Apply voltages.

This is the default state at the beginning of each test:
LINE, NEUTRAL, EARTH and RECTIFIER OUT are high voltage inputs. If not in use they need to be disconnected from the UUT.

First Group interboard connectors: top left

PL500	-5V LPP	S	-5V	PL501	+5V LPP	S	+5V
PL502	20V	S	20V	PL503	N-E IN	AO	
PL504	25A ON	DI	(0V)	PL505	TB-E IN	AO	
PL506	25A CUTOUT	AO		PL507	L-Ex10	AO	
PL508	-5V	S	-5V	PL509	N-Ex10	AO	
PL511	L-N IN	AO		PL512	L-E IN	AO	

Second group - by range switch.

PL515	+5V	S	+5V	PL516	50HZ CLK	AO	
PL517	MAINS LANE	AO		PL518	ZERO CROSS	AO	
PL519	NOT USED			PL520	ZERO I MON	AO	
PL521	0V	S	0V	PL522	RL NorL	RI	(+5V)
PL523	RCD DRIVE	AI	(0V)	PL524	RELAY POWER	S	+5V
PL525	MID RANGE	DI	(0V)	PL526	RL N	RI	(+5V)
PL527	NOT USED			PL528	RL NorE	RI	(+5V)
PL529	NOT USED			PL530	NOT USED		
PL531	NOT USED			PL532	TEMPCD	AO	
PL533	STROBE	DI	(+5V)	PL534	HI RANGE	DI	(0V)

Key:

S Supply
DI Digital input
DO Digital output
AI Analogue input
AO Analogue output
RI Relay input ~ 50mA drive for each relay.

Check PCB power consumption

1) Check power consumption of +5V rail = < 15mA
2) Check power consumption of -5V rail = < 15mA
3) Check power consumption of +20V rail = < 10mA

Check supply measurement op-amps (Sheet 1)
L-N Voltage

4) Connect LINE = 0V , NEUTRAL = 0V , EARTH = 0V Check IC502 pin7 = -100mV to 100mV
5) Connect LINE = +300V , NEUTRAL = 0V , EARTH = 0V Check IC502 pin7 = 1.2V to 1.6V
6) Connect LINE = -300V , NEUTRAL = 0V , EARTH = 0V Check IC502 pin7 = -1.6V to –1.2V

L-E & LEx10 Voltage

7) Connect LINE =0 V , NEUTRAL = 0V , EARTH = 0V Check IC502 pin1 = -100mV to 100mV
8) Check PL507 = -100mV to 100
9) Connect LINE = +30V , NEUTRAL = 0V , EARTH = 0V Check IC502 pin1 = 120mV to 160mV
10) Check PL507 = -1.6V to –1.2V
11) Connect LINE = +300V , NEUTRAL = 0V , EARTH = 0V Check IC502 pin1 = 1.2V to 1.6V
12) Connect LINE =-30V , NEUTRAL = 0V , EARTH = 0V Check IC502 pin1 = -160mV to -120mV
13) Check PL507 = 1.2V to 1.6V
14) Connect LINE = -300V , NEUTRAL = 0V , EARTH = 0V Check IC502 pin1 = -1.6V to –1.2V

N-E & NEx10 Voltage

15) Connect LINE = 0V , NEUTRAL = 0V , EARTH = 0V Check IC507 pin7 = -100mV to 100mV
16) Check PL509 = -100mV to 100
17) Connect LINE = 0V , NEUTRAL = +30V , EARTH = 0V Check IC502 pin1 = 120mV to 160mV
18) Check PL507 = -1.6V to –1.2V
19) Connect LINE = 0V , NEUTRAL = +300V , EARTH = 0V Check IC502 pin1 = 1.2V to 1.6V
20) Connect LINE = 0V , NEUTRAL = -30V , EARTH = 0V Check IC502 pin1 = -160mV to -120mV
21) Check PL507 = 1.2V to 1.6V
22) Connect LINE = 0V , NEUTRAL = -300V , EARTH = 0V Check IC502 pin1 = -1.6V to –1.2V

Touch button and adjust pot

23) Connect LINE = 0V , NEUTRAL = 0V , EARTH = 0V , TOUCH BUTTON = 0V
Check PL505 = -100mV to 100mV
24) Connect LINE = +300V , NEUTRAL = +300V , EARTH = 0V , TOUCH BUTTON = 0V
Check PL509 = -10mV to 10mV Adjust R513 if necessary
25) Connect LINE = 0V , NEUTRAL = +30V , EARTH = 0V , TOUCH BUTTON = +200V
Check PL505 = -2.4V to –0.8V

Switch relays on and check 50Hz CLK, Mains lane, ZERO I MON and ZERO CROSS. (Sheet 1 & 3)

Switch relays to L-N: RL N = ON , RL NorL = ON , RL Nor E = OFF

26) Connect LINE = 0V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = -500mV to 500mV
27) Check Mains Lane = -500mV to 500mV
28) Check ZERO I MON = -500mV to 500mV
29) Check ZERO CROSS = 4V to 6V
30) Connect LINE = +300V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = -1.6V to –1.2V
31) Check Mains Lane = 1.7V to 2.1V
32) Check ZERO I MON = 4V to 6V
33) Check ZERO CROSS = 4V to 6V
34) Connect LINE = -300V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = 1.2V to 1.6V
35) Check Mains Lane = 1.7V to 2.1V
36) Check ZERO I MON = 4V to 6V
37) Check ZERO CROSS = -500mV to 500mV

Switch relays to L-E: RL N = OFF , RL NorL = ON , RL Nor E = ON

38) Connect LINE = 0V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = -500mV to 500mV
39) Check Mains Lane = -500mV to 500mV
40) Check ZERO I MON = -500mV to 500mV
41) Check ZERO CROSS = 4V to 6V
42) Connect LINE = +300V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = -1.6V to -1.2V
43) Check Mains Lane = 1.7V to 2.1V
44) Check ZERO I MON = 4V to 6V
45) Check ZERO CROSS = 4V to 6V
46) Connect LINE = -300V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = 1.2V to 1.6V
47) Check Mains Lane = 1.7V to 2.1V
48) Check ZERO I MON = 4V to 6V
49) Check ZERO CROSS = -500mV to 500mV

Switch relays to N-E: RL N = ON , RL NorL = OFF , RL Nor E = ON

50) Connect LINE = 0V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = -500mV to 500mV
51) Check Mains Lane = -500mV to 500mV
52) Check ZERO I MON = -500mV to 500mV
53) Check ZERO CROSS = 4V to 6V
54) Connect LINE = +300V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = -1.6V to -1.2V
55) Check Mains Lane = 1.7V to 2.1V
56) Check ZERO I MON = 4V to 6V
57) Check ZERO CROSS = 4V to 6V
58) Connect LINE = -300V , NEUTRAL = 0V , EARTH = 0V Check 50HZ CLK = 1.2V to 1.6V
59) Check Mains Lane = 1.7V to 2.1V
60) Check ZERO I MON = 4V to 6V
61) Check ZERO CROSS = -500mV to 500mV

Check dynamic load circuit (Sheet 3)

Connect +48V to RECTIFIER OUT
Set RCD Drive to 2V
62) Check current from 48V = -500uA to 500µA
63) Set strobe = low Check current from 48V = 18mA to 22mA
64) Check voltage across R584 = 1.6V to 2.2V
65) Set mid current = high Check current from 50V = 180mA to 220mA
66) Check voltage across R584 = -100mV to 100mV

Check 25A ON & cutout circuit (Sheet 3)

67) Check 25A cutout = 4.5V to 5.5V
68) Take 25A ON = high Check 25A cutout = 1.0V to 3V

Check temperature measurement

69) Check TEMPCD = 600mV to 1000mV

General – All tests

For the majority of tests the processor is held in reset state and PLD outputs are disabled by pulling OE- on TP397 high.

This assumes that the display and backlight is fitted, but not the rotary switch.

Power Supply – Main Board Sheet 2

'BATTERY TEST' low for all these tests. Connect 500 ohm resistor 'RELAY POWER' to 0V.

		Rotary Switch TP90	PRETEST PWR- TP108	20V ON TP112	GEN POWER OFF TP67	RELAY PS TP71	Tests
1_1	Switched off	High	X	X	X	X	Current < 100µA
2_1	Standby	Low	High	Low	High	High	Current < 600µA
3_1							Vcc = 5V ± 0.1V
4_1	Switched on	Low	Low	Low	Low	Low	Current < 100mA
4_2							+5VLPP = 5V ± 0.1V
4_3							+5V = 5V ± 0.1V
4_4							-5VLPP = -5V ± 0.3 V
4_5							-5V = -5V ± 0.3V
4_6							'RELAY POWER' = 5V ± 0.1V
5_1	Power Save Relays	Low	Low	Low	Low	High	'RELAY POWER' = 3.8V ± 0.5V
6_1	Switch 20V on	Low	Low	High	Low	Low	'20V' = 22V ± 2V

Check battery test circuit.

7_1 Check BROWNOUT REF (TP66) = 0.6V ± 0.1 V
8_1 BATTERY TEST = Low, Check BATT/2 = 0
8_2 BATTERY TEST = High, Check BATT/2 = 4.5V ± 0.1 V (Assuming driven off 9V).

Mux, PSD and AMP – Main Board Sheet 1(A)

	Analogue Inputs					Digital Inputs					Output
	L-EX10	N-EX10	L-E IN	N-E IN	L-N IN	INA	INB	INC	ZERO CROSS	INV ZERO CROSS	Check TP6
9_1	0V	0V	0V	0V	0V	0	0	0	0	1	0V±0.1V
10_1	0.6V	0V	0V	0V	0V	0	0	0	0	1	3V ± 0.3V
11_1	-0.6V	0V	0V	0V	0V	0	0	0	0	1	-3V ± 0.3V
12_1	0V	0.6V	0V	0V	0V	1	0	0	0	1	3V ± 0.3V
13_1	0V	0V	0.6V	0V	0V	0	0	1	0	1	-3V ± 0.3V
14_1	0V	0V	0V	0.6V	0V	1	0	1	0	1	-3V ± 0.3V
15_1	0V	0V	0V	0V	0.6V	0	1	1	0	1	-3V ± 0.3V
16_1	0V	0V	0V	0V	0.6V	0	1	1	0	0	3V ± 0.3V
17_1	0V	0V	0V	0V	0.6V	0	1	1	1	0	-3V ± 0.3V

Difference measurement – Main Board Sheet 1(B)

We need to drive the output of IC 4 (TP6 above) with 3V). The easiest way to do this is to set from above

L-EX10	N-EX10	L-E IN	N-E IN	L-N IN	INA	INB	INC	ZERO CROSS	INV ZERO CROSS
0.6V	0V	0V	0V	0V	0	0	0	0	1

Check we are working:

	CAP/ZERO	UNLOADED	LOADED	VD TP18
18_1	1 for 200ms	0	0	0V ± 0.1V
18_2	0	1 for 200ms	0	1.5V ± 0.1V
	0	0	1 for 200ms	

18_3 Repeat the above sequence, measuring and displaying the final ‘0V’ output. Adjust R6 for minimum.

18_4 Repeat the above sequence, measuring the intermediate ‘1.5V’ output. Adjust R5 for 1.66V+/-0.02V

Mux and AC-DC convertor – Main Board Sheet 4

	Analogue inputs			Driven by IC2 via 10k's		Digitial inputs				Outputs	
	L-N IN	L-E IN	N-E IN	N-E	L-E	AC/DCin A	AC/DCin B	ZERO I MON	ZERO CROSS	AC/Dcout	L-E/FREQ
19_1 19_2	0	0	0	0	0	0	0	0	0	0V ±0.1V	0
20_1 20_2	0	0	0	0	0	0	1	0	0	0V ±0.1V	0
21_1 21_2	0	0	0	0	0	1	0	0	0	0V ±0.1V	0
22_1 22_2	0	0	0	0	0	1	1	0	0	0V ±0.1V	0

	Analogue inputs			Driven by IC2 via 10k's		Digitial inputs				Outputs	
23_1 23_2	3V	0	0	0	0	0	0	0	1	2.4V ± 0.3V	1
24_1 24_2	-3V	0	0	0	0	0	0	0	1	2.4V ± 0.3V	1
25_1 25_2	0	3V	0	0	1	1	0	0	0	2.4V ± 0.3V	1
26_1 26_2	0	0	3V	1	0	0	1	0	0	2.4V ± 0.3V	1
27_1	0	0	0	0	0	1	1	1	0	X	1

Mux and Referances – Main Board Sheet 3(A)

	TP87	TP88	ADCinA	ADCin B	AD REF HI	AD IN HI
28_1 28_2	0	0	1	0	0.987 V ± 2%	0V ± 0.1V
29_1 29_2	0	3V	0	0	X	3V ± 0.3V
30_1 30_2	1V	1V	0	0	254 mV ± 2%	1V ± 0.1V
31_1 31_2	1V	-3V	0	1	26 mV ± 2%	-3V ± 0.3V

Frequency window compartors – Main Board Sheet 5(A)

	L-E IN	L-E (TP9)
32_1	0V	+5V
32_2	1V	0V
32_3	-1V	0V

	N-E IN	N-E (TP10)
33_1	0V	+5V
33_2	1V	0V
33_3	-1V	0V

Buzzer – Main Board Sheet 5(C)

34_1 Apply 2kHz square wave to BUZZ (TP302). Check buzzer sounds.

EEPROM – Display Board Sheet 6(A)

35_1 Test as per CM500

Mux – Display Board Sheet 6(B)

	TEMP AB	TEMPCB	TP303	TP304
36_1	2V	1V	0	2V
36_2	2V	1V	1	1V

Backlight – Display Board Sheet 7(A)

37_1 'BACKLIGHT ON' low, check backlight is off
37_2 'BACKLIGHT ON' high, check backlight is on.

Watchdog, Reset Brownout and NMI – Display Board Sheet 9, and Brownout – Main Board Sheet 3

38_1 Switch off all supplies and drive VCC to 0V. Drive VCC to 5V and check for 40 - 110mS pulse on TP382.

Restore all supplies to normal.

38_2 Pulse WATCHDOG. Check for 65 - 220mS pulse on IC304 pin 12 (TP487).

Take TP70 High
39_1 Check for high on BROWNOUT-
Take TP70 low
39_2 Check for low on BROWNOUT-.

Relay Drivers – Main board sheet 3

	Drive Digital	Digital Inputs			Pull high with 1k resistors		
	RL TEST DISABLE TP413	RLY(0)	RLY(1)	RLY(2)	RL NorE	RL N	RL NorL
40_1	0	1	1	1	1	1	1
40_2	0	0	1	1	1	1	0
40_3	0	1	0	1	1	0	1
40_4	0	1	1	0	0	1	1
40_6	1	0	1	1	1	1	1
40_6	1	1	0	1	1	1	1
40_7	1	1	1	0	1	1	1

PLD Clock – Display Board Sheet 10
Input : 50Hz CLk. Outputs CLOCK1 and CLOCK2.

41_1 Take 50Hz CLK –5V -> +5V and check for pulse on CLOCK2 (300 -1100µS)
41_2 Take 50Hz CLK +5V -> -5V and check for pulse on CLOCK1. (300 -1100µS)

'Load on' monostable – Display Board Sheet 10

42_1 Take LOAD ON low-high and check for 5 – 30mS pulse on TP432

25A multivibrator – Display Board Sheet 11

43_1 With STROBE 25A low, check for 0 Hz on 25A ON.
43_2 Take STROBE 25A high and check for square wave.

PLD – Display Board Sheet 11

This does not test the PLD functionally, just a check that it's present and has (probably) the correct program. This is done by writing to the ports and checking the outputs.

Write to a port by selecting it with A0 and clocking it in with CE (pulse high). The ports are 'write – through' when CE is high.

44_1 PORT 0 = $55 and check for the following

0	Spare Output	1
1	ADCinA	0
2	ADCinB	1
3	AC/DCinA	0
4	AC/DCinA	1
5	(MODE 0)	NA
6	(TRIGGER)	NA
7	IN A	0

44_2 PORT 0 = $AA and check for the following

0	Spare Output	0
1	ADCinA	1
2	ADCinB	0
3	AC/DcinA	1
4	AC/DCinA	0
5	(MODE 0)	NA
6	(TRIGGER)	NA
7	IN A	1

45_1 PORT 1 = $55 and check for the following

0	(LOAD SEL A)	NA
1	(LOAD SEL B)	NA
2	SPARE	1
3	20V ON	0
4	RELAY PS	1
5	LOAD ON	0
6	(HI I LOOP)	NA
7	(MODE 1)	NA

45_2 PORT 1 = $AA and check for the following

0	(LOAD SEL A)	NA
1	(LOAD SEL B)	NA
2	SPARE	0
3	20V ON	1
4	RELAY PS	0
5	LOAD ON	1
6	(HI I LOOP)	NA
7	(MODE 1)	NA

RCD Circuit Current Control

As with the CM400 and CM500 IC313 is dual DAC. You write to this using DAC/AD, DAC/WR- and the data bus.

46_1 Apply 3V to MAINS LANE, and write $80 to DAC A. Adjust R391/R389 for -1.5V ± 15 mV on TP456 (output of IC311)

46_2 Write $FF to DAC A and $80 to DAC B. Adjust R393/R388 for 1.5V ± 15 mV on TP448 (output of IC311)

46_3 With 20V supply on and RCD OPT1 = 0 , check RCD DRIVE is 6V.

46_4 Take RCD OPT1 high and check RCD DRIVE is 12V.

46_5 Take MAINS LANE to 0V and Adjust for minimum output on R383.

Start up processor and check display and operation

This test starts the board up, fooling it that there's a Power Board attached connected to a 240V 50Hz L-PE. We can therefore check that the processor and A/D runs ok in pre-test mode. Running a test is complex and therefore not attempted.

This is the sequence:

Apply 9V battery voltage, (instrument switched off - i.e. TP90 0V)
Connect TEMPCD to 0.7 V
L-E to 3V pk-pk 50Hz
L-E/FREQ to 5V
TP122 to battery +ve
TP120 to 'Switch A' and 0V to 'Switch B' (Loop L-PE Switch posistion)

47_1 The board should power up into 'CAL' mode – there will be display test, followed by version number, checksum, 'CAL' and the L-PE voltage (should be 180V to 220V).

Note that error and faults are possible at this stage, as self-checking is carried out as the board powers up. Refer to separate lists for details.

LCB2500 ONLY from here – RS232 circuits

RS232 Transceiver - main board sheet 5

48_1 Check reading received from RS232 is 180 to 220V

Isolated transceiver – sheet 12

49_1 Connect –10V to PL700 pin 2. Check D705 unlit

50_1 Connect +10V to PL700 pin 2. Check D705 is lit

51_1 Check PL700 pin 3 –6V to –13 V

52_1 Shine a light onto D705. Check PL700 pin 3 +6 to +13V