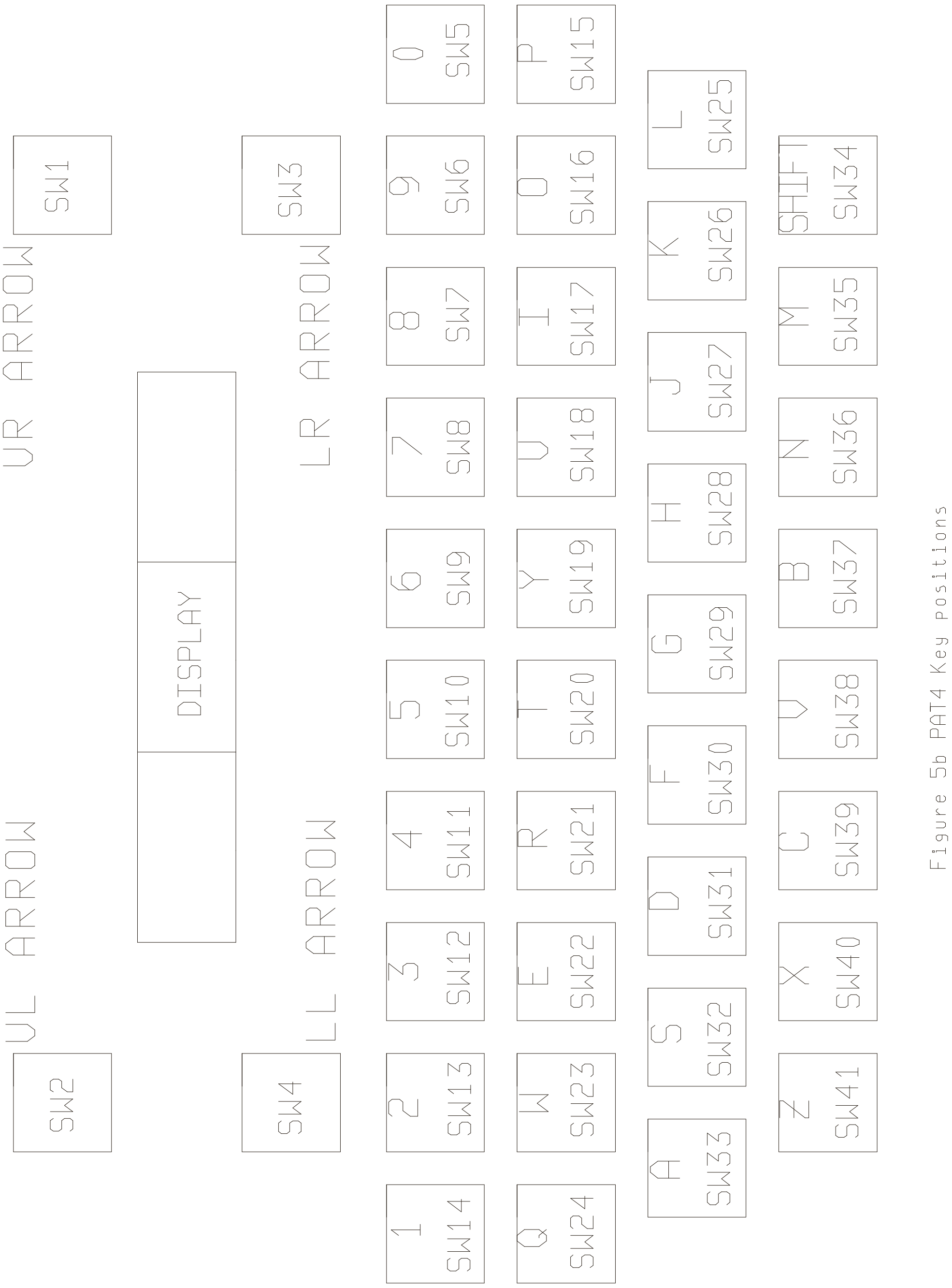

Figure 5b

7.0 Communications Block.

Reference should be made to ***figure 6.***

7.1 Serial Port. RS232 interface.

The PAT4 can transmit data to a serial device, and receive from it. A Handshake line (input) is provided so that the receiving device can control the data flow.

Microprocessor IC27 contains a built in serial communication interface, which is capable of operation asynchronously or synchronously, with a variety of data formats.

The baud rate may be derived from the system clock, an internal timer or from an external oscillator. It takes parallel data generated within the microprocessor and converts it into serial, which is output on pin 6 labelled TX data (O/P).
PAT4 uses asynchronous mode with a data format of 1 start bit, 8 data bits, 1 stop bit and no parity. The baud rate generator is derived from an external source (connected to pin 4) labelled TX CLOCK which is divided by 16.
For example a baud rate of 9600 baud (bits per second). 9600 baud is equivalent to 104.17µs per bit. Given the division ratio, the period of the baud rate signal is given by (104.17µs/16) = 6.51µs (or 153.6kHz). With a 2.4576MHz ceramic resonator (XL1) a division ratio of 16 is required.
IC21 is a 14 stage binary counter with onboard oscillator, driven by a 2.4576MHz ceramic resonator XL1. Not all of the outputs from the 14 stages are available. IC21 produces the following outputs: -

IC21 Output	Division	Output	Baud Rate
Q4 (pin 7)	**16**	**153.6kHz**	**9600**
Q5 (pin 5)	**32**	**76.8kHz**	**4800**
Q6 (pin 4)	**64**	**38.4kHz**	**2400**
Q7 (pin 6)	**128**	**19.2kHz**	**1200**
Q8 (pin 14)	**256**	**9.6kHz**	**Not Used**
Q9 (pin 13)	**512**	**4.8kHz**	**Not Used**
Q10 (pin 15)	**1024**	**2.4kHz**	**Not Used**
Q12 (pin 1)	**4096**	**600Hz**	**Not Used**
Q13 (pin 2)	**8192**	**300Hz**	**Not Used**
Q14 (pin 3)	**16384**	**150Hz**	**Not Used**

Q4 to Q7 outputs from IC21 supply Multiplexer, IC20, whose selection inputs are driven from latch IC23, signals BAUD_1 and BAUD_2. This allows changing the baud rate of the serial port under software control. The selection inputs of IC20 are as follows: -

S0	**S1**	**Baud Rate**
BAUD_1	**BAUD_2**	
0	**0**	**9600**
1	**0**	**4800**
0	**1**	**2400**
1	**1**	**1200**

IC13 is a level shifter and inverter, TTL inputs are translated to RS232 outputs.

Driver Input Pins **10, 12, & 14**	**Driver Output Pins 3, 5 & 7**
+5V	**-12V**
0V	**+12V**

It also converts incoming RS232 signals (±3V to ±30V) to TTL outputs.

Receiver Input Pins 2, 4, & 6	**Receiver Output Pins 15, 13 &11**
+ 12V	**0V**
- 12 V	**+ 5V**

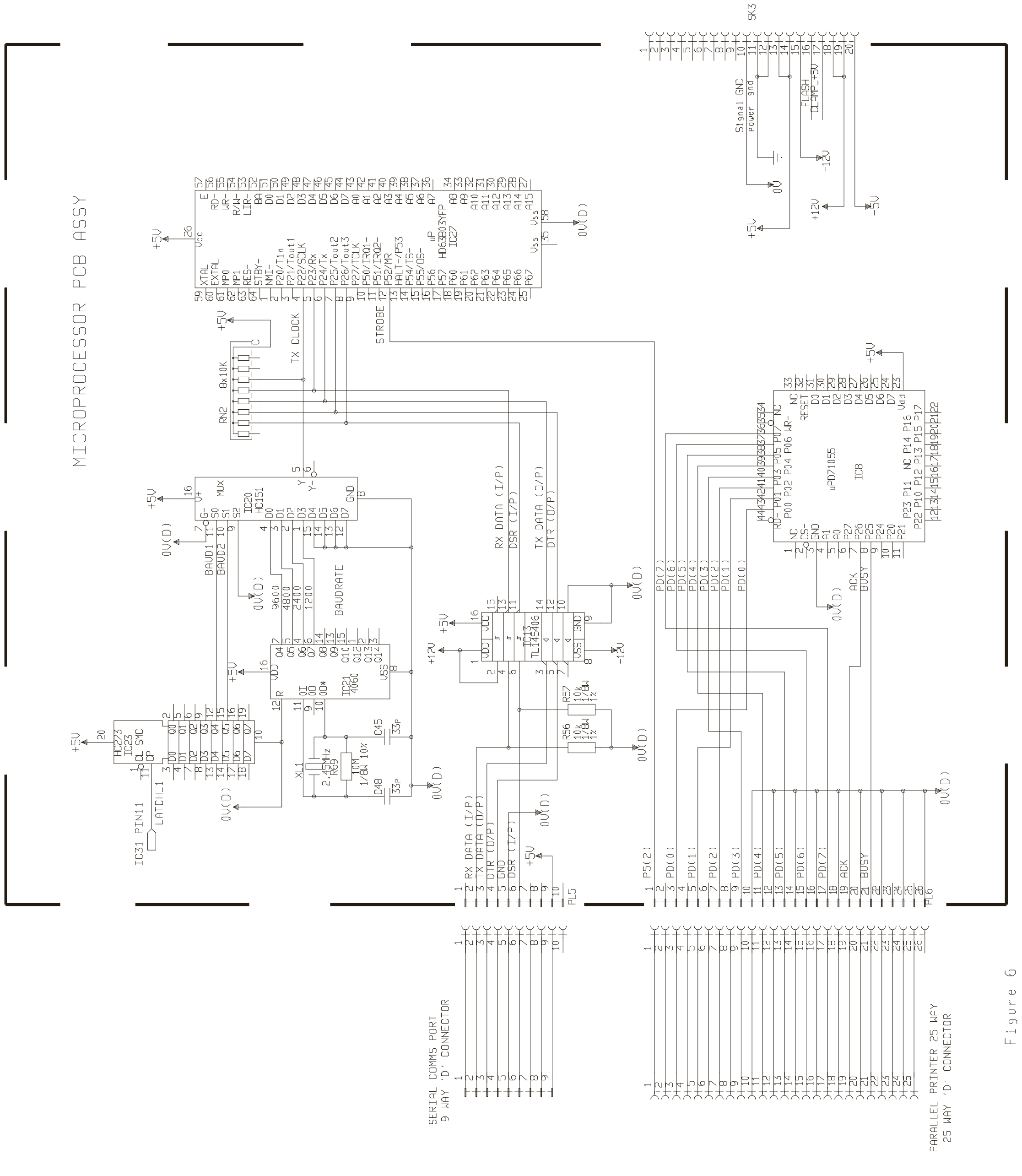

Figure 6

7.2 Parallel Port.

PAT4 implements a simplified form of a parallel port using the signals shown below. With the exception of "***Strobe***" all signals originate from or are read by the PIA chip IC8. Device is memory mapped as described in section 4.1 above. Connections are brought out to a standard 25 way female 'D' connector.

A simple protocol is as follows.

The microprocessor IC27 (pin 12) sets the ***Strobe*** Line ***High.*** The status of the ***Busy*** Line is tested via PIA IC 8, If ***Busy*** is ***Low*** the 8 bit Word to be printed is loaded to PIA IC 8 Port 0(0:7). After loading the Data Word the microprocessor IC27 (pin 12) sets the

Strobe Line ***Low*** for approx. 100ms after which time ***Strobe*** returns ***High***. The printer sets ***Busy High*** in response to the falling edge of ***Strobe***, to prevent the PAT4 sending further data, until the current data has been processed The process repeats for the next characters.

Signal Name	**Direction**	**Function.**
Strobe -	**O**	**Printer must read Data on a HIGH to LOW Transition**
D0	**O**	**Parallel Data (High = 1)**
D1	**O**	**Parallel Data (High = 1)**
D2	**O**	**Parallel Data (High = 1)**
D3	**O**	**Parallel Data (High = 1)**
D4	**O**	**Parallel Data (High = 1)**
D5	**O**	**Parallel Data (High = 1)**
D6	**O**	**Parallel Data (High = 1)**
D7	**O**	**Parallel Data (High = 1)**
BUSY	**I**	**LOW on this line = Send Data to Printer**
ACK-	**I**	**Not used**

8.0 Power supply Circuits.

Reference should be made to ***Figure 7.***

8.1 Auto ranging input selection.

During power up the voltage delivered from the rectified output from transformer TX1 is monitored by voltage comparator IC1. This element determines the correct position for voltage changeover relay RL14 which performs a series / parallel switching to the primary winding of TX1. Auxiliary outputs switch the Bond Test transformer primary and on PAT4DVF models the Flash Test transformer. PAT4 models always start in the 230-Volt position.

The non-inverting (Reference) input at pin 11 is derived from the +5 Volt regulator VR3. Resistors R28 & R34 generate a 2.5-Volt reference. This voltage is connected to pin 11 by resistor R38. Capacitor C39 allows the reference voltage to remain for a period after switch off. This 2.5 volt reference is independent of relay RL14 position.

The magnitude of the mains supply is monitored after step down transformer TX1 and rectification by bridge rectifier BR1. Resistors R24, R25 & R29 form a potential divider. With a 230-Volt supply the voltage presented to IC1 inverting input pin 10 will be 3.4 Volts. This combination will force the comparator output Low.
With a 110-Volt supply the voltage presented to IC1 inverting input pin 10 will be 1.4 Volts. This combination will force the comparator output High via "pull up resistor R27.
Due to the feedback action of the circuit this 110V condition cannot normally be measured as the circuit reconfigures for 110V operation with the secondary of TX1 returning to the 230Volt condition.
To prevent spurious switching during power up (and down) a transistor clamp operates on comparator IC1 output. Transistors TR7 & TR8 form this clamp circuit. Transistor TR7 is held in the off condition for a period determined by the current presented via

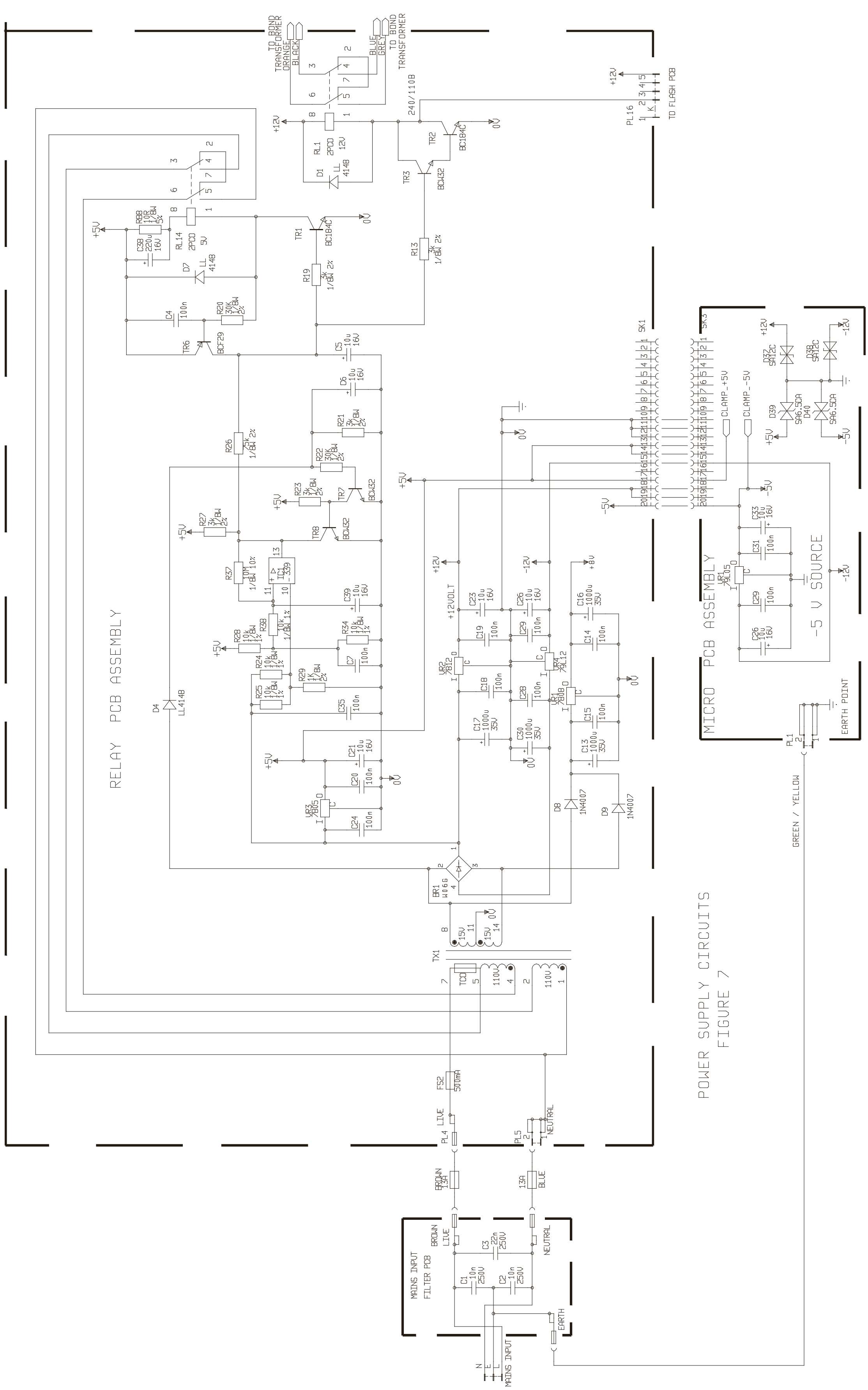

Figure 7

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resistor R22, which is coupled to a fast acting version of the rectified supply derived via diode D4. With TR7 "Off" transistor TR8 is biased "On" via resistor R23 and comparator output is pulled to ground.

Assuming 110 Volt supply at start up, comparator output from IC1 pin 11 will be high and supplying base current to transistor TR1. Resistor R26 ensures that the comparator output current is insufficient to allow relay RL14 to energise. However TR1 collector current is sufficient to allow transistor TR6 base to conduct causing an increase in base drive to TR1 and hence operation of relay RL14 and via R13, TR2 & TR3 operation of relay RL1. The combination of TR2 & TR6 form latching elements with an initial time delay determined by capacitors C4 & C5.

8.2 Positive 5 Volt supply.

The +5Volt supply used for all logic devices is derived from linear voltage regulator VR3. This 1A device obtains its unregulated 20Volt D.C. input from across smoothing capacitor C17. Bridge rectifier BR1 provides rectification. C20, C21 and C24 form the usual filtering function close to the regulator. The signal labelled "clamp_+5v" provides a non-current carrying path from analogue clamp diodes on the microprocessor PCB back to the low impedance source. Transient Suppresser D39 fitted to the Microprocessor PCB protects the semiconductor devices against the effects of transients on the supply line. (Not fitted to earlier PAT4 models)

8.3 Negative 5-Volt supply.

The -5Volt supply is derived from linear voltage regulator VR1 located on the Microprocessor PCB. This 100mA device obtains its regulated -12Volt D.C. input from the regulated –12V supply described below. C26, C29, C31 and C33 form the usual filtering function close to the regulator. The signal labelled "clamp_-5v" provides a non-current carrying path from analogue clamp diodes on the microprocessor PCB back to the low impedance source. Transient Suppresser D40 fitted to the Microprocessor PCB protects against the effects of transients on the supply line (not on PAT4 Mk 1 models).

8.4 Positive 12 Volt supply.

The +12Volt supply is derived from linear voltage regulator VR2. This 1A device obtains its unregulated 20Volt D.C. input from across smoothing capacitor C17. Bridge rectifier BR1 provides rectification. C17, C18, C19 and C23 form the usual filtering function close to the regulator. Transient Suppresser D37 fitted to the Microprocessor PCB protects the semiconductor devices against the effects of transients on the supply line. (Not fitted to earlier PAT4 models).

8.5 Negative 12-Volt supply.

The +12Volt supply is derived from linear voltage regulator VR4. This 100mA device obtains its unregulated input from across smoothing capacitor C30. Bridge rectifier BR1 provides rectification. C26, C28 and C29 form the usual filtering function close to the regulator. Transient Suppresser D38 fitted to the Microprocessor PCB protects against the effects of transients on the supply line. (Not fitted to earlier PAT4 models).

8.6 Positive 8 Volt supply.

The +8Volt supply used to power the Insulation test inverter is derived from voltage regulator VR1. This 1A device obtains its unregulated input from across smoothing capacitor C13. Diodes D8 & D9 provide rectification, this arrangement was used to prevent the large start-up current demand from the inverter loading all other supply rails. C14, C15 and C16 form the usual filtering function close to the regulator.

8.7 Fusing.

13Amp 1" Front panel mounted fuses are provided in both the "Live" & "Neutral" conductors on PAT4 Mk 2 & 3 models. This allows operation on "European" mains systems where the Polarity of the mains supply is reversible. Fuse FS2, provides protection against electric shock should a relay fault develop in RL6 while operating with reversed mains supply. Fuse FS2, provides protection against fire should a short circuit develop within the mains transformer. Fuse FS4 provides protection against electric shock should a relay fault develops in RL5.

8.8 Mains Input filter.

Components C1, C2 and C3 form a mains filter. This prevents unwanted Electro Magnetic Radiation (EMC) travelling from the PAT4DVF into the electrical supply network.

9.0 Operation Test and Earth Leakage Test Circuits.

Reference should be made to ***figure 8.*** During both an Operation Test and combined Earth Leakage Test the Appliance under Test is operated using Rated Voltage supplied from within the PAT4DVF.

When testing 230-Volt Appliances an incoming 230V supply is used and routed to the PAT4DVF 13 Amp socket.
When testing 110-Volt appliances an incoming 110-Volt from an external transformer is used. The supply from the PAT4DV is routed to the 110 Volt panel mounted (BS4343 type) socket.

For an Operation Test measurement of Appliance Voltage and Appliance Load Current are performed to permit the calculation of Power Consumption (VA). The measurement of Appliance voltage is then used to calculate the expected VA rating at nominal mains voltage. I.e. all answers are corrected for a 230 Volt (or 110 Volt) supplies. To allow for situations were the Neutral conductor is substantially above Earth potential, PAT4 software uses the summation of Live voltage and Neutral voltage to calculate the supply voltage. This is particularly relevant when operating at 110Volts from a "Tool Transformer" as these devices provide an output of 55V - 0 – 55 V.

During the Earth Leakage Test any leakage current is measured using the differential Current Transformer (CT) technique on Live and Neutral conductors. To permit linearity (WRT load) correction to be performed, a measurement corresponding to Load Current is also made. As for Operation Tests (see above) compensation for mains voltage variations are calculated based on the actual voltage measured during the test. It should be noted that for Earth Leakage measurements PAT4DVF "Scales Up" the leakage measurement to the value expected at the upper tolerance of nominal mains (254 Volts). This represents the worst case for a safety test.

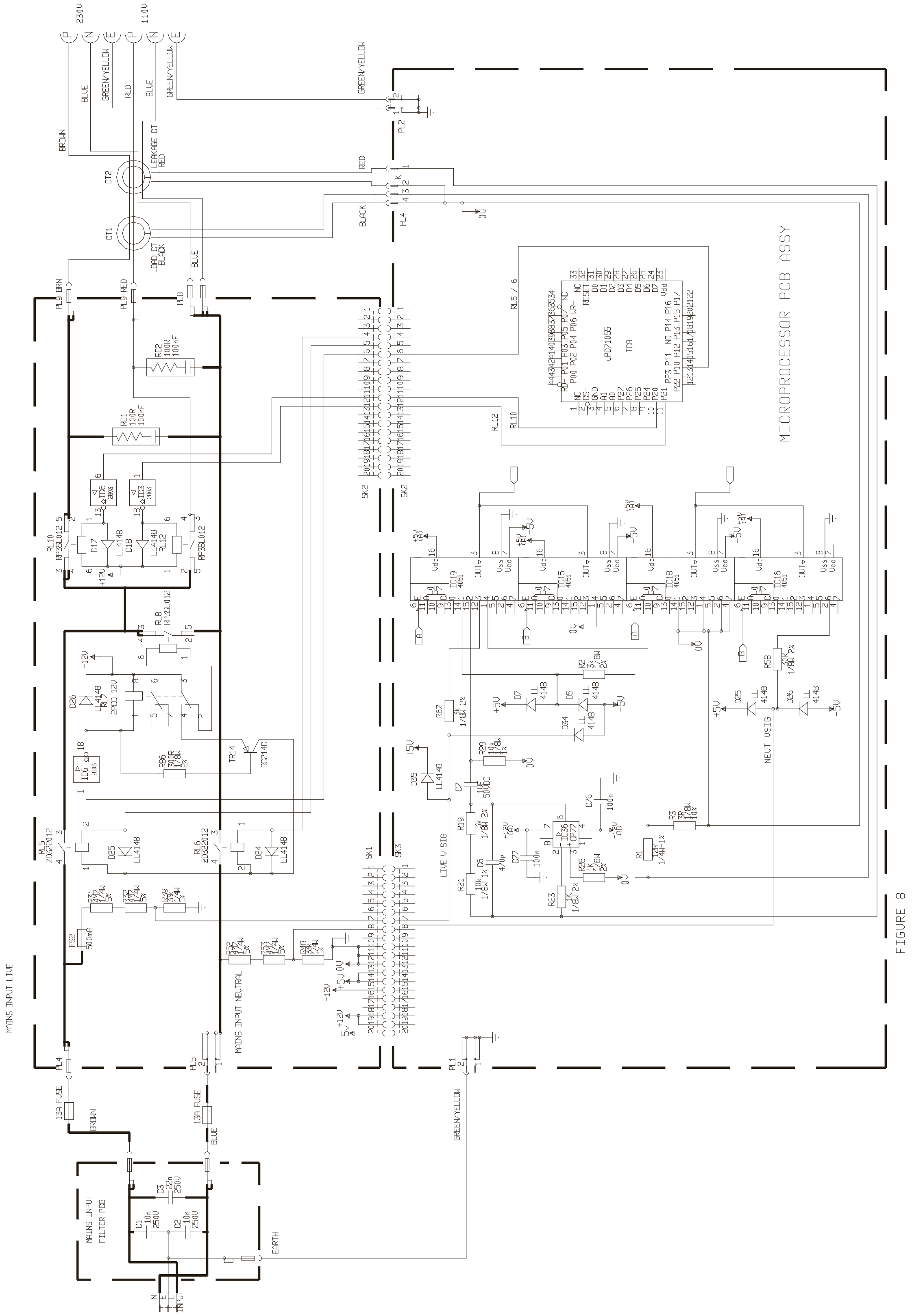
MICROPROCESSOR PCB ASSY
FIGURE 8
MAINS INPUT FILTER PCB
MAINS INPUT LIVE
MAINS INPUT NEUTRAL
LIVE V SIG
NEUT VSIG

Figure 8

9.1 230 Volt Configuration.

The PAT4DVF Live mains supply is connected to relay RL5 and via relay RL10 to the PAT4DVF 13Amp Appliance test socket live pin. The Neutral supply is routed directly from relay RL6 to both Appliance Test sockets.
Current transformers CT1 and CT2 are incorporated into the wiring loom as shown on ***figure 8***. to measure load current and earth leakage current respectively.
Relay RL7 forms a mechanical interlock which prevents Live to Neutral shorting relay RL8 energising simultaneously with power relays RL 5 and RL6. Power relays RL5 & RL6 are (unlike all other relays) energised using active high signals rather than active low signals. Relay switching procedure has previously been described in section 4.2.

9.2 110 Volt Configuration.

The PAT4DVF Live mains supply is connected to single pole power relay RL5 and via relay RL12 to the PAT4DVF 110-V Appliance test socket live pin. The Neutral supply is routed via relay RL6 to both Appliance Test sockets. Current transformers CT1 and CT2 are incorporated into the wiring loom as shown on ***figure 8*** and measure load current and earth leakage current respectively.

9.3 Mains - Live Voltage Measurement.

The potential divider formed from resistors R31, R32 & R39 are used to attenuate the voltage present on the PAT4DVF incoming Live supply. With the chosen resistors, a 230-Volt supply results in 0.6 Volts at SK2 pin 7. This signal is transferred to the PAT4DVF "Microprocessor PCB" Multiplexer channel (03) at IC19 pin12 as shown on ***figure 8.***

N.B. to allow for situations were the Neutral conductor is substantially above earth potential, PAT4 software uses the summation of Live and Neutral voltages to calculate the supply voltage.

9.4 Mains - Neutral Voltage Measurement.

The potential divider formed from resistors R48, R52 & R53 are used to attenuate the voltage present on the PAT4DVF incoming Neutral supply. With the chosen resistor values, and 230 Volts present on the neutral line 0.6 Volts will be present at SK2 pin 8. This attenuated signal is transferred to the PAT4DVF "Microprocessor PCB" Multiplexer channel (14) at IC16 pin2. N.B. to allow for situations were the Neutral conductor is substantially above earth PAT4 software uses the summation of Live voltage and Neutral voltage to calculate the supply voltage.

9.5 Load Current Measurement.

Load current to either PAT4DVF Appliance test socket is measured using Current Transformer CT1. The Live conductors being "looped" through the CT allow the load current to be detected without requiring a current shunt. The CT signal is transferred to the PAT4DVF "Microprocessor PCB" via PL4 (Black wires on later instruments). The current transformer is terminated using resistors R1 & R3, which convert the CT output to a voltage. This voltage is fed to Multiplexer channel (01), which as shown on ***figure 7.*** is connected to IC19 pin 14.

9.6 Leakage Current Measurement.

Current Transformer CT2 is used to determine earth leakage current. Live and Neutral conductors are "looped" through the CT. The CT responds to any differential current present between the Live and Neutral conductors. Any imbalance present would represent a leakage current to earth. The CT signal is transferred to the PAT4DVF "Microprocessor PCB " via PL4 pin 29.

Amplifier IC36 (IC6 in early models) is configured as a virtual earth transconductance element, converting the leakage current to voltage. Resistors R19 & R21 set the gain. With the values fitted 15mA at the CT equates to 0.6 Volts (rms.) at the amplifier output. Capacitor C7 functions as a dc blocking capacitor removing any offset voltages present from the signal presented to Multiplexer channel (02), which as shown on ***figure 8*** is connected to IC19 pin 15. Resistor R29 forms an input bias load for the capacitively coupled input. Channel selection has been described in section 3.4.

10.0 Class 1 Flash Test Circuits.

Reference should be made to ***figure 9a & 9b.***
During a Class 1 Flash Test 1500 Volts AC is supplied between the Earth conductor and Live and Neutral conductors strapped together. In this configuration a measurement of current flow is made.

10.1 Voltage Generation.

The PAT4DVF Live mains supply is connected to the Flash Test Transformer T2 primary using single pole relay RL1. The Live supply to RL1 originates from the Relay PCB at fuse FS2. The Neutral supply is routed to primary via PL4. The Flash Transformer is a "step up" transformer delivering 3000 Volts across the full winding and 1500 Volts at the centre tap. Resistors R4-R7 and the secondary winding resistance limit the short circuit current available to approximately 3mA. Resistor R8 forms a current shunt across which the flash test current is measured.

10.2 Relay configuration 230-Volt Appliances.

Transformer T2 primaries are series connected using relay RL2 during 230V operation. The current limited 1500V output is delivered at PL2. From the Flash PCB this voltage is fed to the Relay PCB at PL10 and on to the 230V / 13A Appliance Test Socket via relay RL10. Relay RL8 connects the "Live" and "Neutral" terminals together. The return path for the test current is via the Appliance socket earth pin.

10.3 Relay configuration 110-Volt Appliances.

Transformer T2 primaries are parallel connected using relay RL2.
The current limited 1500V output is delivered at PL2. From the Flash PCB this voltage is fed to the Relay PCB at PL10 and on to the 110 Volt / BS4343 Appliance Test Socket via relay RL12. Relay RL8 connects the "Live" and "Neutral" terminals together. The return path for the test current is via the Appliance socket earth pin.

10.4 Current Measurement.

Resistor R8 connected in the low potential end of the Flash Transformer secondary is used as a current shunt to enable the Flash Test current to be measured as a voltage, a

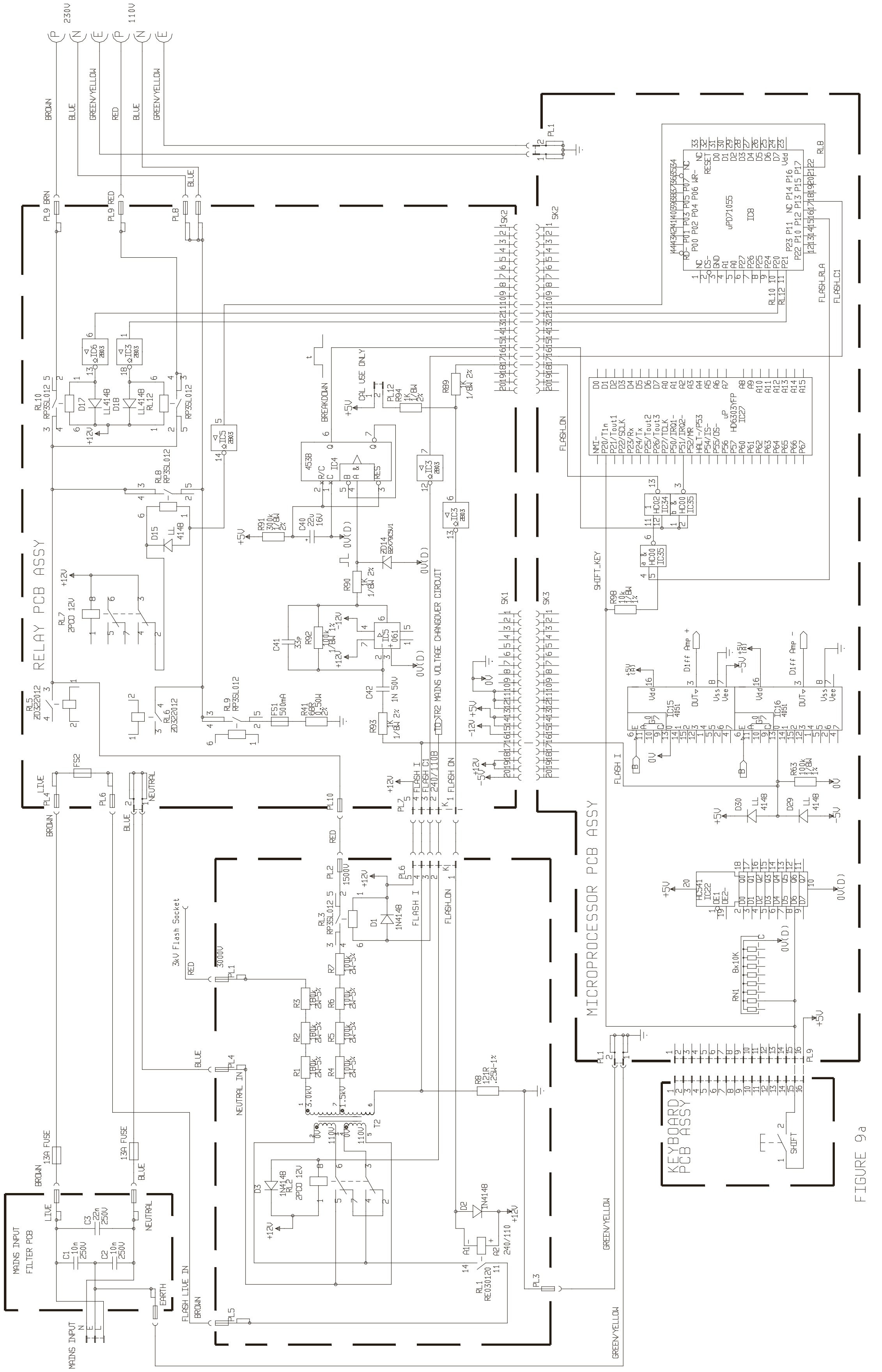

Figure 9a

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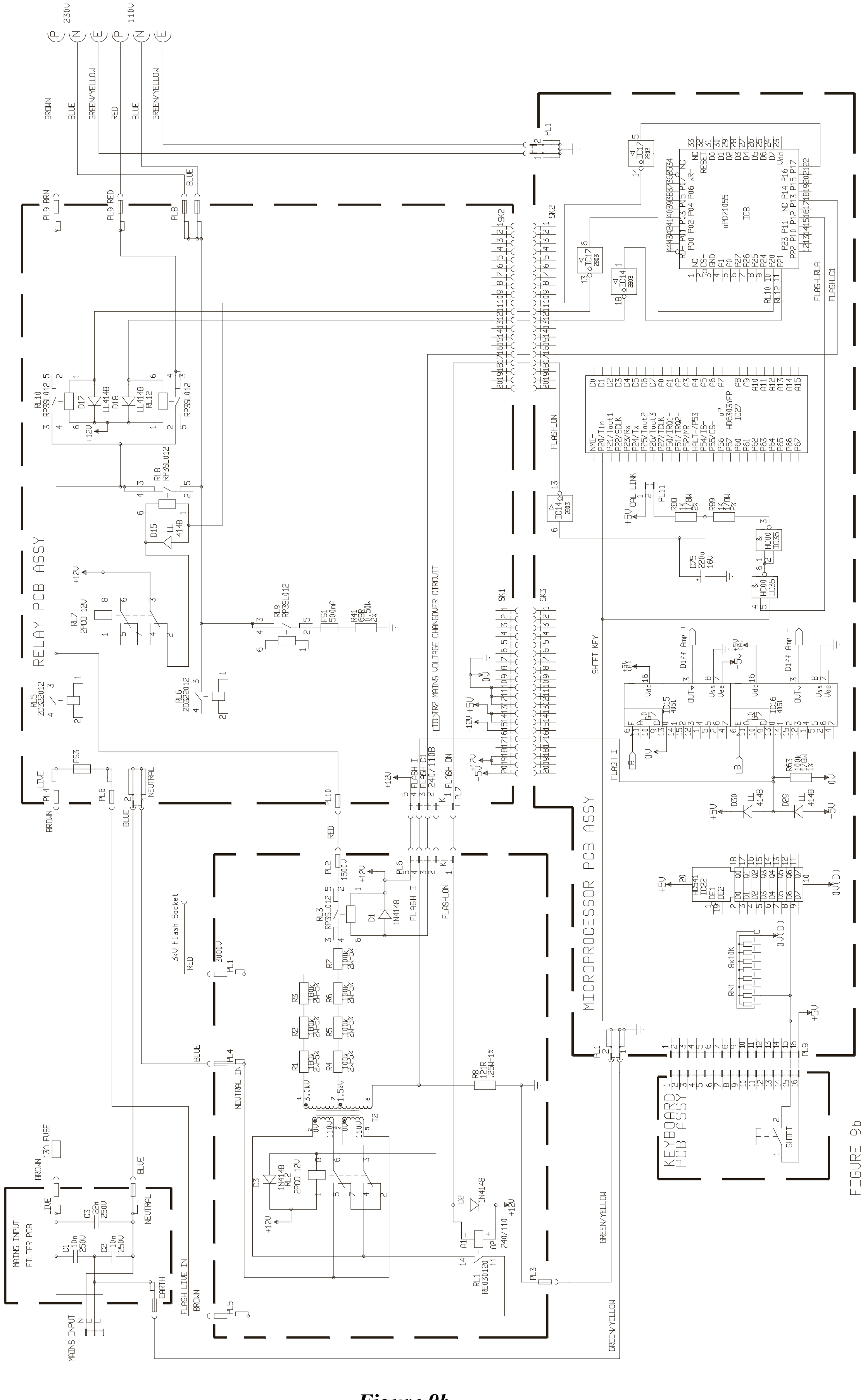
RELAY PCB ASSY
MICROPROCESSOR PCB ASSY
KEYBOARD PCB ASSY
MAINS INPUT FILTER PCB
MAINS INPUT
TR2 MAINS VOLTAGE CHANGEOVER CIRCUIT
3kV Flash Socket
FIGURE 9b

Figure 9b

Flash Test current of 3.0mA equating to approximately 0.6 Volts. This signal is transferred to the PAT4DVF "Microprocessor" via Relay PCB PL7 and SK1. Multiplexer channel (08) being the destination of this signal, which as shown on ***figure 9a.*** is connected to IC16 pin 13.

10.5 Breakdown Detector.

Later PAT4DVF models incorporate a Breakdown detector as shown on ***figure 9a.*** Early models are illustrated on ***figure 9b.*** This circuit prevents the application of a continuous, damaging arc to a faulty appliance. The signal representing the current flowing, derived from Flash PCB (across resistor R8) is applied to a Differentiator formed from amplifier IC5 (on the Relay PCB). This Differentiator produces positive 12 V spikes in response to peaks of current across R8. Resistor R90 and Zener diode ZD14 attenuate these spikes to 5 volts. IC4 is configured as a re-trigerable, edge triggered monostable multivibrator operating on the output from the Differentiator. Capacitor C40 and Resistor R91 determine the monostable period. With the values used a positive pulse with duration of approximately 10 Seconds is produced. The presence of a High level at SK2 Pin15 indicates to both hardware and software that a breakdown has occurred. IC 35b inverts the signal, which feeds into microprocessor IC27 at port 5 bit 1. The hardware interrupt is described in the following section but basically any breakdown will de energise the main Flash test relay, halting the test.

10.6 Shift Key operation.

The "Shift Key" operates a mechanical operation interlock. Prior to pressing the key, a Low level is present at Relay PCB PL9 Pin 15. This Low level is monitored by Microprocessor IC27 at P2 (0) and also feeds "NAND" gate IC35a at Pin 5.
At the start of a Flash Test the Microprocessor via PIA chip IC8 Pin 16 enables the signal referenced "FLASH_RELAY. To allow hardware control of this signal, IC35a & IC34 "AND" together the "Shift Key" signal and "FLASH_RELAY", such that both signals must be present simultaneously to energise the Flash Test. Therefore when the "Shift Key" is pressed IC35a at Pin 5 becomes High and if "FLASH_RELAY" is also High a Low level is generated at IC34a Pin 6. IC34 combines the above signals with the Flash Test Breakdown detector. A Truth Table is shown below

FLASH_RELAY IC35a Pin 4	SHIFT_KEY IC35a Pin 5	IC35a Pin 6	Breakdown IC34 Pin 12	FLASH_ON IC34 Pin 13	FLASH RL1
Low	**Low**	**High**	**Low**	**Low**	**Off**
Low	**High**	**High**	**High**	**Low**	**Off**
High	**Low**	**High**			
High	**High**	**Low**	**Low**	**High**	**On**
High	**High**	**Low**	**High**	**Low**	**Off**

10.7 Calibration Link.

To permit keyboard entry during calibration of the Flash Test range, a manual Flash Test enable link is provided. This link by passes the need to use the "Shift Key" to enable the Flash Test transformer. On PAT4 Mk 2 & 3 models this link is located on the Relay PCB and designated PL12 as shown on ***figure 9a.*** On early models the link is located on the Microprocessor PCB and designated PL11 as shown on ***figure 9b.***

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11.0 Class 2 Flash Test Circuits.

Class 2 Flash Test is similar to Class 1 described above will the following differences. Again reference should be made to ***figure 9a & 9b.*** During a Class 2 Flash Test 3000 Volts AC is supplied between the Flash Test Probe and Live and Neutral conductors strapped together. In this configuration a measurement of current flow is made.

11.1 Voltage Generation.

The PAT4DVF Live mains supply is connected to the Flash Test Transformer T2 primary using relay RL1. The Live supply to RL1 originates from the Relay PCB at fuse FS2. The Neutral supply is routed to primary via PL4. The Flash Transformer is a "step up" transformer delivering 3000 Volts across the full winding. Resistors R1-R3, the secondary winding resistance and further current limiting within the Flash Test Probe in the form of an additional 27kΩ limit the short circuit current available to approximately 3mA. Resistor R8 forms a current shunt across which the flash test current is measured.

11.2 Relay configuration 230-Volt Appliances.

The output from the current limiting network R1-R3 is connected to the Flash Test Probe. The return connection is at the 230V / 13A Appliance Test Socket. Relay RL9 connect the Flash Test return path (earth) from the Neutral side of the 230V / 13A Appliance Test Socket to Earth via Resistor R41. Relay RL8 forms the Live to Neutral appliance connection and RL 10 connects to the "Live Terminal" of the 230V / 13A Appliance Test Socket.

11.3 Relay configuration 110-Volt Appliances.

Flash transformer T2 primaries are parallel connected using relay RL2
Configuration is identical to Section 11.2 except RL 12 connects to the "Live Terminal" of the 110 Volt / BS4343 Appliance Test Socket.

12.0 Insulation Test Circuits.

Reference should be made to ***figure 10.*** During an Insulation Test 500 Volts DC is supplied between the Earth conductor and Live and Neutral conductors Strapped together. In the above configuration a measurement of current flow and applied voltage is made. Using these parameters a value of Insulation Resistance is calculated.

12.1 Voltage Generation.

The voltage source for the insulation range is derived from a DC to DC converter arrangement shown on ***figure 10.***
The voltage feedback system comprising divider resistors R56, R61, R74 and R73 therefore 550Volts at PL11 will equate to 2.0 Volts at IC2c pin 5. This amplifier is configured as a differential input amplifier interfacing a feedback voltage from the above divider and a reference voltage of nominally 2.0V applied to Pin 6. Amplifier IC2d is an error amplifier with a gain of 1.4, which drives transistor TR10.
Transistor TR10 modulates the fall time of oscillator formed around IC1a. A sawtooth waveform will be generated at IC1a pin 6. This sawtooth will have constant risetime but a fall time dependant on the current demand of TR10 which as described above depends on the power output demand required at the output. Typically this sawtooth starts at 1.2 Volts and rises at 0.1V/µs as capacitor C8 charges. As the capacitor reaches

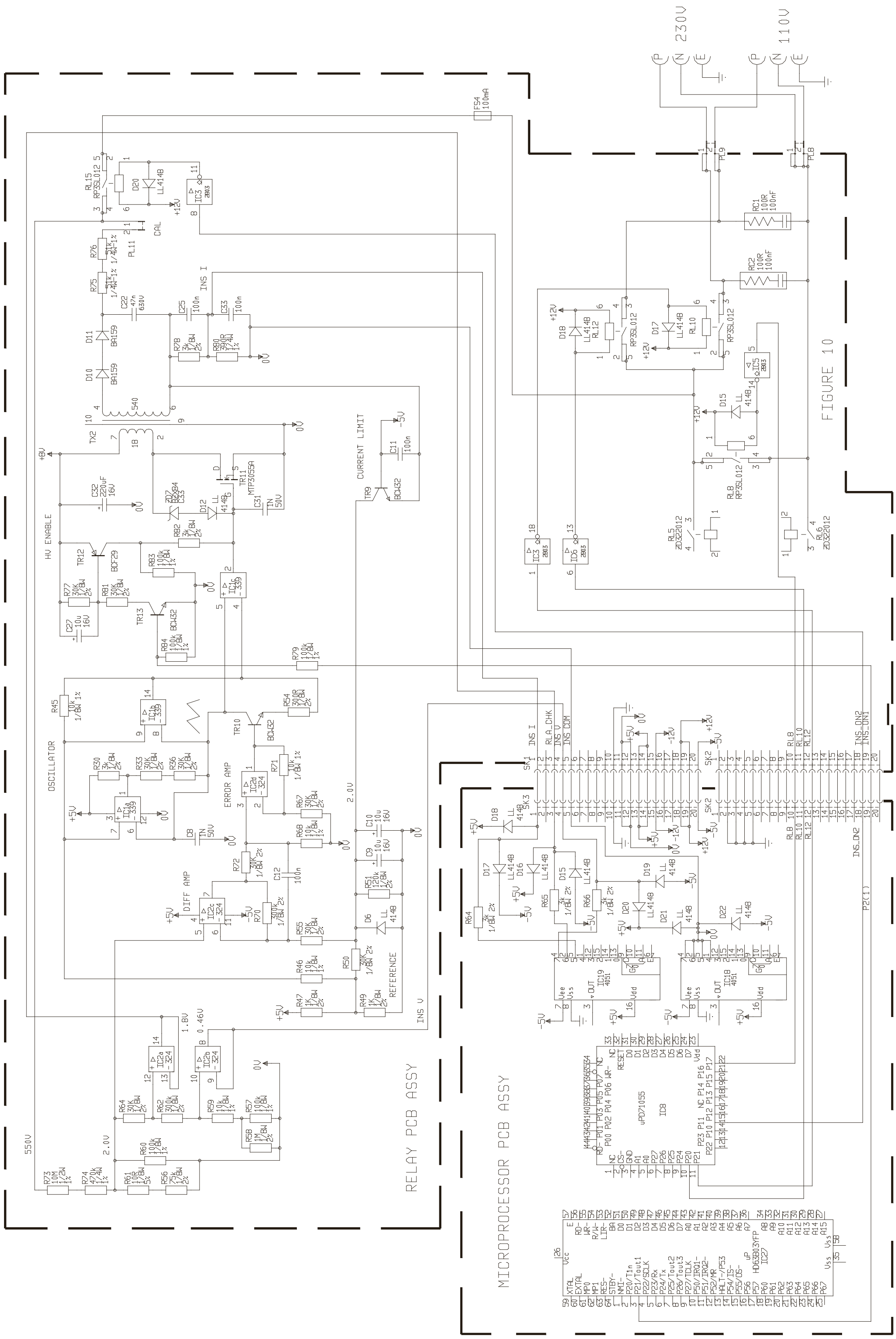
230V
110V
FIGURE 10
RELAY PCB ASSY
MICROPROCESSOR PCB ASSY
OSCILLATOR
ERROR AMP
DIFF AMP
CURRENT LIMIT
HV ENABLE
REFERENCE

Figure 10.

2.5 Volts (the reference voltage on IC1a pin 7 & IC1b Pin 9) the outputs of comparator IC1a & IC1b switch causing the output of IC1c to rise applying gate drive to FET TR11. IC1a changes state and charging of capacitor C8 terminates. IC1b output pin 14 will now be 0V causing transistor TR10 to conduct based on the output from error amplifier IC2d pin 1. The sawtooth output at IC1a Pin 6 now commences its descent to approximately 1.25Volts. During this descent phase gate drive to FET TR11 continues to be applied. Thus the primary of inverter transformer TX2 stores energy during this descent phase. Energy is therefore transferred to the secondary where diodes D10 & D11 rectify the output with capacitor C22 acting as a smoothing capacitor. Resistors R75 & R76 provide basic current limiting. Resistors R78 & R80 form two series connected current shunts. One feeds the current limiting feedback transistor as described below and the other monitors current flow to be used by the measurement circuit as described in section 12.4.

Current limiting is monitored by transistor TR9 which in the lightly loaded output condition is reversed biased. As increasing current flows through resistors R78 & R80 TR9 emitter becomes more negative than the base and therefore conduction occurs. This in turn causes the reference (at D6 cathode) to collapse reducing the effective output power by feedback until the short circuit output condition is removed.

The inverter output is enabled or disabled by the action of the signal labelled “INS_ON1” which controls transistor TR13 and in turns TR12. With "INS_ON1" (SK1 Pin 18) Low TR13 will be biased Off causing TR12 to be On. This situation disables the Gate feed to FET TR11 and hence the inverter output stage is shut down. The output stage is therefore enabled when "INS_ON" is high. Microprocessor IC27 controls "INS_ON1" using Port 2 Bit 1.

12.2 Relay configuration 230-Volt Appliances.

The output from the inverter is connected to relay RL15 via calibration Link PL11. Relay RL10 connects the "Live Terminal" of the 230V / 13A Appliance Test Socket to the insulation test voltage. Relay RL8 links the 230V / 13A Appliance Test Socket "Live" and "Neutral" terminals together. The return path for the test current is via the Appliance socket earth pin.

12.3 Relay configuration 110-Volt Appliances.

The output from the insulation inverter is connected to relay RL15 via calibration Link PL11. Relay RL12 connects the "Live Terminal" of the 110-Volt / BS4343 Appliance Test Socket to the insulation test voltage. Relay RL8 links the 110 Volt / BS4343 Appliance Test Socket "Live" and "Neutral" terminals together. The return path for the test current is via the Appliance socket earth pin.

12.4 Insulation Current Measurement.

Resistor R80 connected in the low potential end of the Insulation Transformer secondary is used as a current shunt to enable the test current to be measured in terms of a voltage. This signal is transferred to the PAT4DVF "Microprocessor PCB" via SK1 pin1. Multiplexer channel (05) being the destination of this signal, which as shown on ***figure 10.*** is connected to IC19 pin 5.

12.5 Insulation Voltage Measurement.

As previously described in section 12.1 Inverter output is monitored using attenuator resistors R56, R60, R61, R73 & R74. The feedback voltage present at IC2c Pin 5 is further subdivided using attenuator resistors R57, R58, R59, R62 & R64.

IC2b buffers the voltage present at Pin 10, which represents the voltage present across the insulation resistance of the appliance under test. 550 Volts at the inverter output corresponds to 0.46 Volts at Buffer IC2b Pin 5.
The output from this buffers is transferred to the PAT4DVF "Microprocessor PCB" via SK1 Pin 4. Multiplexer channel (07) being the destination of this signal, which as shown on ***figure 10.*** is connected to IC19 pin 4 .

12.6 Relay Check Voltage Measurement.

During the PAT4 power up sequence a check is made to ensure that the power relays RL5 & RL6 are not welded closed. This function requires that the microprocessor tests for 230V (or 110V) on the normally open side of power relays RL5 & RL6. This is achieved by using the insulation test voltage attenuator chain, which is further sub divided to provide the voltage at IC2a Pin 12. This voltage which is, 1:0.93 the 2.0V present at IC2c Pin 5 is buffered by IC2a to provide the signal labelled "RELAY_CHK". This signal is transferred to the PAT4DVF "Microprocessor PCB" via SK1 Pin 3. Multiplexer channel (05) being the destination of this signal, which as shown on ***figure 10.*** is connected to IC19 pin 2. To enable this test to function the inverter circuit in inhibited and relay RL15 closed after which a measurement of "RELAY_CHK" is made. This tests RL5 but to test RL6 the test must be repeated but with relay RL8 also closed.

13.0 Bond Test Circuits. (PAT4 Mk 2 & 3 models)

Later PAT4 instruments incorporate a simplified Bond Test source without a Triac Phase Controller. Reference should be made to ***figure 11a.*** During a Bond Test a high current (ac) is supplied between the dedicated Earth Bond terminal and the Earth conductor of the relevant Appliance Test Socket. A short Bond Test Lead is connected to the Earth Bond Terminal and the free end, which is terminated in a crocodile clip is attached to any required piece of the appliance metalwork. The actual test current is configured for 10 Amps or 25 Amps. During the test a measurement of current flow and applied voltage is made. Using these parameters a value of Earth Bond Resistance is calculated.

13.1 Bond Current Generation.

The PAT4DVF Live mains supply is connected via PL4 (Relay PCB) to fuse FS3. The Neutral supply is routed via PL5. A split primary is employed allowing voltage tap changing for 110 Volt or 230-Volt operation. Relay RL1 performs the necessary Series / Parallel transformation, using the automatic voltage change over circuit described in section 8.1.

The Bond Test Transformer is a voltage "step down" transformer delivering approximately 9 Volts open circuit or > 25 Amps short-circuit across the secondary winding. The secondaries as shown in ***figure 11a.*** are connected via relay RL2 between the Bond test terminal and the main Earth point. A current transformer built into the loom monitors output current.

13.2 Bond Current Control.

The Bond Test transformer contains two secondary windings each comprising an identical number of turns, but wound using different gauge wires. The transformer wire coloured Red connects to the common start connection of both windings. A Yellow wire connects to the 10 Amp winding. The Blue wire connects to the final winding.

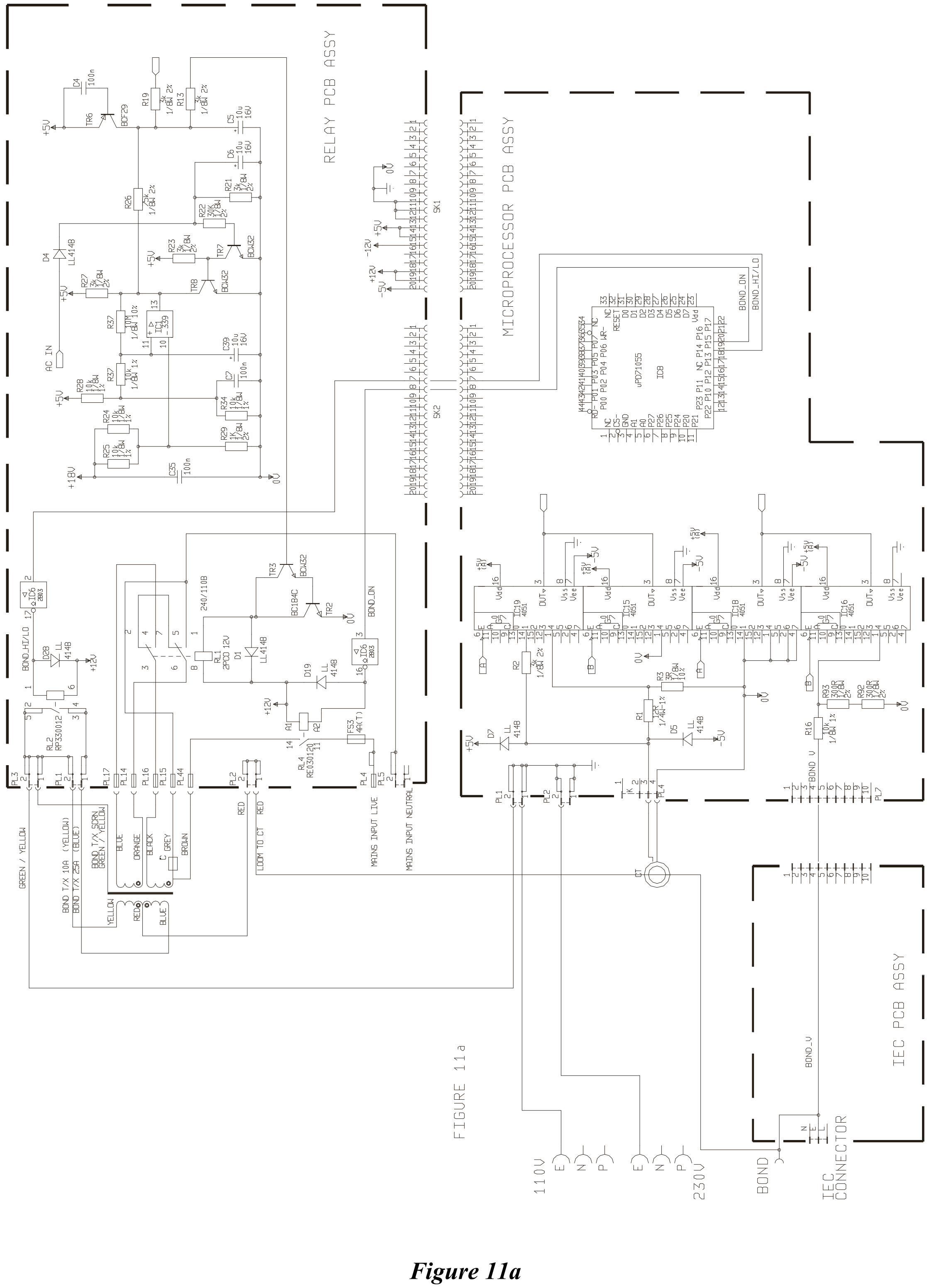

Figure 11a

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Relay R2 controls the High and Low current settings using the signal labelled "BOND_HI/LO" from the microprocessor PCB via SK2 Pin 7. N.B. This logic signal is now reversed compared to early PAT4 instruments.

For the 25A-setting relay RL2 will be energised connecting both Bond Transformer secondary windings in parallel.

For the 10A settings relay RL2 will not be energised thus the 10Amp winding alone will be in circuit.

13.3 Current Measurement.

Bond Test Current is measured using a Current Transformer (CT) through which the common connection to the secondary of the Bond Transformer is passed. The CT signal is transferred to the PAT4DVF "Microprocessor" via PL4 (Black wires) to Multiplexer channel (01), which as shown on ***figure 11a.*** is connected to IC19 pin 1. Resistors R1 and R3 form the CT terminating load converting the current produced by the CT to a voltage, 25 Amps corresponds to ≈ 0.5 Volts at IC19 pin 1.

13.4 Voltage Measurement.

Voltage measurement is made using a three terminal method at the Bond Test Terminal. A voltage "sense" wire is attached at the terminal and routed via PL7 to the "Microprocessor PCB". The network comprising R16, R92 & R93 form a voltage divider and low pass filter. The output from this filter is transferred to Multiplexer channel (12) being the destination of this signal, which as shown on ***figure 11a.*** is connected to IC16 pin 1. 8.0 Volts correspond to ≈ 0.5 Volts at IC16 pin 1.

14.0 Bond Test Circuits. (PAT4 Mk 1 models)

Reference should be made to ***figure 11b.*** During a Bond Test a high current (ac) is supplied between the dedicated Earth Bond terminal and the Earth conductor of the relevant Appliance Test Socket. A short Bond Test Lead is connected to the Earth Bond Terminal and the free end, which is terminated in a crocodile clip is attached to any required piece of the appliance metalwork. The actual test current is configured for 10 Amps or 25 Amps. During the test a measurement of current flow and applied voltage is made. Using these parameters a value of Earth Bond Resistance is calculated.

14.1 Bond Current Generation

The PAT4DVF Live mains supply is connected via PL4 (Relay PCB) to fuse FS3. Triac D2 controls the live supply current fed to the Bond Test Transformer primary via single pole relay RL4 the contacts of which are closed during a Bond Test. The Neutral supply is routed via PL5. A split primary is employed allowing voltage tap changing for 110 Volt or 230-Volt operation. Relay RL1 performs the necessary Series / Parallel transformation, using the automatic voltage change over circuit operating transistors TR2 & TR3. This changeover circuit was described in section 8.1 above.
The Bond Test Transformer is a voltage "step down" transformer delivering approximately 10 Volts open circuit or > 25 Amps short-circuit across the secondary winding. The secondary as shown in ***figure 11b.*** is connected between the Bond test terminal and the main Earth point. A current transformer built into the loom monitors output current.

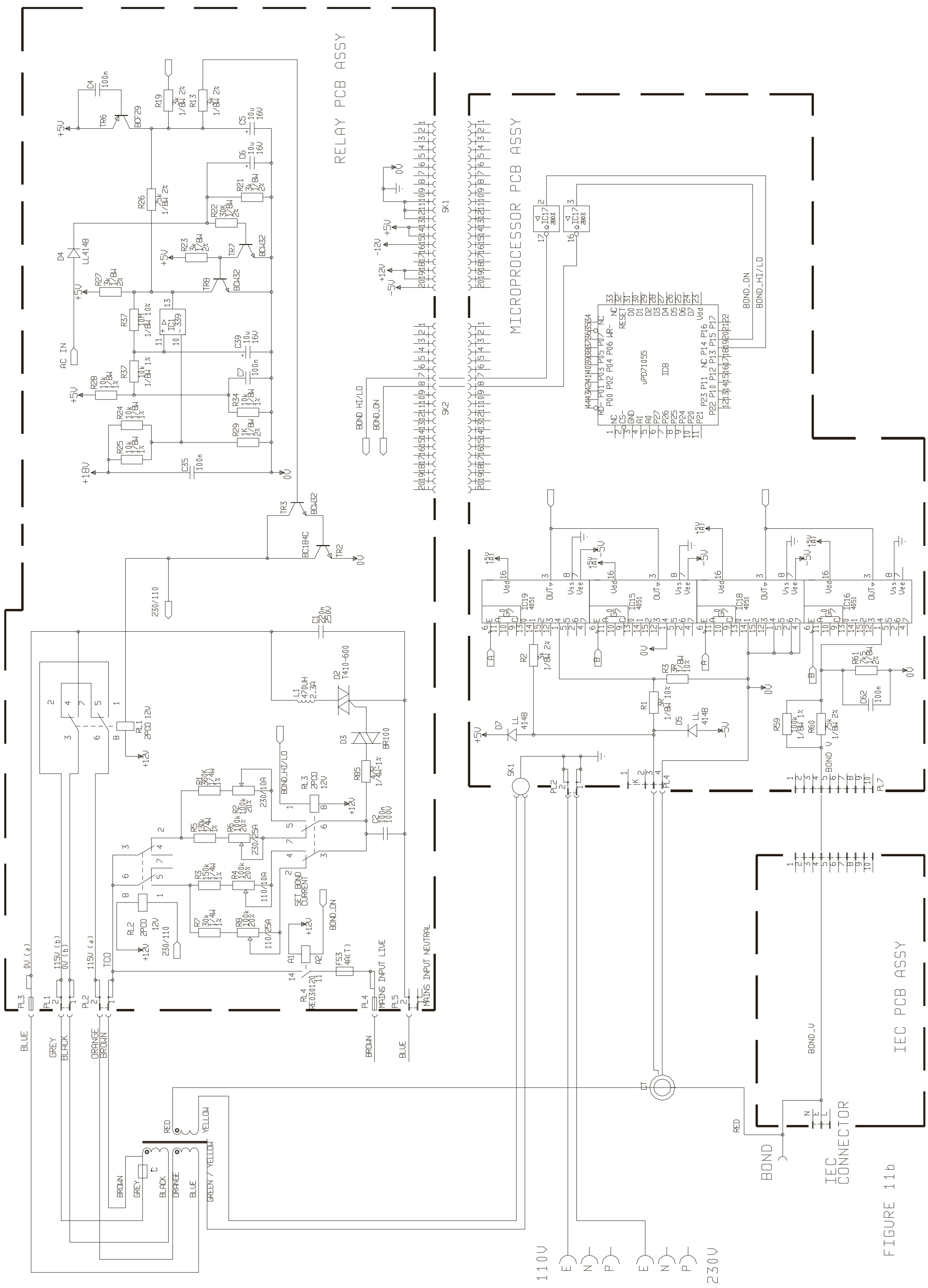
RELAY PCB ASSY
MICROPROCESSOR PCB ASSY
IEC PCB ASSY
BOND
IEC CONNECTOR
FIGURE 11b

Figure 11b

14.2 Bond Current Control.

Triac D2 and Diac D3 are configured as a classic variable power controller. Four potential divider and phase shift networks are formed using Capacitor C2 and resistors R1 to R8. One divider is selected using relays RL2 & RL3. The Diac D3 is used as a simple trigger device that fires when the voltage across C2 reaches ≈35 Volts. After triggering D2 discharges C2 into the gate of Triac D2 causing the device to conduct. As the voltage on C2 falls a point will be reached (≈35 Volts) when the Diac will cease conducting and become high impedance allowing C2 to recharge.

Four divider networks are required to provide settings for 10Amp and 25Amp currents at both 230-Volt and 110Volt supplies. Relay R3 controls the High and Low current settings using the signal labelled "BOND_HI/LO" from the microprocessor. Relay RL2 provides switching based on the energising supply voltage i.e. 230 Volt or 110 Volt.

For the 25A settings the resistors selected by the relays RL2 & RL3 will be low in value resulting in minimal attenuation and phase shift from the potential divider. In this condition the voltage on the capacitor C2 follows the rise time of the mains waveform until the Diac trigger point (≈35 Volts) is attained at which point the Triac fires and remains in conduction to the next zero crossing point. In this condition the Triac fires shortly after the start of each ½ cycle and remains in conduction until the next zero crossing point. i.e. almost full power is applied.

For the 10A settings the resistors selected by the relays RL2 & RL3 will be high in value resulting in a large attenuation and phase shift from the potential divider. In this condition the voltage on the capacitor C2 only just reaches the 35 Volts trigger point when the mains waveform is near it's peak. Under these conditions the Triac will typically fire at approximately 20° from the peak and thus reduced power is applied to the load.

Resistor R85 reduces the large voltage changes experienced across the capacitor C2 when the Diac fires. This is desirable to reduce the hysteresis associated with current setting using the variable resistors. To reduce the conducted and emitted radiation snubber network formed from capacitor C1 and inductor L1 were added.

14.3 Current Measurement.

Bond Test Current is measured using a Current Transformer (CT) through which one connection to the secondary of the Bond Transformer is passed. The CT signal is transferred to the PAT4DVF "Microprocessor" via PL4 (red wires) to Multiplexer channel (01), which as shown on ***figure 11b.*** is connected to IC19 pin 1. Resistors R1 and R3 form the CT terminating load converting the current produced by the CT to a voltage

14.4 Voltage Measurement.

Voltage measurement is made using a three terminal method at the Bond Test Terminal. A voltage "sense" wire is attached at the terminal and routed via PL7 to the "Microprocessor PCB". The network comprising R59-R61 and capacitor C62 form a voltage divider and low pass filter. The output from this filter is transferred to the to. Multiplexer channel (12) being the destination of this signal, which as shown on ***figure 11b.*** is connected to IC16 pin 1.

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15.0 Earth Continuity Test Circuits. (PAT4 Mk 1 models: 100mA / 100mV)

Reference should be made to ***figure 12a.*** During a Continuity Test a low current (100mA dc) is supplied between the dedicated Continuity Test Terminal and the Earth conductor of the relevant Appliance Test Socket. A short Test Lead is connected to the Continuity Terminal, the free end of which is terminated in a crocodile clip, and is attached to any required appliance metalwork. During the test a measurement of current flow and voltage is made. Using these parameters a value of Resistance is calculated.

15.1 Current Generation.

Amplifier IC1 is configured as a constant voltage source. Resistors R4, R6 & R10 set the reference on the non-inverting input to approximately 100mV. Transistor TR1 provides current gain with R11 limiting the base current supplied by the amplifier. The voltage present at the output to the continuity terminal (junction of R5 & R8) is fed back to the inverting output of the amplifier thus completing the feedback path. Standard op amp action will ensure that the voltage output (junction of R5 & R8) will equal that present at the non-inverting input providing sufficient compliance exists within the current source. This constant voltage mode changes to a constant current mode outside the above constraints. The constant current being determined by resistors R8 & R9 for the values shown this current is typically 95mA.
Typically the circuit will be in constant current mode for resistance's < 100mΩ.

15.2 Current Measurement.

Continuity Test Current is measured as a differential voltage across current shunt resistor R8 thus 100mA equates to 0.6 Volts at Multiplexer channel (00), which as shown on ***figure 12a.*** is between IC19 pin 13 and IC 8 pin 13.

15.3 Voltage Measurement.

Voltage measurement is made using a three terminal method at the Continuity Test Terminal. A voltage "sense" wire is attached at the terminal and routed via PL7 to the "Microprocessor PCB." The network comprising R16, R17 and capacitors C3 form a low pass filter. Amplifier IC2 is configured as a non-inverting amplifier with a gain of 7, this gain increase the signal measured at the Continuity terminal from 100mV to a maximum of 0.7 Volts. The output from this amplifier is transferred to Multiplexer channel (13) which as shown on ***figure 12a.*** is connected to IC16 pin 5

16.0 Earth Continuity Test Circuits. (PAT4 Mk 2 & 3 models : 200mA / 4.0V)

Later PAT4 instruments contain an up rated Continuity Test as shown on ***figure 12b.*** During a Continuity Test a current of 200mA-dc maximum is supplied between the dedicated Continuity Test Terminal and the Earth conductor of the relevant Appliance Test Socket. The open circuit potential of this test is 4.0 Volts. A short Test Lead is connected to the Continuity Terminal, the free end of which is terminated in a crocodile clip, and is attached to any required piece of the appliance metalwork. During the test a measurement of current flow and applied voltage is made. Using these parameters a value of Resistance is calculated.

16.1 Current Generation.

Amplifier IC1 is configured as a constant voltage source. Resistors R4, R6 & R10 set the reference on the non-inverting input to 4.0V. Transistor TR1 provides current gain

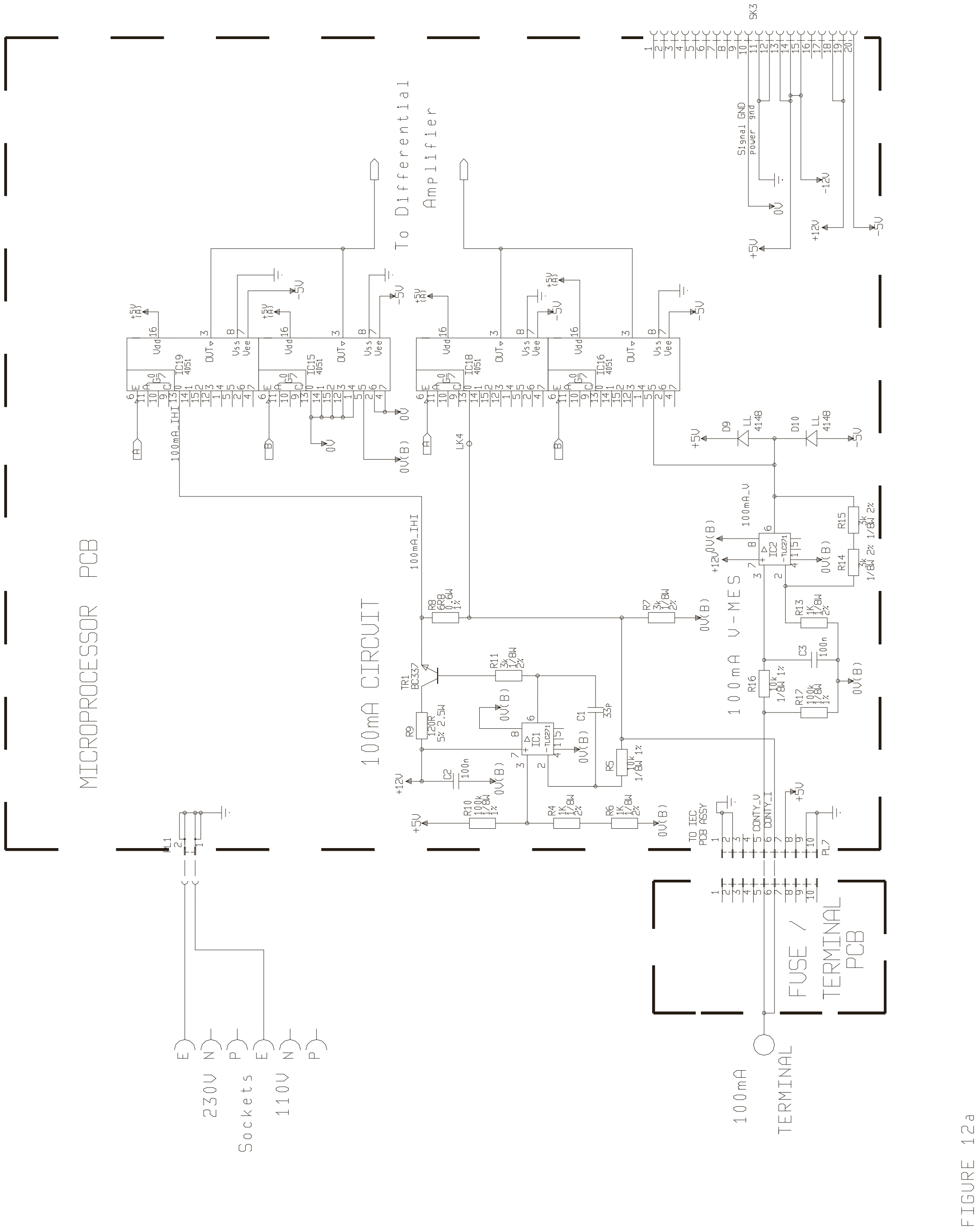
MICROPROCESSOR PCB
100mA CIRCUIT
To Differential Amplifier
100mA V-MES
FUSE / TERMINAL PCB
100mA TERMINAL
230V Sockets 110V
FIGURE 12a

Figure 12a

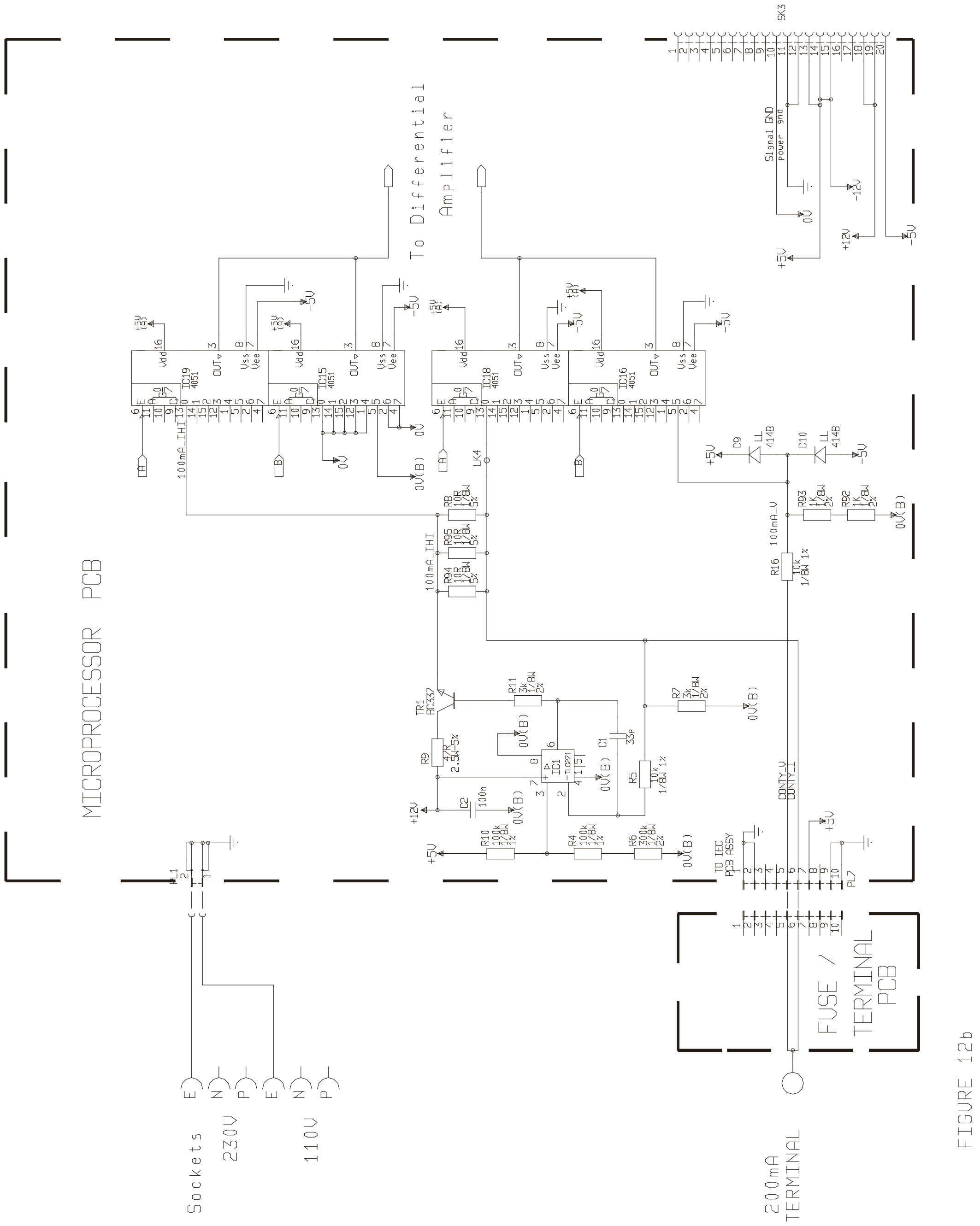

Figure 12b

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with R11 limiting the base current supplied by the amplifier. The voltage present at the output to the continuity terminal (junction of R5 & R8) is fed back to the inverting output of the amplifier thus completing the feedback path. Standard op amp action will ensure that the voltage output (junction of R5 & R8) will equal that present at the non-inverting input providing sufficient compliance exists within the current source. This constant voltage mode changes to a constant current mode outside the above constraints. The constant current being determined by resistors R8 & R9 for the values shown this current is typically 190mA.Typically the circuit will be in constant current mode for resistance's < 100mΩ.

16.2 Current Measurement.

Continuity Test Current is measured as a differential voltage across current shunt resistor R8 thus 200mA equates to 0.6 Volts at Multiplexer channel (00), which as shown on ***figure 12b.*** is between IC19 pin 13 and IC 8 pin 13.

16.3 Voltage Measurement.

Voltage measurement is made using a three terminal method at the Continuity Test Terminal. A voltage "sense" wire is attached at the terminal and routed via PL7 to the "Microprocessor PCB.” The network comprising R16, R92 & R93 form a potential divider that attenuates the voltage measured from across the resistance under test, this reduces the signal measured to 0.7 Volts. This is transferred to Multiplexer channel (13) which as shown on ***figure 12b.*** is connected to IC16 pin 5.

17.0 Circuit Load Tests. (PAT4 Mk 1 models)

Reference should be made to ***figure 13a.*** Prior to the start of any test PAT4DVF performs a "hidden" Circuit Load Test to ensure firstly, that the Appliance under test is switched ON and the that any fuses are intact and secondly that the load presented is not sufficiently high to cause a possible hazard during an Operation Test.

This test is achieved by performing by passing a low voltage (AC) between the Live and Neutral connections to the appliance while monitoring the current flowing and the voltage developed.

17.1 230 Volt Configuration.

The low voltage required to perform this test is derived from the main PAT4DVF power supply transformer TX1, the secondary of which delivers approximately 15 Volts open circuit, short circuit current being limited to about 100mA by resistor R44.

The secondary voltage is routed to single pole relay RL11 the contacts of which are closed for this test and then via fuse FS4 to relay RL10. From RL10 the test current is supplied to the Live pin of the PAT4DVF 230 Volt / 13 Amp Appliance Test Socket.

The Neutral pole of the PAT4DVF 230 Volt / 13 Amp Appliance Test Socket is connected to earth via fuse FS1, relay RL9 and resistor R41.

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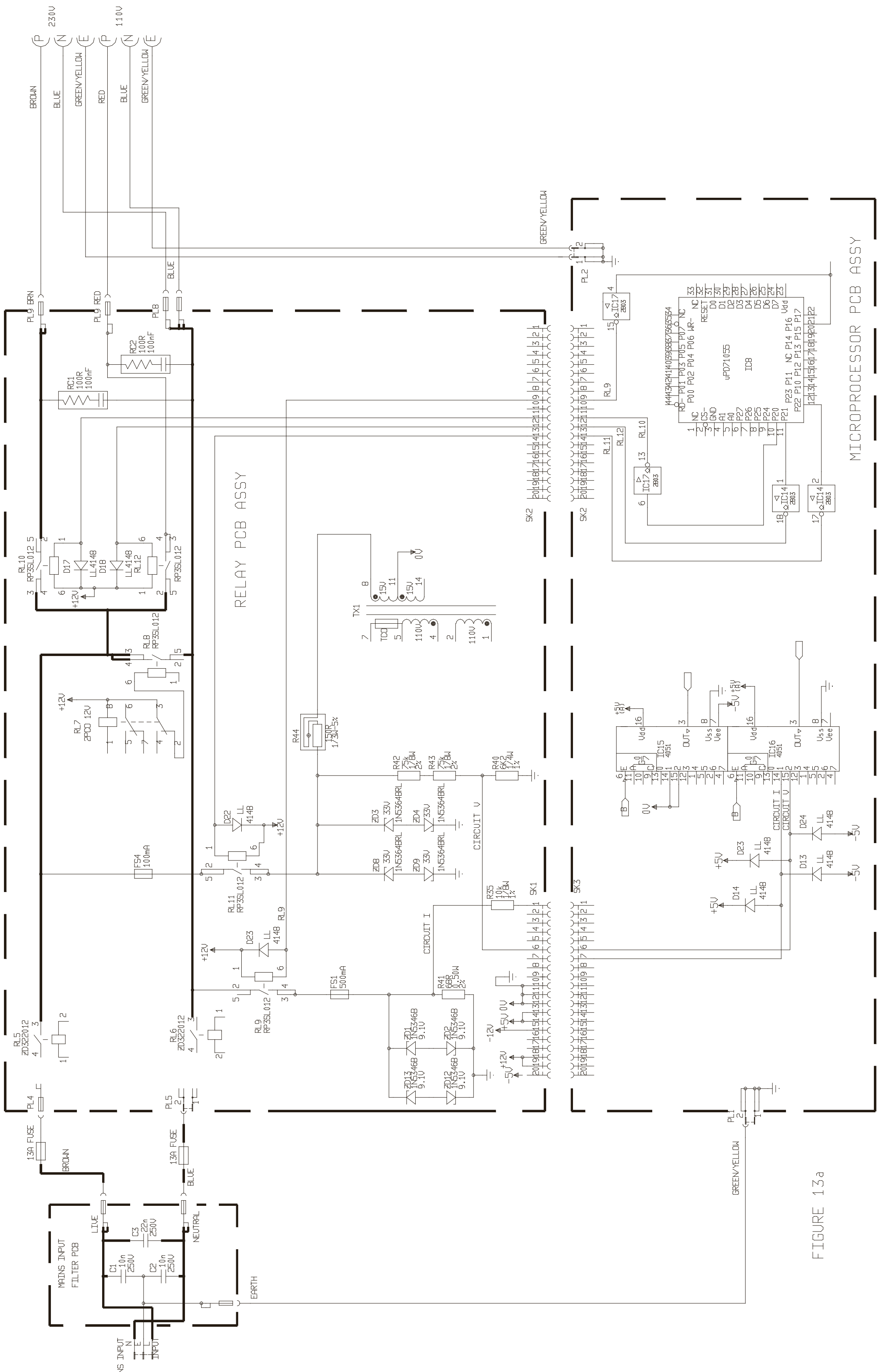

Figure 13a

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This configuration results in the flow of current being dependant on the load presented between the Live and Neutral poles of the PAT4DVF 230 Volt / 13 Amp Appliance Test Socket.

17.2 110 Volt Configuration.

The low voltage required to perform this test is derived from the main PAT4DVF power supply transformer TX1, the secondary of which delivers approximately 15 Volts open circuit, short circuit current being limited to about 100mA by resistor R44.

The secondary voltage is routed to single pole relay RL11 the contacts of which are closed for this test and then via fuse FS4 to relay RL12. From RL12 the test current is supplied to the Live pin of the PAT4DVF 110 Volt / BS4343 Appliance Test Socket.

The Neutral pole of the PAT4DVF 110 Volt / BS4343 Appliance Test Socket is connected to earth via fuse FS1, relay RL9 and resistor R41.

This configuration results in the flow of current being dependant on the load presented between the Live and Neutral pins of the PAT4DVF 110 Volt / BS4343 Appliance Test Socket

17.3 Voltage Measurement.

Potential divider formed from resistors R40, R42 & R43 are used to attenuate the voltage present on the PAT4DVF appliance socket. With the resistor values used and the no appliance connected approximately 0.6 Volts is present at SK1 pin 6. This is transferred to the PAT4DVF "Microprocessor PCB". Multiplexer channel (10) being the destination of this signal, which as shown on ***figure 13a.*** is connected to IC16 pin 15. This measurement is not actually scaled to volts but is used in BIT form. Zener diodes ZD3, ZD4, ZD8 & ZD9 provide protection in the event of power relay RL5 becoming welded presenting mains energy at RL11. In such a case the clamping action of the Zener diodes (33 Volts) will cause a large current flow-rupturing fuse FS4.

17.4 Current Measurement.

Load current to either PAT4DVF Appliance test socket is measured via current shunt R41. The voltage present across this resistor being transferred to the PAT4DVF "Microprocessor PCB" via SK1 pin 1and Multiplexer channel (09), which as shown on ***figure 13a.*** is connected to IC16 pin 14. With the resistor values used and a short circuit applied to the Appliance Socket (Live - Neutral) approximately 0.6 Volts is present at IC16 pin 14.
Zener diodes ZD1, ZD2, ZD12 & ZD13 provide protection in the event of power relay RL6 becoming welded presenting mains energy at RL11 when the incoming supply is reversed. In such a case the clamping action of the Zener diodes (9.1 Volts) will cause a large current flow rupturing fuse FS1.

18.0 Circuit Load Tests. (PAT4 Mk 2 & 3 models)

Later PAT4 instruments contain an up rated Circuit Load Test as shown on ***figure 13b.*** A constant amplitude square wave in wave employed rather than the sine wave from the main transformer. This improved circuit is more consistent across the mains voltage input range.

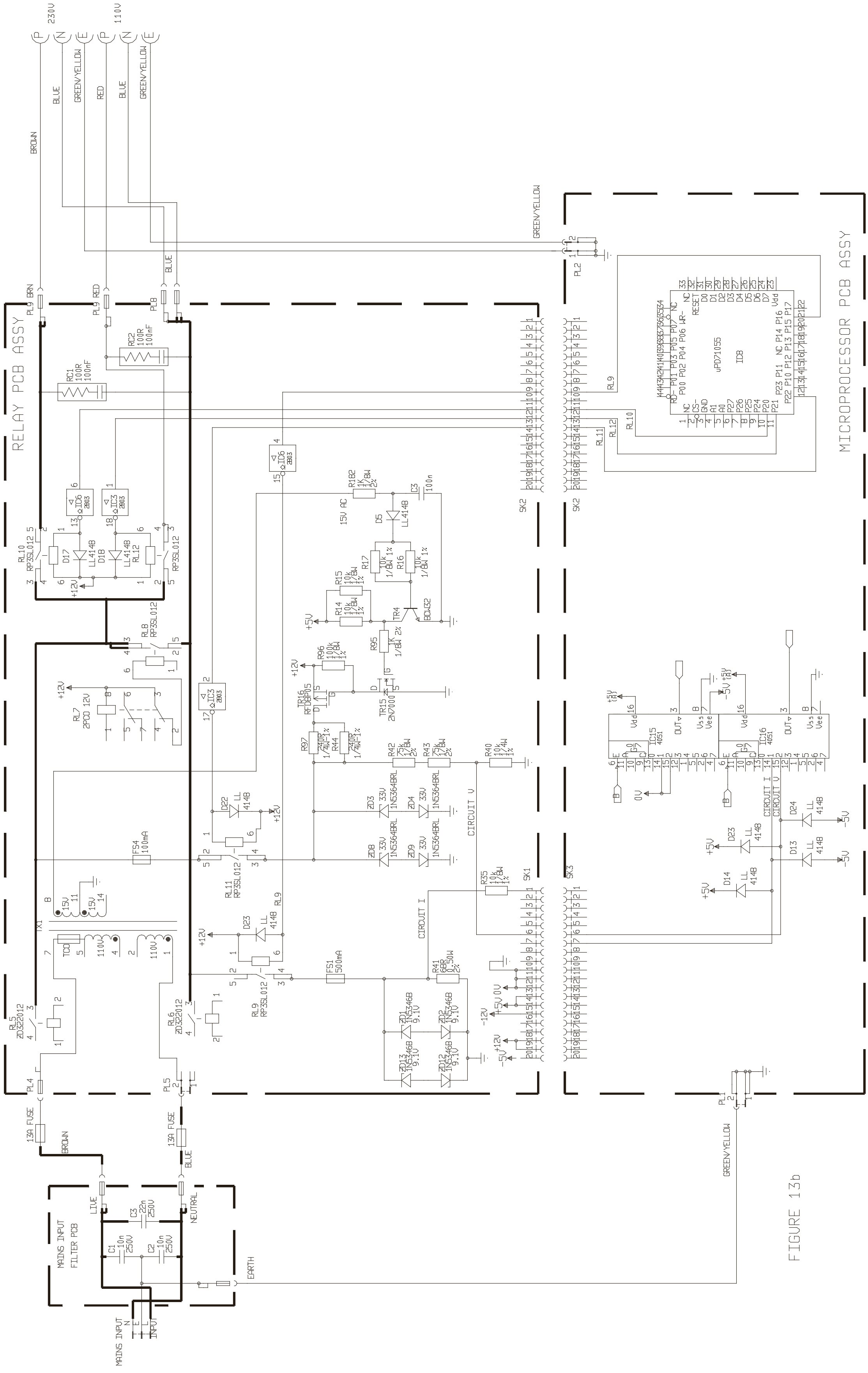

Figure 13b

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Prior to the start of any test PAT4DVF performs a "hidden" Circuit Load Test to ensure firstly, that the Appliance under test is switched ON and the that any fuses are intact and secondly that the load presented is not sufficiently high to cause a possible hazard during an Operation Test.

This test is achieved by performing by passing a low voltage (AC) between the Live and Neutral connections to the appliance while monitoring the current flowing and the voltage developed.

18.1 230 Volt Configuration.

The low voltage required to perform this test consists of a switched DC waveform originating from the + 12 Volts supply but synchronised to the incoming mains supply frequency. The secondary voltage from mains transformer TX1 (located on the relay PCB) is fed via resistor R18 and diode D5 to transistor TR4. This transistor simply provided a 50Hz (or mains frequency equivalent) 5Volt positive square wave which is fed via R95 to the gate of FET TR15. This N Channel FET drives the gate of FET TR16 which as a P - Channel device can act as a "High side Driver " providing the test current to RL11. Resistors R44 & R97 limit the current to 100mA. This new circuit arrangement provided a constant amplitude (with respect to mains supply variations) 50Hz 12 Volt square wave.

The test current passes via RL11 and then via fuse FS4 to relay RL10. From RL10 the test current is supplied to the Live pin of the PAT4DVF 230 Volt / 13 Amp Appliance Test Socket.

The Neutral pole of the PAT4DVF 230 Volt / 13 Amp Appliance Test Socket is connected to earth via fuse FS1, relay RL9 and resistor R41.

This configuration results in the flow of current being dependant on the load presented between the Live and Neutral poles of the PAT4DVF 230 Volt / 13 Amp Appliance Test Socket.

18.2 110 Volt Configuration.

The low voltage required to perform this test consists of a switched DC waveform originating from the + 12 Volts supply but synchronised to the incoming mains supply frequency. The secondary voltage from mains transformer TX1 (located on the relay PCB) is fed via resistor R18 and diode D5 to transistor TR4. This transistor simply provided a 50Hz (or mains frequency equivalent) 5Volt positive square wave which is fed via R95 to the gate of FET TR15. This N Channel FET drives the gate of FET TR16 which as a P - Channel device can act as a "High side Driver " providing the test current to RL11. Resistors R44 & R97 limit the current to 100mA. This new circuit arrangement provided a constant amplitude (with respect to mains supply variations) 50Hz 12 Volt square wave.

The test voltage is routed to single pole relay RL11 the contacts of which are closed for this test and then via fuse FS4 to relay RL12. From RL12 the test current is supplied to the Live pin of the PAT4DVF 110 Volt / BS4343 Appliance Test Socket.

The Neutral pole of the PAT4DVF 110 Volt / BS4343 Appliance Test Socket is connected to earth via fuse FS1, relay RL9 and resistor R41.

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This configuration results in the flow of current being dependant on the load presented between the Live & Neutral pins of the PAT4DVF 110 Volt / BS4343 Appliance Test Socket

18.3 Voltage Measurement.

Potential divider formed from resistors R40, R42 & R43 are used to attenuate the voltage present on the PAT4DVF appliance socket. With the resistor values used and the no appliance connected approximately 0.6 Volts is present at SK1 pin 6. This is transferred to the PAT4DVF "Microprocessor PCB". Multiplexer channel (10) being the destination of this signal, which as shown on ***figure 13b.*** is connected to IC16 pin 15. This measurement is not actually scaled to volts but is used in BIT form.
Zener diodes ZD3, ZD4, ZD8 & ZD9 provide protection in the event of power relay RL5 becoming welded presenting mains energy at RL11. In such a case the clamping action of the Zener diodes (33 Volts) will cause a large current flow-rupturing FS4.

18.4 Current Measurement.

Load current to either PAT4DVF Appliance test socket is measured via current shunt R41. The voltage present across this resistor being transferred to the PAT4DVF "Microprocessor PCB" via SK1 pin 1and Multiplexer channel (09), which as shown on ***figure13b.*** is connected to IC16 pin 14. With the resistor values used and a short circuit applied to the Appliance Socket (Live - Neutral) approximately 0.6 Volts is present at IC16 pin 14.
Zener diodes ZD1, ZD2, ZD12 & ZD13 provide protection in the event of power relay RL6 becoming welded presenting mains energy at RL11 when the incoming supply is reversed. In such a case the clamping action of the Zener diodes (9.1 Volts) will cause a large current flow rupturing fuse FS1.

19.0 Extension Lead (IEC) Tests.

Tests are performed on standard 13 Amp plug to IEC (female) leads (kettle leads etc.) using the configuration shown in ***figure 14.*** "Normal" 13 Amp extension leads can also be tested but an adaptor lead must be used to allow connection to the PAT4DVF panel connector, this adapter which consists simply of a standard 13 Amp plug to IEC (female) connector, is fitted in series with the extension lead to be tested. Tests can also perform the tests via the 110 Volt / BS4343 Appliance Test Socket.

19.1 230 Volt Lead Test Configuration.

This test is supplied from the + 5 Volt rail through resistor R69. Test current is fed via relay RL13 and fuse FS4 to relay RL10. From RL10 the test current is switched to the PAT4DVF 230 Volt / 13 Amp Appliance Test Socket, Live Pin. The neutral pin follows is connected to earth by the action of relay RL9 and resistor R41. From this description we now have a high source impedance +5 Volt supply across the active pins of the PAT4DVF 230 Volt / 13 Amp Appliance Test Socket.

19.2 110 Volt Lead Test Configuration.

This test is supplied from the + 5 Volt rail through resistor R69. Test current is fed via relay RL13 and fuse FS4 to relay RL12. From RL12 the test current is switched to the PAT4DVF 110 Volt / BS43430 Appliance Test Socket, Live Pin. The neutral pin follows is connected to earth by the action of relay RL9 and resistor R41. From this

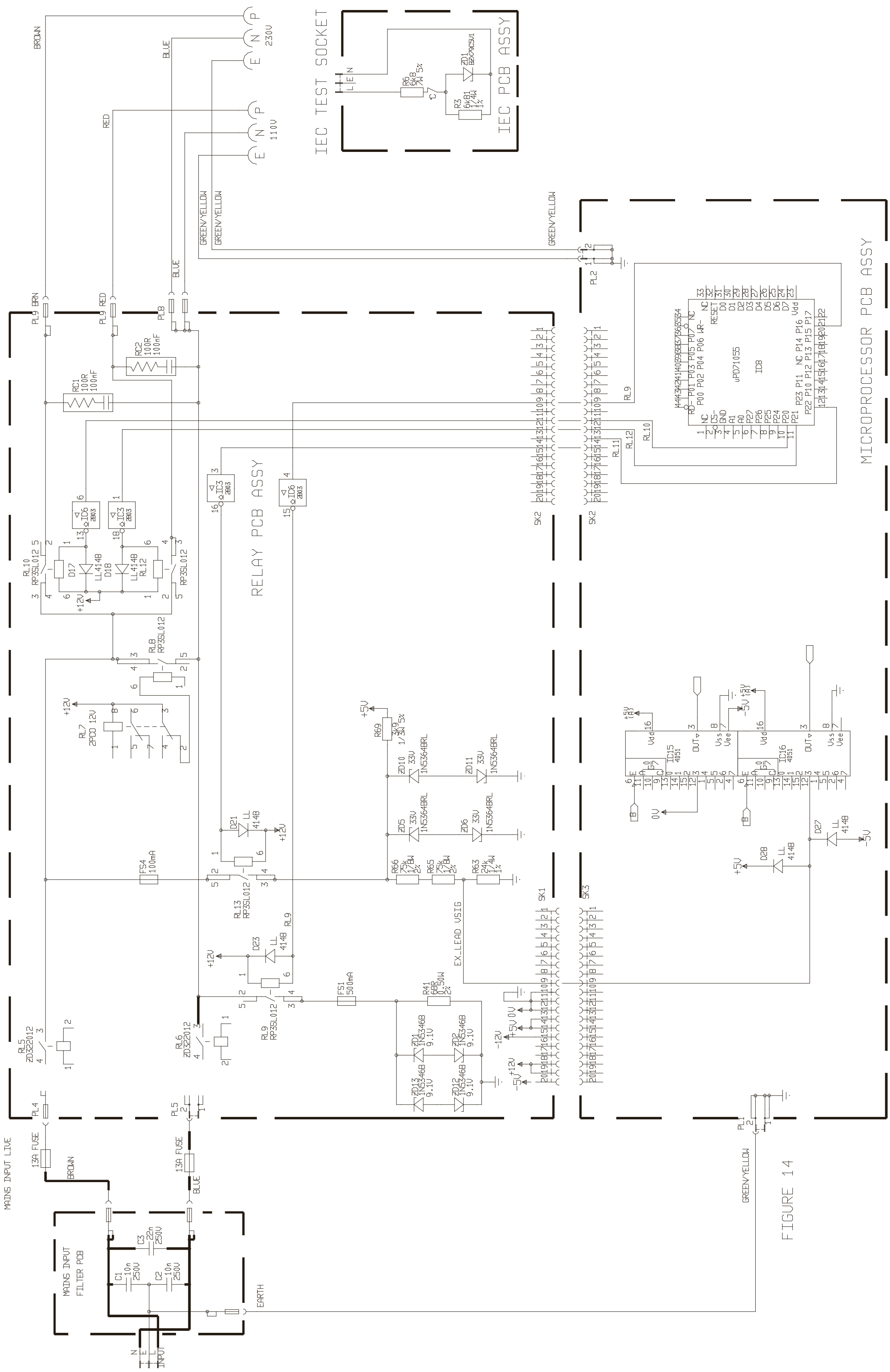
IEC TEST SOCKET
IEC PCB ASSY
RELAY PCB ASSY
MICROPROCESSOR PCB ASSY
MAINS INPUT FILTER PCB
MAINS INPUT LIVE
EARTH
BROWN
BLUE
RED
GREEN/YELLOW
230V
110V
FIGURE 14

Figure 14

description we now have a high source impedance +5 Volt supply across the active pins of the PAT4DVF 110 Volt / BS4343 Appliance Test Socket.

19.3 Polarity Test.

Contained on the IEC PCB are components to determine the state of extension leads under test. Resistor R6 provides a low impedance to allow the test current to pass. This resistor also incorporates a thermal overload element that will rupture after prolonged heating this protects the PAT4DVF in the event of a direct mains connection being made to IEC connector. Dependent on the state of the extension lead under test, four defined load impedance's can be generated.

Impedance.	Lead Condition.	Circuit Elements	Load Presented
Low	**L/N Shorted**	**Direct Connection**	**Lead L/N = 0Ω**
Z1	**Lead is OK**	**ZD1 acts as diode (0.6V)**	**R6**
Z2	**L/N Reversed**	**ZD1 acts as Zener (5.6V)**	**R6 + R3**
High	**L/N Open**	**None**	**Lead L/N = ∝**

19.4 Voltage measurement.

The above conditions are measured in terms of terminal voltage present between the active pins of the Appliance test socket in use. This voltage is measured using voltage divider network formed from resistors R63, R65 & R6, with the values indicated and the Appliance Test Socket vacant approximately 0.68 Volts will be present at connector SK1 pin 9. This is transferred to the PAT4DVF "Microprocessor PCB. Multiplexer channel (11) being the destination of this signal, which as shown on ***figure 14.*** is connected to IC16 pin 12. Note this measurement is not actually scaled to volts for PAT4DVF use but is used in BIT form.

20.0 Common Problems.

20.1 PAT4DVF is "Dead"
- Check Main Panel mounted fuses.
- Check Mains Lead Plug top fuse.
- Power Supply on board Fuse FS2.
- On PAT4 Mk 1 models fit latest software (V1.6).

20.2 Operation Test reads 0VA
- Check test time is > 3 seconds in set up menu.
- Check correct operation of CT.

20.3 Instrument reads 3XX Volts on neutral
- Replace IC 18 (Microprocessor (PCB)

20.4 Bond test is inaccurate.
- Check the two CTs have not been transposed.

21.0 Routine Maintenance.

Before use the PAT4 should be visually inspected for mechanical damage that could result in injury to the user.

Test leads should be examined regularly and replaced if any damage is found..

The PAT4 should be calibrated at least once per year.

No other general maintenance is required.

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Section (ii) Backing up customers PAT4 data

PAT4 instruments returned for service or calibration will contain customer records. Every attempt should be made to preserve this data as the PAT4 may contain the only copy. Therefore at the earliest opportunity the PAT4 should be backed up to a PC running **AVO Backup software (AVO Pt. No. 6220-646).** This data should be returned to the PAT4 prior to shipping back to the customer. A backup copy should be retained for customer security.

If the PAT4 is booting up properly, "log in" if necessary.
If the username and PIN are not available and the usual AVO/1234 combination doesn't work, use the special user names "CT17 9EN" (for software version 1.4 and higher) or "SCOOBY DOO" (for software version 1.3 and earlier). These special user names will log in without the need for any PIN.

Once logged in go to the ***User*** database (in the setting menu) and use the ***edit*** function to find a valid user and PIN and login using these.
Always upgrade the PAT4 to the latest software to allow access to any newly released features and bug fixes.

If the PAT4 will not boot up at all, try installing the latest software version (version 1.7) as a software problem in PAT4's using version 1.4 and earlier software can make the PAT4 appear "dead" when they have over about 700 assets stored.

If the PAT4 is still not booting up correctly, take extreme care when fault finding do not disturb the RAM (IC10) as it contains the test results and data, or the real time clock module (IC9) which contains the battery which maintains the RAM when the power is off.

When you have logged into the PAT4, and selected a ***client*** and ***location***, go to the ***Comms*** menu.

On a convenient PC running Microsoft Windows , install the PAT4 backup software if it is not currently installed.
Start the **PAT4BU.EXE** program by double clicking the AVO icon. If the program has not been set up previously you need to select a COM port for the program to use - choose one with a 9-way connector - and plug in the serial download cable between the PAT4 and the PC. On the PC, select the menu selection called '***Options***' and select the COM port you are using from the list.
Click on the button marked "***From PAT***", the screen should change to prompt for a filename to store the PAT4 data under, enter a suitable name for the file (perhaps use part of the PAT4 serial number for easy identification). Once the name has been specified, the screen changes to show the download window.
On the PAT4, from the ***Comms*** menu, press the button next to the screen prompt ***SEND*** - the display will change to "***Connecting***", then shortly after to "***Sending***". If the PAT4 remains in the "***Connecting***" stage or "times out", check that the header from the 9-way d-type connector (on the PAT4 front panel) is correctly mated onto the microprocessor board. Also check that the correct download cable is being used.
When the data has all been sent the PC software should return to the point where the two large buttons are displayed. The PAT4 should return to the ***Comms*** menu. If either the PC or the PAT4 does not return to the point expected assume the download has failed to complete - try it again - if the problem persists there may be a corruption in the stored data (contact AVO Dover for help).

Section (iii) Restoring data to the PAT4 after repair/calibration

Generally most repairs and/or calibration do not affect the data in the PAT4 so the user name and PIN will not have been affected by the work carried out. Log in if necessary and select the ***Comms*** menu. In the ***Comms*** menu press the key next to word "***Receive***" on the display.
If however, you cannot gain entry to the PAT4, and just want to restore the data you downloaded earlier you may use the "shortcut to upload method" - power up the PAT4 with the '***U***' key held down.
The PAT4 will ask whether it is "***OK to erase all the data in the PAT4***" - leave the PAT4 displaying this stage until you have prepared the PC software for the upload.
Ensure the PAT4 is connected to the PC with the serial download cable.
Start the ***PAT4BU.EXE*** program by double clicking on the ***AVO icon***. Click the mouse on the "***To PAT***" button, the software will offer a list of data files (*.asc) stored in the directory.
Select the file appropriate for the instrument - there may be a short delay while the software re-indexes the data in the file prior to send it.
When the upload window appears, return to the PAT4 and confirm ***OK*** (twice) to allow the data in the PAT4 to be erased and the upload to proceed.
The PAT4 display will show a message while it erases the data, then it will display "***Connecting***", followed shortly by "***Receiving***".
Uploading a large database of assets and results can take a long time - maybe over an hour for a full database - the time will vary depending how much text has been entered in the data.
N.B. Early versions of the software are slower to upload.

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Section (iv) Calibration Checks and Accuracy certification.

Table (a) Equipment Required:

Equipment Reference	Description.	**Value / Specification.**
T1	**16A Variac Variable Transformer**	**With output voltage metering.**
R1	**Calibrated 100mΩ resistor.**	**65 Watt rating.**
R2	**Calibrated 1.0MΩ resistor.**	**3000 Volt rating @ 2.0 Watt**
R3	**Calibrated 9.0Ω resistor**	**2 Watt Rating**
R4	**Calibrated 1.8Ω resistor.**	**65 Watt rating**
R5	**15kΩ (⇒ 230V / 15mA)**	**300 Volt rating @ 4 Watt**
R6	**47kΩ (⇒ 230V / 5mA)**	**300 Volt rating @ 2 Watt**
R7	**Calibrated 40MΩ**	**600 Volt rating @ 0.1 Watt**
R8	**Calibrated 7M Ω**	**600 Volt rating @ 0.5 Watt**
R9	**Calibrated 0.1M Ω**	**600 Volt rating @ 0.5 Watt**
R10	**7.5kΩ (⇒ 110V / 15mA)**	**300 Volt rating @ 2 Watt**
R11	**22kΩ (⇒ 110V / 5mA)**	**300 Volt rating @ 1 Watt**
R12	**200kΩ resistor. (⇒ Class 1 Flash)**	**3000 Volt rating @ 3 Watt**
R13	**400kΩ resistor. (⇒ Class 2 Flash)**	**1500 Volt rating @ 3 Watt**
R14	**2MΩ resistor. (⇒ Class 2 Flash)**	**1500 Volt rating @ 3 Watt**
P1	**3kW Load @ 230V.**	**Power Resistor or Heater**
P2	**1.5kW Load @ 230V.**	**Power Resistor or Heater**
P3	**60W Load @ 230V.**	**Power Resistor or Lamp**
P4	**1.5kW Load @ 110V.**	**Power Resistor or Heater**
P5	**500W Load @ 110V.**	**Power Resistor or Lamp**
P6	**60W Load @ 110V.**	**Power Resistor or Heater**
M1, M2	**Digital Multi-meters (i.e. M2008)**	
M3	**100GΩ / 3000Volt Meter**	**High Impedance voltmeter or divider for M1**
PL1	**13A Plug Top**	**5Ω resistor connected between Live & Neutral**
PL2	**13A Plug Top**	**100kΩ resistor connected between Live & Neutral**
PL3	**13A Plug Top**	**47kΩ resistor connected between Live & Neutral**
PL4	**110V Plug Top**	**5Ω resistor connected between Live & Neutral**
PL5	**110V Plug Top**	**47kΩ resistor connected between Live & Neutral**
TL1	**13A Plug to IEC Socket**	**Correctly wired**
TL2	**13A Plug to IEC Socket**	**Live & Neutral Swapped at the 13A Plug.**
TL3	**13A Plug to IEC Socket**	**Live & Neutral Shorted together at the 13A Plug**
TL4	**110V Plug to IEC Socket**	**Correctly wired**
TL5	**110V Plug to IEC Socket**	**Live & Neutral Swapped at the 110V Plug.**
TL6	**110V Plug to IEC Socket**	**Live & Neutral Shorted together at the 110V Plug**
TL7	**2 Standard Bond Test Lead**	**Hook Spade to 13A Plug top (Earth Pin Only).**
TL8	**2 Standard Bond Test Lead**	**Hook Spade to Hook Spade**
TL9	**2 Standard Bond Test Lead**	**Hook Spade to 110V Plug top (Earth Pin Only).**
TL10	**Custom 13A Plug to 13A Socket.**	**Ammeter between Live in and Live Out**
LK1	**Shorting Link**	**2 pole shorting link 0.1" pitch**
LK2	**Insulation Test Calibration Lead.**	**2 pole 0.1" pitch connector to 4mm plugs fly lead.**

(a) Change the PAT4 from normal mode to calibrate mode as follows:

Supply 230V to thePAT4 from supply **T1** whilst holding down the '**SHIFT**' and '**1**' keys. The buzzer should sound briefly.
PAT4 will prompt for the value of the 0.1Ω test resistor **R1**.

(b) Enter the exact resistance of the test resistor R1 as above to four decimal places.
(E.g. 0.1038)
Press OK Key.

N.B PAT4 Mk 1 models do not support the above instructions.
For early models a separate Calibration EPROM must be used (AVO Pt. No.6139-138).

Table (b) Calibration Menu

Menu Option Number 0:	Calibrate **Insulation test**.
Menu Option Number 1:	Calibrate **Circuit Test**.
Menu Option Number 2:	Calibrate **Earth Continuity Test**.
Menu Option Number 3:	Calibrate **Earth Bond Test**.
Menu Option Number 4:	Calibrate **Earth Leakage Test**.
Menu Option Number 5:	Calibrate **Extension Lead Test.**
Menu Option Number 6:	Calibrate **Operation Test**.
Menu Option Number 7:	Calibrate **Flash Test**.
Menu Option Number 8:	Calibrate **Real time clock.**
Menu Option Number 10:	Run **Insulation test.**
Menu Option Number 11:	Run **Circuit Test**.
Menu Option Number 12:	Run **Earth Continuity Test.**
Menu Option Number 13:	Run **Earth Bond Test @ 10 Amps**
Menu Option Number 14:	Run **Earth Bond Test @ 25 Amps**
Menu Option Number 15:	Run **Extension Lead Test.**
Menu Option Number 16:	Run **Operation / Earth Leakage Test.**
Menu Option Number 17:	Run **Flash Test Class 2.**
Menu Option Number 18:	Run **Flash Test Class 1.**
Menu Option Number 19:	Display Time and Date.
Menu Option Number 21:	Adjust contrast.
Menu Option Number 22:	Change PAT4 Model.
Menu Option Number 23:	Change individual calibration constant. !!
Menu Option Number 24:	Test Serial and Parallel Ports.
Menu Option Number 25:	Change to Diagnostics menu.
Menu Option Number 100:	Store default calibration constants. !!

!!!! Must be used with care.

1.0 Insulation Test

(1.1) Checks Insulation Test *at 230V supply*

(A) Supply 230V power to PAT4 from a stabilised supply.
(B) Select **Option "10"** from the menu. **Press OK Key.**
(C) Check that the measured values on the PAT4 correspond with the table below:

5% ± 100kΩ

PAT4 13A Socket. Live to Earth	MIN READING	MAX READING	M1 or M2
M1 (1000V dc)			**500 to 600V**
O/C	**>50MΩ**	**>50MΩ**	
R7	**R9 - (R9*0.05) - 0.1MΩ**	**R7 + (R7x0.05) + 0.1MΩ**	
R8	**R8 - (R8x0.05) - 0.1MΩ**	**R8 + (R8x0.05) + 0.1MΩ**	
R9	**R9 - (R9x0.05) - 0.1MΩ**	**R9 + (R9x0.05) + 0.1MΩ**	
R9 & M2 in series (3mA dc)			**1.5 to 1.9mA**
S/C	**0MΩ**	**0.1MΩ**	

(C) **Press and Hold the OK Key** To return to main menu.
(D) Remove 230V Supply from PAT4.

(1.2) Checks at 110V supply.

(A) Supply 110V power to PAT4 from a stabilised supply.
(B) **Select Option "10"** from the menu. **Press OK Key.**
(C) Check the measured values on the PAT4 correspond with the table below:

5% ± 100kΩ

PAT4 110V Socket. Live to Earth	MIN READING	MAX READING
O/C	**>50MΩ**	**>50MΩ**
R7	**R9 - (R9*0.05) - 0.1MΩ**	**R7 + (R7x0.05) + 0.1MΩ**
R9	**R9 - (R9x0.05) - 0.1MΩ**	**R9 + (R9x0.05) + 0.1MΩ**
S/C	**0MΩ**	**0.1MΩ**

(D) **Press and Hold the OK Key** To return to main menu.
(E) Switch Off Stabilised supply.

(2.0) Continuity Test .

(A) Supply 230V power to PAT4 from a stabilised supply.
(B) **Select Option "12"** from the menu. **Press OK Key.**
(C) Connect meter **M1** (Volts dc) between PAT4 13A Socket & 200mA terminal.
N.B. This connection is in addition to resistors listed below.
(D) Check that the measured values on the PAT4 correspond with the table below.
(E) Connect using **TL7 and TL8**:

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0<R>999mΩ 5%± 5mΩ 1.0<R>9.9Ω 5%± 10mΩ

PAT4 13A Socket to 200mA Continuity Socket	MIN READING (PAT4)	MAX READING (PAT4)	M1
TL7	**0.000Ω**	**0.005Ω**	**-**
R1	**R1 - (R1*0.05) – 5mΩ**	**R1 + (R1*0.05) + 5mΩ**	**15.1 to 18.5mV**
R3	**R3 - (R3*0.05) – 10mΩ**	**R3 + (R3*0.05) + 10mΩ**	**-**
(O/C)		**>10**	**3.6 to 4.4V**

(F) **Press and Hold the OK Key** To return to main menu.

(3.0) Bond Test.

<u>3.1 Checks @ 230V & 25A.</u>

(A) Supply 230V power to PAT4 from a stabilised supply.
(B) Connect meter **M1** (Volts ac) between PAT4 13A Socket and Bond Test Terminal.
N.B. This connection is in addition to resistors listed below.
(C) **Select Option "14"** from the menu. **Press OK Key.**
(D) Check the following readings are obtained on the PAT4 and readings on **M1.**
N.B. All connections must include **TL7 + TL8.**

0<R>499mΩ 5%± 5mΩ 500<R>1999mΩ 5%± 50mΩ

PAT4 13A Socket to Bond Test Terminal	MIN READING (PAT4)	MAX READING (PAT4)	M1 Min Max.
TL7 + TL8	**0.000Ω**	**0.005Ω**	
R1	**R1 - (R1*0.05) – 5mΩ**	**R1 + (R1*0.05) + 5mΩ**	**23/R1 to 27/R1**
R4	**R4 - (R4*0.05) – 50mΩ**	**R4 + (R4*0.05) + 50mΩ**	
(O/C)	**> 2.0Ω**	**> 2.0Ω**	

(E) **Press and Hold the OK Key.** To return to main menu.

<u>3.2 Checks @ 230V & 10A.</u>

(A) Supply 230V power to PAT4 from a stabilised supply.
(B) Connect meter **M1** (Volts ac) between PAT4 13A Socket and Bond Test Terminal.
N.B. This connection is in addition to resistors listed below.
(C) **Select Option "13"** from the menu. **Press OK Key.**
(D) Check the following resistance readings are obtained on the PAT4 and current readings on the test box:
N.B. All connections must include **TL7 + TL8.**

0<R>499mΩ 5%± 5mΩ 500<R>1999mΩ 5%± 50mΩ

PAT4 13A Socket to Bond Test Terminal	MIN READING (PAT4)	MAX READING (PAT4)	M1 Min Max.
TL7+TL8	**0.000Ω**	**0.005Ω**	
R1	**R1 - (R1*0.05) – 5mΩ**	**R1 + (R1*0.05) + 5mΩ**	**8/R1 to 12/R1**
R10	**R10 - (R10*0.05) – 50mΩ**	**R10 + (R10*0.05) + 50mΩ**	
R4	**R4 - (R4*0.05) – 50mΩ**	**R4 + (R4*0.05) + 50mΩ**	
(O/C)	**> 2.0Ω**	**> 2.0Ω**	

(E) **Press and Hold the OK Key.** To return to main menu.

3.3 Checks @ 110V & 25A.

(A) Supply 110V power to PAT4 from a stabilised supply.
(B) Connect meter **M1** (Volts ac) between PAT4 110V Socket and Bond Test Terminal.
N.B. This connection is in addition to resistors listed below.
(C) **Select Option "14"** from the menu. **Press OK Key.**
(D) Check the following resistance readings are obtained on the PAT4 and current readings on the test box:
N.B. All connections must include **TL8 + TL10.**

0<R>499mΩ 5%± 5mΩ 500<R>1999mΩ 5%± 50mΩ

PAT4 13A Socket to Bond Test Terminal	**MIN READING (PAT4)**	**MAX READING (PAT4)**	**M1 Min Max.**
TL8 + TL10	**0.000Ω**	**0.005Ω**	
R1	**R1 - (R1*0.05) – 5mΩ**	**R1 + (R1*0.05) + 5mΩ**	**23/R1 to 27/R1**
R10	**R10 - (R10*0.05) – 50mΩ**	**R10 + (R10*0.05) + 50mΩ**	
R4	**R4 - (R4*0.05) – 50mΩ**	**R4 + (R4*0.05) + 50mΩ**	
(O/C)	**> 2.0Ω**	**> 2.0Ω**	

(E) **Press and Hold the OK Key.** To return to main menu.

3.4 Checks @ 110V & 10A.

(A) Supply 110V power to PAT4 from a stabilised supply.
(B) Connect meter **M1** (Volts ac) between PAT4 13A Socket and Bond Test Terminal.
N.B. This connection is in addition to resistors listed below.
(C) **Select Option "13"** from the menu. **Press OK Key.**
(D) Check the following resistance readings are obtained on the PAT4 and current readings on the test box:
N.B. All connections must include **TL8 + TL10.**

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0<R>499mΩ 5%± 5mΩ   500<R>1999mΩ 5%± 50mΩ

PAT4 13A Socket to Bond Test Terminal	MIN READING (PAT4)	MAX READING (PAT4)	M1 Min Max.
TL8 + TL10	**0.000Ω**	**0.005Ω**	
R1	**R1 - (R1*0.05) – 5mΩ**	**R1 + (R1*0.05) + 5mΩ**	**8/R1 to 12/R1**
R10	**R10 - (R10*0.05) – 50mΩ**	**R10 + (R10*0.05) + 50mΩ**	
R4	**R4 - (R4*0.05) – 50mΩ**	**R4 + (R4*0.05) + 50mΩ**	
(O/C)	**> 2.0Ω**	**> 2.0Ω**	

(E) **Press and Hold the OK Key.** To return to main menu.

(4.0) Extension Lead Test.

<u>(4.1) Checks @ 230V.</u>

(A) Supply 230V power to PAT4 from a stabilised supply.
(B) **Select Option "15"** from the menu. **Press OK Key.**
(C) PAT4 will request "Connect Ext. Lead Plug and Socket to PAT".
(D) **Press OK Key to repeat test.**
(E) Check that each of the given conditions is displayed:

Connection between PAT4 13A Socket & IEC Plug	PAT4 MESSAGE
TL2	**L & N Transposed**
None	**Lead is O/C**
TL1	**Lead is O/K**
TL3	**Lead is Shorted**

(E) **Press and Hold the ESC Key.** To return to main menu.
(F) Disconnect the Stabilised supply and the test leads.

<u>(4.2) Checks @ 110V.</u>

(A) Supply 110V power to PAT4 from a stabilised supply.
(B) **Select Option "15"** from the menu. **Press OK Key.**
(C) PAT4 will request "Connect Ext. Lead Plug and Socket to PAT".
(D) **Press OK Key to repeat test.**
(E) Check that each of the given conditions is displayed:

Connection between PAT4 13A Socket & IEC Plug	PAT4 MESSAGE
TL5	**L & N Transposed**
None	**Lead is O/C**
TL4	**Lead is O/K**
TL6	**Lead is Shorted**

(D) **Press and Hold the ESC Key.** To return to main menu.
(E) Disconnect the Stabilised supply and the test lead.

(5.0) Operation Test

<u>(5.1) Checks @ 230V.</u>

(A) Supply 230V power to PAT4 from a stabilised supply.
(A) **Select Option "16"** from the menu. **Press OK Key.**
(B) Connect Power Loads detailed below to the 230 V socket on the PAT4.
(C) Check the following readings are obtained on the PAT4.

0<VA>99VA 5%± 5VA 100<VA>999VA 5%± 10VA 1.00<VA>3.0kA 5%± 100VA

Load resistor	MIN READING (PAT4)	MAX READING (PAT4)
P1	**P1 - (P1*0.05) – 100VA**	**P1 + (P1*0.05) + 100VA**
P2	**P2 - (P2*0.05) – 100VA**	**P2 + (P2*0.05) + 100VA**
P3	**P3 - (P3*0.05) – 5VA**	**P3 + (P3*0.05) + 5VA**

(D) **Press and Hold the OK Key.** To return to main menu.
(E) Disconnect supply **T1**.

<u>(5.2) Checks @ 110V.</u>

(A) Supply 110V power to PAT4 from a stabilised supply.
(A) **Select Option "16"** from the menu. **Press OK Key.**
(B) Connect Power Loads detailed below to the 110 V socket on the PAT4.
(C) Check the following readings are obtained on the PAT4.

0<VA>99VA 5%± 5VA 100<VA>999VA 5%± 10VA 1.00<VA>1.6kA 5%± 100VA

Load resistor	MIN READING (PAT4)	MAX READING (PAT4)
P4	**P4 - (P4*0.05) – 100VA**	**P4 + (P4*0.05) + 100VA**
P5	**P5 - (P5*0.05) – 10VA**	**P5 + (P5*0.05) + 10VA**
P6	**P6 - (P6*0.05) – 5VA**	**P6 + (P6*0.05) + 5VA**

(D) **Press and Hold the OK Key.** To return to main menu.
(E) Disconnect supply **T1**.

(6.0) Earth Leakage Test.

(6.1) Checks @ 230V.

(A) Supply power **@ 254V** from **T1** to the PAT4.
N.B. This test displays the effective leakage current that would be present at high mains (254 Volts)
(B) Connect meter **M1** (30mA ac) in series with resistor specified. Connect series combination between PAT4 13A Socket Live and Earth Pins.
N.B. Do not use a supply incorporating a 15mA RCD during this test.
(C) **Select Option "16"** from the menu. **Press OK Key.**
(D) Compare the readings on meter **M1** with those displayed on PAT4.

5%± 100µA

M1 in series with	M1 READING	PAT4 MIN READING	PAT4 MAX READING
O/C		**0mA**	**0.1mA**
R6	**I_1**	**I_1 - (I_1 * 0.05) – 0.1mA**	**I_1 + (I_1 * 0.05) + 0.1mA**
R5	**I_2**	**I_2 - (I_2 *0.05) – 0.1mA**	**I_2 + (I_2 * 0.05) + 0.1mA**

(E) **Press and Hold the OK Key.** To return to main menu.
(F) Disconnect supply **T1**

(6.2) Checks @ 110V.

(A) Supply power **@ 121V** from **T1** to the PAT4.
N.B. This test displays the effective leakage current that would be present at high mains (121 Volts)
(B) Connect meter **M1** (30mA ac) in series with resistor specified. Connect series combination between PAT4 110V Socket Live and Earth Pins.
N.B. Do not use a supply incorporating a 15mA RCD during this test.
(C) **Select Option "16"** from the menu. **Press OK Key.**
(D) Compare the readings on meter **M1** with those displayed on PAT4.

5%± 100µA

M1 in series with	M1 READING	PAT4 MIN READING	PAT4 MAX READING
O/C		**0mA**	**0.1mA**
R10	**I_1**	**I_1 - (I_1 * 0.05) – 0.1mA**	**I_1 + (I_1 * 0.05) + 0.1mA**
R11	**I_2**	**I_2 - (I_2 *0.05) – 0.1mA**	**I_2 + (I_2 * 0.05) + 0.1mA**

(E) **Press and Hold the OK Key.** To return to main menu.
(F) Disconnect supply **T1**

(7.0) Circuit / Load Test.

(7.1) Checks @ 230V.

(A) Supply 230V power to PAT4 from supply **T1**.
(B) **Select Option "11"** from the menu. **Press OK Key.**

(C) Check that the appropriate message appears when the requested plug is applied.

Plug fitted to PAT4	PAT4 INDICATION
None	"O / C"
PL3	"OK"
PL1	"S / C"

(D) **Press and Hold the OK Key.** To return to main menu.
(E) Disconnect supply **T1**

(7.2) Checks @ 110V.

(A) Supply 110V power to PAT4 from supply **T1**.
(B) **Select Option "11"** from the menu. **Press OK Key.**
(C) Check that the appropriate message appears when the requested plug is applied.

Plug fitted to PAT4	PAT4 INDICATION
None	"O / C"
PL5	"OK"
PL4	"S / C"

(D) **Press and Hold the OK Key.** To return to main menu.
(C) Disconnect supply **T1**

(8.0) Flash Test Class 1. This section is omitted on PAT4DV models!!!.

(8.1) Checks @ 230V

Warning ! 1500V is applied during this test:
3000V is applied to the flash test socket. Ensure probe is not connected.

(A) Supply 230V power to PAT4 from supply **T1**.
(B) Connect meter **M1** (30mA ac) in series with resistor specified.
(C) Connect series combination between PAT4 230V Socket Live and Earth Pins.
(D) **Select Option "18"** from the menu. **Press OK Key.**
(E) Check the following are obtained. To energise the flash test :
Press and hold the shift key.

5%± 100µA

M1 in series with	M1 READING	PAT4 MIN	PAT4 MAX
O/C		0mA	0.1mA
R2	I_1	I_1 - (I_1 * 0.05) – 0.1mA	I_1 + (I_1 * 0.05) + 0.1mA
R12	I_2	I_2 - (I_2 *0.05) – 0.1mA	I_2 + (I_2 * 0.05) + 0.1mA
S/C	I_3 =2.7 to 3.0mA	I_3 - (I_3 *0.05) – 0.1mA	I_3 + (I_3 * 0.05) + 0.1mA

(F) **Release the shift key** To stop the test before changing resistors.

(G) **Re select Option "18"** to perform next value. **Press OK Key.**
(H) Connect meter **M3** between PAT4 230V Socket Live and Earth Pins.
(I) **Re select Option "18"** to perform next value. **Press OK Key.**

	MIN	MAX
M3 READING	**1400 V**	**1600 V**

(J) **Release the shift key** To return to main menu.

(8.2) Checks @ 110V

Warning ! 1500V is applied during this test:
3000V is applied to the flash test socket. Ensure probe is not connected.

(A) Supply 110V power to PAT4 from supply **T1**.
(B) Connect meter **M1** (30mA ac) in series with resistor specified. Connect series combination between PAT4 110V Socket Live and Earth Pins.
(C) **Select Option "18"** from the menu. **Press OK Key.**
(D) Check the following are obtained on the PAT4**.** To energise the flash test **press and hold the shift key**.

5%± 100µA

M1 in series with	M1 READING	PAT4 MIN	PAT4 MAX
O/C		**0mA**	**0.1mA**
R2	I_1	$I_1 - (I_1 * 0.05) - 0.1mA$	$I_1 + (I_1 * 0.05) + 0.1mA$
R12	I_2	$I_2 - (I_2 * 0.05) - 0.1mA$	$I_2 + (I_2 * 0.05) + 0.1mA$
S/C	I_3 **=2.7 to 3.0mA**	$I_3 - (I_3 * 0.05) - 0.1mA$	$I_3 + (I_3 * 0.05) + 0.1mA$

(E) **Release the shift key** To stop the test before changing resistors.
(F) **Re select Option "18"** to perform next value. **Press OK Key.**
(G) Connect meter **M3** between PAT4 110V Socket Live and Earth Pins.
(H) **Re select Option "18"** to perform next Test. **Press OK Key.**

	MIN	MAX
M3 READING	**2700 V**	**3000 V**

(I) **Release the shift key** To return to main menu.

(9.0) Flash Test Class 2. !!!! This section is omitted on PAT4DV models!!!.

(9.1) Checks @ 230V

Warning ! 3000V is applied during this test:

(A) Supply 230V power to PAT4 from supply **T1**.

(B) Connect meter **M1** (30mA ac) in series with resistor specified. Connect series combination between PAT4 230V Socket Live and 3kV Flash Probe.
N.B. An actual Flash Probe must be used as it contains a 27kΩ resistor.
(C) **Select Option "17"** from the menu. **Press OK Key.**
(D) Check the following are obtained on the PAT4**.**
(E) To energise the flash test **press and hold the shift key**.

5%± 100µA

M1 in series with	M1 READING	PAT4 MIN	PAT4 MAX
O/C		**0mA**	**0.1mA**
R14	**I_1**	**I_1 - (I_1 * 0.05) – 0.1mA**	**I_1 + (I_1 * 0.05) + 0.1mA**
R13	**I_2**	**I_2 - (I_2 *0.05) – 0.1mA**	**I_2 + (I_2 * 0.05) + 0.1mA**
S/C	**I_3 =2.7 to 3.0mA**	**I_3 - (I_3 *0.05) – 0.1mA**	**I_3 + (I_3 * 0.05) + 0.1mA**

(F) **Release the shift key** To stop the test before changing resistors.
(G) **Re select Option "18"** to perform next value. **Press OK Key.**
(H) Connect meter **M3** between PAT4 230V Socket Live and Flash Probe.
(I) **Re select Option "18"** to perform next value. **Press OK Key.**

	MIN	MAX
M3 READING	2840 V	3160 V

(J) **Release the shift key** To return to main menu.

(9.2) Checks @ 110V.

Warning ! 3000V is applied during this test:

(A) Supply 230V power to PAT4 from supply **T1**.
(B) Connect meter **M1** (30mA ac) in series with resistor specified. Connect series combination between PAT4 110V Socket Live and 3kV Flash Probe.
N.B. An actual Flash Probe must be used as it contains a 27kΩ resistor.
(C) **Select Option "17"** from the menu. **Press OK Key.**
(D) Check the following are obtained on the PAT4**.**
(E) To energise the flash test **press and hold the shift key**.

5%± 100µA

M1 in series with	M1 READING	PAT4 MIN	PAT4 MAX
O/C		**0mA**	**0.1mA**
R14	**I_1**	**I_1 - (I_1 * 0.05) – 0.1mA**	**I_1 + (I_1 * 0.05) + 0.1mA**
R13	**I_2**	**I_2 - (I_2 *0.05) – 0.1mA**	**I_2 + (I_2 * 0.05) + 0.1mA**
S/C	**I_3 =2.7 to 3.0mA**	**I_3 - (I_3 *0.05) – 0.1mA**	**I_3 + (I_3 * 0.05) + 0.1mA**

(F) **Release the shift key** To stop the test before changing resistors.
(G) **Re select Option "18"** to perform next value. **Press OK Key.**

(H) Connect meter **M3** between PAT4 110V Socket Live and Flash Probe.
(J) **Re select Option "18"** to perform next value. **Press OK Key.**

	MIN	MAX
M3 READING	**2840 V**	**3160 V**

(K) **Release the shift key** To return to main menu.

Section (v) Calibration Procedures.

(1.0) Insulation Test.

(A) Remove Calibration link PL11 on the relay PCB and replace with "**LK2**".
(B) A **3mA-dc meter** (**M1**) should be attached to the 4mm plugs located on the far end of the test lead.
(C) Connect a Meter **M2** (1000-Volt range) between the Live & Earth pins of the PAT4 13Amp socket.
(D) **Select Option "0"** from the menu. **Press OK Key.**
(E) PAT4 will request "Set to O/C Volts Continue?" **Press OK Key.**
(F) PAT4 will request "Input O/C Volts" **Type in the voltage .**
Press OK Key.
(G) PAT4 will request " 1.0M ohm " Set?"
(H) Connect Test Resistor **R2** between the Live & Earth pins of the PAT4 13Amp socket.
Press OK Key.
(J) PAT4 will request "Input mA Measured".
(K) Type in the reading on the ammeter **M1**. **Press OK Key.**
(L) PAT4 will request "Remove 13Amp Plug from PAT4……ok?".
(M) Remove 13Amp plug from PAT4 socket. **Press OK Key.**

Insulation Test Calibration is now complete

(2.0) Continuity Test Calibration.

(A) Connect Resistor **R3** between **200mA terminal & PAT4DV 13Amp socket using TL7 + TL8.**
(B) Connect meter **M1** (10V range) between:
PAT4DV 200mA terminal & "D" connector shroud.
(C) Supply 230V power to PAT4 using **T1**.
(D) **Select Option "2"** from the menu. **Press OK Key.**
(E) PAT4 will request "Continuity Test 9R Set (V cal) OK ?" **Press OK Key.**
(F) PAT4 will request "Input Volts measured"
Type in the voltage indicated on M1.
Press OK Key.
(G) PAT4 will request "Change 9R to 0R1…..Continue"
(H) Replace resistor **R3** with resistor **R1** using **TL7 + TL8.**
(J) PAT4 will request "Continue ?" **Press OK Key.**
(K) PAT4 will request "mV Meter to S/C Current Term.".
(L) Connect meter **M1** (dc Millivolts) across resistor **R1.**
(M) PAT4 will request "Continue ?" **Press OK Key.**
(N) PAT4 will request "Input mV measured" .
Type in the voltage indicated on meter M1.

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Press OK Key

(O) PAT4 will request “Move to Common”.

(P) Remove resistor **R1**.

(Q) Connect Bond Test leads **TL7** + **TL8** between the **200mA terminal & PAT4DV 13Amp socket Earth Pin.**

(R) PAT4 will request “Continue ?” **Press OK Key.**

<u>Continuity Test Calibration is now complete.</u>

(3.0) Bond Test Calibration.

<u>Stabilised 230V supply (T1) must be used for this calibration.</u>

<u>Note to prevent operation of the Bond transformer thermal trip this section must be performed without delay.</u>

(A) Connect resistor **R1** between PAT4DV Bond Test terminal and 13Amp socket . Using **TL7 + TL8**
Important: The value of this resistor must have been entered into the PAT4 during section 1.

(B) Connect **M1** (ac volts) across resistor **R1** Set this meter to read **AC Volts.**

(C) **Select Option “3"** from the menu. **Press OK Key.**

(D) PAT4 will request “0.1 Ohms Continue? ….ical25” **Press OK Key.**

(E) PAT4 will request “Input Volts” ***Type in the voltage indicated on* M1.** **Press OK Key.**

(F) PAT4 will request “Change to 1R8”.

(G) Exchange resistor **R1** for resistor **R4 using TL7 + TL8**

(H) Connect **M1** (**AC Volts)** between **Bond Test Terminal** on PAT4 & 9 pin “D” connector shroud.

(I) PAT4 will request “Measure voltage at PAT4 Continue vcal25?” **Press OK Key.**

(J) PAT4 will request “Input Volts”. ***Type in the voltage on the meter* M1.** **Press OK Key.**

(K) PAT4 will request “Move 1R8 to Common…continue?”.

(L) Connect Bond lead **TL7 + TL8** between the **PAT4DV Bond Test Terminal & 13Amp socket Earth Pin**

<u>(M)</u> **Press OK Key.**

<u>Bond Test Calibration is now complete</u>

(4.0) Extension Lead Test Calibration.

(A) **Select Option “5"** from the menu. **Press OK Key.**

(B) PAT4 will request “Connect TL3 Lead Continue?” **Press OK Key.**

(C) Connect Lead **TL3** between PAT4DV. 13Amp socket and the IEC Connector.

(C) PAT4 will request “Connect TL1 Lead Continue?

(D) Exchange Lead **TL3** for Lead **TL1**. **Press OK Key.**

(E) PAT4 will request “Switch to L < - > N”.

(F) Exchange Lead **TL1** for Lead **TL2**. **Press OK Key.**

<u>Extension Lead Calibration is now complete</u>.

(5.0) Operation Test Calibration .

Stabilised 230V supply (T1) must be used for this calibration.

(A) Configure meter **M1** (300V ac) across PAT4 13Amp socket Live to Neutral.
(B) Configure meter **M2** (20A ac) in series with PAT4 13Amp socket using Lead **TL10**.
(C) Supply power (230V) to the PAT4.
(D) **Select Option "6"** from the menu. **Press OK Key.**
(E) PAT4 will request "Operation Cal Continue ?" **Press OK Key.**
(F) PAT4 will request "Input Volts" ***Type in the voltage shown*** on **M1.** **Press OK Key.**
(G) PAT4 will request "Continue?" **Press OK Key.**
(H) PAT4 will request "Connect 3kW Load Continue? ".
(I) Connect Load **P1** to PAT4DV 13Amp socket. **Press OK Key.**
(J) PAT4 will request "Input Load Amps" ***Type in the current shown on*** **M2.** **Press OK Key.**

Operation Test Calibration is now complete.

(6.0) Earth Leakage Test

Stabilised 230V-supply (T1) must be used for this calibration.

(A) Connect Resistor **R6** in series with meter **M1** (30mA ac).
(B) Connect the above network between Live and Earth pins of 13Amp socket on PAT4.
(C) **Select Menu Option 4.** **Press OK Key.**
(D) PAT4 will request "Cal Earth Leakage 15mA Continue?" **Press OK Key**
(E) PAT4 will request "Input Current measured". ***Type in the Current Displayed on*** **M1.**

Earth Leakage Test Calibration is now complete.

(7.0) Circuit / Load Test Calibration.

Stabilised 230V-supply (T1) must be used for this calibration.

(A) Fit **PL1** to 13Amp socket on PAT4.
(B) **Select Option "1"** from the menu. **Press OK Key.**
(C) PAT4 will request "Insert PL1?" **Press OK Key.**
(D) PAT4 will request "Insert PL2?"
(E) Fit **PL2** to 13Amp socket on PAT4. **Press OK Key**

Circuit Load Test Calibration is now complete.

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(8.0) Flash Test Calibration.

Stabilised 230V-supply (T1) must be used for this calibration.

Warning !

1500V are applied during this test: 3000V are applied to the flash test socket. Ensure probe is not connected.

(A) Supply power to PAT4 (230V) No connections to be made to the13Amp socket on PAT4.
(B) **Select Option "7"** from the menu. **Press OK Key.**
(C) PAT4 will request "Keyboard Link required OK?" **Press OK Key.**
(D) Fit LK1 across PL 12 Relay PCB. (PL11 Micro PCB on PAT4 Mk 1 models)
(D) PAT4 will request "Cal Flash Test. O/C Volts OK?" **Press OK Key.**
(E) PAT4 will request "S/C CURRENT Set OK?"
(F) Configure meter **M1** (30mA ac) across PAT4 13Amp socket Live to Earth .
(G) **Press OK Key.**
(H) PAT4 will request "Input S/C current mA "
(I) Type in the current indicated on meter **M1**. **Press OK Key.**
(J) PAT4 will request "REMOVE Keyboard Link"
(K) Remove keyboard Link. **Press OK Key**

Flash Test Calibration is now complete.

(9.0) Date and Time Settings.

(A) **Select Option 8.** **Press OK Key.**
(B) Follow on screen instructions to set up: **Year, Month, Day, Hours, and Minutes.** **Press Exit Key.**
(C) Check clock settings are correct. To exit routine **Press and Hold OK Key**

(10.0) Watchdog Timer and Model identification Check.

(A) **Select Option 22.** PAT 4 will indicate **PAT4 DV, PAT4 DVF, PAT4 DVe or PAT4 DVFe Correct?** **Press Yes or No.**
Confirm actual model and displayed model agrees - change if required.
(B) **Press OK Key.** And wait approx. 15 seconds.
(C) Note PAT4 Resets to menu. If PAT4 is now dead replace 500mA fuse and Insulation Calibration Link.

(11.0) Fuse Test Check.

(A) Place a good 20mm fuse across the fuse test pads.
NB a real fuse must be used to verify contacts are accessible.
(B) Buzzer must sound.

(12.0) Communications Check.

(A) Connect a Parallel printer to 25 Way "D" Connector.
(B) Connect a Barcode Scanner to 9 Way "D" Connector.
(C) **Select Option 24.**

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(D) Scan Barcode. Note PAT4 displays and Printer duplicates the contents of the bar code.

PAT4-DV

(E) Interrupt the power to the PAT4 to exit this test.
(F) When the PAT4 displays the Calibration Menu, press the ESC key - PAT4 will display ‘Rebooting... Please wait’.

(13.0) Diagnostic Utilities.

To aid faultfinding the following diagnostic routines menu can be obtained using Option 25. From the main Calibration Menu.

Option 0:	Return to calibration Menu.
Option 1:	100mA Continuity Test.
Option 2:	Earth Leakage Test.
Option 3:	Bond Test @ 10A.
Option 4:	Bond Test @ 25A
Option 5:	Flash Test.
Option 6:	A to D Test.
Option 7:	Insulation Test
Option 8:	Display Insulation Attenuator Resistance.
Option 9:	Operation Test.
Option 10:	Extension Lead Test.
Option 11:	Circuit test.
Option 12:	Display Calibration.
Option 13:	Display PAT4 model.
Option 14:	Print PAT4 calibration constants.

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Section (vi) Component listings.

Table (1); **Component locations and descriptions later version** Microprocessor PCB**.**
Refer to Figure 25 and 26 for component locations.
NB Grid locations with **–C** are conventional components shown on Figure 26

Ref.	Description	AVO No.	Grid		Ref.	Description	AVO No.	Grid
C1	33PF, 50V,CSMD	32000-003	B2		C46	10µF,16V,EC	26970-085	B8-C
C2	100nF, 50V,CSMD	32000-004	C2		C47	10nF, 50V,CSMD	32000-005	B8
C3					C48	100nF, 50V,CSMD	32000-003	B9
C4	100nF, 50V,CSMD	32000-004	F3		C49	10nF, 50V,CSMD	32000-005	D11
C5	10µF,16V,EC	26970-085	G3-C		C50	100nF, 50V,CSMD	32000-003	D10
C6	470pF, 50V,CSMD	32000-002	B3		C51	10µF,16V,TEC	26970-005	D11
C7	1µF, 50V,CSMD	32000-015	G4		C52	100nF, 50V,CSMD	32000-003	D10
C8	100nF, 50V,CSMD	32000-003	F4		C53	10nF, 50V,CSMD	32000-005	F9
C9	10nF, 50V,CSMD	32000-005	F4		C54	10nF, 50V,CSMD	32000-005	G9
C10	10µF,16V,TEC	26970-005	F4-C		C55	10nF, 50V,CSMD	32000-005	F10
C11	100nF, 50V,CSMD	32000-004	G4		C56	10nF, 50V,CSMD	32000-005	B11
C12	100pF, 50V,CSMD	32000-014	D4		C57	100nF, 50V,CSMD	32000-003	B11
C13	100nF, 50V,CSMD	32000-004	F4		C58	10µF,16V,EC	26970-085	C11-C
C14	10µF,16V,EC	26970-085	F4-C		C59	10nF, 50V,CSMD	32000-005	F11
C15	10µF,16V,TEC	26970-005	D4		C60	100nF, 50V,CSMD	32000-004	C11
C16	100nF,63V,PE	27889-827	E4-C		C61	10nF, 50V,CSMD	32000-005	G11
C17	10nF, 50V,CSMD	32000-005	D5		C62			
C18	1µF,63V,PC	27889-996	G5-C		C63	100nF, 50V,CSMD	32000-004	F8
C19	330nF,63V,PC	26970-121	F5-C		C64	10µF,16V,EC	26970-085	F8-C
C20	100nF,63V,PE	27889-827	F5-C		C65	10nF, 50V,CSMD	32000-005	C5
C21					C66	10nF, 50V,CSMD	32000-005	D4
C22	10µF,16V,EC	26970-085	G5-C		C67	10nF, 50V,CSMD	32000-005	E4
C23	100nF, 50V,CSMD	32000-004	G5		C68			
C24	100nF, 50V,CSMD	32000-004	G5		C69	100nF, 50V,CSMD	32000-004	C9
C25	100nF,63V,PE	27889-827	G6-C		C70	10nF, 50V,CSMD	32000-005	C10
C26	10µF,16V,EC	26970-085	G6-C		C71			
C27	10µF,16V,EC	26970-085	H6-C		C72	10nF, 50V,CSMD	32000-005	E4
C28					C73	100nF, 50V,CSMD	32000-004	B5
C29	100nF, 50V,CSMD	32000-004	G6		C74	100nF, 50V,CSMD	32000-004	D11
C30	10nF, 50V,CSMD	32000-005	B6		C75			
C31	100nF, 50V,CSMD	32000-004	G6		C76	100nF, 50V,CSMD	32000-004	B3
C32	100nF, 50V,CSMD	32000-004	G7		C77	100nF, 50V,CSMD	32000-004	B3
C33	10µF,16V,EC	26970-085	G6-C		RN1	8x10kΩ	26836-843	C-B9
C34	100nF, 50V,CSMD	32000-004	F7		RN2	8x10kΩ	26836-843	C-D9
C35					RN3	8x10kΩ	26836-843	C-E9
C36	100nF, 50V,CSMD	32000-004	F7		RN4	8x10kΩ	26836-843	C-E10
C37	100nF, 50V,CSMD	32000-004	F7		RN5	8x10kΩ	26836-843	C-C10
C38	100nF, 50V,CSMD	32000-004	F7		RN6	8x10kΩ	26836-843	C-E11
C39	100nF, 50V,CSMD	32000-004	F7		RN7	8x10kΩ	26836-843	C-D11
C40	100nF, 50V,CSMD	32000-004	F7		RN8	8x10kΩ	26836-843	C-F11
C41	10nF, 50V,CSMD	32000-005	C8		PL1	0.25" x 2Way	25920-020	C-C2
C42	100nF, 50V,CSMD	32000-004	F8		PL2	0.25" x 2Way	25920-020	C-D2
C43	100nF, 50V,CSMD	32000-004	F8		PL3	Not Used		
C44	100nF, 50V,CSMD	32000-004	F8		PL4	0.1"x 5Way / 4Pin	25920-045	C-B2
C45	33PF, 50V,CSMD	32000-003	C8		PL5	0.1"x 10Way Dil	25920-066	C-A5
					PL6	0.1"x 26Way Dil	25920-081	C-B4
SK1	Not Used				PL7	0.1"x 10Way Dil	25920-066	C-D7
SK2	20Way Interboard	25925-143	C-A8		PL8	0.1"x 16Way Dil	25920-066	C-E7
SK3	20Way Interboard	25925-143	C-G8		PL9	0.1"x 16Way Dil	25920-066	C-A9
TR1	Transistor BC337	28863-215	C-C2		PL10	0.25" x 2Way	25920-020	C-E2
TR2	Transistor BC184	28862-961	C-B7		PL11	0.25" x 2Way	25920-020	C-D2

Table (1); Continued

Ref.	Description	AVO No.	Grid		Ref.	Description	AVO No.	Grid
D1					IC5	HEF4040B	30000-077	E4
D2					IC6			
D3					IC7			
D4					IC8	UPD7105	30000-064	F4
D5	LL4148	31000-002	B2		IC9	BQ4847YMT	20000-145	D5-C
D6					IC10	TC551001APL	20000-121	E5-C
D7	LL4148	31000-002	B2		IC11	ICL7109	20000-109	F5-C
D8					IC12	TLE202CD	30000-084	G5
D9	LL4148	31000-002	D3		IC13	TL145406	30000-080	B6
D10	LL4148	31000-002	D3		IC14			
D11	LL4148	31000-002	G5		IC15	CD4051BCM	30000-023	E7
D12	LL4148	31000-002	G5		IC16	CD4051BCM	30000-023	E7
D13	LL4148	31000-002	G6		IC17			
D14	LL4148	31000-002	G6		IC18	CD4051BCM	30000-023	E7
D15	LL4148	31000-002	G6		IC19	CD4051BCM	30000-023	F7
D16	LL4148	31000-002	G6		IC20	74HC151	30000-059	B8
D17	LL4148	31000-002	G7		IC21	CD4060BCN	20000-060	C8-C
D18	LL4148	31000-002	G7		IC22	74HC541	30000-083	B9
D19	LL4148	31000-002	G7		IC23	74HC273	30000-049	F9
D20	LL4148	31000-002	G7		IC24	EPROM	6139-136	C8-C
D21	LL4148	31000-002	G7		IC25	74HC574	30000-047	B10
D22	LL4148	31000-002	G7		IC26	74HC574	30000-047	B10
D23	LL4148	31000-002	G7		IC27	63C03Y	30000-060	D10
D24	LL4148	31000-002	G7		IC28	74HC273	30000-049	F10
D25	LL4148	31000-002	G7		IC29	DAC-08	28900-073	B10-C
D26	LL4148	31000-002	G8		IC30	TL061C	30000-010	C11
D27	LL4148	31000-002	G8		IC31	74HC00	30000-016	F11
D28	LL4148	31000-002	G8		IC32	PLD	6139-110	F11
D29	LL4148	31000-002	G8		IC33	X24CO1	30000-038	C11
D30	LL4148	31000-002	G8		IC34	74HC02	30000-073	C9
D31					IC35	74HC00	30000-016	C10
D32					IC36	OP-77G	31000-011	B3
D33	LL4148	31000-002	F8		IC37	AD622AR	30000-087	G3
D34	LL4148	31000-002	G7		VR1	79L05 – 5Volt	28863-199	G6-C
D35	LL4148	31000-002	G7		WD1	Buzzer	27920-010	C7-C
D36					R1	12R/1%/¼W	26900-253	A3-C
D37	Not Fitted		G8-C		R2	3K0/2%/χW	33000-006	B2
D38	Not Fitted		G8-C		R3	3R/2%/χW	33000-011	B2
D39	Not Fitted		F7-C		R4	100K/2%/χW	33000-003	B2
D40	Not Fitted		F8-C		R5	10K/2%/χW	33000-012	B2
					R6	300K/2%/χW	33000-008	B2
IC1	TLC271	30000-003	B2		R7	3K0/2%/χW	33000-006	B2
IC2					R8	10R/2%/χW	33000-021	B2
IC3	74HC00	30000-016	E4		R9	68R/5%/2W	26836-639	C2-C
IC4	HEF4046B	30000-078	D4		R10	100K/2%/χW	33000-003	B2

Table (1); Continued

Ref.	Description	AVO No.	Grid		Ref.	Description	AVO No.	Grid
R11	3K0/2%/χW	33000-006	C2		R63	100K/2%/χW	33000-003	G7
R12	Not Used				R64	3K0/2%/χW	33000-006	G6
R13	Not Used				R65	3K0/2%/χW	33000-006	G7
R14	Not Used				R66	3K0/2%/χW	33000-006	G7
R15	Not Used				R67	3K0/2%/χW	33000-006	G7
R16	10K/2%/χW	33000-012	B3		R68	Not Used		
R17	Not Used				R69	10M/5%/χW	33000-005	C8
R18	Not Used				R70	Not Used		
R19	3K0/2%/χW	33000-006	B3		R71	22R/1%/¼W	26900-133	B8-C
R20	Not Used				R72	Not Used		
R21	10K/2%/χW	33000-012	B3		R73	3K0/2%/χW	33000-006	B11
R22	Not Used				R74	3K0/2%/χW	33000-006	B11
R23	1K0/2%/χW	33000-010	B3		R75	10K/2%/χW	33000-012	B11
R24	Not Used				R76	1K0/2%/χW	33000-010	C11
R25	182K/1%/¼W	26900-103	E4-C		R77	30K/2%/χW	33000-004	C11
R26	91K/1%/¼W	26900-233	E4-C		R78	Not Used		
R27	1M0/2%/χW	33000-009	F4		R79	Not Used		
R28	1K0/2%/χW	33000-010	B3		R80	Not Used		
R29	10K/2%/χW	33000-002	G4		R81	Not Used		
R30	3M3/2%/χW	33000-025	D4		R82	30K/2%/χW	33000-004	F8
R31	1K0/2%/χW	33000-010	F4		R83	300K/2%/χW	33000-008	F8
R32	1M0/2%/χW	33000-009	G4		R84	1M0/2%/χW	33000-009	F8
R33	Not Used				R85	1M0/2%/χW	33000-009	F8
R34	1M0/2%/χW	33000-009	D4		R86	3R/2%/χW	33000-011	D10
R35	1K0/2%/χW	33000-010	G4		R87	3R/2%/χW	33000-011	E9
R36	Not Used				R88	Not Used		
R37	100R/2%/χW	33000-013	E4		R89	Not Used		
R38	Not Used				R90	100R/2%/χW	33000-013	B5
R39	Not Used				R91	300R/2%/χW	33000-002	B3
R40	10K/2%/χW	33000-012	D4		R92	1K0/2%/χW	33000-010	B3
R41	10K/2%/χW	33000-012	G4		R93	1K0/2%/χW	33000-010	B3
R42	10K/2%/χW	33000-012	G4		R94	10R/2%/χW	33000-021	B2
R43	10K/2%/χW	33000-012	G4		R95	10R/2%/χW	33000-021	B2
R44	10K/2%/χW	33000-012	G4		R96	100R/2%/χW	33000-013	E9
R45	10K/2%/χW	33000-012	G4		R97	1K0/2%/χW	33000-010	B7
R46	10K/2%/χW	33000-012	G4		R98	10K/2%/χW	33000-012	B9
R47	10K/2%/χW	33000-012	G4		R99	10K/1%/¼W	26900-073	G3-C
R48	10K/2%/χW	33000-012	G4		R100	100K/2%/χW	33000-003	B7
R49	10K/2%/χW	33000-012	G4		R101	100K/2%/χW	33000-003	B7
R50	10K/2%/χW	33000-012	G4		R102	100K/2%/χW	33000-003	B7
R51	100K/2%/χW	33000-003	G6		R103	100K/2%/χW	33000-003	B7
R52	10K/2%/χW	33000-012	G6		R104	100K/2%/χW	33000-003	B7
R53	10K/2%/χW	33000-012	G6		R105	100K/2%/χW	33000-003	B7
R54	100K/2%/χW	33000-003	G6		R106	100K/2%/χW	33000-003	B7
R55	Not Used				R107	100K/2%/χW	33000-003	B8
R56	10K/2%/χW	33000-012	B6		R108	100K/2%/χW	33000-003	B8
R57	10K/2%/χW	33000-012	B7		R109	100K/2%/χW	33000-003	B8
R58	30R/2%/χW	33000-015	F7		R110	100K/2%/χW	33000-003	B8
R59	10K/2%/χW	33000-012	F7		R111	100K/2%/χW	33000-003	B8
R60	Not Used							
R61	300R/2%/χW	33000-002	F7		XL1	2.45Mhz	28900-030	C-C8
R62	Not Used				XL2	12Mhz	28900-089	C-D10

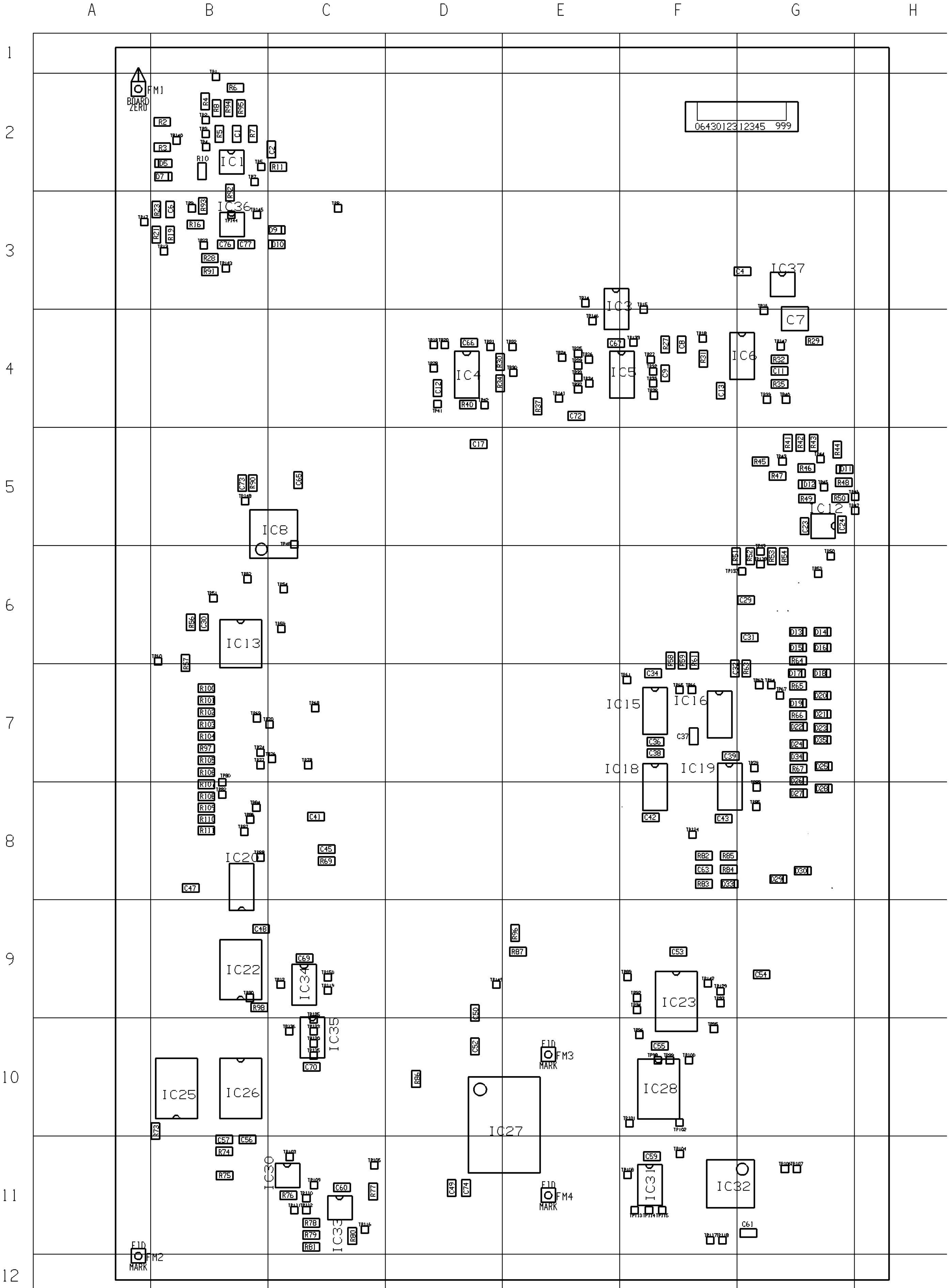

Figure 25

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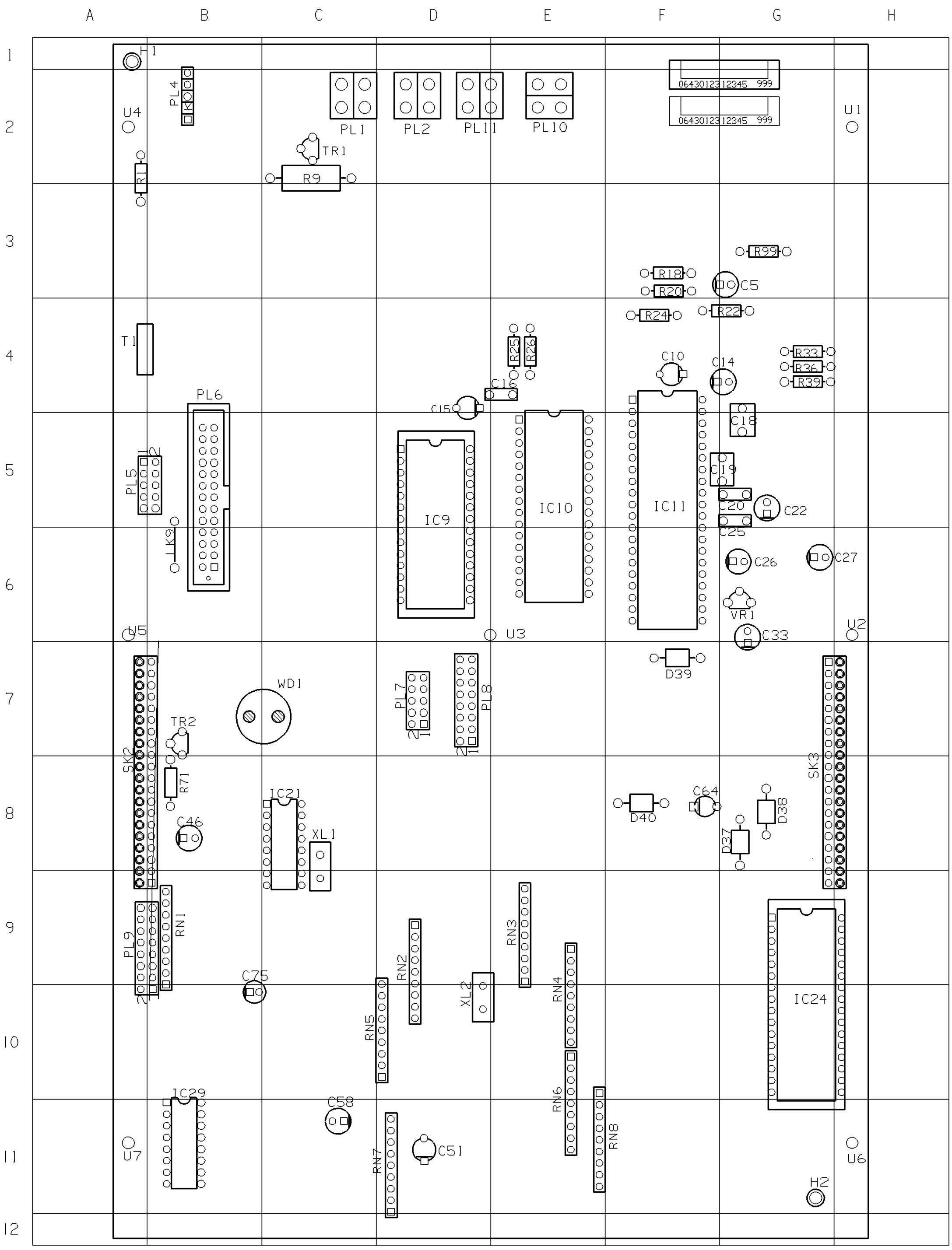
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U1
TR1
R9
R1
R99
R18
R20
C5
R24
R22
T1
R25
R26
C10
C14
R33
R36
R39
C16
C15
PL6
C18
PL5
IC9
IC10
IC11
C19
C20
C22
C25
LK9
C26
C27
VR1
U5
U3
U2
C33
D39
WD1
PL7
PL8
TR2
SK2
SK3
R71
IC21
C64
D40
D38
D37
C46
XL1
RN1
RN3
PL9
RN2
IC24
C75
XL2
RN4
RN5
IC29
C58
RN6
RN8
U7
RN7
C51
U6
H2

Figure 26

Table (2); Component locations and descriptions for later version Relay PCB.
Refer to Figure 27 and 28 for component locations.
NB Grid locations with **–C** are conventional components shown on Figure 27

Ref.	Description	AVO No.	Grid		Ref.	Description	AVO No.	Grid
C1	Not Used				FS1	500mAF 20mm HBC	25413-301	C-D4
C2	Not Used				FS2	500mAT 20mm HBC	25950-114	C-A4
C3	100nF, 50V,CSMD	32000-004	F4		FS3	4A(T) 20mm HBC	25950-115	C-A4
C4	100nF, 50V,CSMD	32000-004	F4		FS4	100mAF 20mm HBC	25413-295	C-C6
C5	10µF,16V,EC	27889-950	F4-C					
C6	10nF, 50V,CSMD	32000-006	F4					
C7	100nF, 50V,CSMD	32000-004	F5		PL1	0.25" x 2Way	25920-020	C-A1
C8	1.0nF, 50V,CSMD	32000-012	F5		PL2	0.25" x 2Way	25920-020	C-A3
C9	10µF,16V,EC	27889-950	F6-C		PL3	0.25" x 2Way	25920-020	C-A3
C10	10µF,16V,EC	27889-950	F6-C		PL4	0.25" x 1Way	25257-668	C-B4
C11	100nF, 50V,CSMD	32000-004	F6		PL5	0.25" x 2Way	25920-020	C-D4
C12	100nF, 50V,CSMD	32000-004	F7		PL6	0.25" x 1Way	25257-668	C-A4
C13	1000µF,35V,EC	26970-135	F7-C		PL7*	0.1"x 6Way / 5Pin	25920-045	C-E5
C14	100nF, 50V,CSMD	32000-004	C8		PL8	0.25" x 2Way	25920-020	C-C5
C15	100nF, 50V,CSMD	32000-004	C7		PL9	0.25" x 2Way	25920-020	C-C6
C16	1000µF,35V,EC	26970-135	C8-C		PL10 *	2.8mm x 1Way	25424-932	C-C6
C17	1000µF,35V,EC	26970-135	C8-C		PL11	0.1"x 2 Pin	25920-045	C-F8
C18	100nF, 50V,CSMD	32000-004	D7		PL12*	0.1"x 2 Pin	920-045	C-E5
C19					PL13	2.8mm x 1Way	25424-932	C-C1
C20	100nF, 50V,CSMD	32000-004	D7		PL14	2.8mm x 1Way	25424-932	C-D1
C21	10µF,16V,EC	27889-950	D7-C		PL15	2.8mm x 1Way	25424-932	C-D1
C22	47nF,630V,PE	27889-936	E7-C		PL16	2.8mm x 1Way	25424-932	C-D1
C23	10µF,16V,EC	27889-950	D8-C		PL17	2.8mm x 1Way	25424-932	C-D1
C24	100nF, 50V,CSMD	32000-004	D8					
C25	100nF, 50V,CSMD	32000-004	F8					
C26	10µF,16V,EC	27889-950	C8-C					
C27	10µF,16V,EC	27889-950	E8-C					
C28	100nF, 50V,CSMD	32000-004	C8		D1	LL4148	31000-002	F1
C29	100nF, 50V,CSMD	32000-004	D8		D2			
C30	1000µF,35V,EC	26970-135	D8-C		D3			
C31	1.0nF, 50V,CSMD	32000-012	E8		D4	LL4148	31000-002	F4
C32	220µF,16V,EC	26970-109	F8-C		D5	LL4148	31000-002	F4
C33	100nF, 50V,CSMD	32000-004	F8		D6	LL4148	31000-002	F6
C34	Not Used				D7	LL4148	31000-002	B7
C35	100nF, 50V,CSMD	32000-004	F4		D8	1N4007	28863-082	C7
C36	Not Used				D9	1N4007	28863-082	C7
C37	100nF, 50V,CSMD	32000-004	E5		D10	BA159	28863-160	E7
C38	10µF,16V,EC	27889-950	B6-C		D11	BA159	28863-160	E7
C39	10µF,16V,EC	27889-950	F5-C		D12	LL4148	31000-002	E8
C40*	22µF,16V,TEC	27889-811	E1		D13			
C41	100nF, 50V,CSMD	32000-003	E2		D14			
C42	1.0nF, 50V,CSMD	32000-012	E2		D15	LL4148	31000-002	B5
C43	10nF, 50V,CSMD	32000-005	E1		D16			
C44*	10µF,16V,EC	26970-085	E1-C		D17	LL4148	31000-002	B5
C45	100nF, 50V,CSMD	32000-004	F5		D18	LL4148	31000-002	B6
					D19	LL4148	31000-002	E2
SK1	Not Used				D20	LL4148	31000-002	E6
SK2	20Way Interboard	25925-143	C-A8		D21	LL4148	31000-002	E6
SK3	20Way Interboard	25925-143	C-G8		D22	LL4148	31000-002	E6
TR1	Transistor BC337	28863-215	C-C2		D23	LL4148	31000-002	E5
TR2	Transistor BC184	28862-961	C-B7		D24	LL4148	31000-002	B5
					D25	LL4148	31000-002	E4
					D26	LL4148	31000-002	B5
RC1	100nF, 250V ,RC	27920-042	D5-C		D27			
RC2	100nF, 250V ,RC	27920-042	C5-C		D28	LL4148	31000-002	B3

Table (2); Continued

Ref.	Description	AVO No.	Grid		Ref.	Description	AVO No.	Grid
IC1	LM339	31000-005	F5		R37	10M/5%/χW	33000-005	F5
IC2	LM324	31000-003	F6		R38	10K/2%/χW	33000-012	F5
IC3	TD62083F	30000-031	E5		R39	30K/1%/¼W	26900-211	A6-C
IC4	CD4538BCM	30000-006	E2		R40	10K/1%/¼W	26900-073	A5-C
IC5	TL061	30000-010	E2		R41	68R/5%/2W	26837-153	B5-C
IC6	TD62083F	30000-031	E6		R42	75K/2%/χW	33000-007	E5
					R43	75K/2%/χW	33000-007	E5
					R44	240R/1%/¼W	26900-174	E3-C
					R45	10K/2%/χW	33000-012	F5
R1	Not Used				R46	10K/2%/χW	33000-012	F5
R2	Not Used				R47	1K0/2%/χW	33000-010	F5
R3	Not Used				R48	30K/1%/¼W	26900-211	A6-C
R4	Not Used				R49	1K0/2%/χW	33000-010	F5
R5	Not Used				R50	30K/2%/χW	33000-004	F5
R6	Not Used				R51	120K/2%/χW	33000-018	F6
R7	Not Used				R52	4M7/5%/¼W	26837-109	A6-C
R8	Not Used				R53	4M7/5%/¼W	26837-109	A6-C
R9	Not Used				R54	10K/2%/χW	33000-002	F6
R10	Not Used				R55	30K/2%/χW	33000-004	F6
R11	Not Used				R56	75K/2%/χW	33000-007	F6
R12	Not Used				R57	100K/2%/χW	33000-003	F6
R13	3K0/2%/χW	33000-006	F4		R58	1M0/2%/χW	33000-009	F6
R14	10K/2%/χW	33000-012	F4		R59	10K/2%/χW	33000-012	F6
R15	10K/2%/χW	33000-012	F4		R60	100K/2%/χW	33000-003	F6
R16	10K/2%/χW	33000-012	F4		R61	Not Used		
R17	10K/2%/χW	33000-012	F4		R62	300K/2%/χW	33000-008	F6
R18	1K0/2%/χW	33000-010	F4		R63	24K/1%/¼W	26900-161	E6-C
R19	3K0/2%/χW	33000-006	F4		R64	30K/2%/χW	33000-004	F6
R20	30K/2%/χW	33000-004	F4		R65	75K/2%/χW	33000-007	E6
R21	3K0/2%/χW	33000-006	F4		R66	75K/2%/χW	33000-007	E6
R22	30K/2%/χW	33000-004	F4		R67	30K/2%/χW	33000-004	F6
R23	3K0/2%/χW	33000-006	F4		R68	10K/2%/χW	33000-012	F6
R24	10K/2%/χW	33000-012	F4		R69	3K9/1%/¼W	26836-225	E6-C
R25	10K/2%/χW	33000-012	F4		R70	300K/2%/χW	33000-008	F6
R26	75K/2%/χW	33000-007	F5		R71	10K/2%/χW	33000-012	F7
R27	3K0/2%/χW	33000-006	F5		R72	30K/2%/χW	33000-004	F7
R28	10K/2%/χW	33000-012	F4		R73	10M/5%/½W	26837-130	F7-C
R29	1K0/2%/χW	33000-010	F5		R74	470K/1%/¼W	26900-134	F7-C
R30	3K0/2%/χW	33000-006	F5		R75	51K/1%/¼W	26900-270	F7-C
R31	4M7/5%/¼W	26837-109	A6-C		R76	51K/1%/¼W	26900-270	F7-C
R32	4M7/5%/¼W	26837-109	A6-C		R77	30K/2%/χW	33000-004	E8
R33	30K/2%/χW	33000-004	F5		R78	3K0/2%/χW	33000-006	F8
R34	10K/2%/χW	33000-012	F5		R79	100K/2%/χW	33000-003	E8
R35	10K/2%/χW	33000-012	B5		R80	390R/1%/¼W	26900-140	F8-C
R36	30K/2%/χW	33000-004	F5		R81	30K/2%/χW	33000-004	E8

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Table (2); Continued

Ref.	Description	AVO No.	Grid		Ref.	Description	AVO No.	Grid
R82	3K0/2%/χW	33000-006	E8		TR8	Transistor BCW 32	30000-001	F5
R83	100K/2%/χW	33000-003	E8		TR9	Transistor BCW 32	30000-001	F6
R84	100K/2%/χW	33000-003	E8		TR10	Transistor BCW 32	30000-001	F6
R85	Not Used				TR11	Transistor MT3055E	28940-037	C-E8
R86	10K/2%/χW	33000-002	B5		TR12	Transistor BCF29	30000-004	E8
R87	Not Used				TR13	Transistor BCW 32	30000-001	E8
R88	10R/2%/χW	33000-021	B7		TR14	Transistor BC214	28862-960	C-B5
R89	1K0/2%/χW	33000-010	F5		TR15	FET 2N7000	30000-016	E2
R90	1K0/2%/χW	33000-010	E1		TR16	FET RFD8P05	27960-041	C-E2
R91	300K/2%/χW	33000-008	E1					
R92	100K/2%/χW	33000-003	E2					
R93	1K0/2%/χW	33000-010	E2		ZD1	1N5346B 9.1V	28863-307	C-C3
R94	1K0/2%/χW	33000-010	F5		ZD2	1N5346B 9.1V	28863-307	C-D3
R95	1K0/2%/χW	33000-010	E2		ZD3	1N5364B 33V	28920-031	C-E5
R96	100K/2%/χW	33000-003	E2		ZD4	1N5364B 33V	28920-031	C-E6
R97	240R/1%/¼W	26900-174	E3-C		ZD5	1N5364B 33V	28920-031	C-E6
					ZD6	1N5364B 33V	28920-031	C-E6
					ZD7	BZX84C33	31000-014	E8
RL1	RP 821012	25980-034	E1-C		ZD8	1N5364B 33V	28920-031	C-E5
RL2	RP 331012	25980-045	A4-C		ZD9	1N5364B 33V	28920-031	C-E5
RL3	Not Used				ZD10	1N5364B 33V	28920-031	C-E5
RL4	RE 030012	25980-043	D2-C		ZD11	1N5364B 33V	28920-031	C-E5
RL5	T9AS1D12-12	25980-052	C4-C		ZD12	1N5346B 9.1V	28863-307	C-D3
RL6	T9AS1D12-12	25980-052	D4-C		ZD13	1N5346B 9.1V	28863-307	C-C3
RL7	RP 821012	25980-034	B5-C		ZD14*	BZX79C9V1	28863-104	C-E2
RL8	RP3SL012	25980-051	C5-C					
RL9	RP3SL012	25980-051	D5-C					
RL10	RP3SL012	25980-051	C5-C		SK1	20Way Interboard	25925-143	C-A6
RL11	RP3SL012	25980-051	D5-C		SK2	20Way Interboard	25925-143	C-F6
RL12	RP3SL012	25980-051	C5-C					
RL13	RP3SL012	25980-051	D6-C		TX1	Mains transformer	6280-324	C-B8
RL14	G2R-2 (5V)	25980-015	B7-C		TX2	Inverter transformer	6131-767	C-E8
RL15	RP3SL012	25980-051	D6-C					
					VR1	7808	28863-321	C-C7
TR1	Transistor BC184	28862-961	C-F4		VR2	7812	28863-236	C-D8
TR2	Transistor BC184	28862-961	C-F4		VR3	7805	28863-138	C-D8
TR3	Transistor BCW 32	30000-001	F4		VR4	79L12	28900-066	C-D8
TR4	Transistor BCW 32	30000-001	F4					
TR5	Not Used							
TR6	Transistor BCF29	30000-004	F4					
TR7	Transistor BCW 32	30000-001	F4					

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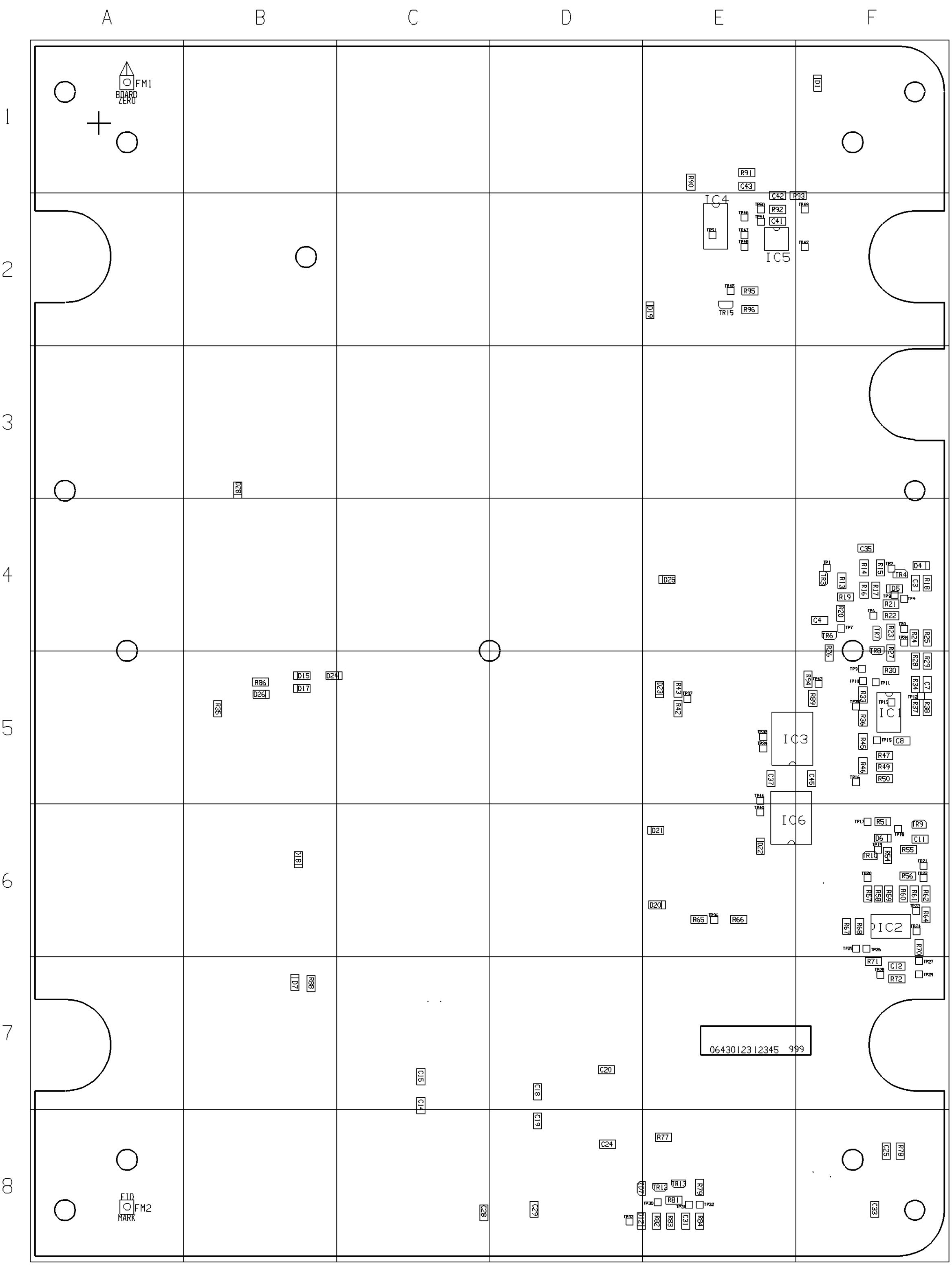

A
B
C
D
E
F
1
2
3
4
5
6
7
8
FM1
BOARD ZERO
FM2
FID MARK
IC1
IC2
IC3
IC4
IC5
IC6
064301231 2345 999

Figure 27

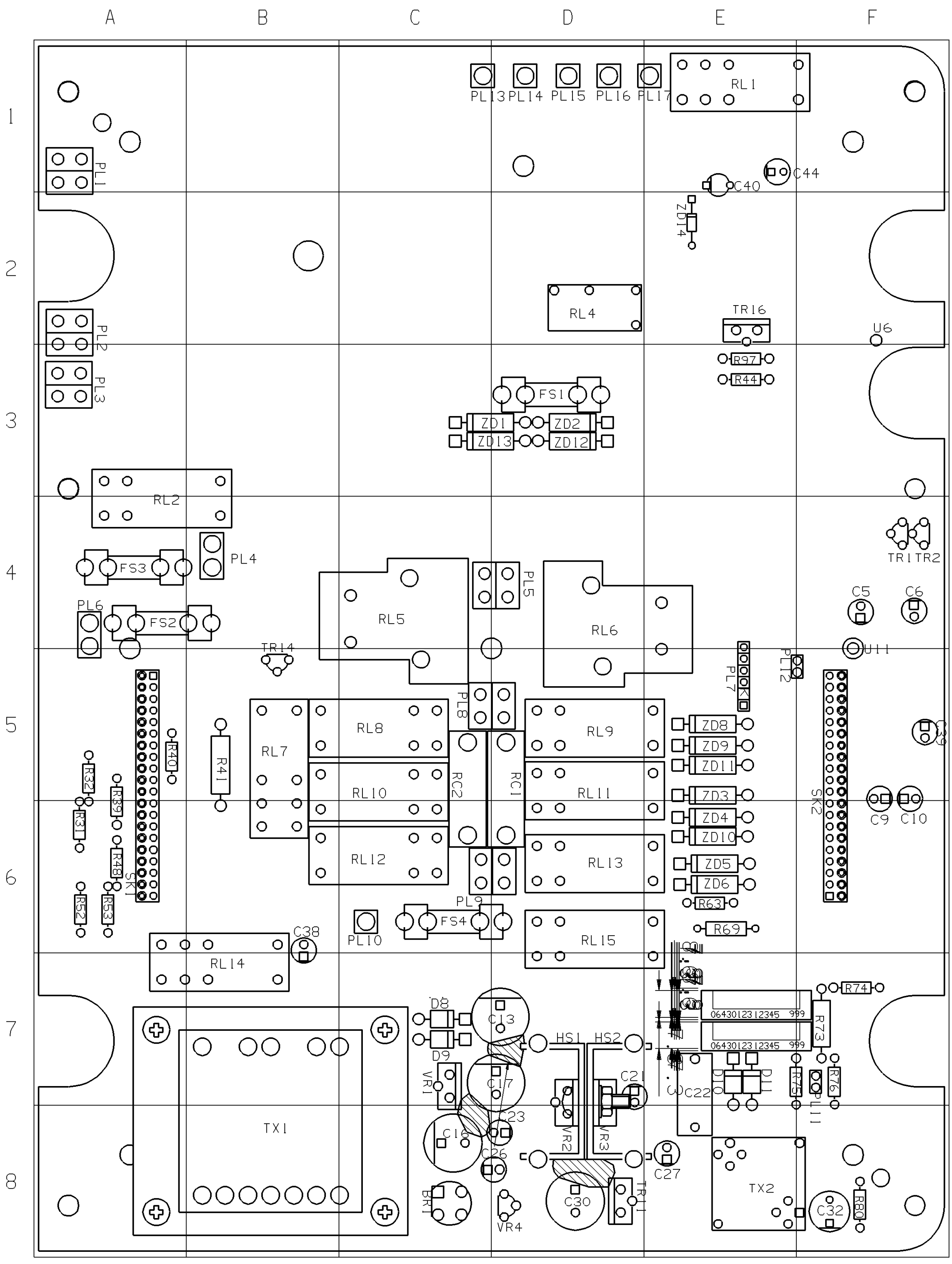

Figure 28

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Table (3); Component locations / descriptions for later version Keyboard / IEC PCB.

Refer to Figure 29 for component locations.

Ref.	Description	AVO No.	Grid		Ref.	Description	AVO No.	Grid
C1	10nF, 250V,ac,Y	26970-003	C1		PL1	IEC PLUG	25960-074	B2
C2	10nF, 250V,ac,Y	26970-003	D1		PL2	0.1"x 16Way Dil	25960-066	C2
C3	22nF, 250V,ac,X	26970-154	D2		PL3	0.1"x 16Way Dil	25960-066	C3
					PL4	16A MAINS IN	25965-108	D1
D1	1N4148	28433-801	C2		PL5	0.25" x 2Way	25920-020	C1
D2	1N4148	28433-801	C2		PL6	0.25" x 2Way	25920-020	C1
					PL7	0.25" x 2Way	25920-020	D1
R1	1K/1%/¼W	26900-049	C2					
R2	10K/1%/¼W	26900-073	C2		ZD14	BZX79C9V1	28863-104	C2
R3	6K81/1%/¼W	26900-069	C2					
R4	300K/1%/¼W	26900-210	C2					
R5	300K/1%/¼W	26900-210	B2					
R6	6K8/7%/¼W	26837-147	C2					

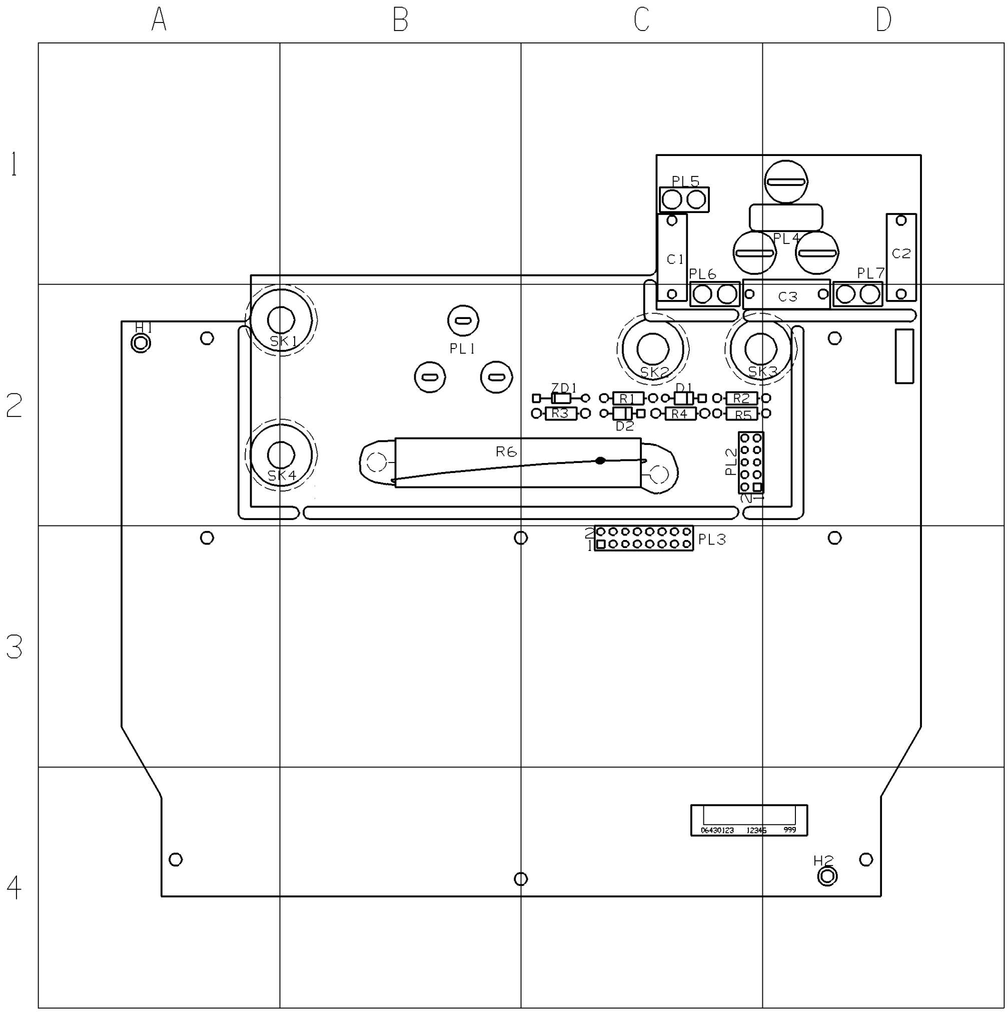

Figure 29

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Table (4); Component locations and descriptions Flash Test PCB.
Refer to Figure 30 for component locations.

Ref.	Description	AVO No.	Grid		Ref.	Description	AVO No.	Grid
R1	180K/5%/2W	26837-152	C2		PL1	2.8mm x 1Way	25424-932	D2
R2	180K/5%/2W	26837-152	C2		PL2	2.8mm x 1Way	25424-932	D4
R3	180K/5%/2W	26837-152	C2		PL3	0.25" x 1Way	25257-668	A3
R4	100K/5%/2W	26837-151	C2		PL4	0.25" x 1Way	25257-668	B4
R5	100K/5%/2W	26837-151	B2		PL5	0.25" x 1Way	25257-668	B4
R6	100K/5%/2W	26837-151	C2		PL6	0.1" x 6Way	25960-001	C3
R7	100K/5%/2W	26837-151	D2					
R8	100K/5%/2W	26837-151	A3		D1	1N4148	28433-801	D3
					D2	1N4148	28433-801	C3
T1	Flash Transformer	6331-750	A2		D3	1N4148	28433-801	C3
RL1	RE 030012	25980-043	C3					
RL2	RP 821012	25980-034	C3					
RL3	RP3SL012	25980-051	D3					

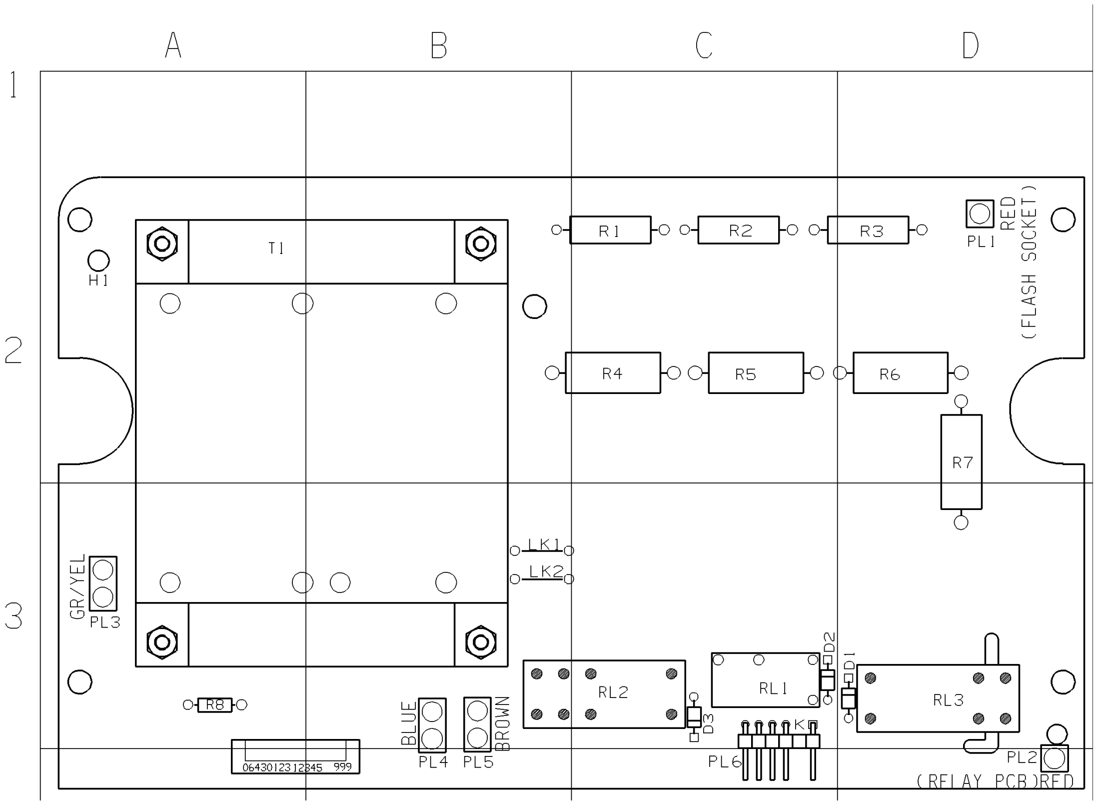

Figure 30

Table (5); Main PAT4 components. locations and descriptions (Later versions).
Refer to Figures 31.

Description	AVO No.		Description	AVO No.
Case moulding Base	5410-260		110V outlet	25965-130
Case moulding Lid	5410-258		13A outlet	25965-132
Case Hinge clip	5310-400		Bond Terminal	25965-098
Rubber keypad	5310-399		Earth Bond lead	6280-315
Front moulding	5410-263		20 Way Connector	25925-021
Display Window	5140-905		Panel 9 Way 'D'	25970-021
Display Gasket	5140-906		Panel 25 Way 'D'	25970-022
Case catch	5310-217		LCD Display	25992-009
Rubber foot	22316-841		16 Way Ribbon Cable	6180-413
PC Link cable	25955-025		10 Way Ribbon Cable	6180-414
Bond Transformer	6280-325		Flash Probe	5340-401
Or Early Version	6280-313		User guide	6172-216

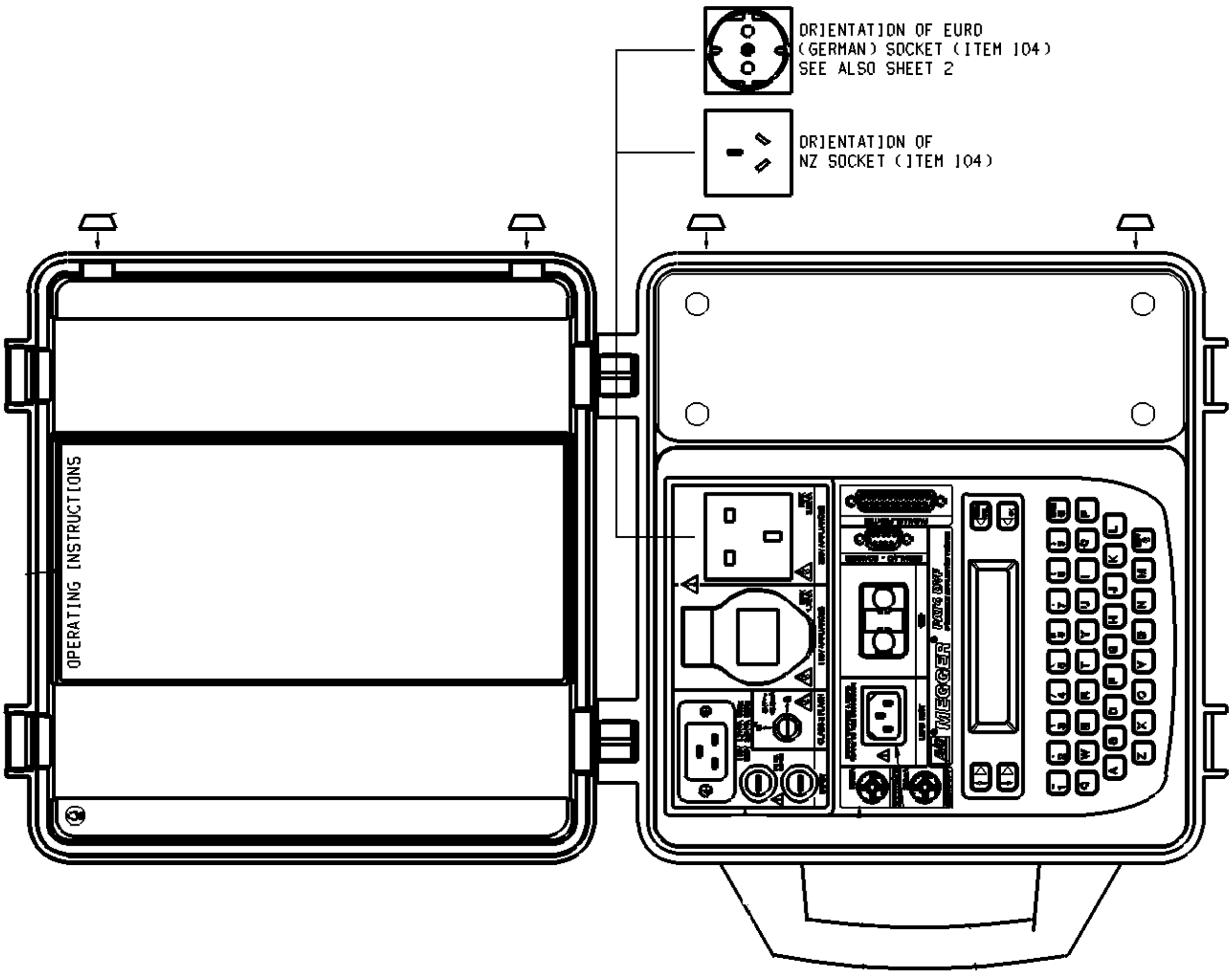

Figure 31 a

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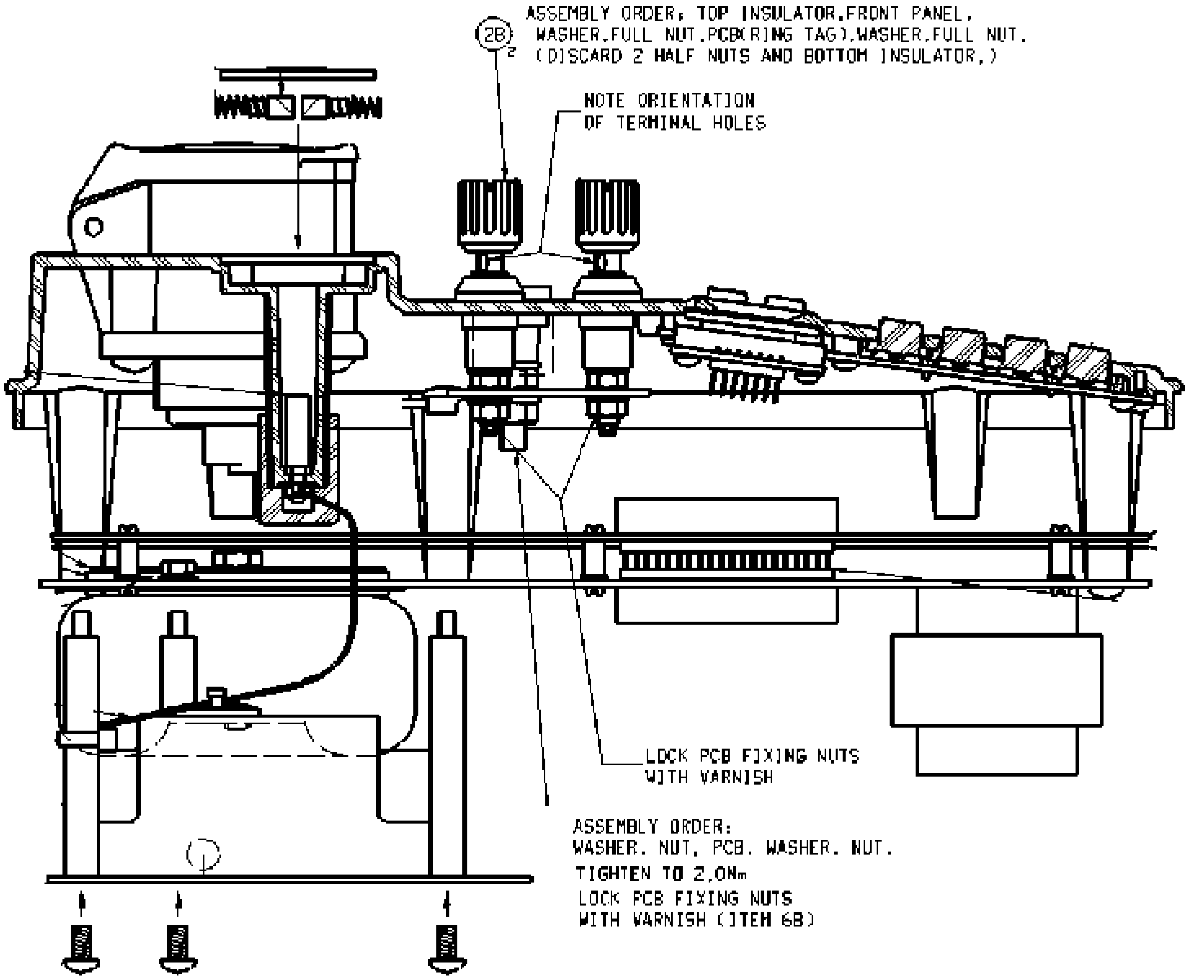
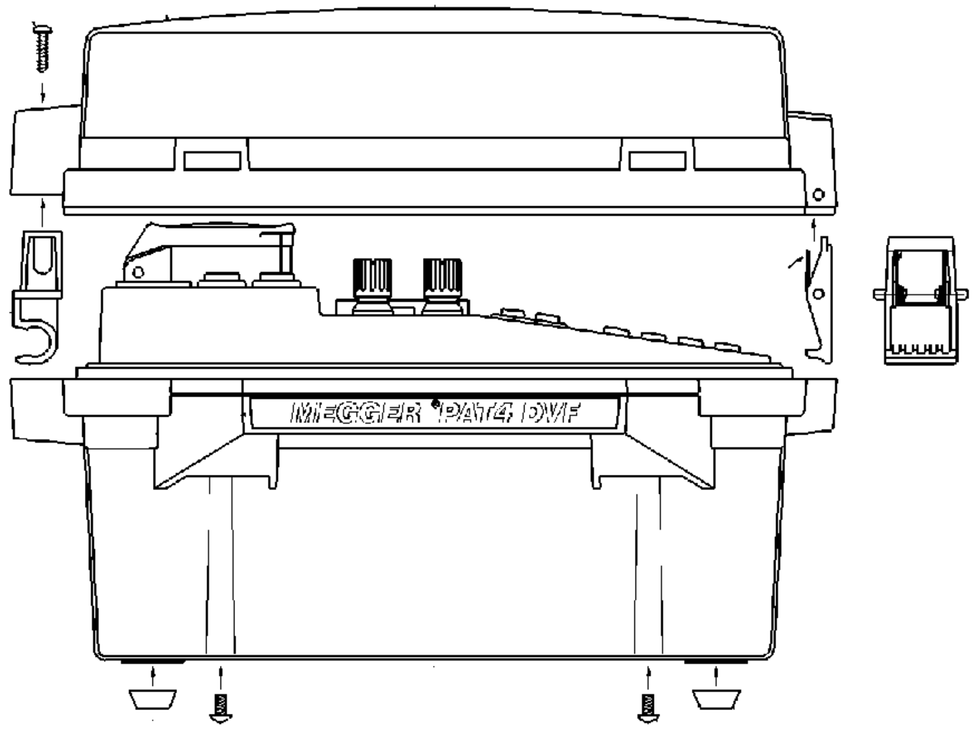


Figure 31b

Figure 31c



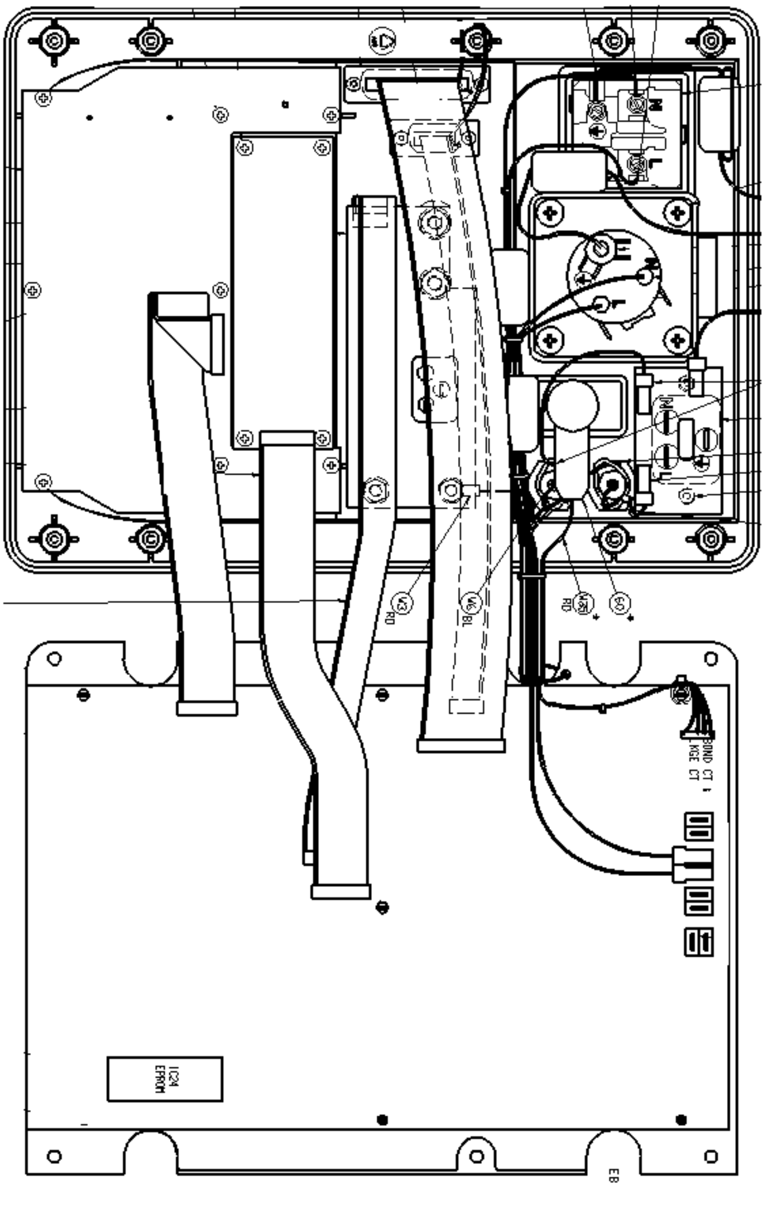


Figure 31d

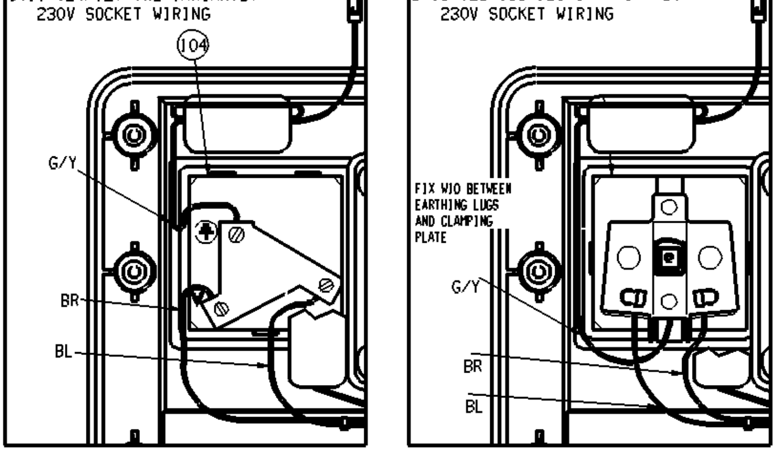


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Figure 31e

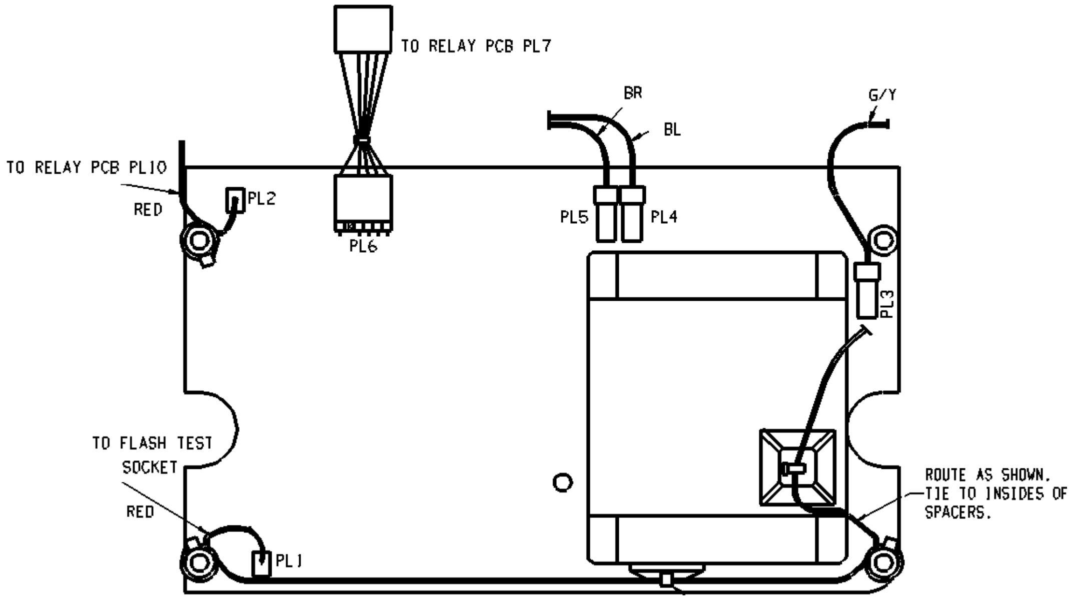
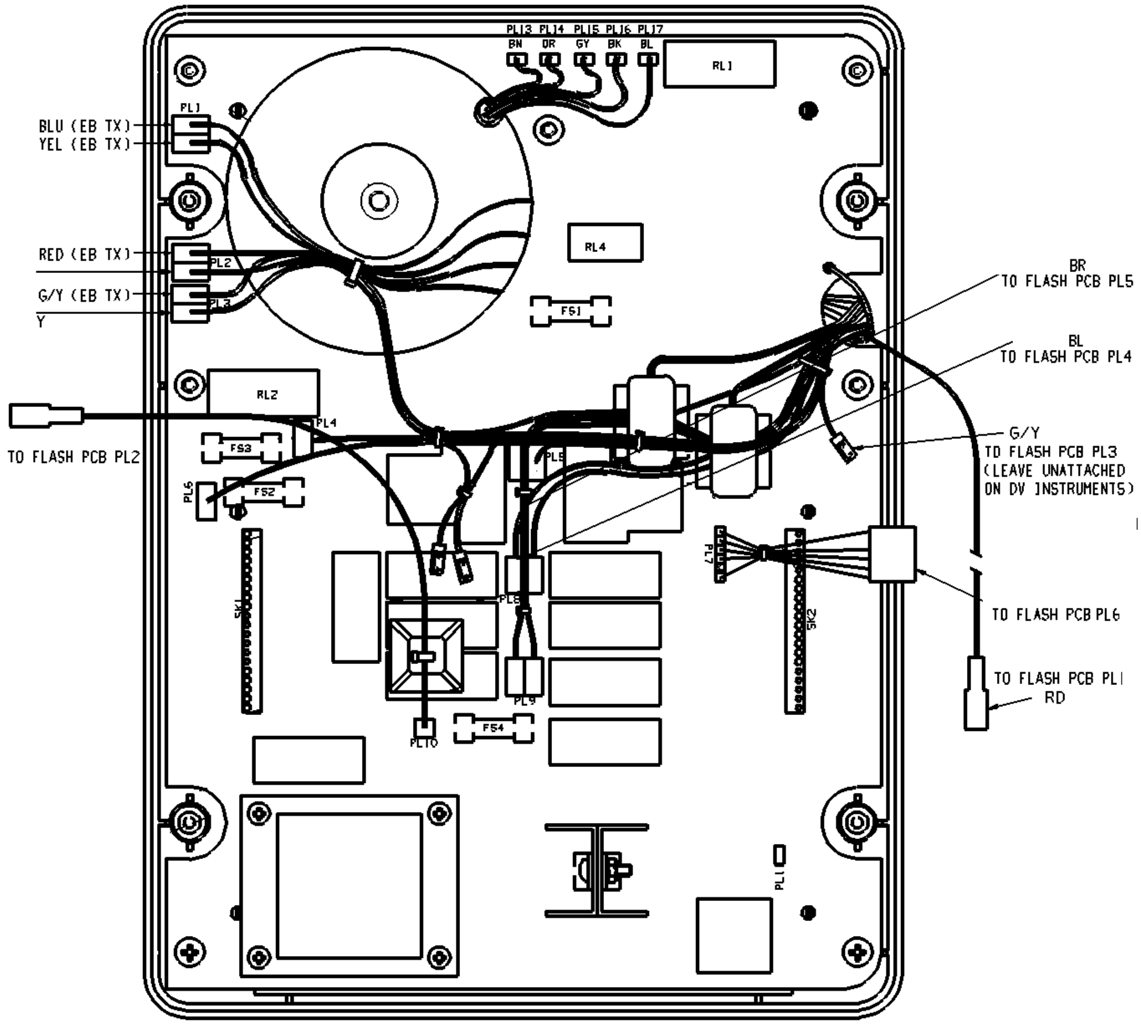


Figure 31 f

Figure 31 g



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Layout of Mk 3 Instuments

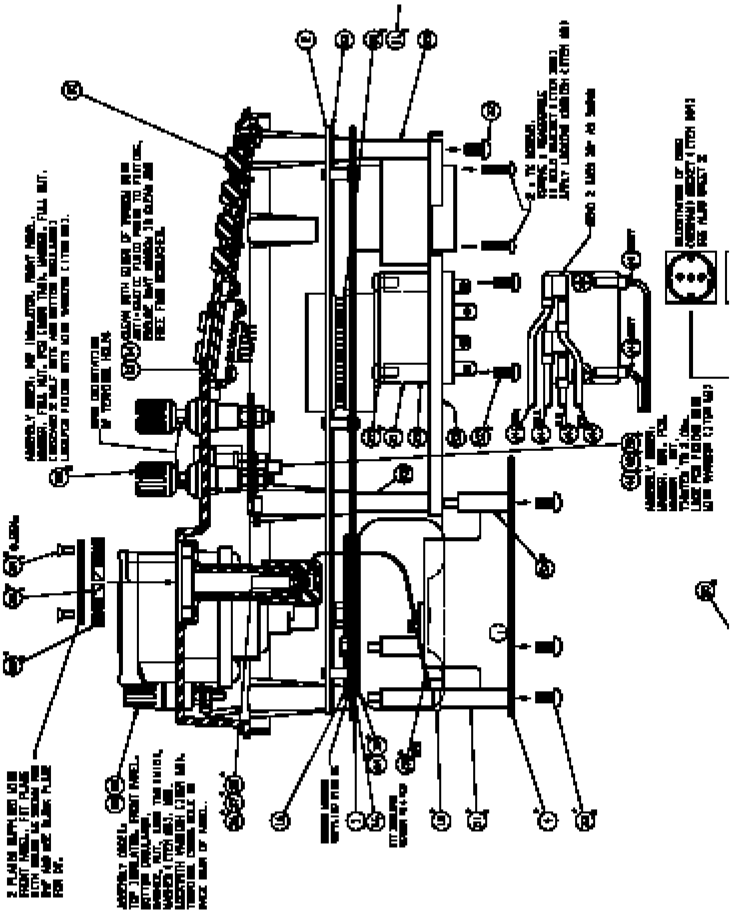

Figure 31 h

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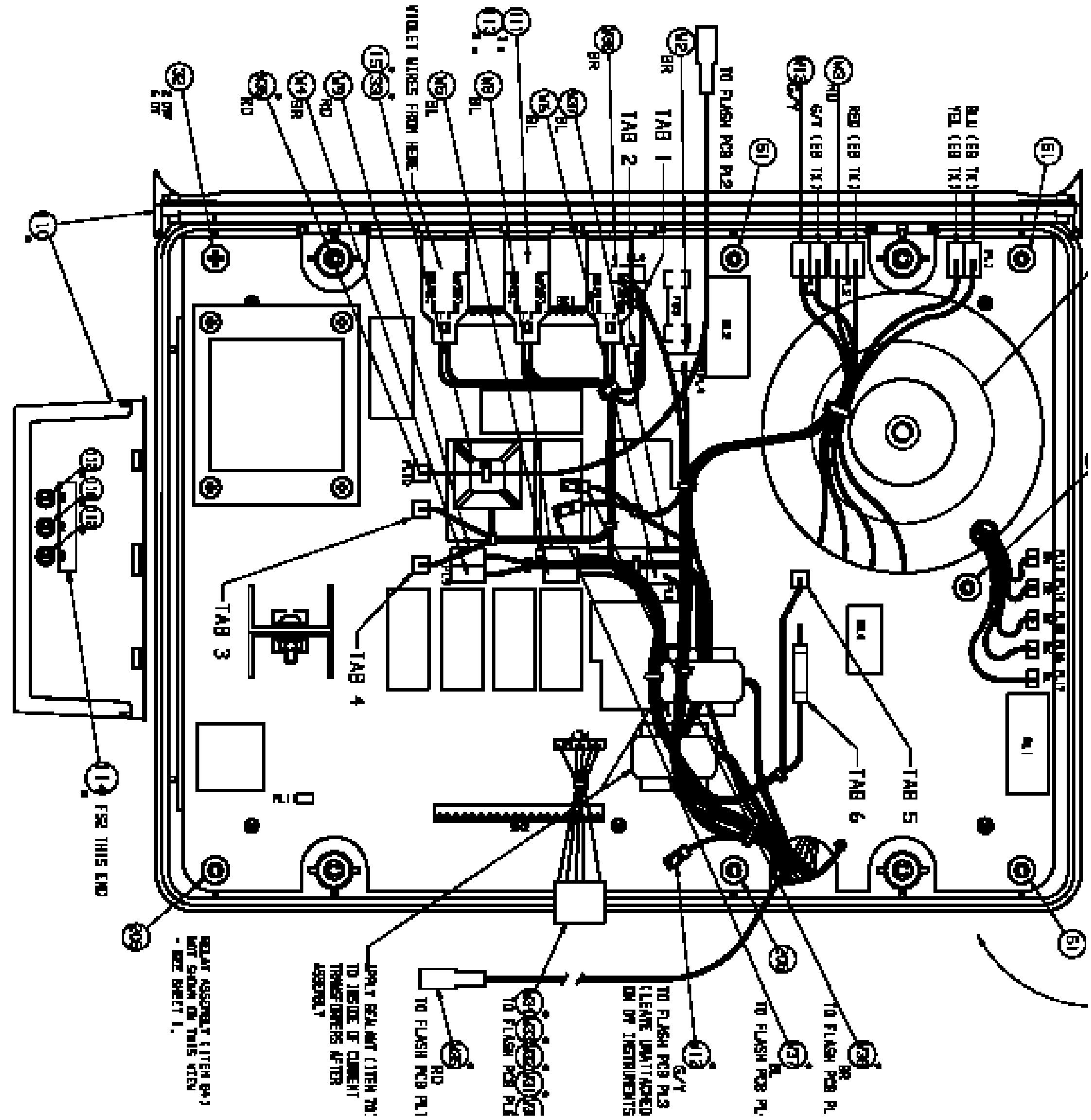
Figure 31 j


TAB 1
TAB 2
TAB 3
TAB 4
TAB 5
TAB 6
TO FLASH PCB PL2
VIOLET WIRES FROM HERE
FS2 THIS END