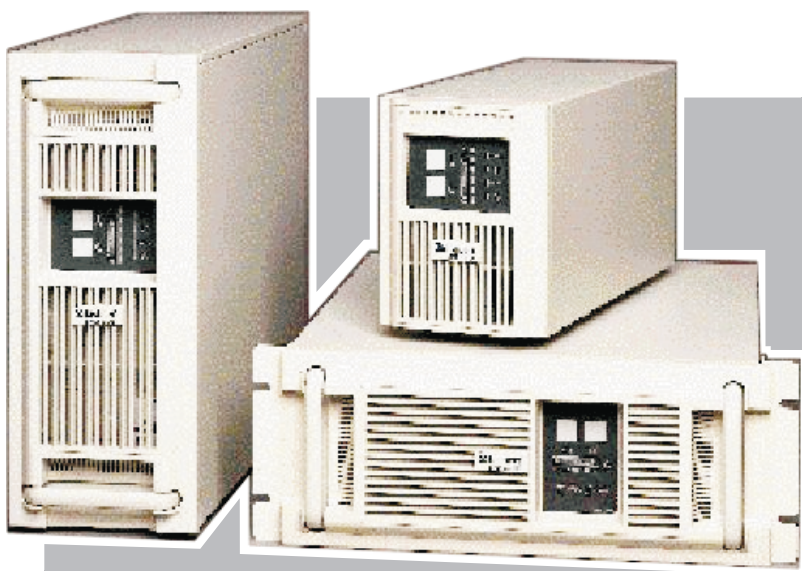


UPStation GXT Series 230V Models

Service Manual



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General Information

Read this manual carefully before working on this UPS equipment

Conventions

This service manual uses the following conventions to alert you to important information for safe operation and quick working.

WARNING:

Denotes a procedure or operation which, if not performed correctly, may result in personal injury. Be sure not to continue operation until indicated conditions are fully understood and met.

Caution:

Denotes a procedure or operation which, if not performed correctly, may cause damage to the UPS. Be sure not to continue operation until indicated conditions are fully understood and met.

Important Safety Instructions

1. The procedures detailed in this manual are intended for qualified service personnel only.
2. DO NOT perform any internal service or adjustment of this product unless a second person, capable of rendering first aid and resuscitation, is present.
3. Dangerous voltage exists at several points in this product. To avoid personal injury, do not touch any exposed connections or components while UPS is powered.
4. Turn off the UPS and disconnect the input power cable before removing the outer covers.
5. AC voltage is always present within the equipment when the connected input AC power is live.
6. High voltage may be present at the DC bus capacitors. After turning off the UPS wait for at least five minutes before removing the UPS cover.
7. DO NOT short-circuit the internal batteries.
8. If the battery is disconnected, be sure to 'pre-charge' the DC bus by powering-up the UPS input mains supply before reconnecting the battery – failure to carry out this action may result in rupturing the battery fuses when the battery is reconnected.
9. After service, verify the polarity of the battery connections and the tightness of all screws and connectors before restarting the UPS.

CHAPTER 1 - Functional Description

1.1 Introduction

There are six 230V models in the Liebert GXT UPS range:

Description	Rating (kVA/kW)	Case Style
GXT700MT-230	700 / 490	Mini Tower
GXT1000MT-230	1000 / 700	Mini Tower
GXT1000RT-230	1000 / 700	Full Tower / Rack
GXT1500RT-230	1500 / 1050	Full Tower / Rack
GXT2000RT-230	2000 / 1400	Full Tower / Rack
GXT3000RT-230	3000 / 2100	Full Tower / Rack

All six models employ the same principles of operation, but for reasons of clarity the component annotations and illustrations shown in this chapter refer to the 1500RT-230 unit. Details of the other models are provided elsewhere in this manual.

The GXT product falls into the category generally described as an “On-Line” UPS system – i.e. under normal circumstances the UPS batteries are being float charged and the UPS inverter is operative and providing processed load power at all times. In the event of a mains supply failure the inverter will continue to provide processed load power while operating from the internal battery, until the battery becomes fully discharged – whereupon the UPS shuts down. The duration for which the batteries can sustain the load power under these conditions is known as the autonomy time and depends upon the battery Ah capacity and the value of the demanded load current. Typically, the battery is sized to offer 5-10 minutes of back-up at full load but this can be increased by connecting additional battery-packs to the system. Purpose-designed external battery cabinets are available as optional equipment to extend the autonomy time – for example a 50 minute back-up time can be achieved with the addition of a further two cabinets.

If the UPS develops an internal fault which prevents it from producing its specified output supply, it will immediately invoke an alternative ‘bypass’ supply line which connects the load directly to the UPS input (mains) supply. Such a load transfer takes place without interrupting the load power; but when the UPS is ‘On-Bypass’ the load is being supplied with unprocessed power which is not immune from supply aberrations or total loss.

The following design features help make this model easy to maintain and service:

- A minimum number of Printed Circuit Boards (PCBs) and sub-assemblies have been employed – thus simplifying fault detection by substitution.
- All major power components are PCB-mounted.
- All major parts are connected with flexible insulated wires and plugs.
- All PCBs are interconnected with connectors – no soldering.
- Easily replaceable battery pack.

1.2 Principles of operation

Figure 1.1 - Basic block diagram

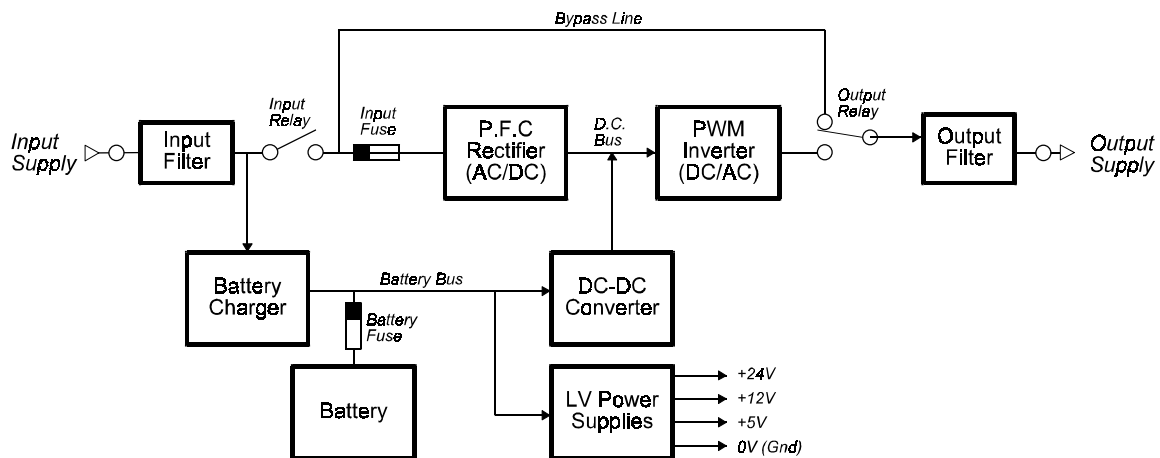


Figure 1.1 illustrates a basic block diagram of the UPS power sections. With the exception of the Input Filter and Output Filter all the blocks shown are contained on the Power Board – which is one of two major boards contained in the UPS. The functional description of the block diagram provided immediately below, is followed by a more detailed description of each of the power sections shown.

1.2.1 Block diagram

Input/Output filter

These are simple low-pass filters designed to prevent mains-borne RFI entering the UPS control system and also prevent any switching noise generated within the UPS radiating back into the mains supply and the UPS output.

Battery Charger

As its name suggests, the Battery Charger is responsible for providing the Battery with a permanent, regulated float charge voltage. The charger circuit is live whenever the UPS mains power is available – irrespective of whether or not the UPS is switched on. The battery float voltage is adjustable by means of a control potentiometer and normally set to provide a float voltage of approximately 2.3V/cell. In addition to charging the battery, the Battery Charger output also provides an input power source to the LV Power Supplies block and the DC-DC Converter.

Battery

The number of batteries contained in the UPS varies according to the UPS rating: ranging from 2 x 12V blocks in the GXT700MT-230 to 8 x 12V blocks in the GXT300RT-230. However, in each case the batteries are contained in a sub-assembly which can be fully withdrawn from the unit after disconnection. This simplifies battery replacement, and is intended that such an operation is undertaken by an operator. Note that the Battery Fuse is located on the Power Board and is not accessible without removing the UPS cover.

Only lead acid batteries of valve-regulated, non-spillable design should be used with the GXT equipment.

LV Power Supplies

A switched-mode DC-DC converter provides the +24V, +12V and +5V low voltage supply rails required by the UPS control system. As this circuit is powered from the battery busbar, the LV supplies are available whenever the UPS input supply is present or the batteries are connected. An additional set of isolated +15V and -5V power supplies, not shown in the block diagram, are also powered from the battery bus. These are required by the inverter power transistor drive circuits – as explained later in this chapter.

Note: the cooling fans are powered directly from the +12V supply rail and the sound of their rotation is a good indication that the LV Power Supply Block is basically functioning.

DC-DC Converter

The DC-DC Converter is responsible for converting the battery bus voltage to two regulated busbars at +410Vdc and -410Vdc (with respect to 0V ground) for use by the inverter in the absence of the UPS input supply. As illustrated in the block diagram, the DC-DC Converter output is effectively connected in parallel with that of the PFC Rectifier at the input to the PWM Inverter section – this permits the PWM Inverter to operate from either power source.

PFC Rectifier

The Power Factor Correction (PFC) Rectifier converts the UPS input mains supply into two regulated $\pm 380\text{Vdc}$ busbars which, under normal circumstances, provide the operating power source for the PWM Inverter. The manner in which the converter is controlled automatically brings the input current in phase with the input voltage, which leads to a higher input power factor than is the case with more traditional rectifier circuits.

The PFC Rectifier is selected ON by the UPS control system only if the input relays (RL2 / RL3) are closed and the input fuse is healthy.

PWM inverter

The PWM Inverter converts the DC Busbar into a regulated 230Vac output supply. As described above, the DC Busbar can itself be derived from the PFC Rectifier (when the input supply is present) or the Battery Busbar via the DC-DC Converter (when the input supply is absent), it is therefore a design requirement that the inverter section is able to produce a regulated output over a widely varying range of input (DC Busbar) voltages – which is achieved through the implementation of pulse-width modulation (PWM) control.

In brief, in order to maintain a regulated a.c. output voltage the inverter PWM mark-space ratio is made to increase as the DC Busbar voltage reduces: this is also true with respect to load current – i.e. as the load increases then the PWM mark-space ratio also increases to allow the extra current through to the load without causing a reduction of the output voltage. The point at which the inverter is unable to sustain its regulated output voltage, and is therefore shut down, is thus determined by both the DC Busbar voltage and the prevailing load demand – i.e. on light loads the inverter can maintain its correct output voltage at a lower DC Busbar level than is possible on higher loads.

1.3 Basic operation

UPS Power-up

1. When mains power is initially connected to the UPS input supply socket the Battery Charger and LV Power Supply sections become active and produce the low voltage power rails required by the UPS control system together with the cooling fan(s). The sound made by the rotating fan(s) is thus a good indication that the power supplies are operating correctly.
2. The control system monitors the input supply and closes the Input Relay if the supply voltage and frequency are found to be valid. This routes the input supply, via the bypass line and Output Relay, to the UPS output sockets and thereby connects the load equipment directly to the Input Supply.
Note: The 'Bypass' led illuminates on the UPS Control Panel to indicate that the load is 'on bypass' and the audible alarm sounds at approximately 2 minute intervals to remind the user that the load is being supplied with unprocessed power.
3. The PFC Rectifier operates as soon as the mains is applied. Its output initially ramps up to approximately 750Vdc and then settles at around 660Vdc (i.e. ± 330 Vdc balanced with respect to 0V ground).

Pressing the ON push-button

1. When the ON push-button is pressed, the UPS control system runs through a series of validity checks on the DC busbar and inverter and, if satisfactory, energises the Output Relay after approximately 10 seconds. This transfers the load to the inverter output which now provides it with processed and backed-up power.
Note: The 'Bypass' led extinguishes and the 'UPS ON' led illuminates on the front panel to indicate the revised load supply status.
2. After a further 4 seconds (approximately) the UPS control system performs an automatic battery test whereby the PFC Rectifier is turned off for approximately 15 seconds and the DC busbar voltage is monitored while the inverter is being powered from the batteries. If the batteries sustain the DC busbar satisfactorily during this time the batteries are considered to be healthy and the PFC Rectifier is turned on again to restore the UPS to normal operation. If the batteries fail the test the load is transferred to the bypass supply (by releasing the Output Relay) and the 'Fault' led illuminates.

Operation during mains failure and return

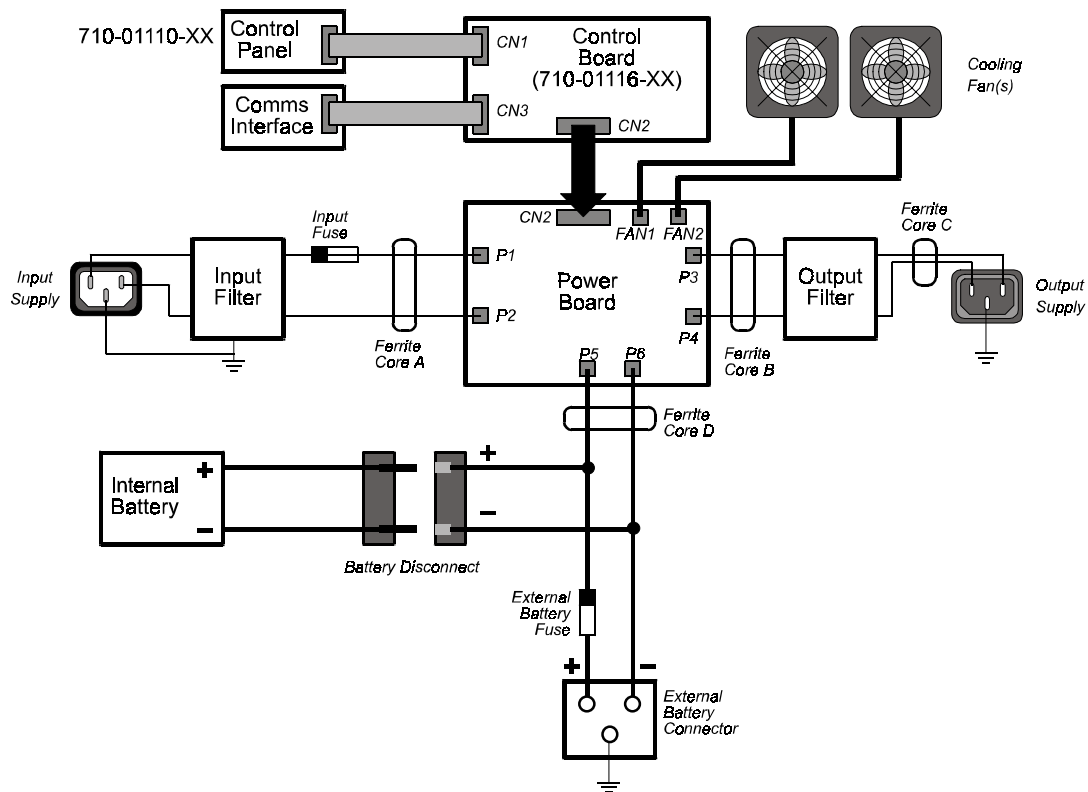
1. If the input supply fails while the UPS is operating normally, the PFC Rectifier and Battery Charger are shut down and the batteries provide the inverter power source via the DC-DC Converter. This situation continues until the batteries have discharged to the point at which they are unable to sustain the DC busbar voltage at an acceptable level – when this point is reached the control system attempts to transfer the load to the bypass supply; but if the input supply is still missing the bypass supply is also unavailable and the UPS therefore totally shuts down and drops the load.
Note: When operating 'On-Battery' the remaining battery time is indicated by the front panel leds.
2. When the UPS shuts down due to battery undervoltage the low voltage DC Power Supply block is also turned off and will not be reactivated until the input mains supply is restored.
3. If the Input Supply returns to normal before the battery reaches its undervoltage level, the PFC Rectifier block is turned on and once again takes over the responsibility of providing the inverter input power. The Battery Charger is also turned back on to recharge the batteries.

Operation under fault conditions

1. If the UPS develops a fault which prevents it from producing its specified output supply the load is transferred to the bypass supply (via the Output Relay).
2. The decision over whether or not to shut down the individual UPS power blocks is taken by the control system according to the particular fault symptoms.
Note: Some fault conditions are positively identified by the front panel leds.

1.4 Major component connection details

Figure 1.2 - Internal connection details



Model	Power Board	Battery	Input Filter	Output Filter	Input Fuse	Ext. Batt Fuse
700MT	710-01126-XX ²	2 off 80946-00 ¹	094-00045-00	094-00050-00	5A	-
1000MT	710-01179-XX ²	3 off 80949-00 or 80950-00 ¹	094-00046-01	094-00050-00	6.3A	-
1000RT	710-01440-XX ²	3 off 33956-00	094-00046-01	094-00050-00	6.3A	6.3 A
1500RT	710-01460-XX	4 off 33965-00	094-00061-00	094-00050-00	10A ⁴	10.0 A
2000RT	710-01042-XX	8 off 80901-01 or 80927-00 or	094-00080-03	710-01108-XX	15A ⁴	15.0 A
3000RT	710-01421-XX	4 off 33956-00 ³	094-00120-00	710-01108-XX	20A ^{4/5}	20.0 A

Note 1: External battery connector not fitted

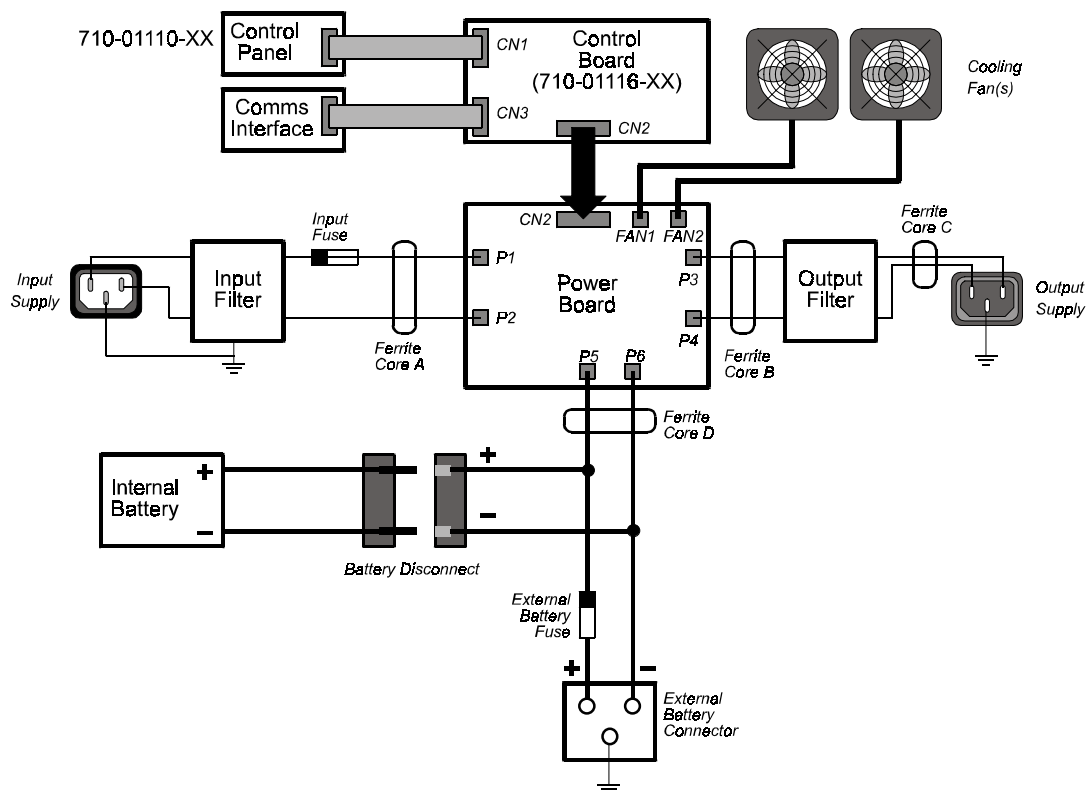
Note 2: Only one fan is fitted to these models (connected to either *Fan1* or *Fan2* connectors)

Note 3: Nominal battery voltage is 96Vdc therefore an additional disconnect socket is fitted mid-way along the battery string to allow the battery to be split into two 48V groups for safe fitting/removal.

Note 4: On the larger models the input fuse is replaced by a resettable circuit breaker.

Note 5: The 300RT model is also fitted with a resettable output circuit breaker.

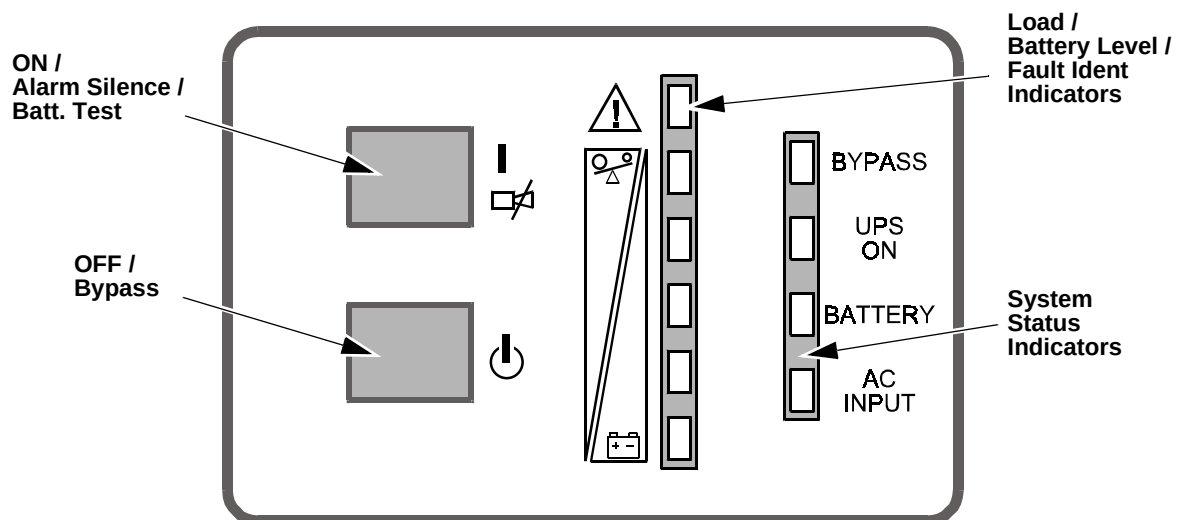
Figure 1.3 - Ferrite core usage



Model	Ferrite Core A	Ferrite Core B	Ferrite Core C	Ferrite Core D
700MT	Not fitted	Not fitted	Not fitted	-
1000MT	80957-00	Not fitted	80959-00	-
1000RT	Not fitted	Not fitted	Not fitted	80915-00
1500RT	Not fitted	Not fitted	80914-00	80915-00
2000RT	80904-00	80223-XX	80902-00	80910-00
3000RT	80904-00	80223-XX	80903-00	80910-00

1.5 Control Panel description

Figure 1.4 - Control Panel



1.5.1 Control Panel push-buttons

There are two tactile push-buttons located on the Control Panel, as described below. To prevent inadvertent operation, these push-buttons must be held pressed for 0.5 seconds before their closure is recognised by the UPS control system.

ON / Alarm Silence / Batt. Test button

As its title suggests, this push-button has three functions depending on the current UPS operational status.

1. When the UPS is either fully powered down or running 'On Bypass' (ON BYPASS status indicator illuminated), pressing this button initiates the UPS start-up operation to bring the UPS on-line.
2. If the UPS is running (UPS ON status indicator illuminated), pressing the button will silence the audible alarm – providing the cause of the alarm condition is no longer present.
3. If the UPS is running and there is no alarm condition, pressing the button initiates a battery test sequence which transfers the load to the battery for approximately 15 seconds to test its serviceability.

OFF / Bypass button

This button is operative only when the UPS is running, whereupon pressing it once transfers the load to the bypass supply (ON BYPASS status indicator illuminated) and pressing it for the second time within four seconds shuts down the UPS (ON BYPASS and ON UPS indicators both extinguished) – if more than four seconds elapse between the first and second button presses the second press has no effect. To shut down the UPS when it is operating 'On Bypass', the button must be pressed twice within four seconds.

1.5.2 System Status indicators

The four leds on the right-hand side of the Control Panel indicate the general UPS operating status.

BYPASS

This amber led illuminates when the load is being powered from the bypass supply and will illuminate briefly when the UPS is initially turned on as the control system goes through its start-up routine. If this led illuminates during normal UPS operation it could be due to an internal UPS fault, an inverter overload, or due to a 'transfer-to-bypass' request from the operator – see the 'OFF / Bypass' button description above.

Note: When this led is illuminated the load is not being provided with backed-up or processed power.

UPS ON

This green led is normally illuminated, and indicates that the UPS is 'On Load' – i.e. the load is being provided with backed-up and processed power.

BATTERY

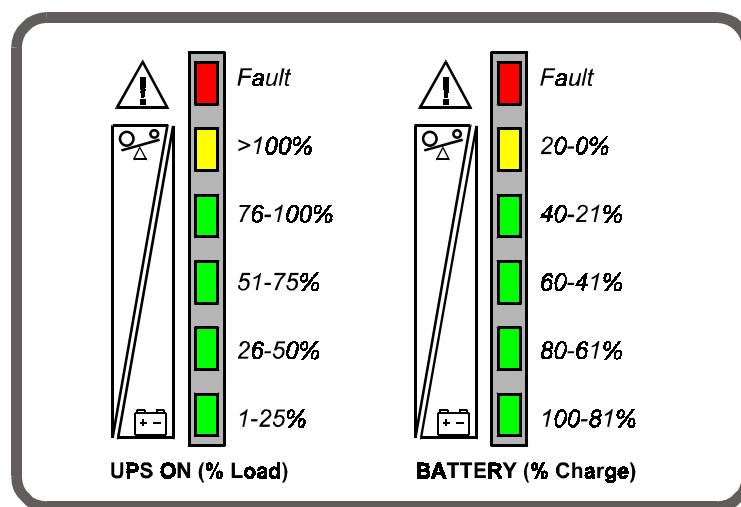
This amber led illuminates whenever the battery is discharging; usually due to an input supply failure, and is accompanied by an audible warning. The led also illuminates when the battery test sequence is performed (whether initiated manually or automatically).

AC INPUT

This green led is normally illuminated and indicates that the input supply is present and within the operating voltage and frequency tolerances required by the UPS control system.

1.5.3 Bargraph Led

Figure 1.5 - Operator Panel Bargraph led functions



The function of the bargraph led in the centre of the Operator Panel depends on the UPS operational status. In all instances the top (red) led is used to indicate a detected fault condition.

Load indicator

When the UPS is operating normally (UPS ON led illuminated), the bargraph indicates the applied load as a percentage of the UPS's rating in steps of 25% – i.e. the lower led illuminates for loads up to 25%, the lower two leds illuminate for loads between 26% and 50%... and so on. The fifth, amber, led illuminates in the event of an overload prior to the UPS transferring the load to bypass.

Charge indicator

If the UPS changes to battery operation (BATTERY led illuminated) the leds indicate the state of battery charge as a percentage of the remaining back-up time. For example, when the UPS first reverts to battery operation all the leds will be illuminated (except the 'fault' led) and as the battery discharges they will extinguish from the bottom led upwards as the remaining time falls below the levels indicated. When the amber (0-20%) led only is illuminated it indicates that the battery is almost fully discharged and that it would be wise to shut down the load equipment in an orderly fashion – as the UPS is about to fully shut down and drop the load supply.

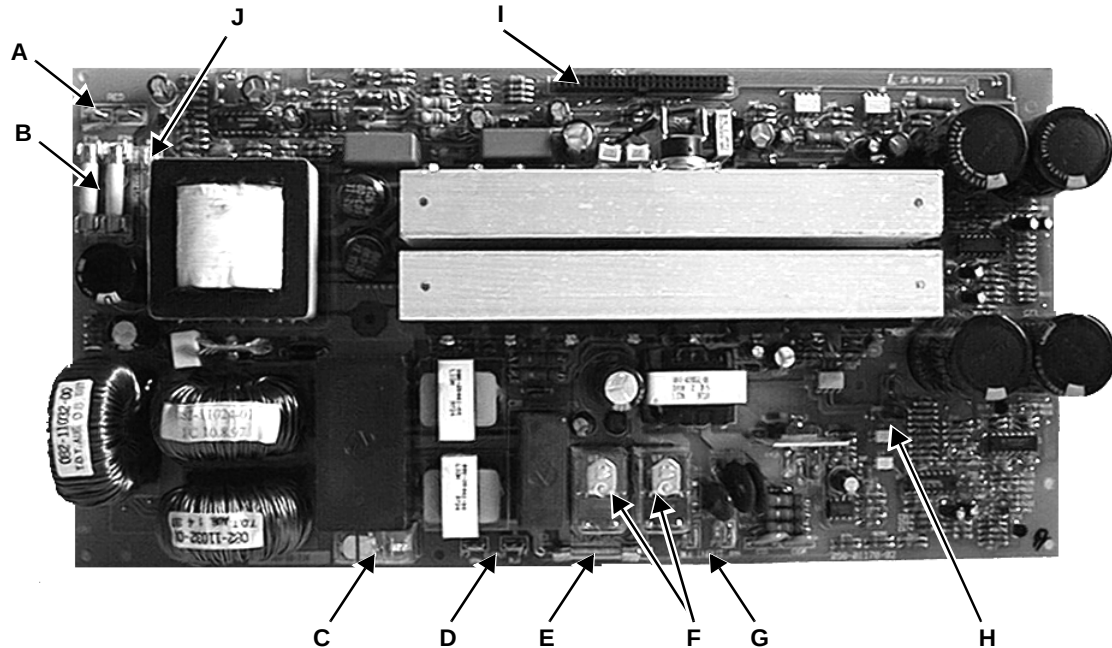
Note that when operating 'On Battery' the audible warning will sound every 10 seconds to alert the operator. This will increase to two beeps every five seconds when there is approximately 2 minutes of battery time remaining.

Fault indicator

If the UPS detects a fault it will indicate the nature of the fault condition by illuminating a combination of the bargraph leds in addition to the 'Fault' led – see Chapter 4 (troubleshooting) of this manual for more details.

CHAPTER 2 - Power Board

Figure 2.1 - 1500VA Power Board



- | | | | |
|---|-----------------------------|---|--------------------------------|
| A | Battery positive connector | B | Battery Fuses |
| C | Bypass Relay (RL1) | D | UPS output power connections |
| E | Input Fuse | F | Input Relays |
| G | UPS Input power connections | H | Charger voltage adjustment pot |
| I | Control Board connector | J | Battery negative connector |

The Power Board contains all the power components associated with the Battery Charger, DC Power Supply, PFC Rectifier, DC-DC Converter, and PWM Inverter. A description of each of these power blocks is described in this chapter.

WARNING

This Board contains potentially dangerous voltages whenever the mains supply OR batteries are connected. The large electrolytic capacitors may retain a high charge when the UPS is turned OFF and should be discharged using a suitable bleed resistor (e.g. 100R / 10W) before working on the board.

2.1 Battery Charger

2.1.1 Introduction

As its name suggests, the primary purpose of the Battery Charger circuit is to produce a regulated voltage to float charge the batteries while the input mains supply is available. The charger output voltage is normally set to a value of 2.3V per cell – e.g. 55.2Vdc for the 24 cells contained in the 1500RT model.

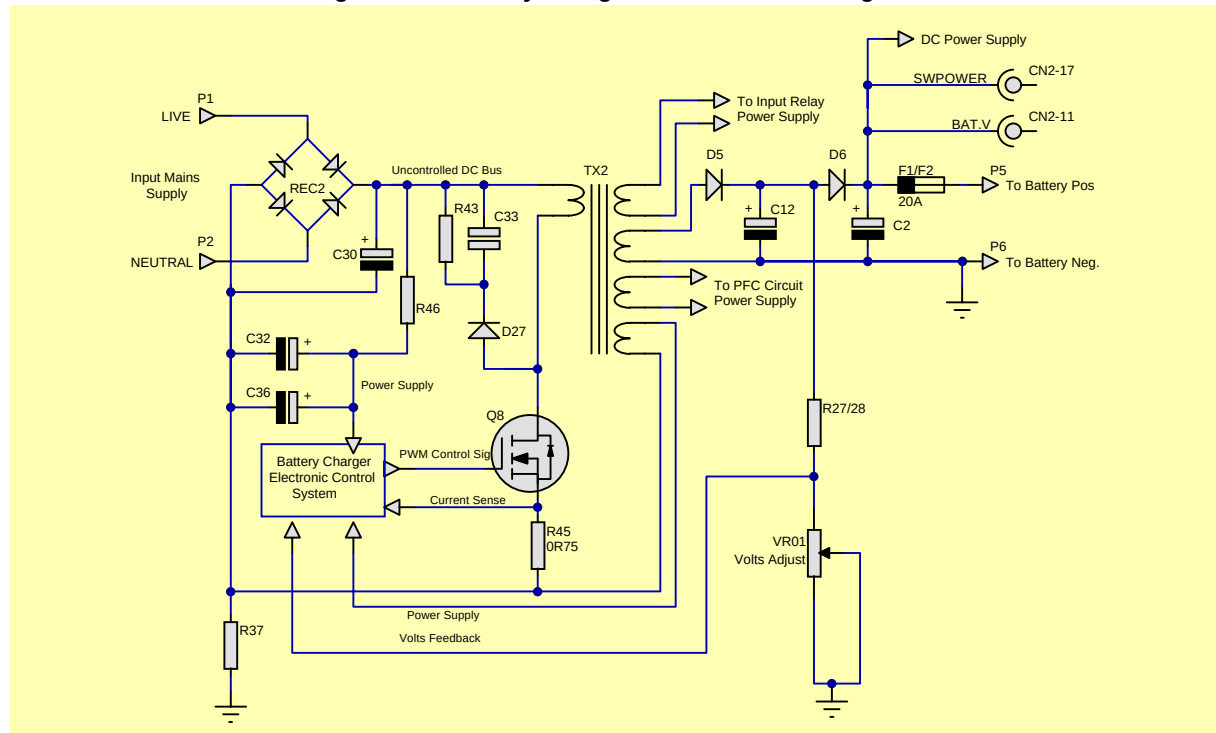
The Battery Charger obtains its power directly from the incoming 230Vac mains supply and is active whenever the input supply is live – i.e. the Battery Charger function is not affected by the front panel ON/OFF push-buttons. Note: the Charger is fed from the ‘live’ side of the input relays and is therefore not affected by the relay(s) or input fuse status.

The DC Power Supply block, which provides the low voltage operating supplies for the control circuits, is also connected to the battery bus, and is therefore also powered from the Battery Charger output under normal circumstances.

2.1.2 Circuit description

Note: The signal annotation flags shown on the circuit diagrams contained at the rear of this manual are shown within a ‘square’ and ‘angled’ bracket in the manual text – for example, the signal annotated “BAT.V” on the diagram will be shown as [BAT.V].

Figure 2.2 - Battery Charger – Power Circuit Diagram



Power circuit operation

The incoming 230Vac mains supply is full-wave rectified by REC2 and smoothed by C30 (470uF) to provide an *uncontrolled dc busbar* of approximately 575V which is connected to a switched-mode DC-DC converter designed around Q8 and TX2.

When its gate terminal is taken high, Q8 turns ON and draws current from the uncontrolled dc busbar through TX1 primary which, through transformer action, induces a current in TX2 secondaries which in turn gives rise to the secondary voltages. The resistance in the primary circuit is very low, and the rise in input current when Q8 turns on is determined almost entirely by the reactance of TX2 primary – the peak current is therefore controlled by the length of time that Q8 is allowed to conduct. If Q8 is turned On for an excessive time (or goes short circuit drain-source) the transformer primary could saturate and the excessive current could cause (further) damage to the Charger circuit, or trip the external mains supply.

The main battery charger output is rectified and smoothed by D5, D6, C12 and C2, and connected to the battery terminals via fuses (F1/F2). The voltage at the junction of D5/D6 is connected to the battery charger control circuit in the form of a voltage feedback signal to a closed-loop control system which determines the battery charger output voltage. Note that this signal doesn't 'see' the battery voltage when the input mains supply is absent, due to the blocking effect of D6.

In addition to charging the battery, the battery charger output at the cathode of D6 (which is also known as the 'battery bus') is also connected to:

1. The DC Power Supply block, where it provides the input power source (*see figure 2.4*).
2. To the Control Panel 'ON' switch [SWPOWER> (CN2-17), via the Control Board (*see figure 3.6*).
3. To the Control Board electronics [BAT.V> (CN2-11) in the form of a battery voltage sense signal.

Notice that these three outputs are also valid when the Battery Charger is shut down (e.g. due to mains failure) where-upon the voltages are furnished by the battery. This implies that:

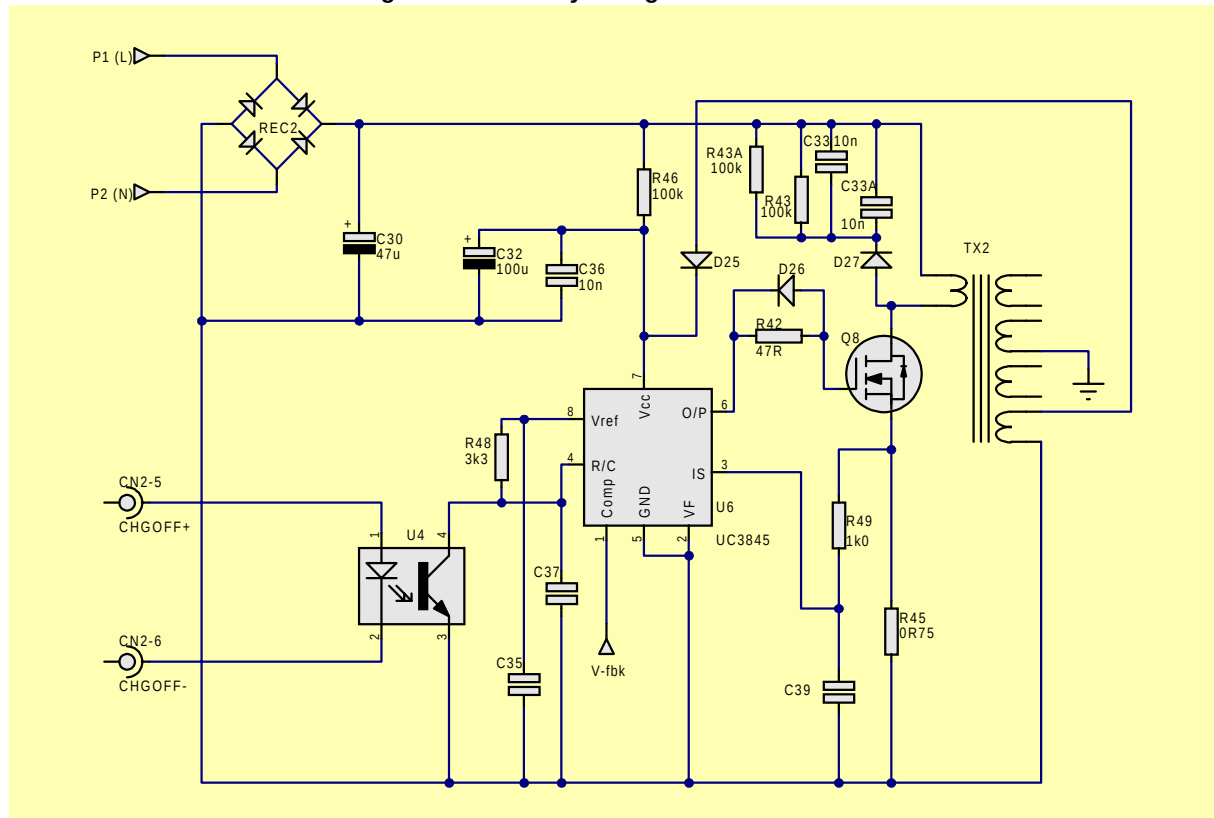
1. The DC Power Supply block operation is sustained when the UPS is operating 'on-battery.'
2. The Control Panel 'ON' switch is functional while the input mains is unavailable, provided the battery is connected.
3. The Control Board electronics monitor the battery voltage directly when the charger is shut down and is thereby able to sense the battery voltage as it discharges.

TX2 secondary functions

TX2 has three secondary windings in addition to the one used to provide the main battery charger output, as illustrated in Figure 2.2:

1. The top winding is half-wave rectified and used as a dedicated 15V supply for the input relay coil(s) (*see figure 2.15*).
2. The third output drives a dedicated power supply used by the PFC Rectifier control circuit, and is necessary to provide an isolated power source for the PFC driver circuit.
3. The lower secondary winding provides a secondary power source for the Battery Charger control circuit.

Figure 2.3 - Battery Charger – control circuit



Control circuit operation

The Battery Charger control circuit is based on a UC3845 ‘current-mode PWM controller’ device (U6) which is also located on the Power Board. This device produces a 20 μ s pulse-train (approximately) which is connected as a drive signal to the base of Q8. The Battery Charger output voltage is controlled by varying the drive signal’s duty cycle (mark-to-space ratio) – i.e. as the duty cycle (m:s) increases more current is drawn through TX2 primary which leads to an increased battery charger output voltage, and vice versa.

The drive signal’s duty cycle is determined by a control loop which takes into account the battery charger output voltage (fed back via R27/R28/VR01 etc.) and the charger current (obtained by monitoring the volts drop across R45 in Q8 drain). The action of the control loop thus maintains a stable float charge voltage.

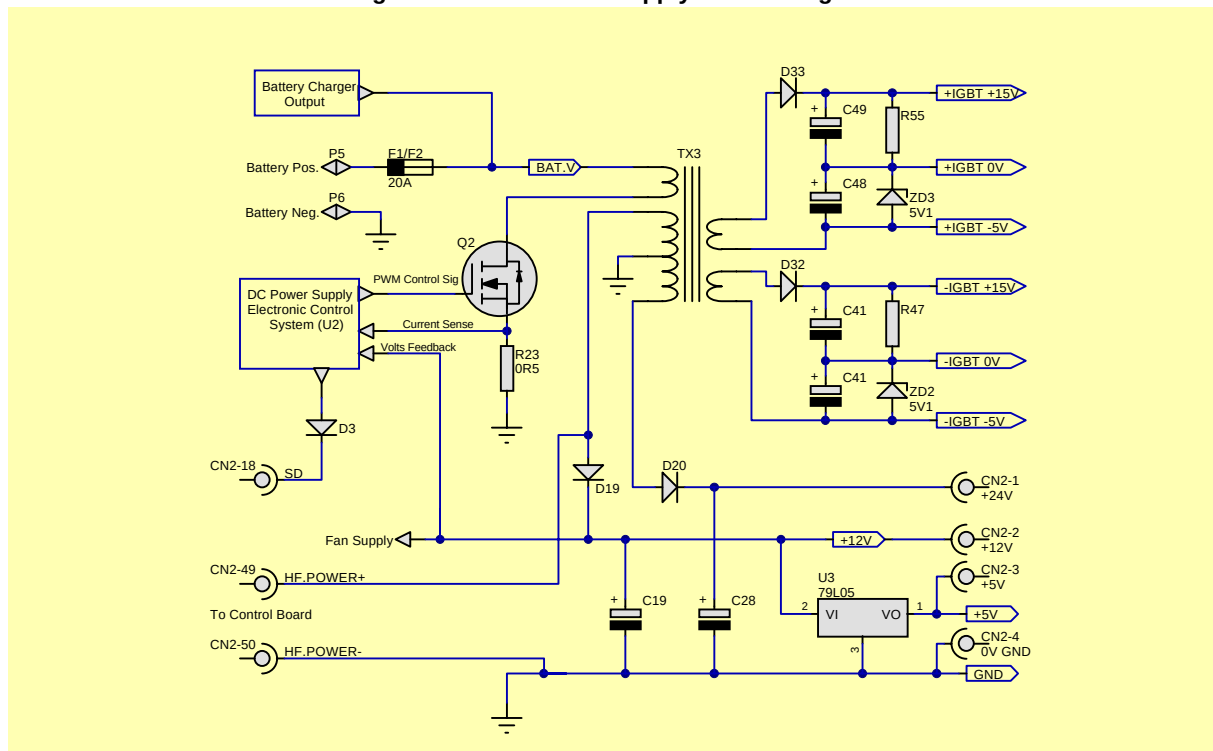
Note that VR01 affects the voltage feedback signal sensitivity and thereby provides a means of adjusting the float charge voltage.

The UC3845 (U6) obtains its operating power from the uncontrolled dc busbar via a series dropper resistor (R46 100K) and can operate over a supply voltage in the range 11V - 34V (typical).

Although all the components associated with the battery charger control circuit are located on the Power Board, the circuit receives an ON/OFF control signal from the micro-control system on the Control Board which is applied via an opto-isolator (U4) and connected via CN2 pins 5 & 6. The Control Board turns ON U4 when it requires the Battery Charger to be shut down – see page 34.

2.2 DC Power Supply

Figure 2.4 - DC Power Supply Circuit Diagram



2.2.1 Introduction

The DC Power Supply block provides various low voltage power supplies required to operate the UPS control electronics. The circuit's input is connected to the Battery Bus which under normal circumstances is held at a regulated 55.2Vdc (2.3V/cell) by the action of the Battery Charger circuit; however when the UPS is operating 'on-battery' this voltage will immediately fall to 48Vdc (nominal) and further reduce to 40Vdc as the battery discharges to its end-of-discharge voltage (1.67V/cell). The DC Power Supply must therefore be able to sustain its regulated outputs over this broad range of input voltages.

2.2.2 Circuit description

Power circuit operation

The DC Power Supply circuit is based on a switched-mode DC-DC converter designed around Q2 and TX3.

When its gate terminal is taken high, Q2 turns ON and draws current from the battery busbar through TX3 primary which, through transformer action, induces a current in TX3 secondaries which in turn gives rise to the secondary voltages. The resistance in the primary circuit is very low, and the rise in input current when Q2 turns on is determined almost entirely by the reactance of TX3 primary – the peak current through TX3 is therefore controlled by the length of time that Q2 is allowed to conduct. If Q2 is turned ON for an excessive time (or goes short circuit d-s) the transformer primary could saturate and the excessive current might:

- further damage other DC Power Supply components.
- rupture the battery fuse.
- shut-down the battery charger due to over-current.

In any event, failure of the DC Power Supply will cause a general UPS failure and transfer the load to bypass.

TX3 has three secondary windings, as illustrated in Figure 2.4:

- The two windings shown on the right-hand side of the transformer in the diagram above provide isolated +15V and -5V for the inverter IGBT transistor drive circuits – see Figure 2.14.
- The left-hand winding provides the regulated dc power rails, as described below.

The left-hand winding is centre-tapped. The lower part is rectified by D20/C28 and produces a +24V rail which is used by the Control Board. The upper part of the winding is rectified by D19/C19 to provide a +12V rail, which in turn drives a three terminal +5V regulator (U3) to provide a stable +5V rail. The +12V and +5V rails are used extensively by the Power Board's electronics and are also connected to the Control Board and Operator Panel. The +12V rail also powers the cooling fan(s).

As illustrated in Figure 2.4, the ac voltage from the top half of the left-hand winding is also connected to the Control Board ([HFPOWER+> and [HFPOWER->) where it drives a further transformer which produces various power supplies for the use of the communications interface system etc. – see Figure 3.3. The voltage between [HFPOWER+> and [HFPOWER-> is approximately 16Vrms.

Control circuit operation

The DC Power Supply control circuit is similar to the Battery Charger control circuit in that it is based on a UC3845 'current-mode PWM controller' device (U2).

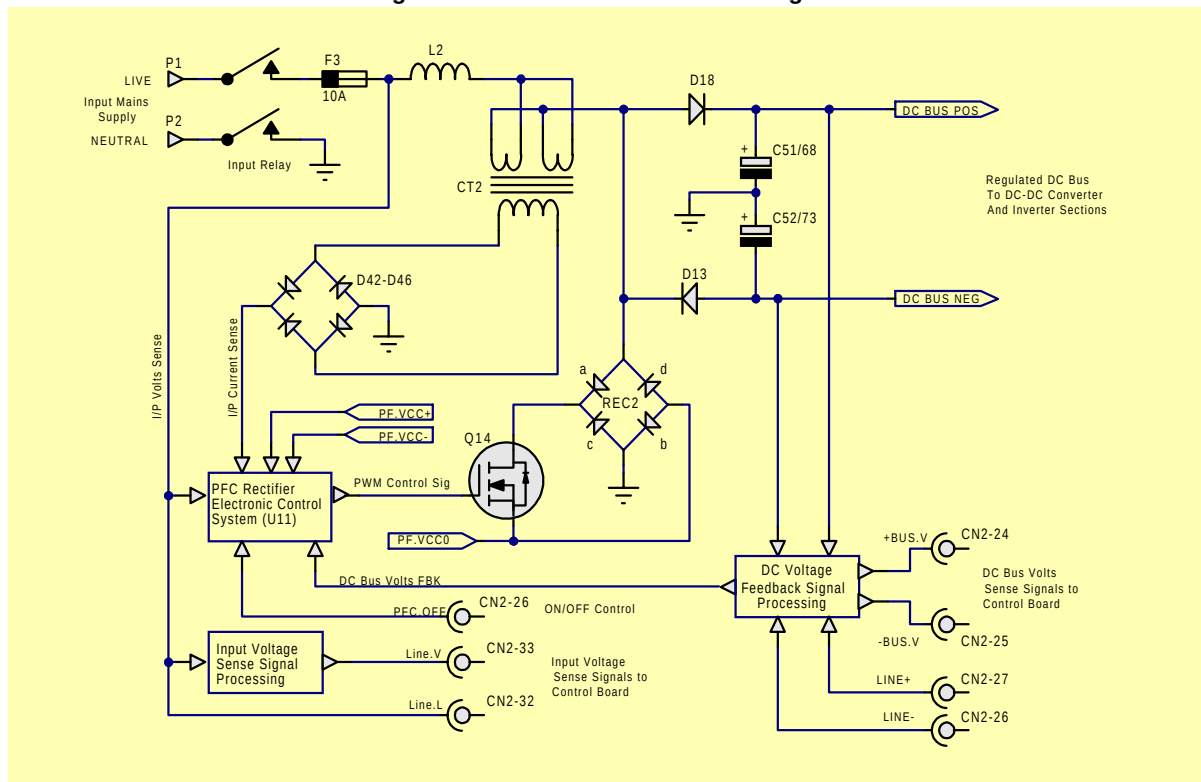
The drive signal's duty cycle is determined by a control loop which takes into account the value of the 12V power rail (fed back via a network comprising R20, R19 and R10) and the source current (obtained by monitoring the volts drop across R23). The action of the control loop thus maintains a stable +12V supply rail voltage.

Note that the voltage feedback resistor network is fixed and the +12V rail is therefore not adjustable.

All the components associated with the DC power Supply control circuit are located on the Power Board; however the power supply to U2 is obtained through a switching transistor which can be turned OFF by a logic low shutdown signal ([SD>) generated on the Control Board and applied to the circuit via CN2-18 and D3 – see Figure 3.6.

2.3 PFC Rectifier

Figure 2.5 - PFC Rectifier Circuit Diagram



2.3.1 Introduction

The Input Power Factor Correction (PFC) circuit, which is shown in full in Figure 2.5, serves two important functions:

1. It converts (rectifies) the input mains supply into two regulated DC busbars of about $\pm 380\text{Vdc}$ with respect to ground – which then provide the input power source for the inverter section.
2. In performing the above conversion it controls the input current waveform such as to keep it in-phase with the input voltage and thereby maintain a higher input power factor than would otherwise be the case with more traditional rectifier circuits.

The mains supply is connected to the circuit via the input fuse (F3) and the Input Relays which, when closed, also grounds (earths) the input neutral. The Input Relays are powered by a dedicated supply obtained from the Battery Charger block (see figure 2.15) and controlled by an energising signal from the Control Board (I/PRLY>) which closes the relay only if it confirms that the input voltage and other system parameters are valid – see Figure 3.7.

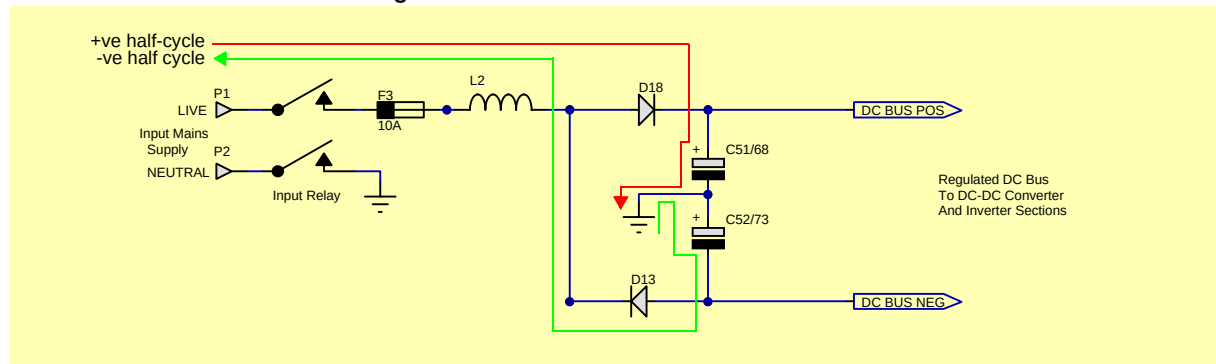
2.3.2 PFC Principles of operation

The PFC circuit employs two ‘boost converters’ operating back-to-back to control both positive and negative half cycles of the incoming mains waveform and thereby produce individually-controllable 380Vdc positive and negative busbars. Figure 2.5 shows that the junction of the DC busbar reservoir capacitors is grounded and thus provides the 0V reference level for both busbars.

PFC Circuit as a basic rectifier

Before describing the boost converters’ operation, first consider the operation of the circuit as a basic full-wave rectifier – i.e. ignoring the effects of Q14 and diode bridge REC2 (see figure 2.6). Under these circumstances, during positive half cycles the input current flows from left to right through the input choke (L2), diode D18 and back to the earthed input neutral via reservoir capacitors C51/C68 and the earth point – the capacitors consequently charge to a value approaching 1.4 times the input rms voltage (e.g. 325Vdc). During negative half cycles the reverse action takes place; and current is drawn out of the circuit via C52/C73 and D13 – charging up C52/C73 in a negative direction and producing the negative 325Vdc busbar.

Figure 2.6 - PFC Circuit as a basic rectifier

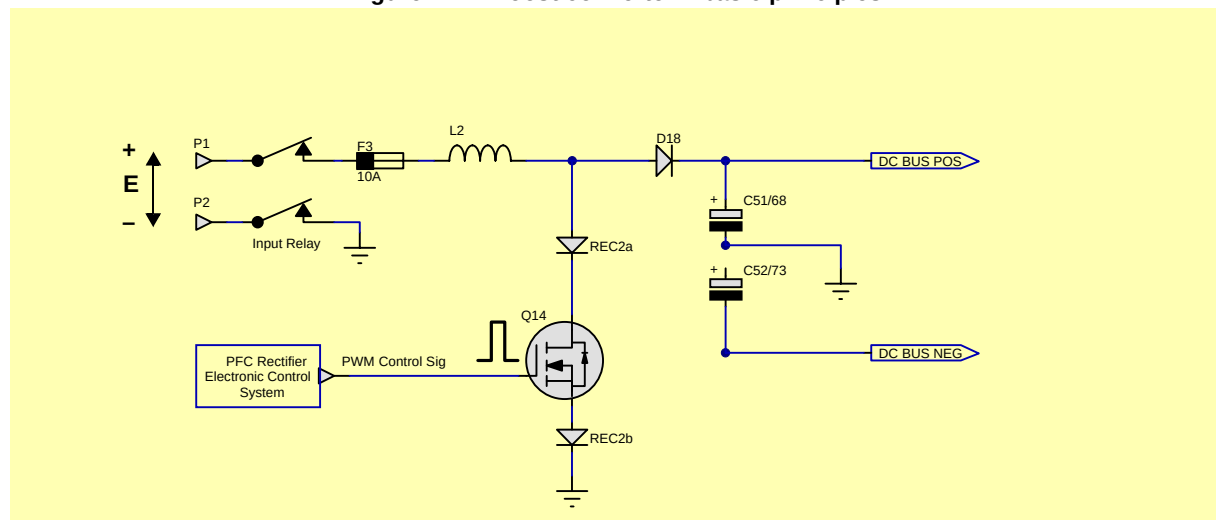


A 'boost converter' is required for two reasons: first, the dc busbar voltage produced by the basic rectifier circuit is unregulated, and will vary with changes in load current and/or input mains voltage; second, the inverter section, which converts the dc busbars back into an ac waveform, requires a higher dc voltage to enable it to produce a sinusoidal output waveform over its complete operating range.

Boost converter – basic principles

The PFC circuit is a form of peak-current switching regulator normally associated with DC-DC converters rather than the AC-DC conversion utilised in this application. To understand how the PFC power circuit works it is best to consider the operation of a standard DC-DC converter and then discuss the additional control features required by the PFC circuit. Figure 2.7 shows a simplified diagram of the boost converter operating with a dc input supply.

Figure 2.7 - Boost converter – basic principles



If the input voltage (E) in the circuit above is held constant (i.e. a d.c. value) and transistor Q14 is never turned on then clearly all that will happen in the circuit is that positive dc bus reservoir capacitors C51/68 will charge to the input voltage (+E volts) via D18.

If a logic high pulse is applied to Q14 gate it will turn hard on and effectively ground the right-hand side of L2 (via two diodes of REC2). This will not affect the charge on C51/68 as D18 blocks any discharge current; however, it will increase the current drawn through L2 and REC2(a/b). The amount of increased current depends on the values of the input voltage (+E) and the drive pulse duration - and can be described using the well known formula $E = -L \frac{di}{dt}$.

As the input voltage (E) and inductance (L) are both constant, the current through L2 increases linearly while Q14 is turned on and therefore reaches its peak value at the end of Q14's drive pulse.

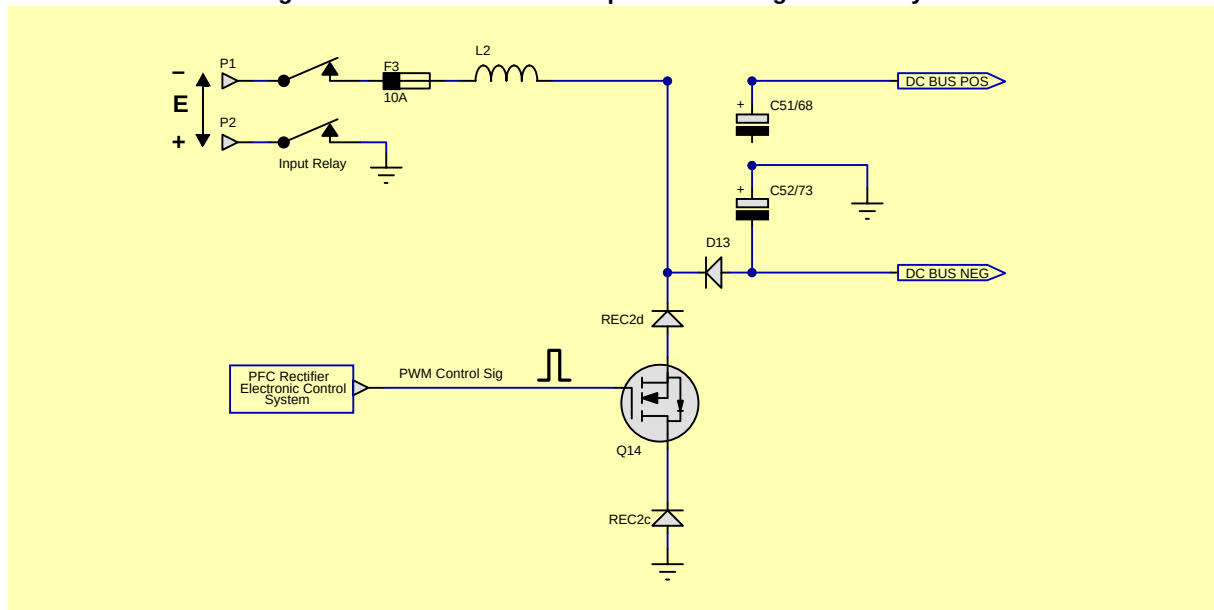
Q14 will turn off when the drive pulse is removed from its gate; however, the current through L2 cannot reduce to zero instantaneously (one of the properties of a choke) and since Q14 now represents an open circuit the only path available for the decaying current is through D18 and C51/68, which therefore charge up to a voltage greater than the input voltage.

Another way to view this action is to consider that the energy stored in the magnetic field around L2 when it draws current ($\frac{1}{2}LI^2$) is transferred to capacitors when Q14 turns off.

In the practical PFC circuit the current passing through D18 not only charges C51/68 but also supplies the UPS load (via the inverter). C51/68 therefore act as a reservoir capacitor, taking on charge when D18 is passing current (Q14 off) and providing the DC Busbar load current when Q14 is turned on.

In a standard DC-DC converter the output voltage is usually regulated by comparing it with a reference level and using any error signal resulting from the comparison to control the width or frequency of the drive pulse. For example, if the circuit's output voltage falls below the reference level then the control circuit would increase the pulse width (or increase its repetition rate), allowing more current to build up in the choke and thereby restore the output voltage to nominal. A similar regulation regime is used in the GXT PFC control circuit.

Figure 2.8 - Boost Converter operation on negative half cycles



During negative half-cycles of the mains supply the 'line' input at P1 is negative with respect to the 'neutral' input at P2 (which is grounded via the input relay), and from a 'dc' point of view the input voltage can be considered to be 'negative'. Under these circumstances the boost converter works in an identical manner to that described above for a positive dc input, however the current polarity is now reversed and the circuit controls the negative dc busbar. That is, when Q14 turns on, current flows from Earth, REC2c, Q14, REC2d, L2, and F3; back to terminal P1. Current is set up in L2 in the same manner as for the positive half cycle; however, in this case when Q14 turns off the inductive current is dissipated via C52/73 and D13 – charging up the capacitors and increasing the negative DC busbar amplitude with respect to ground (earth).

The above examples show that both half-cycles of the input waveform are controlled by a single transistor (Q14) in conjunction with bridge rectifier REC2.

2.3.3 The practical PFC power circuit

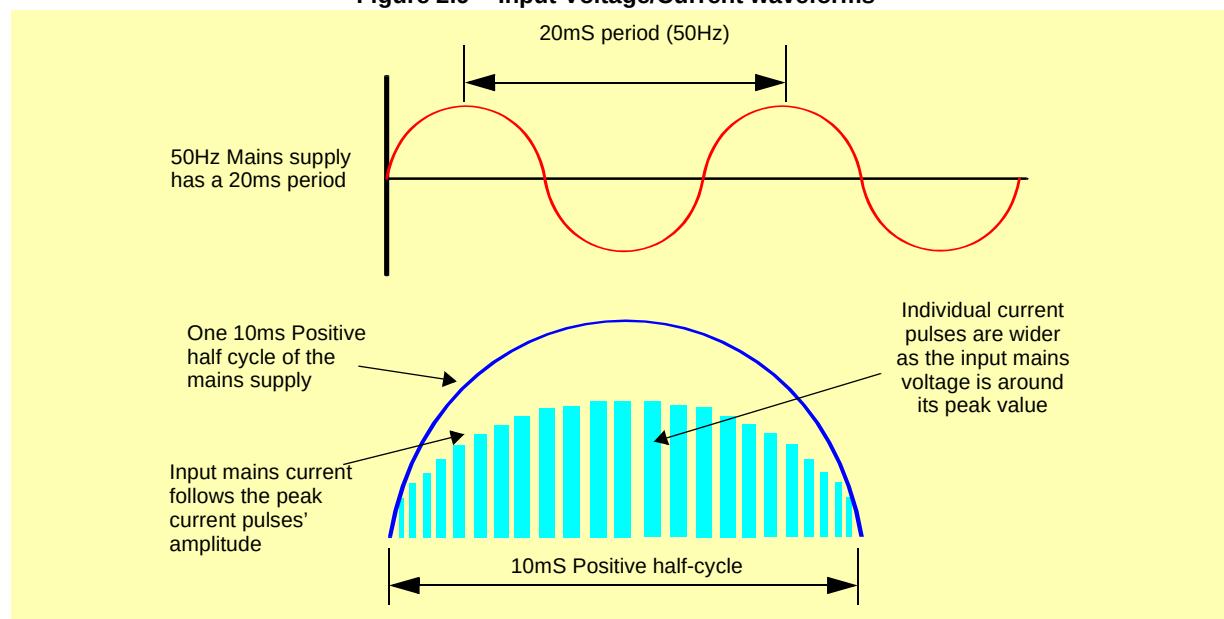
The PFC circuit employed in this equipment works essentially in the same way as the DC-DC boost converter just described. The main difference between the two circuits is that the PFC circuit input voltage is 220/240Vac and not a fixed dc level.

To overcome the fact that the circuit is fed with an ac voltage, the transistor drive pulse used in the PFC circuit is very narrow compared with the period of the input supply – in fact the drive circuit operates at up to 50kHz and therefore has a maximum pulse-width of 20 μ s. As the mains frequency is 50Hz this means that Q14 is turned off and on up to 100 times during every cycle of the input supply; and, despite the fact that the PFC's input voltage is sinusoidal, by using such a narrow drive pulse the input voltage can be considered to be constant during each transistor turn-on period – even though this 'constant level' will vary slightly from one drive pulse to the next.

The circuit maximises the input power factor by controlling the input current in such a way as to not only make it sinusoidal but also keep it in phase with the input voltage. This is achieved by pulse-width modulating the drive signal applied to Q14 - i.e. by turning Q14 on for shorter periods when the input mains voltage is at the low points of its waveform and for longer periods when it is at the higher points. This means that although Q14's drive signal is held at a constant frequency, the mark-to-space ratio (or duty cycle) is made to vary in sympathy with the input voltage waveform amplitude.

The waveform diagram below shows the principles of this circuit by illustrating the rising and falling current pulses against the input voltage; however, this diagram shows only a few current pulse (due to the restriction of the drawing definition) and in practice the current waveform outline at 50kHz is very smooth in comparison to that shown.

Figure 2.9 - Input Voltage/Current waveforms



2.3.4 PFC Control circuit operation

Figure 2.10 - PFC Control circuit block diagram

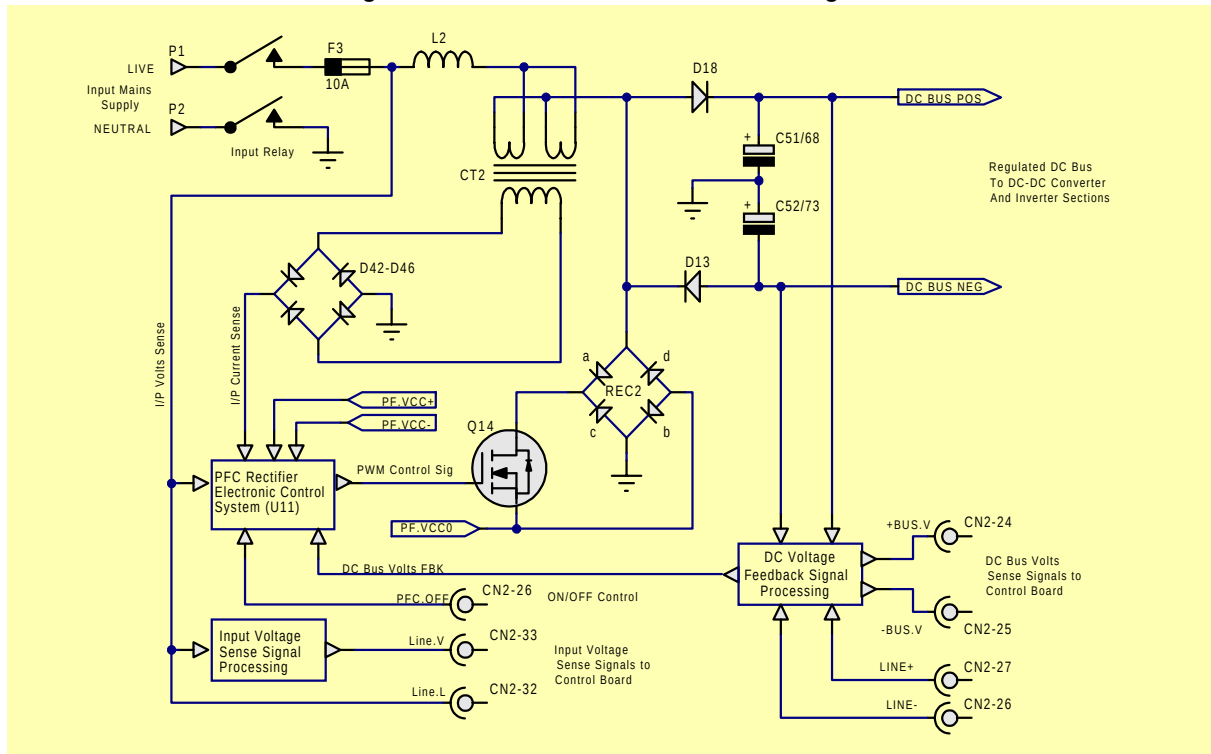
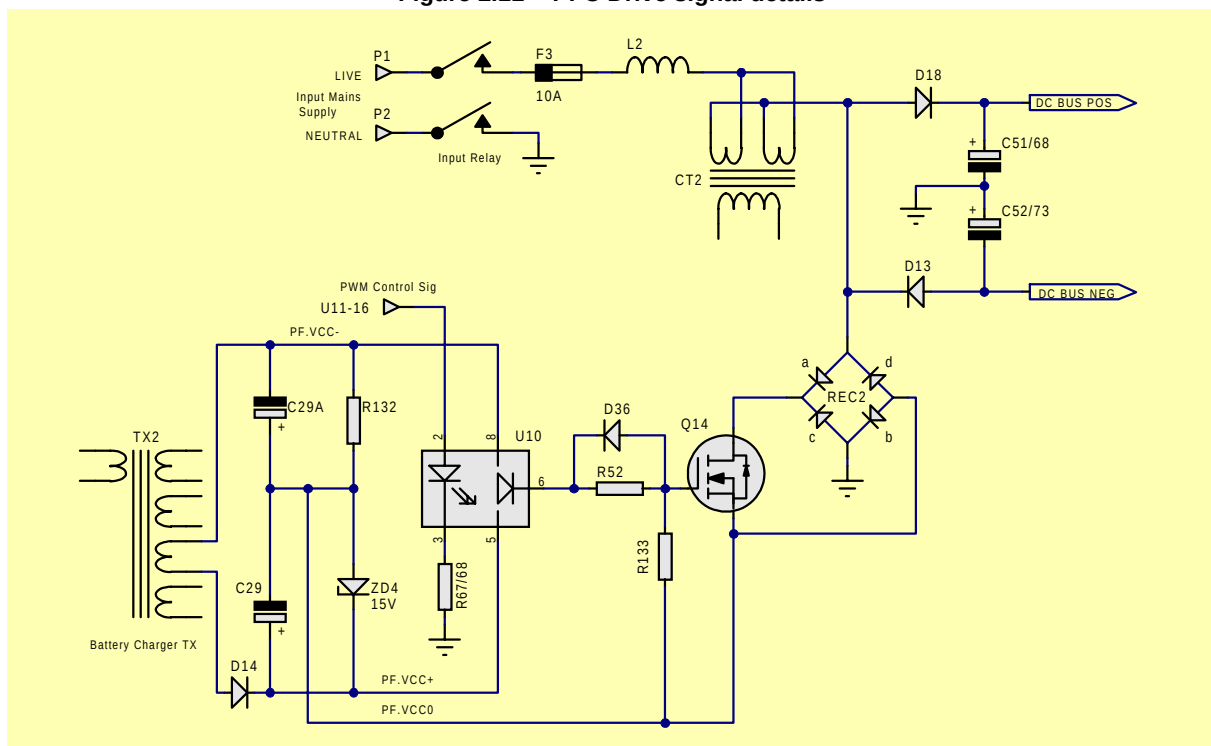


Figure 2.11 - PFC Drive signal details



The PFC control circuit is based on a UC3854 'average current-mode controller' (U11) which is located on the Power Board. This device is powered from the +24Vdc power rail (see figure 2.4) and its output PWM drive signal is connected to Q14 via an opto-isolator (U10) whose output is powered from the isolated PFC power supply rails (PF.VCC) obtained from the Battery Charger transformer (see figure 2.11).

The controller (U11) monitors the following signals:

1. Input voltage sense –

The input voltage is sensed at the cold side of the input fuse (F3). The control system rectifies the input voltage and converts it to a proportional rms value. The PWM controller uses this signal as a reference input for the current control (i.e. the greater the instantaneous input voltage then the greater the current limit level) and also as a ‘feed-forward’ signal, as a means of detecting changes in the input mains supply voltage.

The Control Board also monitors two aspects of the input voltage: first an attenuated ac signal [Line.L] provides the Control Board with an input frequency/phase sensing signal which it uses for synchronisation purposes etc. (see figure 3.5). Second, the [Line.V] signal is a half-wave rectified signal proportional to the input supply, and provides the means to allow the Control Board to detect the input voltage characteristics (see figure 3.4).

2. Input current sense –

The input current is sensed by CT2, rectified by D42-D46 and fed to the PWM controller’s current sense/limit inputs.

3. DC Busbar voltage sense –

As each DC Busbar is independently controlled, their voltages are sensed and processed by two individual signal processing circuits which therefore produce two independent DC Voltage Feedback signals; one proportional to the positive bus and the other proportional to the negative bus.

As shown in Figure 2.10, the DC Voltage Feedback Signal Processing circuit provides only one feedback signal to the PFC Controller (U11). This function is controlled by the [LINE+] and [LINE-] signals from the Control Board which allows either the positive bus voltage feedback signal or negative bus voltage feedback signal through to U11 depending on the polarity of the input half-cycle being processed – i.e. during positive half cycles [LINE+] switches the positive busbar feedback signal through to U11 (and vice versa).

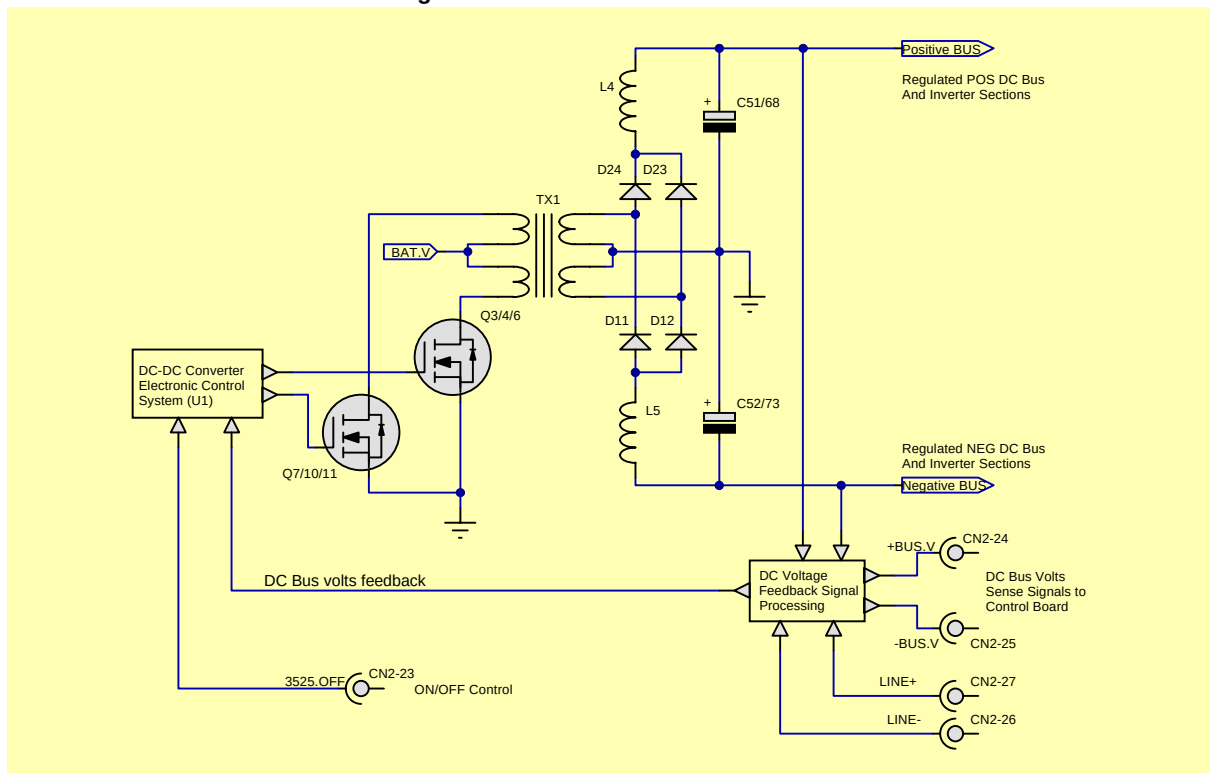
Effects of the inputs from the Control Board

The effect of [LINE+] and [LINE-] on the PFC control circuit described above was somewhat simplified as, in practice, the feedback signal is not permanently applied during the respective whole half cycle but is in fact ‘modulated’. This permits the micro-controller to moderate the effect of the feedback signal and so effect fine adjustment of the DC busbar(s) voltage. The purpose of applying this control technique is to enable the micro-controller to control the DC Busbar voltage balance with respect to 0V. That is, the micro monitors the two busbar feedback voltages ([+BUS.V] & [-BUS.V]) together with the 0V rail, and detects any bus voltage offset. If an error is found it is corrected by the modifying the effective DC bus voltage feedback signals by means of the [LINE+] and [LINE-] signals.

The microcontroller on the Control Board also provides the PFC with an ON/OFF control signal [PFCOFF] which is applied to U11-10 via CN2-26 (low = OFF) – (see figure 3.7).

2.4 DC-DC Converter

Figure 2.12 - DC-DC Converter circuit



2.4.1 Introduction

When the mains supply fails, the PFC Rectifier circuit is unable to produce the DC Busbar required by the inverter for its power operation. Under these circumstances, the DC-DC Converter takes over control of the DC Busbar by converting the battery voltage [BAT_V] to a controlled DC busbar of approximately 410Vdc. This allows the inverter to continue its operation from battery-sourced power until the mains supply returns (or the battery becomes fully discharged).

2.4.2 Circuit description

Power circuit operation

The power circuit is a form of push-pull DC-DC Converter. Transformer TX1 centre-tapped primary is connected to the battery busbar [BAT_V] and its winding extremities are connected to ground (0V) via two transistors operating in push-pull. In practice, in the 1500RT circuit shown in Figure 2.12, each of the transistors comprises three transistors connected in parallel – to provide sufficient drive current. Q3/Q4/Q6 turn on to draw current through one primary winding and Q7/Q1/Q11 turn on to draw current through the other.

By alternately switching on these two groups of transistors (i.e. push-pull operation) an a.c. current is set up in the transformer which is rectified by D11/D12/D23/D24 and fed to the DC Busbars via L4/L5.

Notice that the centre-tap of TX1 secondary is grounded, which ties together the 0V reference points of the DC-DC Converter and the PFC Rectifier.

Control circuit operation

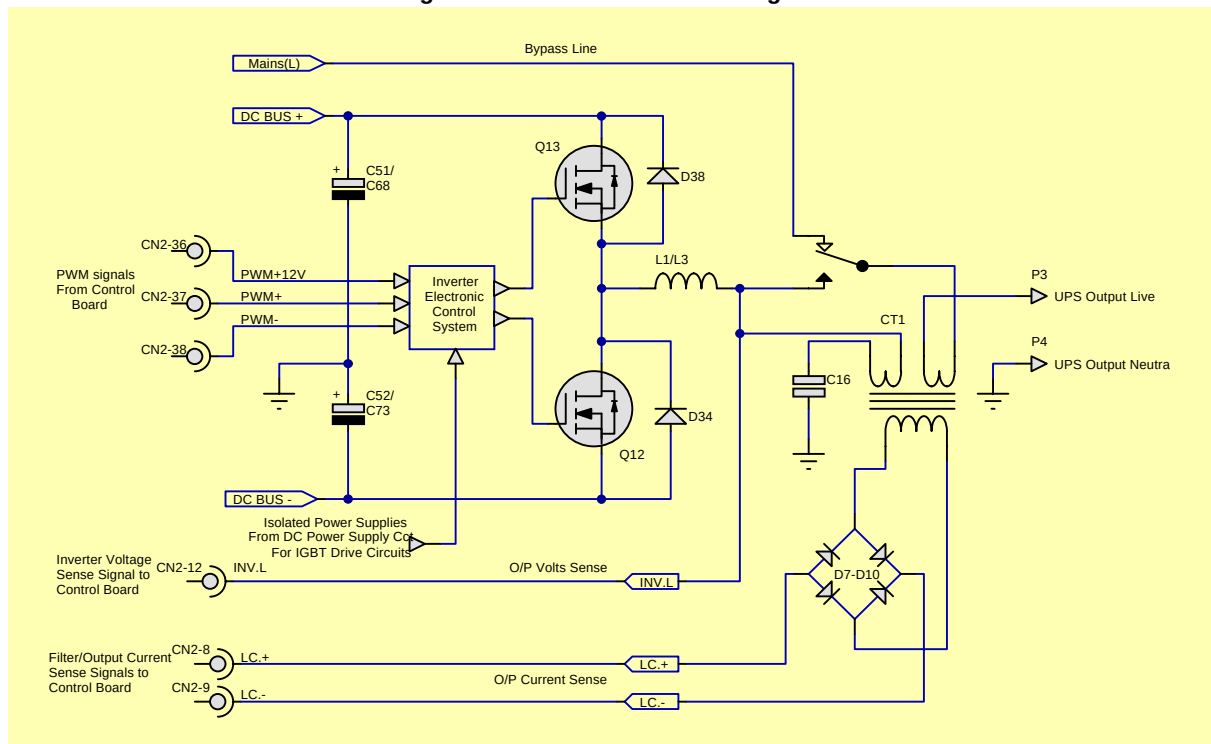
The DC-DC Converter control circuit is based on a UC3525 'SMPS controller' device (U1) which produces two complementary outputs on pins 11 and 14 which form the transistor drive signals.

The drive signal duty cycle is determined by a control loop which monitors the DC Busbar voltage via the same feedback control circuit as that used by the PFC Rectifier control circuit described previously.

The Control Board's processor system also furnishes a DC-DC Converter ON/OFF control signal [3525OFF] which is applied via CN2-23 (high = off) – see Figure 3.5.

2.5 PWM Inverter

Figure 2.13 - Inverter Circuit Diagram



2.5.1 Introduction

The inverter is responsible for converting the DC Busbar into a 230Vac/50Hz supply which is then connected to the load equipment as the UPS output.

2.5.2 Power circuit description

The inverter function is carried out by two IGBTs, Q12/Q13, connected in series across the positive and negative DC Busbars, as shown in Figure 2.13. These are driven by complementary 20kHz PWM signals to produce the required 230V/50Hz output. The 20kHz component is removed from the output waveform by the action of the output filter formed by L1/L3 and C16, and the ultimate UPS output supply is taken from the junction of these components and connected to the output sockets via the output relay.

CT1 is a current sensing transformer which monitors both the filter current and output current. The resulting current sense signal is rectified and fed back to the control logic on the Control Board via CN2 pins 8 & 9 [L.C.-> & [L.C.->.

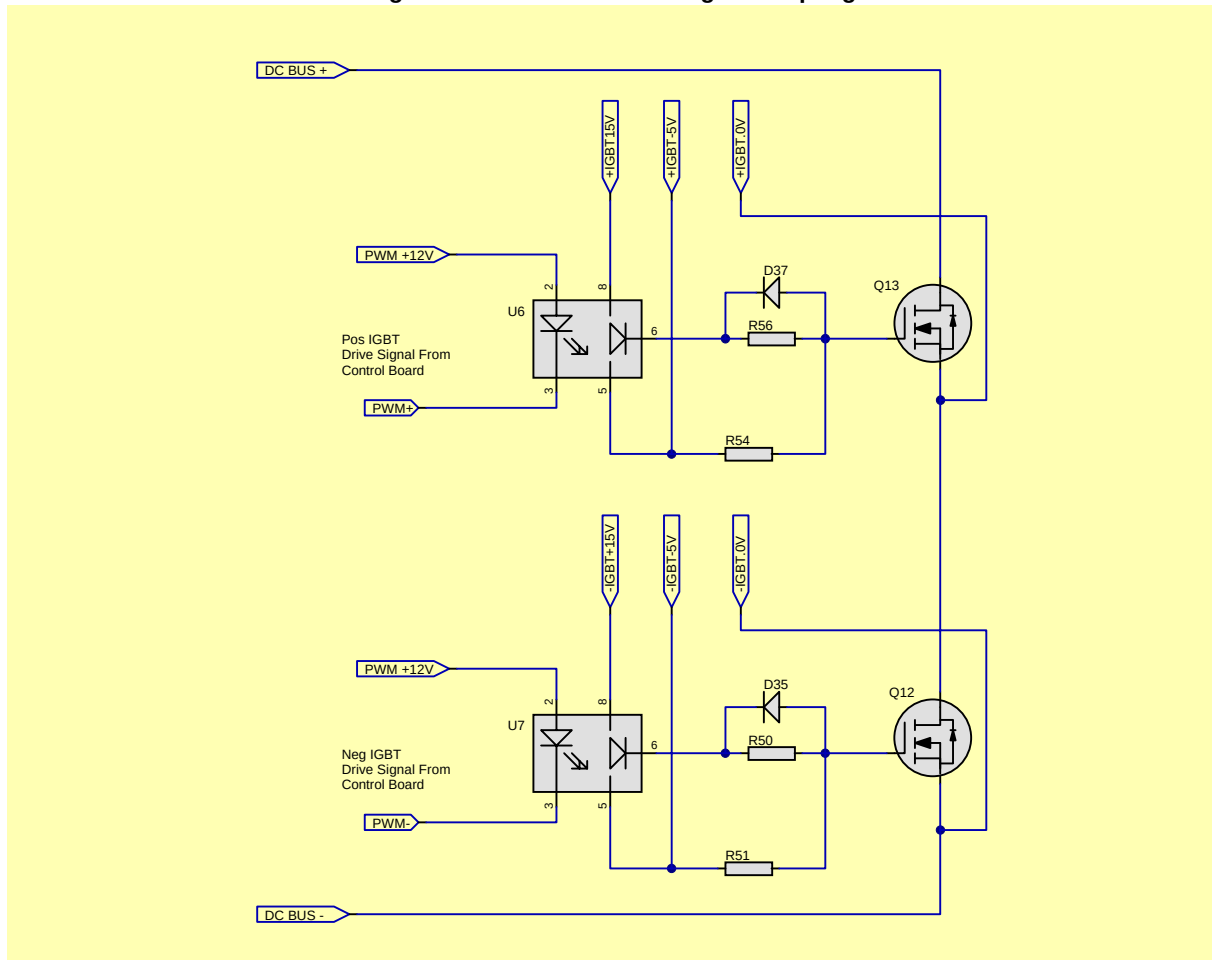
The output voltage waveform is also monitored by the Control Board via the [INV.L> signal at CN2-12.

2.5.3 Control circuit description

The inverter transistor drive signals' PWM pattern is generated on the Control Board and connected to the Power Board via CN2 pins 36-38 as [PWM+> and [PWM-> and [PWM+12V>. The PWM frequency is determined by the micro-controller on the Control Board which synchronises the inverter output to the bypass frequency under normal circumstances, and determines the inverter frequency when the mains supply is unavailable. However, the mark-space of the PWM signal is determined by an analogue circuit on the Control Board which compares the micro-controller's reference waveform with the inverter voltage and current feedback signals – and produces a waveform with the mark-space ratio necessary to produce the correct inverter output voltage (see figure 3.8). The voltage is not adjustable; however, VR1 (on the Control Board) provides a means of adjusting the output voltage balance to allow the mid-point of the output ac waveform to be centred about the earth reference.

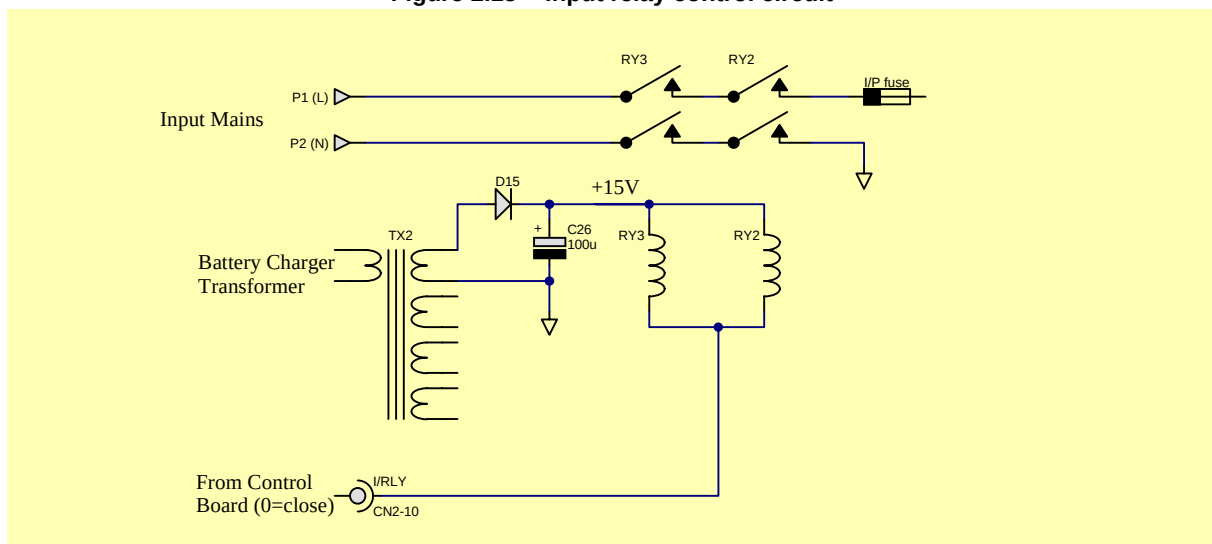
The [PWM+> and [PWM-> drive signals, which are always complementary, are connected to the power transistors via opto-coupled devices (U6/U7) to provide the necessary isolation. The isolator devices (see figure 2.14) use the [PWM+12V> supply from the Control Board to power its input section and the isolated IGBT power supplies illustrated in Figure 2.4 to power its outputs.

Figure 2.14 - Inverter drive signal coupling



2.6 Input relay control

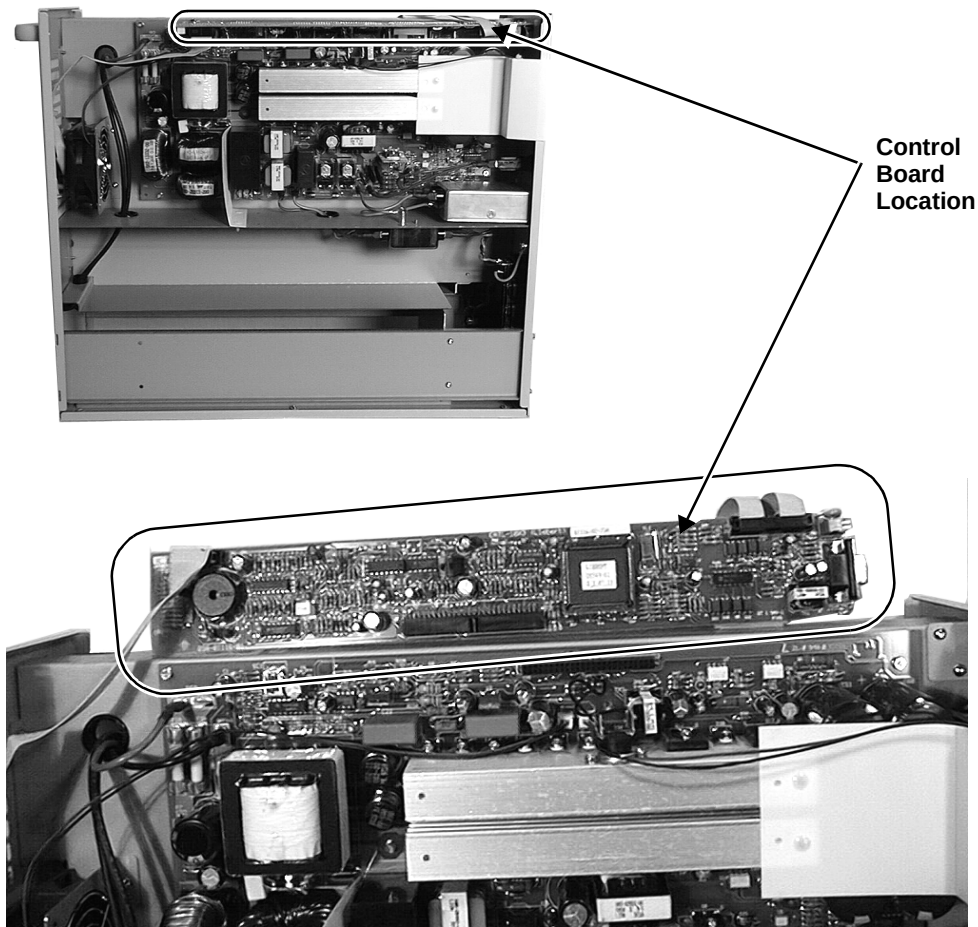
Figure 2.15 - Input relay control circuit



The input relay coils are provided with a permanent +15V supply by rectifying the output of one of the Battery Charger transformer outputs. The relays are then controlled by a single open/close signal derived on the Control Board and applied via CN2-10.

CHAPTER 3 - Control Board

Figure 3.1 - Control Board



The Control Board is mounted perpendicular to the Power Board and connected directly to it by means of a 50-pin connector (CN2), as shown above. Once fitted, the board is held in place by a screw which secures the two boards together and is also secured to the rear of the UPS chassis by means of two threaded studs which screw into the 9-pin D-type socket.

3.1 Control system operation

3.1.1 Introduction

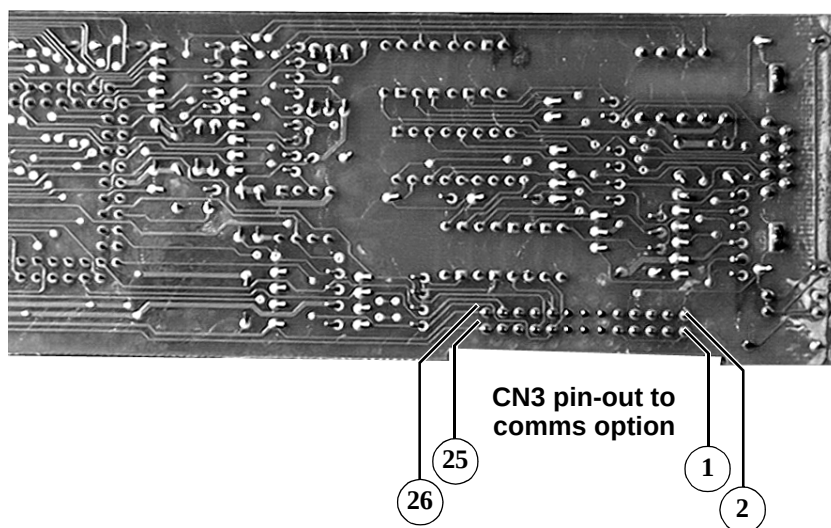
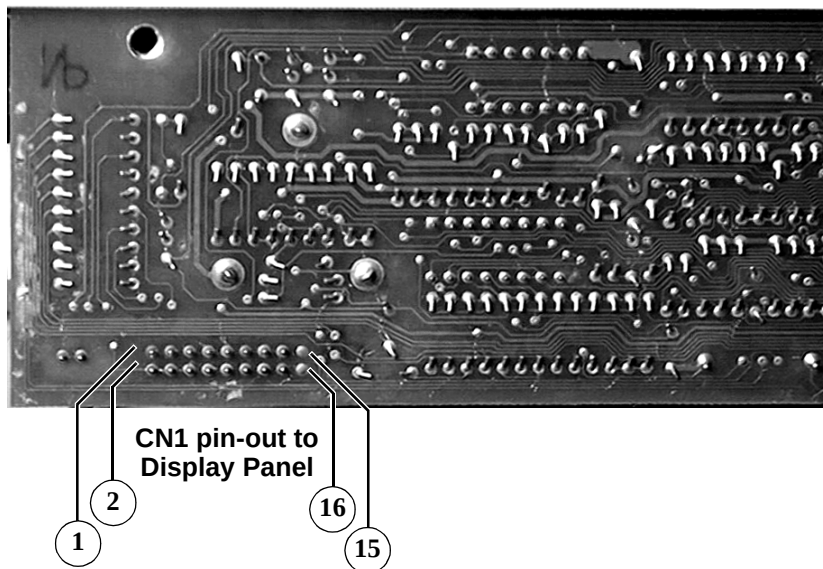
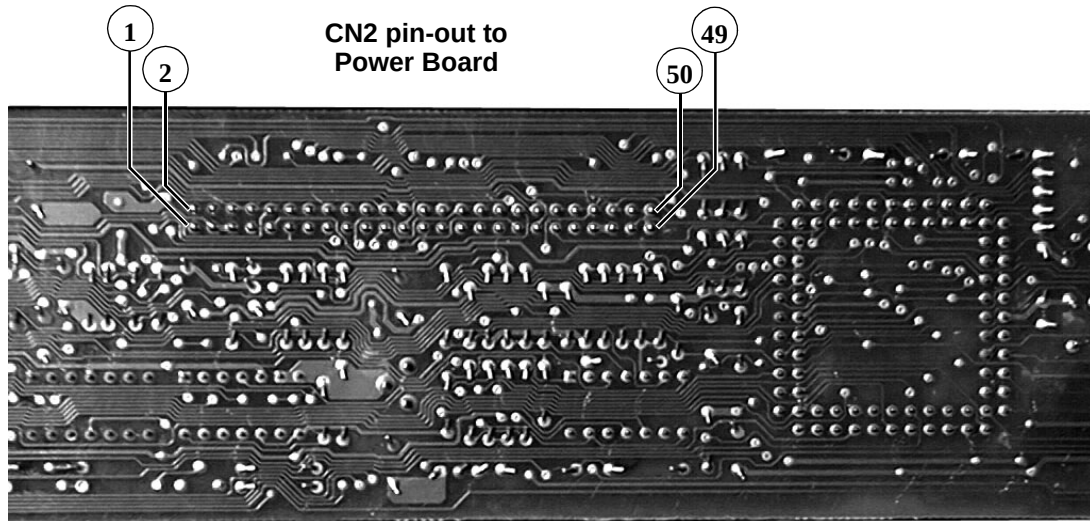
The various power blocks located on the Power Board are affected by a micro-controller-based 'system level' control circuit centred on the Control Board. Although the internal functions of the micro-controller are complex, and beyond the scope of this manual, the purpose of its various input and output signals, and their relevant values, are described in this section to a level which should aid general fault-finding – i.e. to assist the troubleshooting engineer to establish whether or not the Control Board appears to be working normally.

IMPORTANT NOTE

The following description contains several '*simplified*' circuit diagrams to help understand the Control Board functions; however, when the board is in-situ most of its components are inaccessible, and the easiest method of checking that the board is working correctly is to monitor the input/output signals between the Control Board and the Power Board at the soldered points of connector CN2 – i.e. *on the back* of the Control Board PCB.

CAUTION: *This requires a steady hand and should be undertaken with EXTREME care. The pin numbers for CN2 are shown in the diagram below.*

Figure 3.2 - Control Board Connector pin-outs

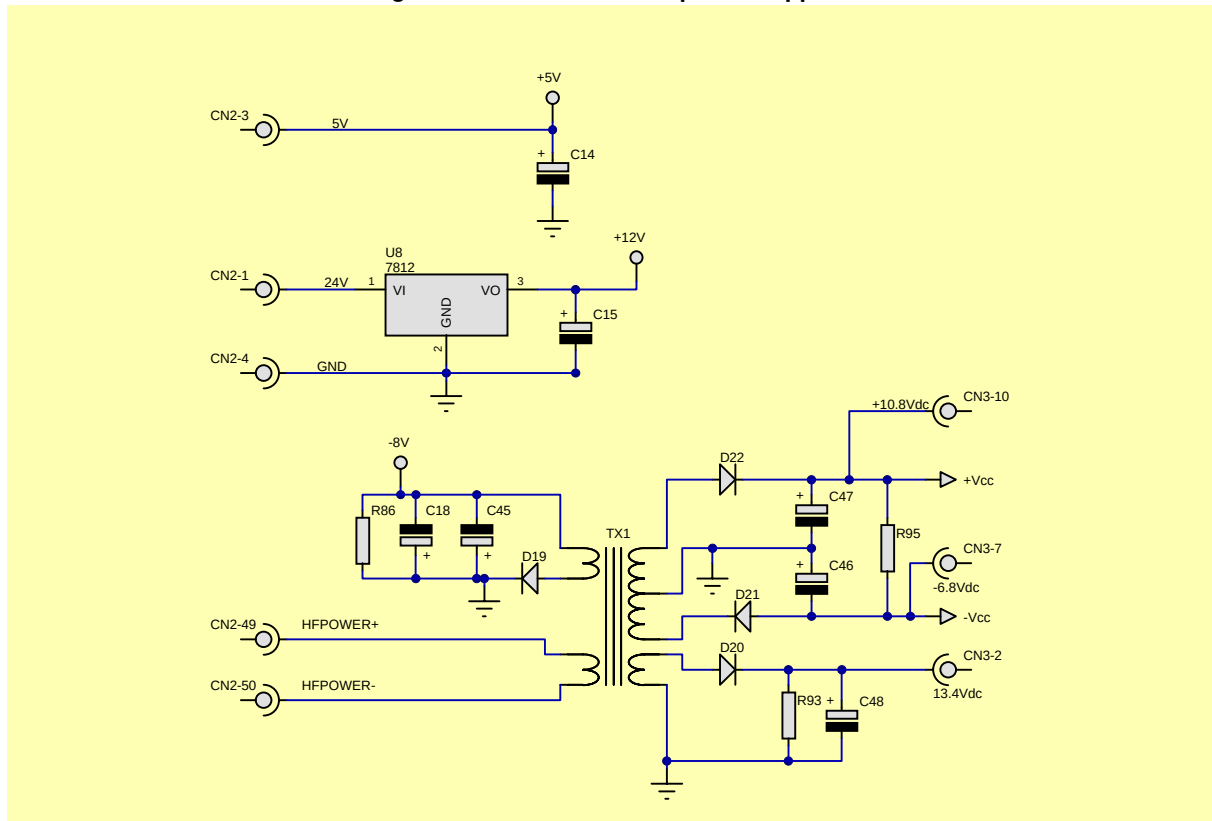


The Control Board circuits, which are totally isolated from the high voltage environment found on the Power Board, can be categorised into the following areas:

- Micro-controller sub-system.
- UPS output voltage and frequency regulation control through the generation of the PWM Inverter drive signals.
- Start-Stop control of the various Power Board power blocks as part of the general UPS control management and protection system.
- Load transfer decision making and implementation through controlling the Inverter (output) Relay.
- Interfacing the UPS control system with the Operator Panel and Remote Communication ports.

3.1.2 Control Board power supplies

Figure 3.3 - Control Board power supplies



General control power supplies

The Control Board obtains its main operating power from the +5V and +24V power rails generated on the Power Board via CN2 pins 3 and 1 respectively (CN2-4 = 0V). On the Control Board the +24V supply also drives a three-terminal +12V regulator (U8) which provides a general +12V power rail. The +12V rail is also fed back to the Power Board as [PWM.12V] via CN2-36.

In order to preserve isolation of the signals presented to the communications port (CN3 / CN4) the Control Board generates dedicated power supplies which are connected to the associated signal opto-isolator devices ($\pm V_{cc}$).

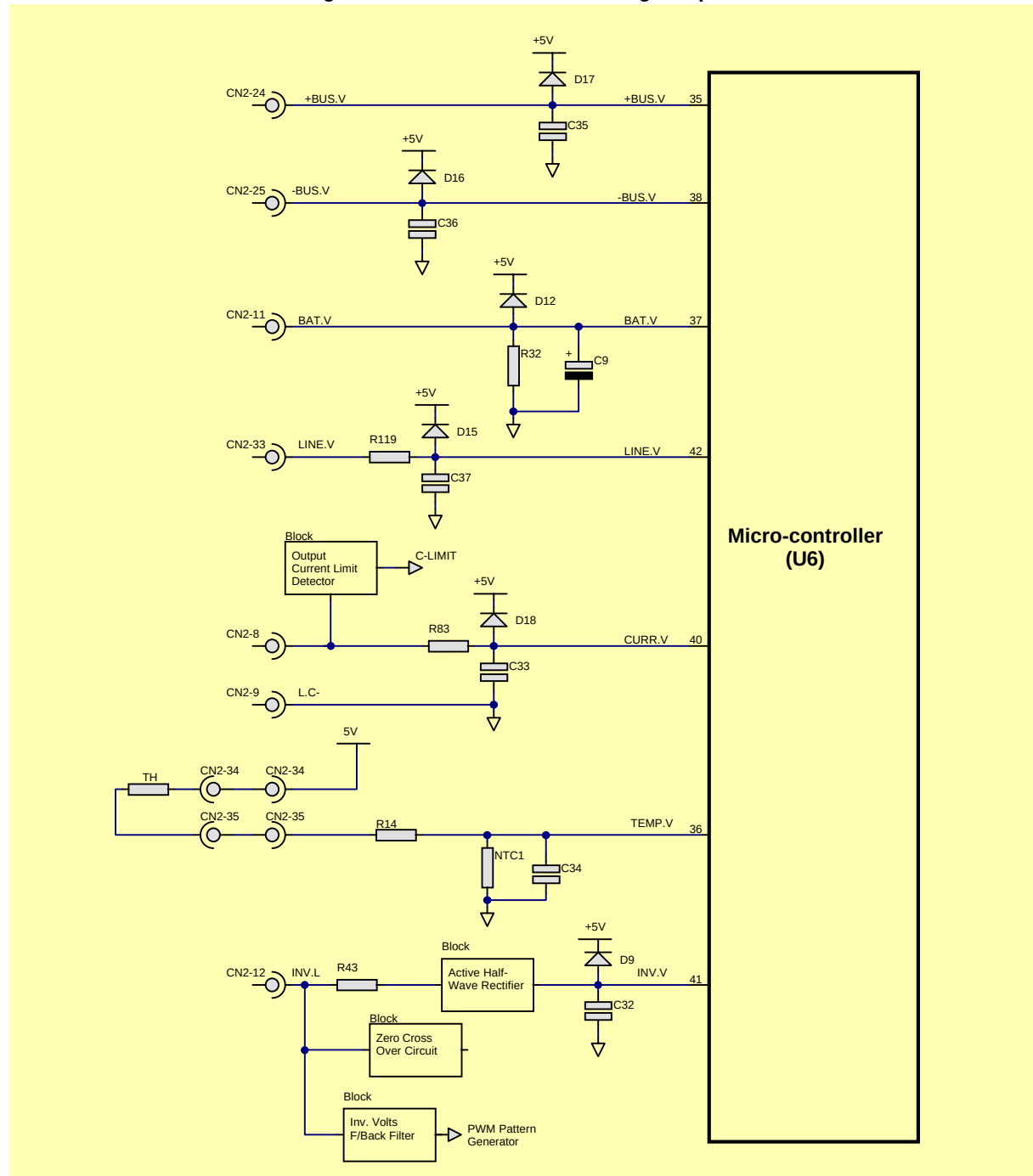
This circuit is based on TX1, whose primary is driven by the 16Vac (approximately) [H.POWER+] and [H.POWER-] outputs from the DC Power Supply circuit on the Power Board (see figure 2.4). TX1 has three secondary windings which drive standard half wave rectifier circuits, as shown, to produce the following isolated outputs:

1. -8V supply rail which is used by the output voltage balance potentiometer (see figure 3.8).
Note: this potentiometer may not be fitted to some models.
2. +10.8Vdc and -6.8Vdc rails which are annotated $\pm V_{cc}$. These provide the operating power for the serial communications driver chip (U19) together with opto-couplers U12 and U17.
+Vcc (10.8Vdc) can be monitored at CN3-10 and -Vcc (-6.8Vdc) can be monitored at CN3-7.
3. +13.4Vdc supply which is connected to CN3-2 and provides signalling power to the remote communications device.

3.1.3 Micro-controller analogue inputs

The microcontroller (U6) contains an 8-bit analogue-digital converter which monitors the following signals:

Figure 3.4 - Micro-controller analogue inputs



DC Bus voltage sensing

Under normal operating conditions the positive and negative DC Busbar voltages are independently controlled (with respect to 0V ground) by the PFC Rectifier circuit on the Power Board. When the input mains supply fails this responsibility is taken over by the DC-DC Converter. The micro-controller monitors the voltage of both DC busbars in order to detect abnormal (fault) conditions and provide associated alarms and indications.

The micro-controller also uses the DC busbar sense signals to detect an unbalanced condition between the two DC busbars and applies a correction to the PFC/DC-DC Converter feedback circuit (*see figure 2.10*). In addition, the micro-controller provides the PFC Rectifier and DC-DC Converter with independent RUN/STOP command signals – see Figure 3.7.

A resistor network on the Power Board attenuates the DC Busbar voltages and, depending on the loading, the resulting voltage sense signals [+BUS.V> and [-BUS.V> applied to the Control Board are typically in the range 2.5Vdc to 3.5Vdc at nominal DC Busbar voltage (note that due to the effects of the busbar balance control circuit these signals are not necessarily identical at a given time).

Battery Bus voltage sensing

The battery voltage sense signal [BAT.V>, connected to CN2-11, is obtained from the Battery Bus on the Power Board. Under normal circumstances the Battery Bus is controlled by the Battery Charger output at the appropriate battery float charge voltage and reverts to the actual battery voltage when the input mains supply is absent. The microcontroller monitors the battery voltage in order to detect abnormal (fault) conditions and provide associated alarms and indications.

Note: the micro-controller does not play a direct part in controlling the Battery charger voltage with the exception of providing it with RUN/STOP command signals.

The [BAT.V> signal is connected to the Battery Bus via a series resistor chain on the Power Board. This chain is terminated by R32 on the Control Board, which drops the nominal sense voltage by approximately 92% – e.g. approximately 4.2V at a nominal float charge voltage of 55.2V.

Input line (bypass)voltage monitor

The input line voltage is sensed on the Power Board at the cold side of the input fuse. The signal is then attenuated and passed through an active rectifier circuit before being connected to the Control Board via CN2-33 as [LINE.V>. At nominal input mains voltage [LINE.V> is approximately 2.3V.

The micro-controller monitors the input mains voltage in order to detect abnormal (fault) conditions, determine when it is appropriate to switch the UPS to its ‘battery mode’ of operation, and provide associated alarms and indications.

Inverter current monitor

The inverter current monitor input to CN2-8 and CN2-9 takes the form of a d.c signal proportional to the inverter current, as detected by CT1 on the Power Board. This signal combines both the output (load) current and the output filter current.

On the Control Board this signal is used by the microcontroller to detect abnormal (fault) conditions and also drives a hardware-based overload circuit which applies a current-limit input to the PWM pattern generator circuit.

Temperature

The micro-controller monitors the ambient temperature via an NTC and normally-closed thermostat located on the semiconductors’ heatsink on the Power Board which opens at 90°C

Inverter output voltage monitor

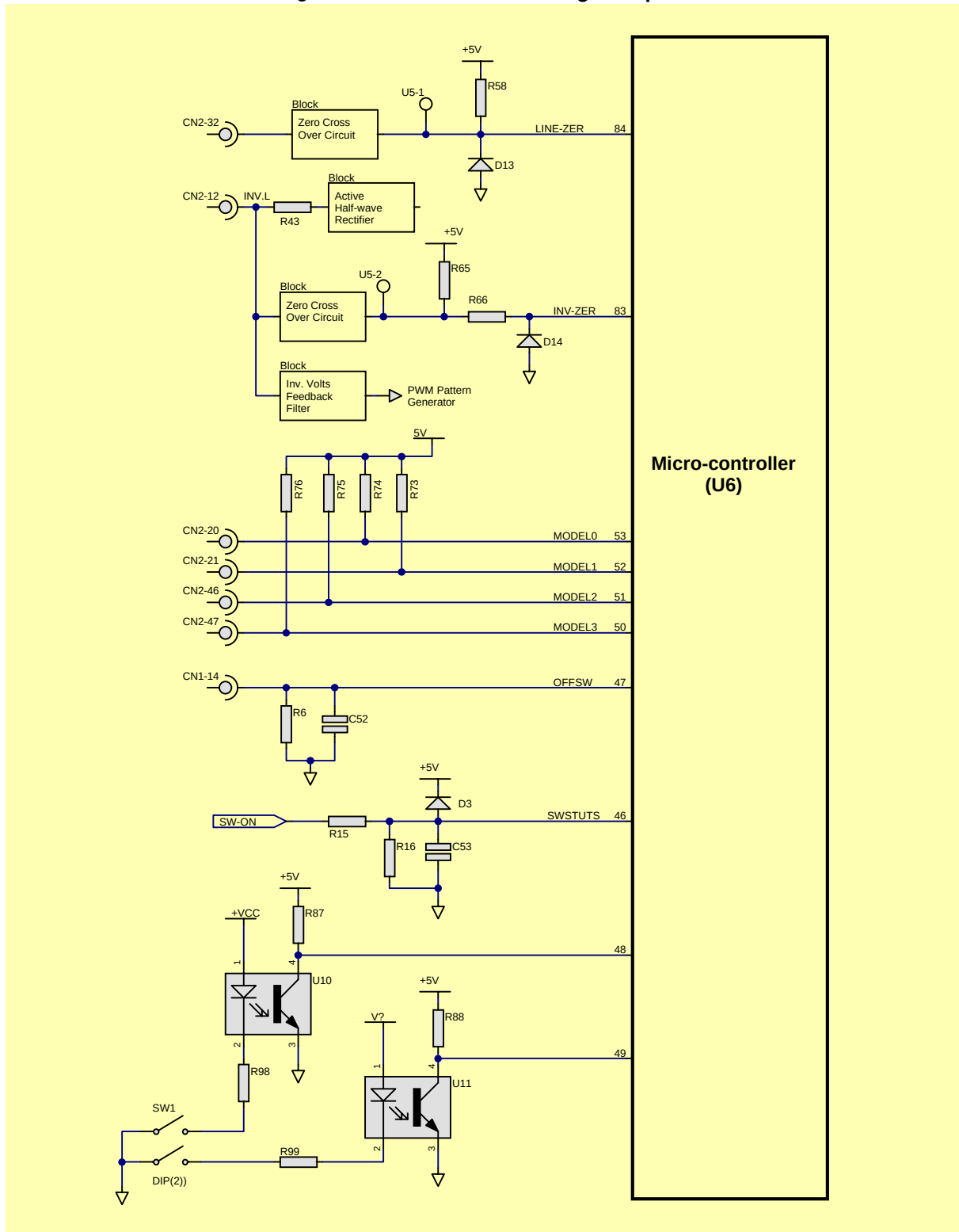
The inverter output voltage is sensed on the Power Board at the inverter side of the output relay. The signal is passed through a series resistor chain and then connected to the Control Board via CN2-12 as [INV.L>. At nominal 230V output voltage [INV.L> is approximately 17.2V.

On the Control Board, [INV.L> is processed by three circuits:

1. [INV.L> is attenuated and half-wave rectified by an active circuit and applied to the microcontroller as a proportional voltage sense signal. The microcontroller monitors the inverter voltage in order to detect abnormal (fault) conditions, determine when it is appropriate to transfer the load between the inverter and bypass supplies, and provide associated alarms and indications.
2. [INV.L> is processed by a zero-crossing circuit which converts the sinusoidal inverter output sense signal into a square-wave coinciding with the zero-crossing points (see figure 3.5).
3. [INV.L> is also connected to the PWM pattern generator circuit in the form of an inverter voltage feedback signal which directly affects the inverter voltage regulation loop (see figure 3.8).

3.1.4 Micro-controller digital inputs

Figure 3.5 - Micro-controller digital inputs



Input line (bypass) frequency monitor

The input line frequency monitor circuit is driven by an input mains voltage sense signal which is derived on the Power Board from the cold side of the input fuse. This signal (LINE.L) is passed through a series resistor chain on the Power Board before being connected to the Control Board via CN2-32 from where it drives a zero-crossing detector circuit which converts the sinusoidal input voltage waveform into a 50Hz, 5V square-wave.

The zero-crossing signal is used by the microcontroller as a frequency reference input with which to synchronise the inverter frequency. It thereby affect the timing of the clock signal produced by the micro and applied to the PWM pattern generator circuit (*see figure 3.8*). It is also used as part of the load transfer control mechanism to inhibit a non-synchronous load transfer between the inverter and bypass supplies.

Inverter output frequency monitor

The inverter frequency is monitored through the inverter output voltage sense signal described earlier in conjunction with Figure 3.4.

[INV.L> is processed by a zero-crossing circuit which converts the sinusoidal inverter output sense signal into a square-wave coinciding with the zero-crossing points. This produces a frequency/phase signal relative to the inverter output which is used by the microcontroller to synchronise the inverter frequency to the bypass supply (using the input line frequency sense signal described above). It is also used as part of the load transfer control mechanism to inhibit a non-synchronous load transfer between the inverter and bypass supplies.

Model identification

The four inputs to U6 pins 50-53 are used to inform the Control Board which model of Power Board is currently connected. This allows the Control Board to understand the UPS model rating, working battery voltage etc. The inputs to U6 are pulled down by jumpers fitted on the Power Board and connected via the CN2 as shown in the table below:

Table 3.1 - Model ident jumpers

UPS Model	Model0 (CN2-20)	Model1 (CN2-21)	Model2 (CN2-46)	Model3 (CN2-47)
GXT700MT-230	–	–	JP01 Fitted	JP02 Open
GXT1000MT-230	–	–	JP01 Open	JP02 Open
GXT1000RT-230	–	–	JP01 Open	JP02 Open
GXT1500RT-230	GND	–	GND	JP02 Open
GXT2000RT-230	+5V	GND	JP01 Fitted	–
GXT3000RT-230	+5V	GND	JP01 Open	–

OFF Switch

The [OFFSW> input to U6 pin 47 is taken high (+5V) when the OFF switch is pressed on the Operator Panel. The Operator Panel is connected to the Control Board via CN1, and the +5V supply for the switch, and also the supply to the leds is connected to CN1 pin 13.

ON Switch

The [SWSTUTS> input to U6 pin 46 is taken high (+5V) when the ON switch is pressed on the Operator Panel.

The path for this signal includes the Power Board, as shown in Figure 3.6. The power source [SWPOWER> is obtained from the battery bus on the Power Board via R16. When the ON switch is pressed on the Operator Panel this supply is further dropped across R15 and R16 on the Control Board, raising U6 input pin 46 to logic high (+5V), which informs the micro-controller that the ON button is operated.

The [SWSTUTS> signal is inhibited if the micro-controller is calling for the UPS to be shut down due to a detected fault condition. This is effected by a logic high [SHUTDOWN> output from U6-61 which is inverted to a low at U1 pin 10 which clamps the [SW-ON> signal by hold D2 cathode low.

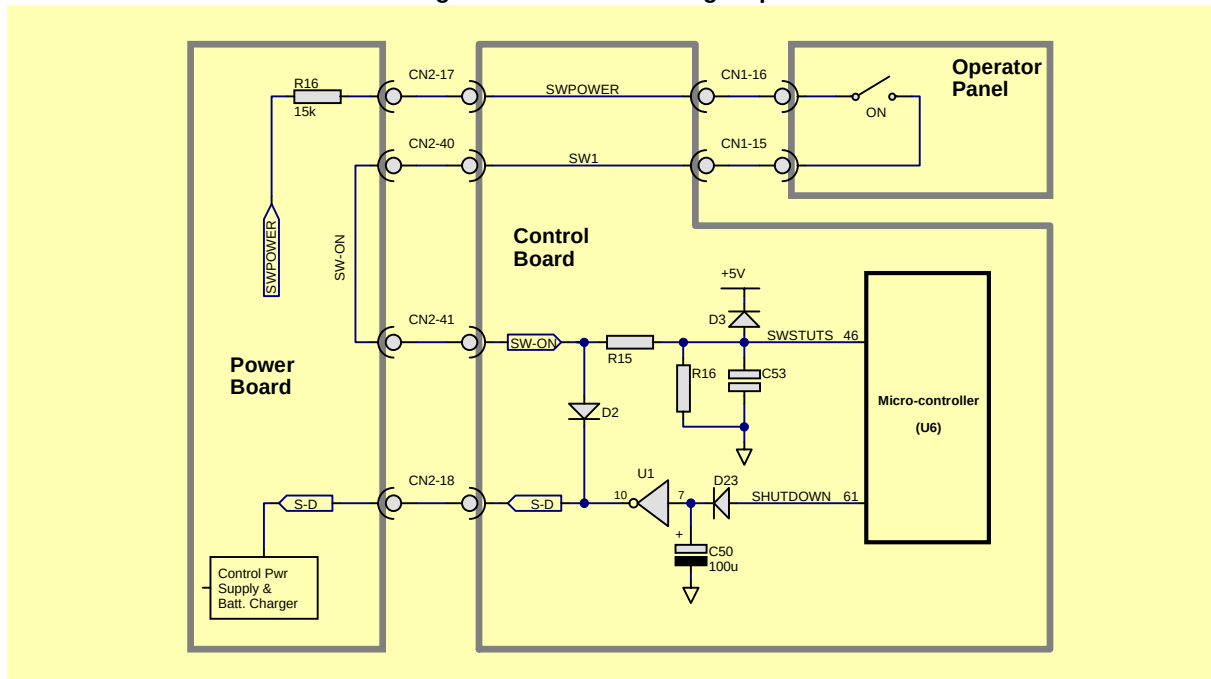
The [S-D> signal is also passed to the Power Board where it shuts down the Battery Charger and Control Power Supply circuits.

DIP-Switch

The input to U6 pins 48 & 49 are opto-coupled to the two sections of a DIP Switch which protrude through the UPS back panel and are used to select the working output voltage.

Note: turn the UPS off before selecting a new working voltage.

Figure 3.6 - ON-Switch signal path



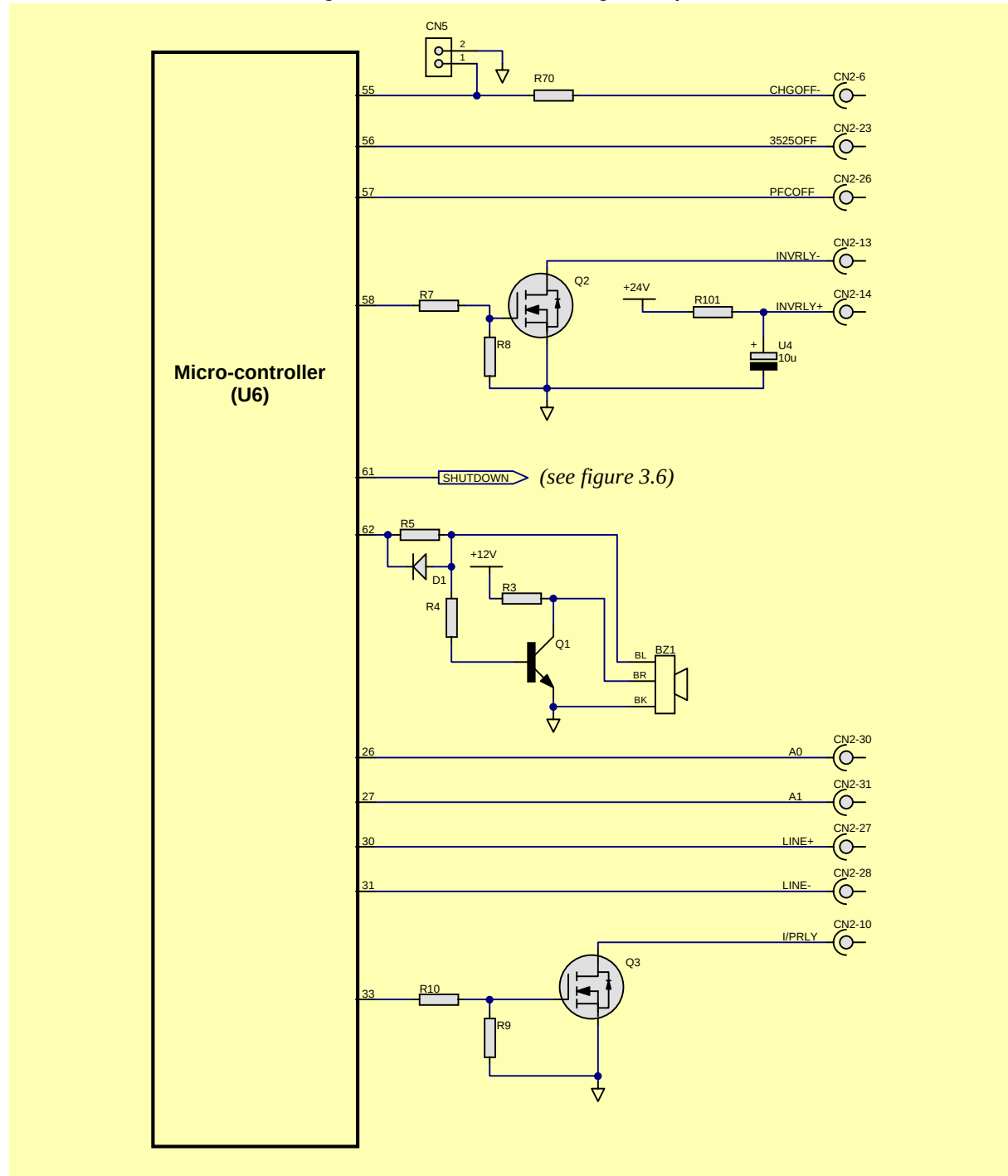
When the UPS is switched ON by means of the Operator Panel ON button, a logic high [SWSTUTS> signal is applied to U6 pin 46 via the path shown in Figure 3.6. This signal is sourced from the battery bus [SWPOWER> and is therefore available when the battery is connected or the input mains is live.

If the micro-controller detects a fault that requires the system to be shut down, the [SHUTDOWN> output from U6-61 is driven high, which clamps the [SWSTUTS> signal and prevents it from requesting an 'ON' condition at U6-46. This also provides a logic low [S-D> input to the Power Board, via CN2-18, which turns off the Control Power Supply and Battery Charger operation.

3.1.5 Micro-controller digital outputs

The micro-controller contains several data ports through which it communicates with the Operator Panel, external (remote) communication facilities and the remainder of the control system. The functions described in this sub-section are concerned with the digital command signals produced by the micro-controller which affect the rest of the UPS Control system – as illustrated in Figure 3.7 below:

Figure 3.7 - Micro-controller digital outputs



Battery charger ON/OFF control

The micro-controller controls the battery charger ON/OFF function through the [CHGOFF-> output from U6 pin 55 which is taken low to turn OFF the battery charger – this signal can also be invoked by fitting a jumper to CN5.

This output is coupled to the Power Board via CN2-6 where it turns on an opto-isolator (U4) which inhibits the Battery Charger's Control circuit. The positive supply to the opto device is also derived on the Control Board and connected to the Power Board via CN2-5 ([CHGOFF+>]).

DC-DC Converter ON/OFF control

The micro-controller controls the DC-DC Converter ON/OFF function through the [3525OFF> output from U6 pin 56 which is taken low to turn OFF the converter. This signal is not easily monitored on the Control Board; however, on the Power Board it can be measured at the 'cold' end of R14 (other end is held at +5V) or directly on pin 10 of the DC-DC Converter controller i.c. U1.

Power Factor Correction Rectifier ON/OFF control

The micro-controller controls the PFC Rectifier ON/OFF function through the [PFCOFF> output from U6 pin 57 which is taken low to turn OFF the PFC. Once again this signal is not easily monitored on the Control Board; however, on the Power Board it can be measured at one end of R86 (other end is held at 0V) or directly on pin 10 of the PFC Rectifier controller i.c. U11.

Inverter (output) relay control

The inverter relay status determines whether the load is connected to the inverter output or the bypass supply, and the controlling output from U6 pin 58 is the result of a complex decision-making process carried out by the micro-controller in response to several of its analogue and digital inputs.

When U6-58 is taken high, it turns on Q2 and pulls CN2-13 to 0V which then energises the inverter (output) relay on the Power Board – thereby placing the load 'on-inverter.' The supply to the relay coil positive connection is made via CN2-14, as illustrated in Figure 3.7.

UPS Shutdown

The output from U6 pin 61 is driven high when the micro-controller wishes to shutdown the UPS – this is inverted by U1-10 and applied to the Power Board as a logic low [S.D.> signal. The passage of this signal to the control Power Supply and Battery Charger blocks of the Power Board is illustrated in Figure 3.6, which also shows that the Operator Panel ON switch is effectively inhibited while the shutdown signal is active.

Audible alarm

The audible alarm is controlled from U6-62 whose output activates the sounder via driver transistor Q1.

PFC Rectifier voltage selector

The [A0> & [A1> outputs from U6 pins 26/27 are connected to the DC Busbar voltage feedback circuit on the Power Board where they determine the gain of the positive and negative busbar voltage feedback amplifiers.

These are used to select the appropriate working voltage selection according to model rating.

PFC Rectifier voltage control

The PFC Rectifier control circuit on the Power Board uses a single controller i.c. to individually control the positive and negative DC Busbar voltages. The [LINE+> & [LINE-> outputs from U6 pins 30/31 are used to control solid-state switches on the Power Board which are in series with the busbar voltage feedback signals. These signals allow the micro-controller to control the gain of the feedback loop and are used to effect voltage balance control on the two busbars with respect to 0V – (see figure 2.10).

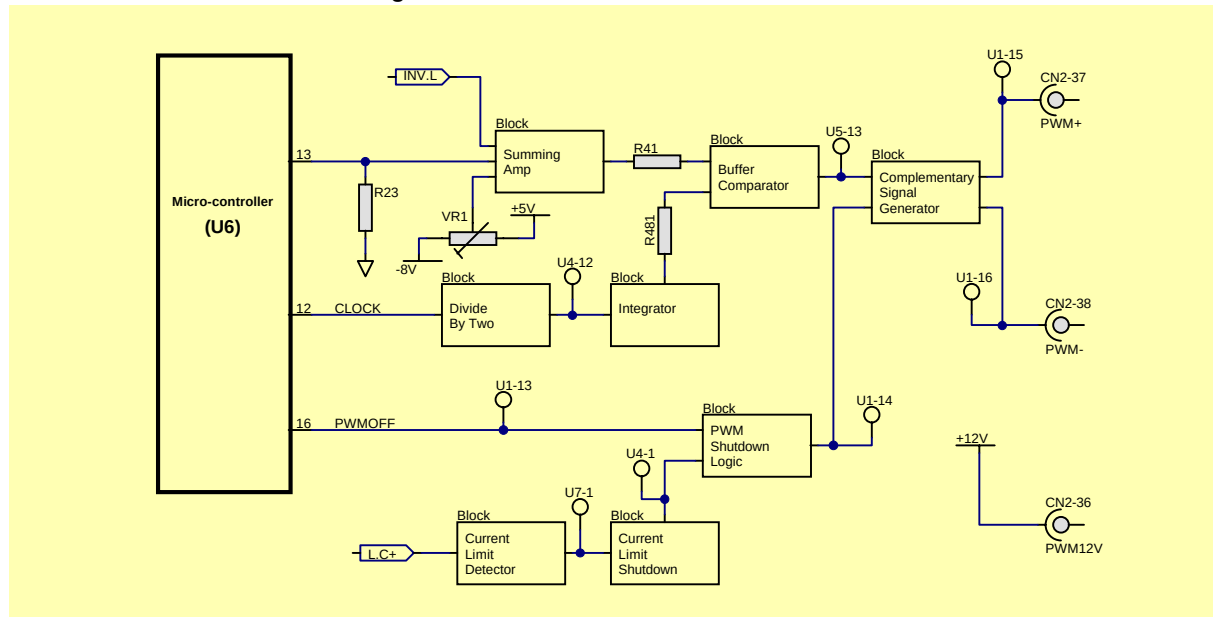
These signals are not easily monitored on the Control Board; however, on the Power Board they can be viewed at one end of R115 and R125 respectively.

Input relay control

The Input Relay is energised when U6-33 is driven high. This turns on Q3 which pulls CN2-10 down to the 0V rail. The Input Relay's positive voltage is provided by a dedicated output from the Battery Charger circuit (see figure 2.2).

3.1.6 PWM Pattern Generator

Figure 3.8 - PWM Pattern Generator circuit



The inverter PWM control regime is largely based on an analogue closed-loop regulation circuit which constantly monitors the output voltage and amends the PWM drive signal pattern as necessary to regulate the UPS output.

The micro-controller provides the circuit with three signals.

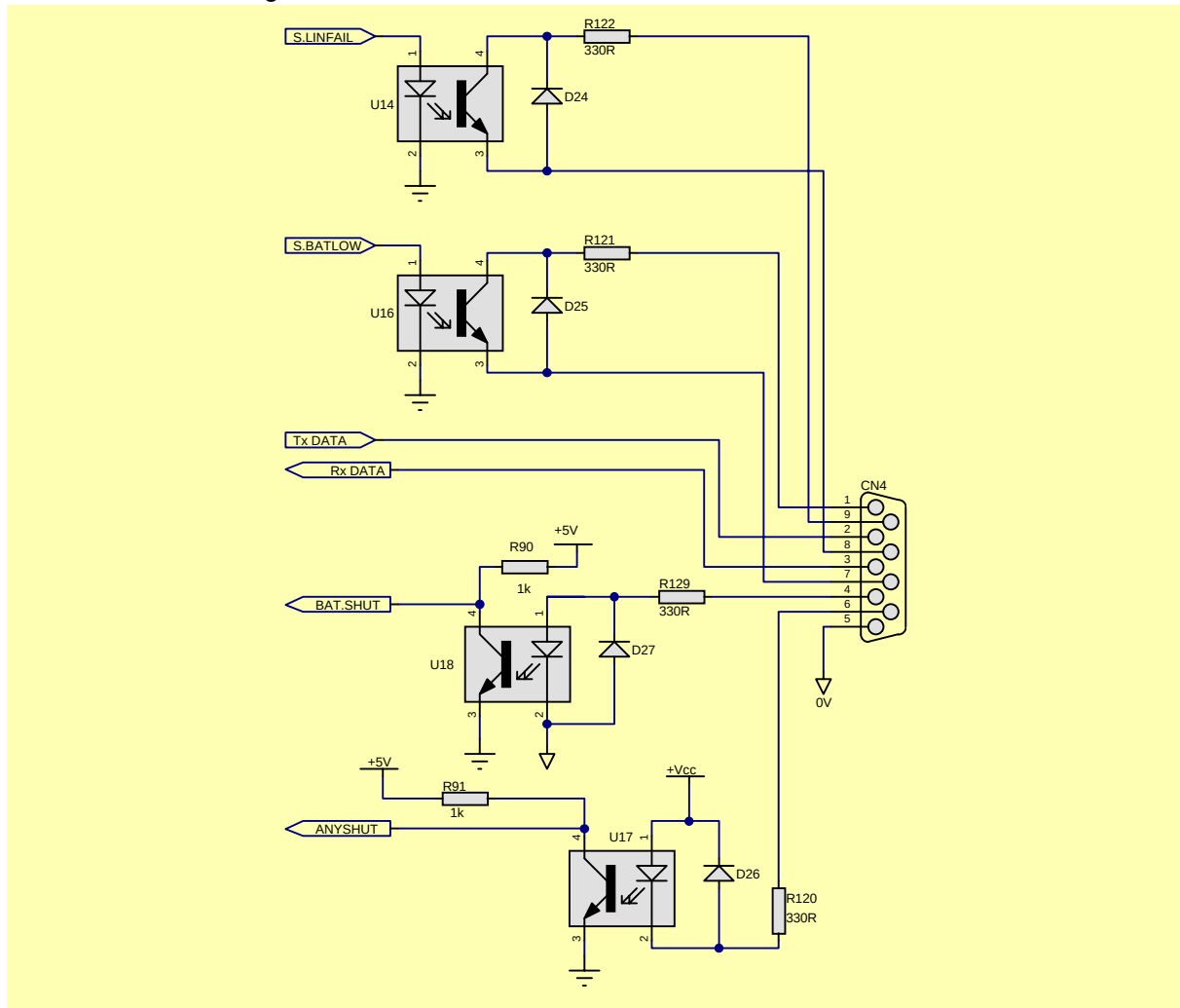
1. [PW2> is a digitally-generated, fixed amplitude reference a.c. waveform which is synchronised to the input (bypass) supply frequency and ac-coupled to the 'summing amp' where it is compared with the output voltage feedback signal [INV.L>. The 'summing amp' output thus takes the form of an ac waveform superimposed with a 'voltage error' signal, which serves as a 'control' input to the 'buffer-comparator' block. Note that the output voltage balance potentiometer (RV1) provides an offset input to the 'summing amp' and is used to centralise the output voltage about the neutral point – i.e. to balance the rms values of the positive and negative half cycle voltages.
2. The [CLOCK> output from U6-12 determines the basic PWM frequency. The 'buffer-comparator' compares the 'summing amp' output and the divided clock signal and produces a PWM output depending on the relative signals – the output pattern can be monitored at U5 pin 13.
3. The [PWMOFF> output from U6-16 provides the means for the micro-controller to turn-off the inverter when required – due to a fault condition for example. This output can be monitored at U1 pin 13 as a logic low when the inverter is being commanded OFF – (note that this is inverted with respect to the output at U6-16 shown).

The 'complementary signal generator' block converts the PWM pattern presented to U5 pin 13 into two complementary waveforms which are then connected to the inverter transistor drive circuits via CN2 pins 37 & 38, as shown. This block also contains certain timing elements which impart a controlled degree on under-lap between the two waveforms to allow the off-going inverter IGBT time to turn off before the on-coming IGBT is triggered.

The PWM drive signals can be inhibited by the 'current limit shutdown' block if the 'current limit detector' senses an inverter current overload. This takes place on a sub-cycle basis. In an overcurrent event U7 pin 1 switches to a logic high (+12V) which resets U4 and sends U4 pin 1 low – note that the overcurrent operating threshold is not adjustable.

3.1.7 9-Pin Communications Interface Port

Figure 3.9 - 9-Pin Communications Interface Port circuit details



The Control Board contains a 9-pin (female) connector which protrudes through the UPS back panel and provides passage for several signals which can be monitored by the connected computer running the Liebert SiteNet (or other) UPS monitoring and control software.

The signals passing through this port, which are all connected via opto-isolator to provide the required signal isolation, are shown in Figure 3.9, and described below.

Mains Failure

The [S.LINEFAIL> signal switches high in the event of a mains failure and produces a low impedance between CN4 pins 8 & 9.

Low Battery

When the UPS is operating 'on-battery' the [S.BATLOW> signal switches high when the battery voltage approaches its 'end-of-discharge' value (i.e. the UPS is near to shutting down). When active, this produces a low impedance between CN4 pins 1 & 7.

Serial data transmit

The micro-controller contains a serial communications facility which transmits data pertaining to the UPS operating status and parameter values (such as mains and UPS power values) in pre-arranged packets via CN4 pin 2. This data can be processed by suitable software (such as SiteNet) and displayed at a remote terminal.

Serial data receive

This is similar to the Serial Data Transmit feature described above, and allows the UPS to receive commands etc. from a remote station via CN4 pin 3 (using suitable software).

Remote battery shutdown

When pulled high (5-12Vdc), the input to CN4 pin 4 causes the UPS to shut down if it is operating 'on-battery'. This facility can be used when the mains power fails to shut down the UPS (and thereby conserve battery charge) once the attached computer has been shut down in a controlled manner.

UPS Shutdown

The input to CN4 pin 6 will shut down the UPS if taken low (i.e. if connected to CN4 pin 5 externally).

3.1.8 UPS INTELLISLOT™ Communications

The UPS contains an INTELLISLOT™ communications port for use with an optional internal Ethernet SNMP card which can be fitted in a receptacle at the back of the UPS after removing a cover-plate.

When this option is fitted, the card is connected to the Control Board CN3 via a ribbon cable – note that when the INTELLISLOT™ is fitted the *Tx Data* and *Rx Data* serial communication facilities of the 9-pin D-type connector are disabled, but the opto-coupled signals shown in Figure 3.9 are still active.

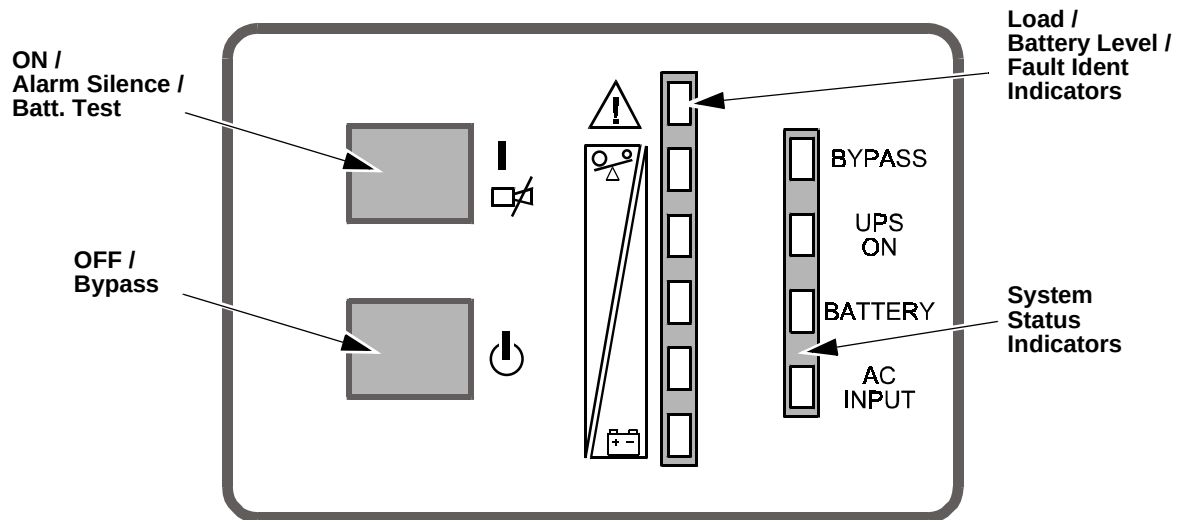
Details of the signal functions at CN3 are shown in the following table – when working on the Control Board in-situ these are best monitored at the soldered side of the board (*see figure 3.2*).

Table 3.2 - CN3 signal details

Pin #	In/Out	Signal Function
1	–	SELV isolated 0V supply rail (common for pins 1-10)
2	–	SELV isolated supply (+7Vdc to +10Vdc @ 500mA)
3	In	Rx Data from SNMP card to Control Board
4	Out	Tx Data from Control Board to SNMP card
5	–	Rx Data from SNMP card to PC
6	–	Tx Data from PC to SNMP card
7	Out	SELV isolated supply (-Vcc RS232 level -8Vdc to -12Vdc)
8	In	Goes high when SNMP card fitted (inhibits D-type connector data comms facility)
9	–	SELV isolated 0V supply rail (common for pins 1-10)
10	Out	SELV isolated supply (+Vcc RS232 level +8Vdc to +12Vdc @ 100mA)
11	–	Reserved
12	–	Reserved
13	–	Reserved
14	–	Reserved
15	–	Reserved
16	–	Reserved
17	In	Logic low shuts down UPS when operating in 'On-Battery' mode
18	In	Logic Low shuts down UPS when operating in any mode
19	Out	Goes high when any UPS alarm is active (summary alarm)
20	Out	Goes high when the UPS is operating in 'On-Bypass' mode
21	Out	Goes high when UPS detects a mains failure (i.e. goes to 'On-Battery' mode)
22	Out	Goes high when a <i>new</i> UPS fault alarm is activated
23	–	0V Ground (common for pins 17-26)
24	Out	Goes high when the UPS battery voltage is near 'end-of-discharge' value
25	Out	+24V supply (+22Vdc to +28Vdc)
26	Out	+12V supply (+11Vdc to +12Vdc)

CHAPTER 4 - Operating Procedures

Figure 4.1 - UPS Control Panel



4.1 Start-up procedure

1. Connect and energise the UPS input mains supply:
 - The UPS fans should operate.
 - The 'BYPASS' status led should illuminate and the audible alarm should sound at approximately 2 minute intervals to remind the user that the load is being supplied with unprocessed power.
 - The 'Load' bargraf leds should illuminate according to the percentage load being supplied.
2. Hold the UPS ON push-button pressed for 2-4 seconds:
 - The UPS control system should run through a series of validity checks and, if successful, transfer the load to the UPS inverter after approximately 10 seconds.
 - The 'BYPASS' status led should extinguish and the 'UPS ON' status led should illuminate to indicate the revised supply status.
 - After a further 4 seconds the UPS control system should perform an automatic battery test (for approximately 10-15 seconds) and, if successful, return to normal operation.

4.2 Manual battery test

To perform a manual battery test while the UPS is on-line:

1. Hold the UPS ON push-button pressed for 2-4 seconds:
 - The 'Battery' status led should illuminate.
 - The 'Battery Autonomy' bargraf leds should illuminate to show the available autonomy time (all segments should illuminate if the battery is healthy and fully charged).
 - After approximately 10-15 seconds the UPS should revert to normal operation; unless the batteries are faulty, in which case the 'Fault' led should illuminate accompanied by an audible alarm.

4.3 Shutdown procedure

1. Press the OFF push-button:
 - The load should transfer to bypass. The 'Bypass' status led should illuminate on the UPS Control Panel and the 'Inverter' status led should extinguish.
2. Press the OFF push-button again within 4 seconds:
 - The UPS should immediately turn OFF the load supply and fully shut down after approximately 10 seconds.

Note: to shutdown the UPS when operating on bypass press the OFF push-button twice within 4 seconds.

CHAPTER 5 - Maintenance & Repair Procedures

5.1 Maintenance

The GXT UPS is virtually maintenance-free.

Batteries

The lead acid batteries are valve regulated, non-spillable should be maintained in a charged state in order to obtain their designed life. Under normal circumstances the batteries are continuously float charged while the UPS is turned ON; however, if the UPS is to be removed from service for any length of time, it should be powered-up for at least 24 hours every four to six months to ensure the batteries remain adequately charged.

Cleaning

The UPS case can be cleaned with a dampened lint-free cloth if required. Do not use solvent cleaner.

Remove any excessive dirt build-up on the fan ventilation grill(s) if necessary.

5.2 Repair Procedures

This section contains procedures pertaining to the removal and refitting of the UPS major components. Photographs of the 1500VA model are used to illustrate the procedures, but the general methods described apply to the other models in the GXT range.

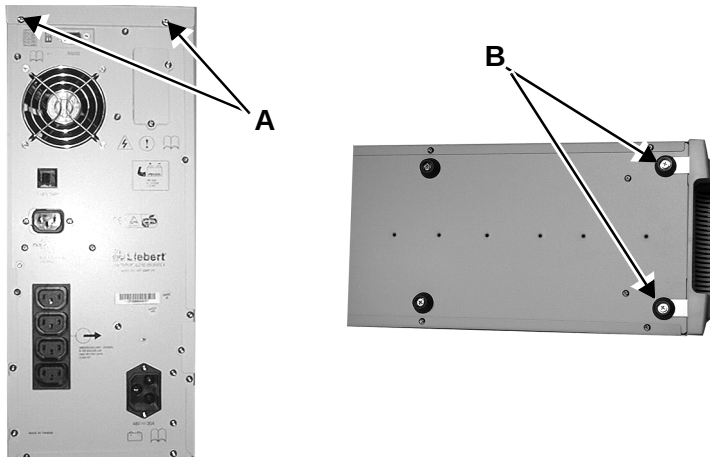
IMPORTANT: If a major component is replaced, carry out a general UPS functional check as detailed in Paragraph 5.6.

5.2.1 Important Safety Considerations

- The following procedures should be undertaken by qualified service personnel only.
- DO NOT perform any internal service or adjustment of this product unless another person is capable of rendering first aid and resuscitation is present.
- Dangerous voltage exists at several points in this product. To avoid personal injury, don't touch any exposed connections or components while the UPS is live.
- Turn off the UPS and disconnect input power cord before removing the outer cover – AC mains voltage is always present if the input AC power is still available.
- High voltages may be present at the DC capacitors. Wait for at least five minutes after turning off the UPS before removing the outer cover.
- Take care to avoid shorting the internal batteries.
- If the battery is disconnected, be sure to plug in the input power cord and apply input mains power before re-connecting the battery connector.

5.3 Gaining internal access to the UPS components (all *230RT models)

Figure 5.1 - Removing the top cover and front bezel



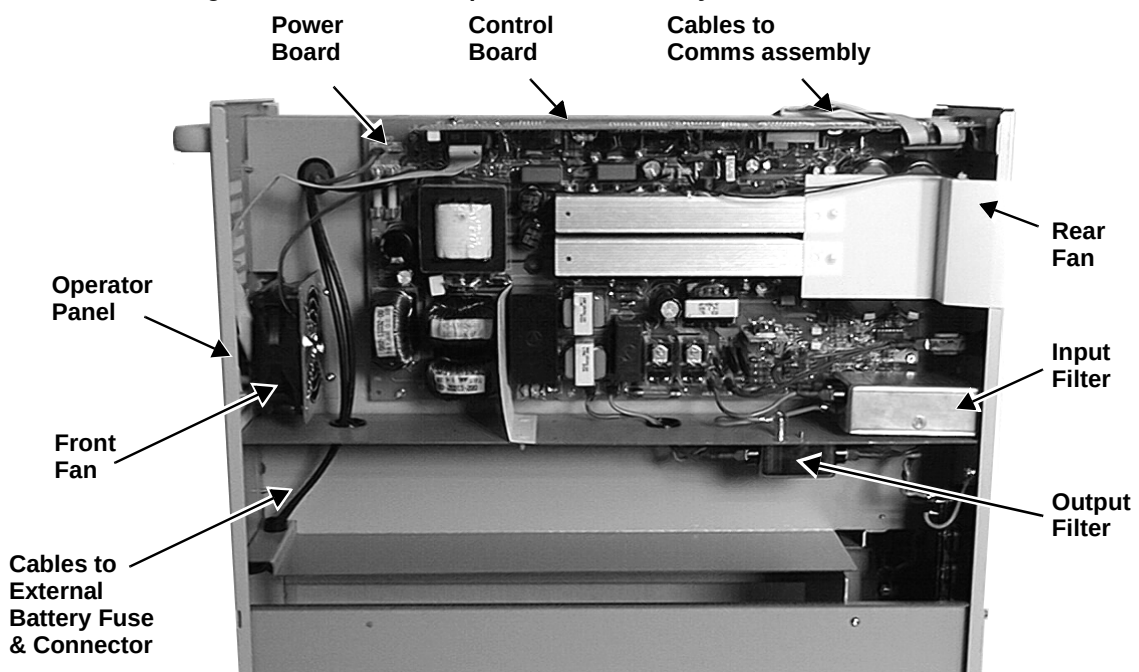
5.3.1 Removing the Top and Front bezel:

1. Remove the two screws (A) securing the top cover to the UPS back panel.
2. Push the top panel towards the back of the UPS to disengage its locating lugs from the inner panel, then lift away.
3. Remove the two screws (B) securing the front bezel mounting brackets to the UPS bottom chassis (these screws pass through the front feet). Then remove two similar screws securing the bezel mounting brackets to the UPS inner top cover.
4. Pull away the front bezel over the lifting handles.

5.3.2 Removing the left and right side covers

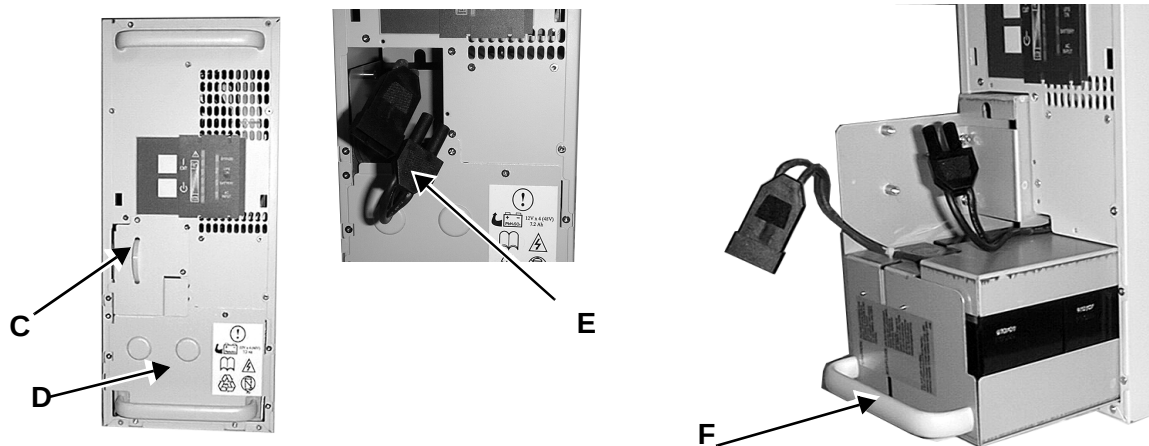
5. The left-hand cover is L-shaped and also forms the inner top cover. To remove this cover first remove the screws securing it to the right-hand cover, back-panel top and left side, and the UPS chassis base.
6. Once the left-hand panel is removed the right-hand panel can also be removed in the same manner.
7. This provides full access to the internal components as shown in Figure 5.2.

Figure 5.2 - Internal components accessibility with covers removed



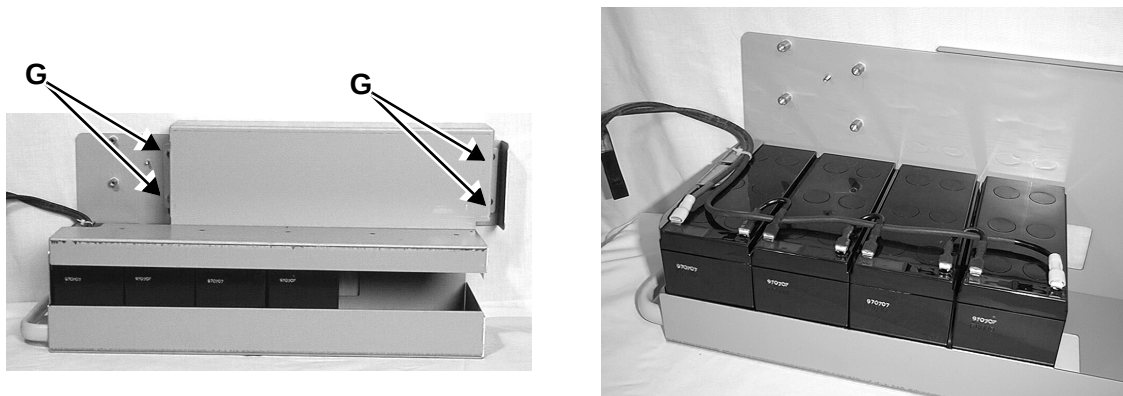
5.4 Disconnecting, replacing / servicing the Batteries (all *230RT Models)

Figure 5.3 - Removing the batteries



1. Remove the top cover and front bezel as described in Paragraph 5.3.1.
2. Remove the screws securing the battery connector cover (C).
3. Withdraw the battery connector (E) and disconnect it.
4. Remove the screws securing the battery assembly cover-plate (D).
5. Withdraw the battery assembly (F). CAUTION: the battery assemblies fitted to the larger models are heavy.

Figure 5.4 - Dismantling the battery assembly



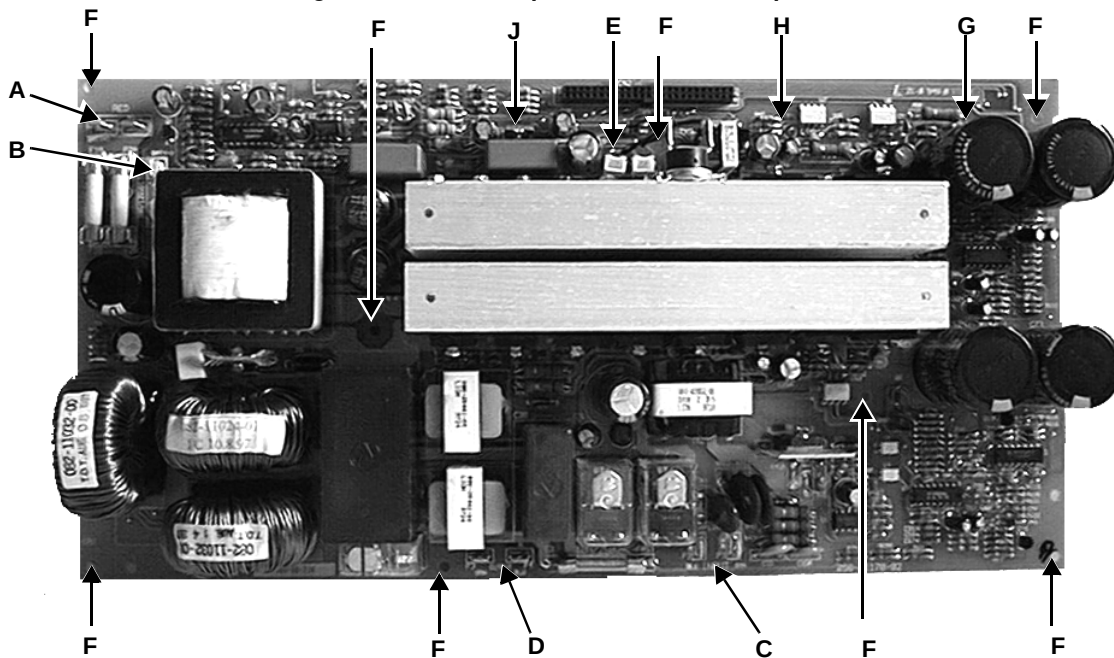
6. If the batteries require changing or visual examination they can be accessed by removing the four screws (G) which secure the battery assembly top cover to the main assembly.
CAUTION: Lift away the top cover carefully to prevent shorting the battery terminals.
7. To reassemble the battery follow the dismantling instructions in reverse order.
IMPORTANT: A self adhesive insulating strip is applied across the front of the batteries and folds down over the terminals to prevent the battery assembly top cover shorting out the terminals.
ENSURE THIS STRIP IS FITTED BEFORE REASSEMBLING THE BATTERY PACK.

WARNING: When refitting the battery pack, apply mains power to the UPS and allow it to run **before** you reconnect the battery connector (E). This pre-charges the Battery Charger electrolytics and avoids rupturing the battery fuses due to the initial inrush current when the battery is connected – Note: if the electrolytics have not been discharged there is no need to observe this precaution (refer to Paragraph 5.5. for details concerning discharging the electrolytics).

5.5 Replacing the Power Board & Control Board

1. Gain internal access as described in Paragraph 5.3.
2. Ensure that the battery is disconnected (*see paragraph 5.4*).
3. On the Control Board:
 - a. Disconnect the ribbon cables from CN1 and CN3.
 - b. Remove the D-type connector securing screws at the UPS back panel.
4. To remove the Control Board independent of the Power Board, remove the screw securing the two boards together (located to the rear of the Control Board) and separate the main connector CN2 – to remove both boards together continue with this procedure.

Figure 5.5 - Board replacement – detailed points



5. On the Power Board:
 - a. Disconnect the battery positive (A) and negative (B) cables.
 - b. Disconnect the input supply cables (C).
 - c. Disconnect the UPS output cables (D).
 - d. Disconnect the Fan supply cable(s) (E)
6. Remove the (8) screws (F) securing the board to the UPS chassis, and withdraw the Power Board (& Control Board) from the UPS housing.

WARNING: The Battery Charger and DC Busbar electrolytic capacitors on the Power Board may still be charged. Do not rest the Power Board on a conductive (i.e. metal) surface or damage might occur.

- a. To discharge the Battery Charger electrolytics, temporarily connect a discharge resistor (100R / 10W) across the Control Board's battery positive (A) and negative (B) terminals.
 - b. To discharge the positive DC Busbar electrolytics, temporarily connect a discharge resistor (100R / 10W) between the right-hand side of R58 (G) and the flange of U3 (J) (ground).
 - c. To discharge the negative DC Busbar electrolytics, temporarily connect a discharge resistor (100R / 10W) between TP1 (H) and the flange of U3 (J) (ground).
7. To refit the board follow the above procedure in reverse.

WARNING: If the Battery Charger electrolytics have been discharged do not reconnect the battery connector (*see figure 5.3*) before the UPS has been restarted (*see paragraph 5.4*).

5.6 Functional check procedures

This procedure should be used following the replacement of a major component, or at any other time where the UPS's general serviceability is suspect.

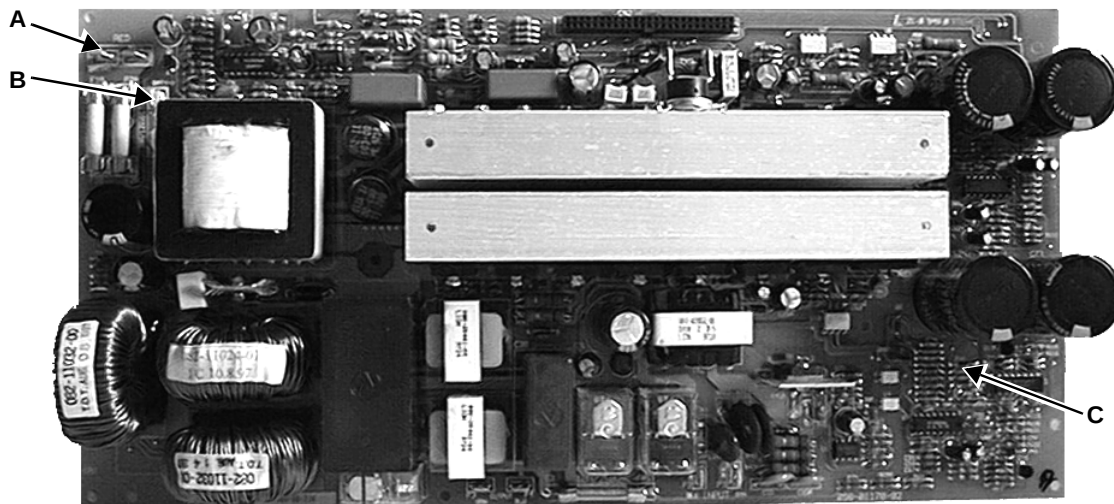
CAUTION: Do not operate the unit for long periods with the covers removed as it may cause the Battery Charger transformer (TX3) to overheat.

5.6.1 Preliminary information

1. The procedure assumes:
 - a. The UPS is isolated from the input mains supply.
 - b. Full access to the internal components – the top and side panels are removed.
 - c. The UPS is complete (all assemblies fitted).
 - d. The battery is disconnected (*see figure 5.3*) and no external batteries are connected.
 - e. The UPS is isolated from the input mains supply.
 - f. The DIP switches on the back of the UPS have been set correctly for the required output voltage.

5.6.2 Battery Charger calibration

Figure 5.6 - Battery charger calibration points



1. On the Power Board, connect a DVM to the battery terminals (A) and (B).
2. Connect and energise the input mains supply.
 - a. The cooling fans should run.
 - b. The DVM should indicate the Battery Charger output voltage.
3. If necessary adjust VR01 (C) to obtain the nominal charge voltage of 2.3V/cell (i.e. 55.2V in 1500RT model).
4. Turn OFF the input mains supply, wait 2 minutes then connect the battery.
Note: a small arc may be experienced when the battery connector is initially 'made'.
5. With the DVM still connected verify that the battery off-load voltage is satisfactory (nominal 48Vdc) if found to be substantially less than this then remove the battery pack and check for faulty cell(s) or incorrectly wired battery (*see paragraph 5.4*).
6. Turn ON the input mains supply and check the battery float charge voltage. If this is substantially less than the value set in step 3 it may be due to the battery being fully discharged and causing the Battery Charger to operate in current limit mode. Leave the battery on charge for a few hours to see if the voltage increases as the battery takes on charge – if this fails to occur then again it could be due to a faulty cell(s).
7. Once you are satisfied that the battery charger is operating correctly:
 - a. Turn OFF the input mains supply.
 - b. Disconnect the DVM.
 - c. Ensure the battery assembly and connector are correctly housed then fit and secure their front cover-plates.

5.6.3 Bypass check

1. Turn ON the input mains supply
 - a. All of the load/battery leds should illuminate momentarily.
 - b. The unit should be in the 'BYPASS' mode, with the 'Bypass' and 'AC input' leds illuminated, and will emit a 1 second warning beep (every two minutes).
2. Connect a true rms-reading DMV to the UPS output socket and verify that the bypass voltage is present (and identical to the input mains supply voltage).

5.6.4 UPS switch ON check

1. Press the UPS ON button.
 - a. The UPS control system should run through a series of validity checks on the DC busbar and inverter and, if satisfactory, energises the Output Relay after approximately 10 seconds. This transfers the load to the inverter and the 'Bypass' led should extinguish and the 'UPS ON' led illuminate.
 - b. After a further 4 seconds (approximately) the UPS control system should perform an automatic battery test whereby the PFC Rectifier is turned off for approximately 15 seconds and the DC busbar voltage is monitored while the inverter is being powered from the batteries. The 'Battery' led should illuminate during this period and the 'load/battery' bargraph leds should fully illuminate if the battery is well charged.
2. At the end of the battery test sequence:
 - a. The 'Battery' led should extinguish.
 - b. The load/battery bargraph leds should extinguish.
 - c. The 'UPS ON' led should illuminate to show that the output is now 'on-inverter'.

Note: If the batteries fail the test the load is transferred to the bypass supply and the 'Fault' led illuminates.

5.6.5 DC Busbar voltage checks

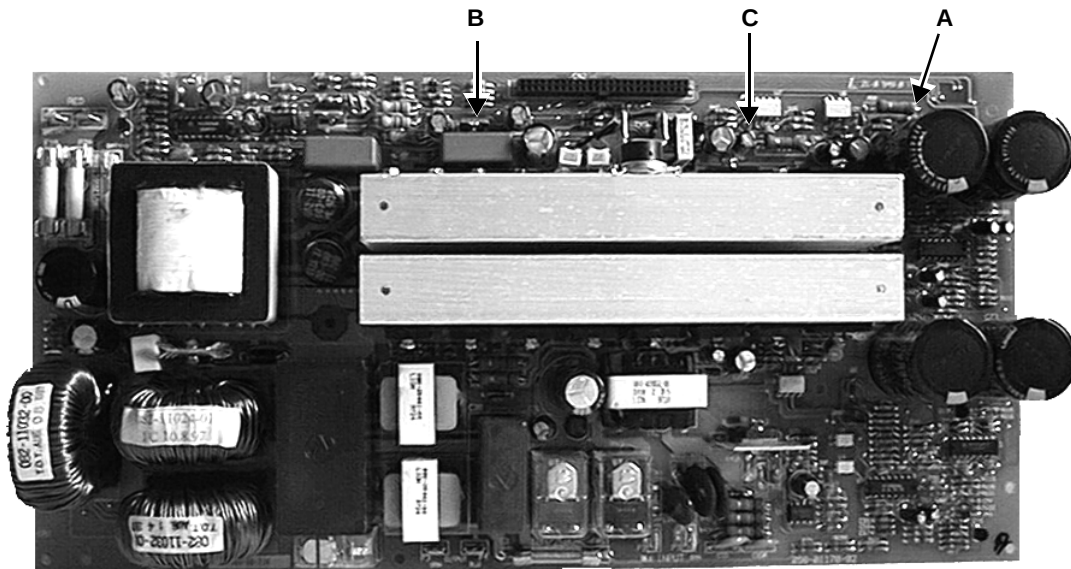
The following checks verify the correct operation of the PFC Rectifier, DC-DC Converter and Inverter:

CAUTION: High voltages are present. Care must be taken when connecting and disconnecting the DVM from the circuit under test. If in doubt, turn OFF the UPS and input mains supply between taking the following measurements.

Note: the voltage measurements given below will vary slightly according to the value of the input mains voltage, and also assume that the UPS is totally unloaded.

DC Bus voltage (from PFC Rectifier)

Figure 5.7 - DC Bus voltage calibration



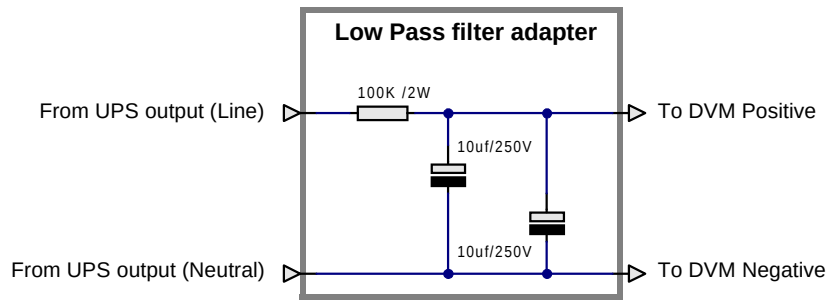
1. Turn OFF the UPS and the input mains supply.
2. Connect a DVM across the DC Busbar – the right-hand side of R58 (A) is the positive bus and TP1 (B) is the negative bus.
3. Turn ON the input mains supply:
 - a. The PFC Rectifier should turn ON.
 - b. The DC Bus voltage indicated on the DVM will initially rise to approximately 750Vdc and then fall back to approximately 630-660Vdc as the regulation circuit settles down.
4. Measure the individual positive and negative DC busbar voltages with respect to 0V (ground) to ensure that they are balanced – i.e. using U3 flange (C) as the 0V reference point, the voltages between A-C and B-C should be equal.

DC Bus voltage (from DC-DC Converter)

5. Repeat steps (1) and (2) above.
6. Turn ON the UPS and allow it to run through its start-up test sequence and give it time to settle into normal operation – i.e. 'ON UPS' led illuminated.
7. Turn OFF the input mains supply:
 - a. The 'AC INPUT' led should extinguish and the 'BATTERY' led illuminated to indicate that the UPS is operating on battery power.
 - b. The DC Bus voltage indicated on the DVM should rise to approximately 790-800Vdc.
8. Measure the individual positive and negative DC busbar voltages with respect to 0V (ground) to ensure that they are balanced – i.e. using U3 flange (C) as the 0V reference point, the voltages between A-C and B-C should be equal.
9. Restore the input supply and observe the DC Busbar voltages return to their normal levels.

5.6.6 Output voltage offset check

Figure 5.8 - Low pass filter adapter



1. Connect a DVM, set to DC Volts, to the UPS output socket via the low pas filter adapter shown above (locally constructed).
2. With the UPS running both normally (mains supply connected) and 'on-battery' (mains supply disconnected) check that the DVM indicates no more than 400mV.

CHAPTER 6 - Troubleshooting Procedures

6.1 Introduction

When the UPS detects an internal fault it will usually transfer the load to the bypass supply and indicate the nature of the problem by illuminating a combination of the left-hand bargraph LEDs on the Operator Panel – note that the top-most (red) LED signifies ‘Fault’ – (see paragraph 1.5.3).

Troubleshooting table

If the UPS malfunctions the likely cause usually can be found by interpreting the LED indications in Table 2 and carrying out the suggested checks.

Dismantling the equipment

In most instances the Control Board and/or Power Board must be removed to enable the detailed checks to be carried out – full dismantling details are provided in the Repair chapter (see paragraph 5.2). Remember always to discharge the Charger and DC Bus capacitors when removing the Power Board (see paragraph 5.5).

Live functional checks

When a faulty unit is repaired it should be fully functionally checked as described in Paragraph 5.6. This ensures that the unit is correctly set-up and ready to be put back into service.

Using the ‘Quick Start (for 2000/3000VA models see Paragraph 6.11)’ Procedure

By their very nature, the ‘power components’ are those most likely to be affected by an internal UPS fault, or extreme overload problem.

The ‘Quick Start (for 2000/3000VA models see Paragraph 6.11)’ troubleshooting procedure describes a series of checks that can be carried out on the primary components located in the various UPS power blocks, and can be used as a *general* troubleshooting procedure which can be undertaken ahead of the more detailed procedures: i.e. a problematic area can usually be quickly identified, or narrowed down, by following the ‘Quick Start (for 2000/3000VA models see Paragraph 6.11)’ procedure.

This procedure should also be used if there is a problem in starting the UPS.

Procedures

The procedures contained in this chapter are listed below:

- Procedure 6.3 Quick Start (for 2000/3000VA models see Paragraph 6.11)
- Procedure 6.4 PFC Rectifier check procedure (for 2000/3000VA models see Paragraph 6.12)
- Procedure 6.5 DC-DC Converter check procedure (for 2000/3000VA models see Paragraph 6.13)
- Procedure 6.6 DC Power Supply check procedure (for 2000/3000VA models see Paragraph 6.14)
- Procedure 6.7 Battery Charger check procedure (for 2000/3000VA models see Paragraph 6.15)
- Procedure 6.8 Inverter check procedure (for 2000/3000VA models see Paragraph 6.16)
- Procedure 6.9 Overtemperature checks
- Procedure 6.10 DC Voltage Feedback loop checks (for 2000/3000VA models see Paragraph 6.18)

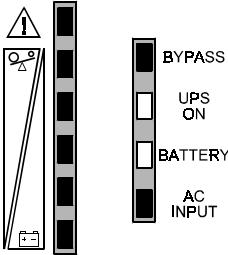
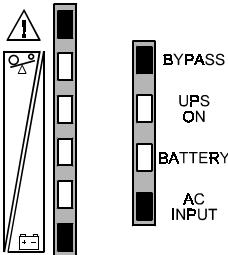
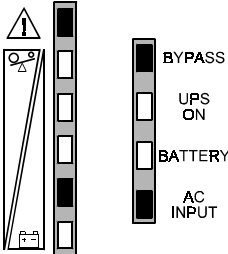
6.2 Operating problems

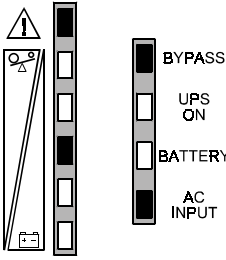
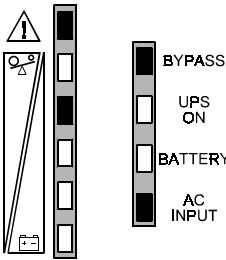
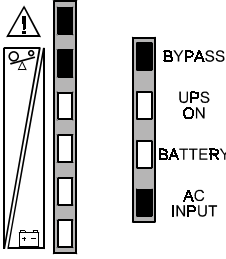
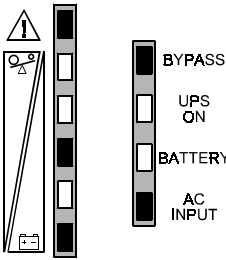
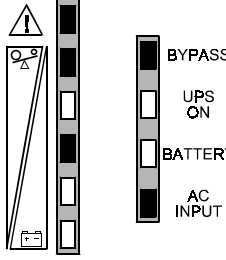
Table 6-1 describes the actions to take in respect of Operating Problems – i.e. those situations that occur which do not illuminate the FAULT led (which are described in the Troubleshooting Table 6-2).

Table 6.1 - Operating Problems

SYMPTOM	POSSIBLE CAUSE	ACTIONS
UPS Fails to start when the ON button is pressed	UPS Output is short circuited or overloaded	Turn OFF the UPS. Disconnect all loads and ensure that nothing is lodged in the output sockets. Ensure loads are not internally shorted
	Faulty internal fuse or power component	Carry out the Quick Start (for 2000/3000VA models see Paragraph 6.11) check procedure
BATTERY indicator is illuminated	UPS not connect to input mains supply	Ensure input supply cable is connected and mains supply is turned ON
	UPS input supply failure	Rectify the cause of mains failure. The UPS is responding normally to a mains supply problem – SAVE DATA AND CLOSE APPLICATIONS
UPS Fails Battery Test	Poorly charged battery	Allow the batteries to charge for 24 hours then repeat the test.
	Faulty battery cell(s)	Inspect the batteries and replace if necessary
UPS Has reduced battery time	Battery not fully charged	Allow the batteries to charge for 24 hours then repeat the test.
	UPS is overloaded	Check the displayed load level and reduce if applicable
	Ageing batteries	Replace batteries

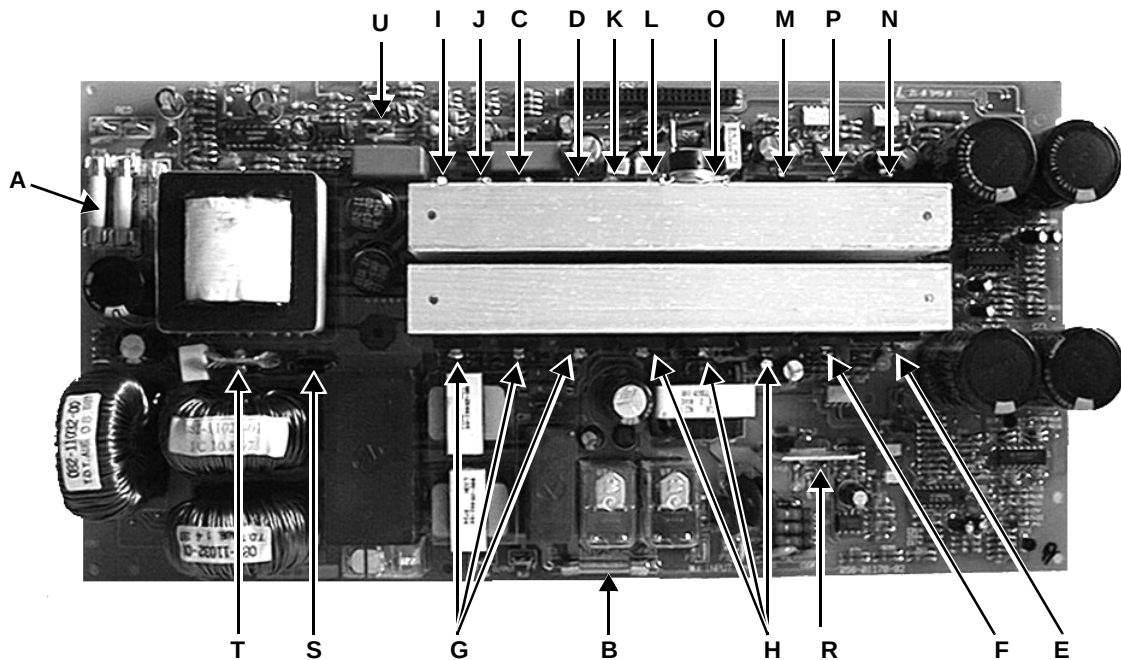
Table 6.2 - Fault indication

INDICATION	INTERPRETATION	CAUSE & INITIAL ACTIONS
	On Bypass due to output overload	Possible Cause: O/P load is larger than the UPS VA or Wattage rating. Actions: Reduce the load connected to the UPS output socket to an acceptable level (within the UPS rating).
	On Bypass due to Over-temperature	Possible Cause 1: Ambient Temperature is above the specified permissible operating temperature. Actions: 1. Reduce the ambient temperature if possible 2. Ensure ventilation grills are unobstructed 3. Temporarily reduce the O/P load to allow the UPS to cool down Possible Cause 2: Thermal detection circuit failed. Actions: Refer to the functional check procedure in Paragraph 6.9.
	On Bypass due to DC Bus Overvoltage	Possible Cause 1: Some non-fatal misbehaviour of UPS. Actions: Turn OFF the UPS then turn it back ON to see if the problem clears. Possible Cause 2: PFC Rectifier circuit failure. Actions: Refer to the functional check procedure in Paragraph 6.4 Possible Cause 3: DC/DC circuit failure. (In this situation, AC INPUT LED will not light). Actions: Refer to the functional check procedure in Paragraph 6.5 Possible Cause 4: Bus voltage feedback circuit problem. Actions: Refer to the functional check procedure in Paragraph 6.10

	On Bypass due to DC Bus Undervoltage	Possible Cause 1: Too much step load added on O/P under Backup mode. Actions: Remove excess load. Possible Cause 2: Battery capacity is too low. Actions: 1. Reduce the load (or leave 'On-bypass') and allow the batteries to re-charge. 2. Replace faulty or aging battery. Possible Cause 3: DC/DC circuit problem. Actions: Refer to the functional check procedure in Paragraph 6.5
	On Bypass due to PFC Rectifier failure	Possible Cause: PFC circuit Failed. Actions: Refer to the functional check procedure in Paragraph 6.4
	On Bypass due to Inverter failure	Possible Cause 1: O/P short circuit. (In this situation, no power will transfer to the O/P socket.) Actions: Remove short circuit condition, turn OFF the UPS then turn it back ON again. Possible Cause 2: Inverter circuit failed. Actions: Refer to the functional check procedure in Paragraph 6.8
	On Bypass due to failed battery test	Possible Cause: Battery too weak. Actions: Charging battery for a while then re-test. If the problem still exists then replace the batteries.
	UPS Shut down by command from the communications port	Possible Cause: UPS has received a signal from the attached computer. Actions: Problem with the attached computer (software incorrectly installed). Problem with communications cable (or incorrect communications cable is in use).

6.3 Quick Start (for 2000/3000VA models see Paragraph 6.11)

Figure 6.1 - 'Quick Start' procedure component location*

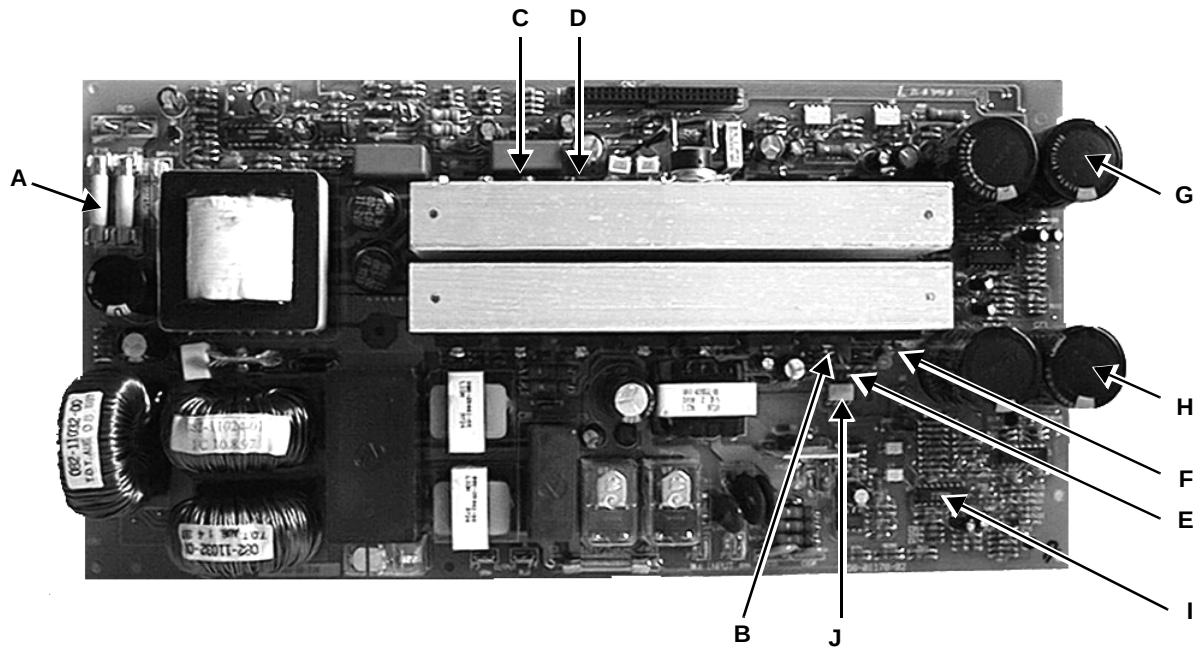


* Photograph shows 1500VA Power Board. Components are in same relative positions on 700VA & 1000 VA models

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check the Battery Fuses F1/F2 (A) (F1 only on 700VA model)
If the battery fuse(s) are ruptured it could be due to:
 - faulty battery; faulty Battery Charger; faulty L.V Power Supply (or problem elsewhere on the board placing a short on the power supply rails)
3. Check the Input Fuse F3 (B)
If the input fuse is blown it could be due to:
 - faulty PFC Rectifier; faulty Control Board; faulty Inverter or severe instantaneous output overload.
4. PFC Rectifier section:
 - Check D13 (C) and D18 (D) for open/short circuit.
 - Check diode bridge REC1 (E) for open/short circuit between any two legs.
 - Check FET Q14 (F) Drain-to-Source for open/short circuit.
5. DC-DC Converter:
 - Check FETs Q3/Q4/Q6 (G) Drain-to-Source for open/short circuit (no Q3/Q7 fitted on 700VA model). (Note these devices are connected in parallel and all three should be replaced if any one fails).
 - Check FETs Q7/Q10/Q11 (H) Drain-to-Source for open/short circuit. (Note these devices are connected in parallel and all three should be replaced if any one fails).
 - Check power diodes D11 (I), D12 (J) D23 (K), D24 (L) for open/short circuit. (Note: these are connected in a bridge format across the DC Busbar and the busbar capacitors can be seen charging/discharging depending on the polarity of the meter leads).
6. Inverter:
 - Check FETs Q12 (M) and Q13 (N) Drain-to-Source for open/short circuit
 - Check power diodes D34 (O), D38 (P) for open/short circuit (Note: these are in parallel with Q12 and Q13)
7. Battery Charger:
 - Check FET Q8 (R) Drain-to-Source for open/short circuit
 - Check power diodes D5 (S), D6 (T) for open/short circuit
8. DC Power Supply:
 - Check FET Q2 (U) Drain-to-Source for open/short circuit

6.4 PFC Rectifier check procedure (for 2000/3000VA models see Paragraph 6.12)

Figure 6.2 - 'PFC Rectifier' procedure component location*



* Photograph shows 1500VA Power Board. Components are in same relative positions on 700VA & 1000 VA models

6.4.1 Fault characteristics

A PFC Rectifier fault usually can be attributed to:

- A faulty PFC power component, which renders the circuit inoperable and likely to rupture the input fuse.
- An overload on the circuit's output DC Busbar(s), due to shorted busbar or inverter problem. Once again, this could rupture the input fuse in extreme cases, or else force the PFC to operate in a current limited mode.
- A PFC Control fault which either fails to turn on the controlling transistor (resulting in low DC Bus volts and perhaps a 'battery on-load' condition) or, conversely, turns on the transistor inappropriately – causing an unbalanced output, or once again rupturing the input fuse.

This procedure seeks to identify a problem falling into the (a) and (b) categories above; however, due to the inaccessibility of the components on the Control Board when it is in-situ there is little that can be done to troubleshoot the control circuit at component level, and this situation is best remedied by replacing the Control Board and returning the suspect Board for bench testing.

6.4.2 Static checks

- Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
- Check **ALL** the following PFC Rectifier components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	input Fuse F3	Short circuit	Open circuit
B	PFC Power Controller Transistor Q14 (Drain-Source)	0.46 (diode range)	Short/Open circuit
C/D	Flywheel diode D13 / D18	0.46 (diode range)	Short/Open circuit
E	Resistor R52	47 Ohms	Short/Open circuit
F	Diode bridge REC1 (between adjacent terminals)	0.46 (diode range)	Short/Open circuit

3. Check out the DC Busbar by measuring the resistance across the positive bus capacitors (G) and negative bus capacitors (H) (observe polarity) (only one capacitor fitted to each position on 700VA model). The result should show typical capacitor charging characteristics to high impedance. If a short-circuit or low resistance is indicated then:
 - a. check for a faulty electrolytic capacitor and replace where necessary.
 - b. if the capacitors are serviceable then there is likely to be a faulty Inverter power component, or short-circuited diode in the DC-DC Converter circuit's output – carry out the Inverter / DC-DC Converter static checks.

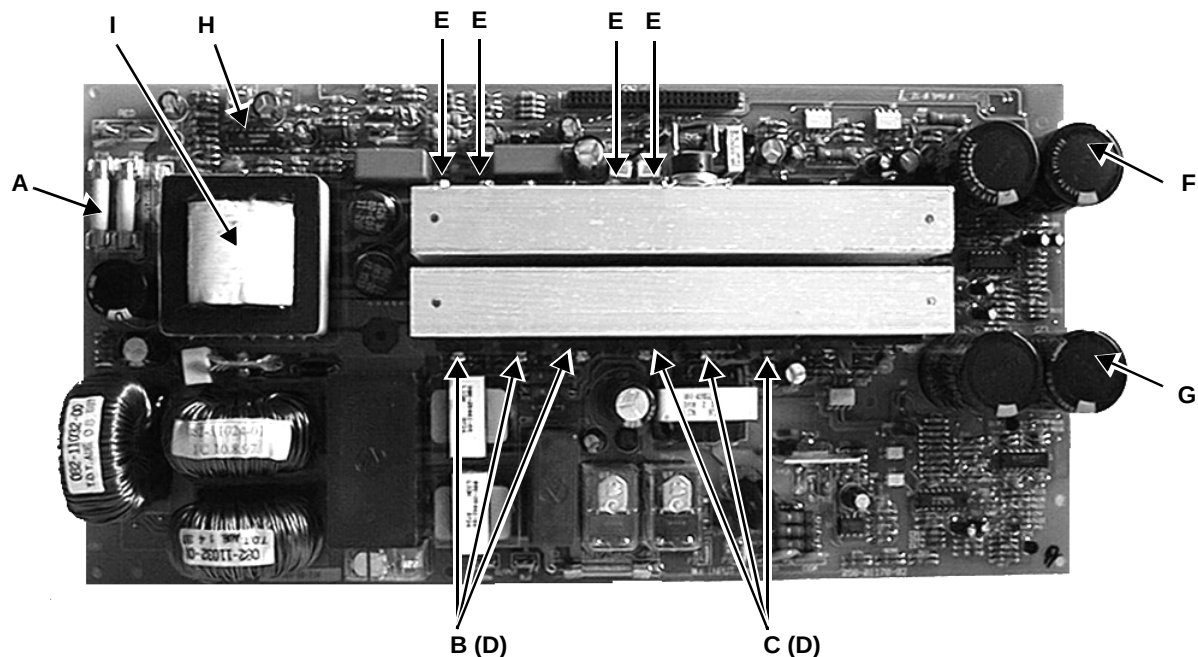
6.4.3 Power checks

4. If ALL the components listed in step (2) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.

WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuse and damage the charger's electrolytic(s).
5. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
6. If the PFC Rectifier still fails to work correctly.
 - a. remove the Power Board once again (remember to discharge the Charger and DC Busbar capacitors).
 - b. replace U11 (3854) (I) and U10 (TLP250) (J).
 - c. refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then check out the DC Feedback loop components (*see paragraph 6.10*) or replace the Power Board and Control Board in turn.

6.5 DC-DC Converter check procedure (for 2000/3000VA models see Paragraph 6.13)

Figure 6.3 - DC-DC Converter procedure component identification*



* Photograph shows 1500VA Power Board. Components are in same relative positions on 700VA & 1000 VA models

6.5.1 Fault characteristics

A DC-DC Converter fault usually can be attributed to:

- A faulty power component, which renders the circuit inoperable. Depending on the failure mode, this is likely to rupture the battery fuses (F1/F2) or render the circuit incapable of sustaining the UPS output when working 'on battery'. A short-circuited DC-DC Converter output diode could also effectively present a short-circuit to the DC Busbar which in turn could affect the PFC Rectifier's operation (with possible input fuse failure).
- An overload on the circuit's output DC Busbar(s), due to shorted busbar or inverter problem. Once again, this could rupture the battery fuses in extreme cases, or else force the DC-DC Converter to operate in a current limited mode, which prevents correct operation when 'on battery'.
Note: if there is a short-circuit fault on the DC Bus / Inverter, it will also affect the PFC Rectifier operation (see paragraph 6.4) under normal circumstances and will affect the DC-DC converter only in the event of an input supply failure.
- A DC-DC Converter control fault which either fails to turn on the controlling transistors (resulting in total inability to run the UPS 'on battery' or, conversely, turns on the transistor inappropriately – causing an unbalanced or excessive DC Busbar voltage, or once again rupturing the battery fuses.

This procedure seeks to identify a problem falling into the (a) and (b) categories above; however, due to the inaccessibility of the components on the Control Board when it is in-situ there is little that can be done to troubleshoot the control circuit at component level, and this situation is best remedied by replacing the Control Board and returning the suspect Board for bench testing.

6.5.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following DC-DC Converter components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	Battery fuses F1/F2	Short circuit	Open circuit
B	Transistors Q3*/Q4/Q6 (paralleled) (Drain-Source)	0.43 (diode range)	Short/Open circuit
C	Transistors Q7*/Q10/Q11 (paralleled) (Drain-Source)	0.43 (diode range)	Short/Open circuit
D	Gate resistors R26*/R32/R33/R35*/R39/R40 (10R)	10 Ohms	Short/Open circuit
E	Diodes D11/D12/D23/D24	0.40 (diode range)	Short/Open circuit
	<i>*Not fitted on 700VA model</i>		

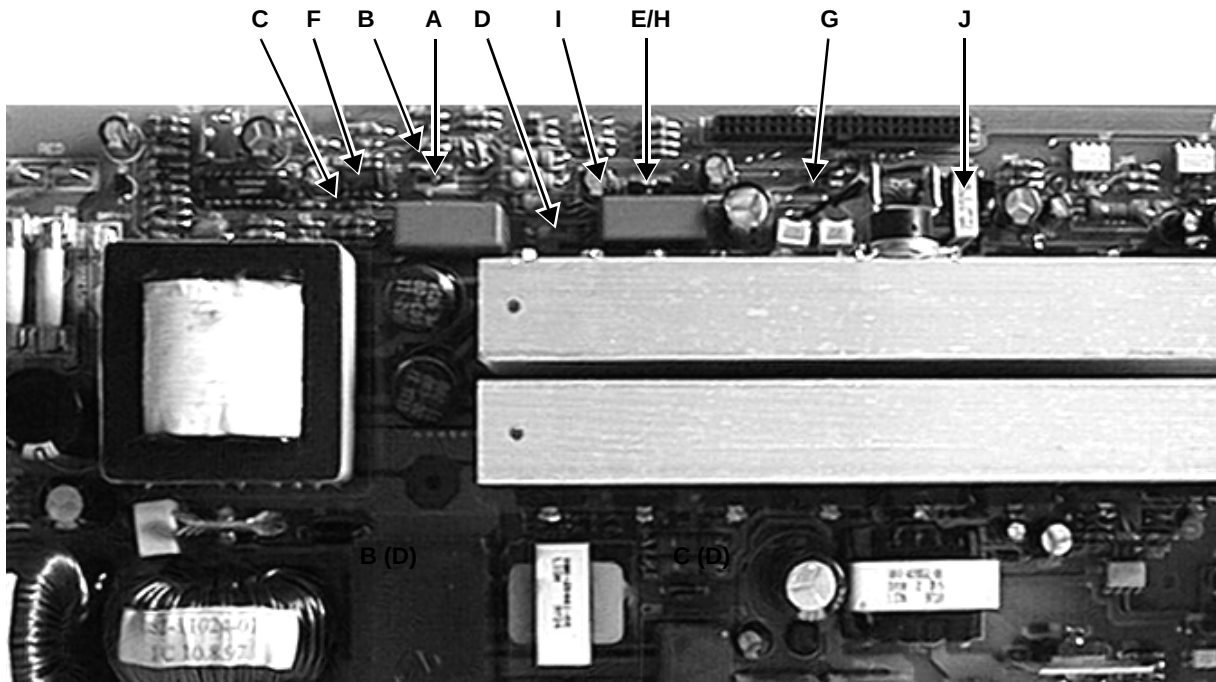
3. Check out the DC Busbar by measuring the resistance across the positive bus capacitors (F) and negative bus capacitors (G) (observe polarity) (only one capacitor fitted to each position on 700VA model). The result should show typical capacitor charging characteristics to high impedance. If a short-circuit or low resistance is indicated then:
 - a. check for a faulty electrolytic capacitor and replace where necessary.
 - b. if the capacitors are serviceable then there is likely to be a faulty Inverter power component, or short-circuited diode in the DC-DC Converter circuit's output – carry out the Inverter / PFC Rectifier static checks.

6.5.3 Power checks

4. If ALL the components listed in steps (2/3) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger's electrolytic(s).
5. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
6. If the DC-DC converter still fails to work correctly (i.e. the UPS will not operate 'on battery'):
 - a. remove the Power Board once again (remember to discharge the Charger and DC Busbar capacitors).
 - b. replace U1 (3525) (H) and transformer TX1 (I).
 - c. refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then check out the DC Feedback loop components (*see paragraph 6.10*) or replace the Power Board and Control Board in turn.

6.6 DC Power Supply check procedure (for 2000/3000VA models see Paragraph 6.14)

Figure 6.4 - DC Power Supply procedure component identification*



* Photograph shows 1500VA Power Board. Components are in same relative positions on 700VA & 1000 VA models

6.6.1 Fault characteristics

A DC Power Supply fault will render the UPS totally inoperable to the extent that the UPS totally shuts down and the Operator Panel may appear to be totally 'dead' (no indications) or display 'nonsensical conditions'. This type of fault will also prevent the UPS from being started, and if it occurs when on line it could also cause fault repercussions in other areas of the UPS.

A DC Power Supply fault usually can be attributed to:

- a. A faulty Power Supply power component, which renders the circuit inoperable. Depending on the failure mode, this could rupture the battery fuses (F1/F2).
- b. An overload on one of the circuit's output supply rails due to a faulty UPS control circuit component (on either the Power Board or Control Board).

Note: such a problem may affect the operation of *any* of the UPS power blocks and initiate a related error indication.

- c. A problem with the Battery Charger block.

The DC Power Supply is normally powered from the Battery Charger output and if this power source is unavailable it will take its operating power from the battery, thereby causing the battery to discharge.

This procedure seeks to identify a problem falling into the (a) and (b) categories above; the Battery Charger circuit check procedure is provided in Paragraph 6.7.

6.6.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following DC Power Supply components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	Switching transistor Q2 (Drain-Source)	0.43 (diode range)	Short/Open circuit
B	Resistor R18	47 Ohms	Short/Open circuit
C	Resistor R21	1 kOhm	Short/Open circuit
D	Resistor R23/R23A (No R23A on 700VA / 100VA)	0.5 Ohms 0.22 Ohm (700VA)	Short/Open circuit
E	Regulator U3 (between Input and Output)	>1 MOhm	Short/Open circuit
F	Controller i.c. (3845) U2: Pin 5-6 Pin 5-7 Pin 5-8 Pin 6-8	>1 MOhm >1 MOhm >1.5 kOhm >1 MOhm	Lower resistance

3. Carry out a resistance check of the power supply rails as detailed below. If the measured resistance is much lower than the suggested figures it indicates that the original problem was due to an overload on one of the Power Supply outputs. Unless the components causing the overload problem can be identified by observation (i.e. shows signs of overheating / distortion) then return the faulty board(s) for repair:

Note: Use the flange of U3 (E) as the 0V reference.

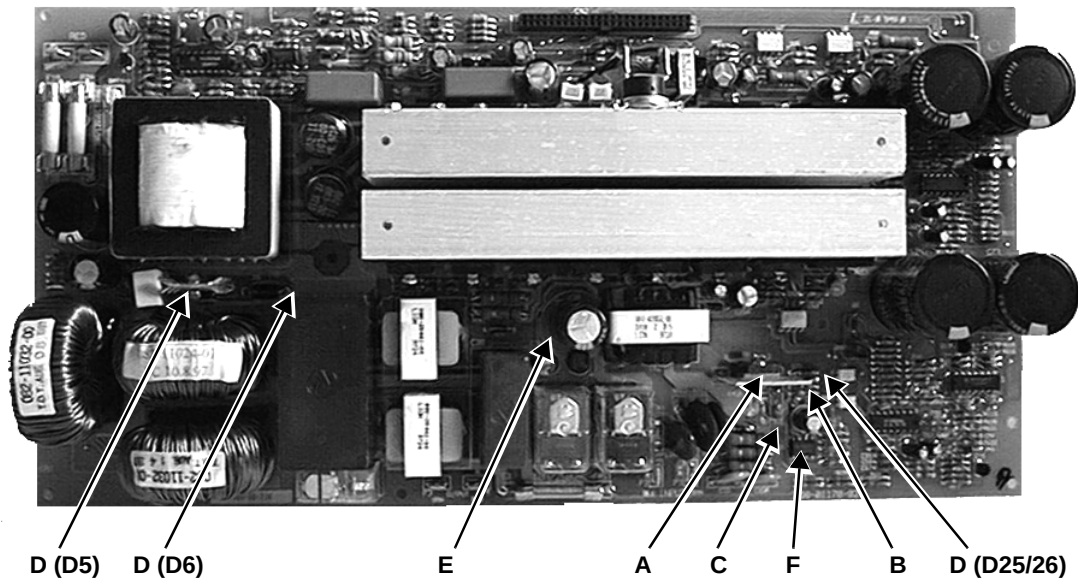
REF	Test Point	Control Board Fitted?	Typical Resistance
G	+24V Rail at D20 cathode	Yes / No	2.4k / 2.4k Ohms
H	+12V Rail at U3 input	Yes / No	>1M / >1M Ohms
I	+5V Rail at U3 output (or C21+)	Yes / No	8.4k / 2.6k Ohms

6.6.3 Power checks

4. If ALL the components listed in steps (2/3) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger's electrolytic(s).
5. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
6. If the UPS still fails to work correctly and indicates a Power Supply problem then:
 - a. remove the Power Board once again (remember to discharge the Charger and DC Busbar capacitors).
 - b. replace U2 (3845) (F) and transformer TX3 (J).
 - c. refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then replace the Power Board and Control Board in turn.

6.7 Battery Charger check procedure (for 2000/3000VA models see Paragraph 6.15)

Figure 6.5 - Battery Charger procedure component identification*



* Photograph shows 1500VA Power Board. Components are in same relative positions on 700VA & 1000 VA models

6.7.1 Fault characteristics

A Battery Charger malfunction could affect the UPS in several ways:

- If the charger just stop working (e.g. turned OFF by the Control Board) not only would the battery lose its float charge supply but it would also begin to slowly discharge as it is now required to furnish the DC Power Supply operating power.
The same effects would result from a charger overload which causes its output voltage to fold-back under current limit control.
- If the charger operates at too great a voltage it could cause a rise in battery temperature (and battery damage in extreme cases) and the DC Power Supply switching transistor circuitry.
- If the charger develops a short-circuit output it will rupture the Battery fuses F1/F2, the DC Power Supply will also lose its operating power and the UPS would therefore totally shutdown (perhaps in a disorderly manner which triggers failure in other UPS power areas).

A Battery Charger fault usually can be attributed to:

- a. A faulty Battery Charger power component, which renders the circuit inoperable.
- b. An overload on its output supply rail due to a faulty DC Power Supply, or serious battery problem.
Note: a DC Power Supply problem may affect the operation of *any* of the UPS power blocks and initiate a related error indication.
- c. A problem with the Battery Charger control fault which either fails to turn on the controlling transistor (resulting in low output volts and perhaps a 'battery on-load' condition) or, conversely, turns on the transistor inappropriately – causing an excessive charger output voltage.

This procedure seeks to identify a problem falling into the (a) and (b) categories above; a control problem can be identified by carrying out the functional check procedure in Paragraph 5.6

6.7.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following Battery Charger components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	Switching transistor Q8* (Drain-Source)	0.5 (diode range)	Short/Open circuit
B	Resistor R42	47 Ohms	Short/Open circuit
C	Resistor R45	0.75 Ohm (1 Ohm on 700/1000VA)	Short/Open circuit
D	Diodes D25 / D26 / D5 / D6	0.5 - 0.5 (diode range)	Short/Open circuit
E	Diode bridge REC2 (measure across C30) (Bridge is formed by D28-D31 on 700VA / 1000VA models)	0.5 (diode range)	Short/Open circuit
F	Controller i.c. (3845) U6: Pin 5-6 Pin 5-7 Pin 5-8 Pin 6-8	45 - 50 kOhm >1 MOhm 3 - 4 kOhm 50 - 60 kOhm	Lower resistance

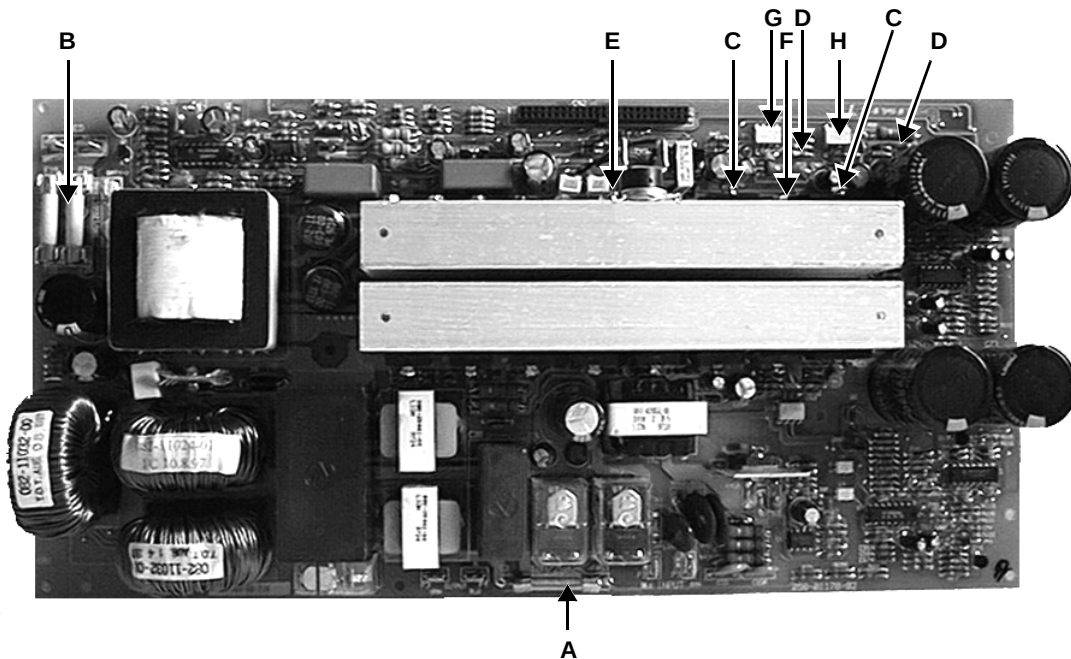
*** If Q8 is faulty then also replace ALL other components listed in the above table.**

6.7.3 Power checks

3. If ALL the components listed in steps (2/3) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger's electrolytic(s).
4. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (see paragraph 5.6).
 - b. completely reassemble the UPS and return it to service.
5. If the UPS still fails to work correctly:
 - a. remove the Power Board once again (remember to discharge the Charger and DC Busbar capacitors).
 - b. replace U6 (3845) U4 Opto and transformer TX2.
6. Refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then replace the Power Board and Control Board in turn.

6.8 Inverter check procedure (for 2000/3000VA models see Paragraph 6.16)

Figure 6.6 - Inverter procedure component identification*



* Photograph shows 1500VA Power Board. Components are in same relative positions on 700VA & 1000 VA models

6.8.1 Fault characteristics

An Inverter fault usually can be attributed to:

- A faulty Inverter power component, which renders the circuit inoperable. In extreme circumstances this could overload the PFC Rectifier to the extent that it could rupture the input fuse.
- An overload on the circuit's output, due to a problem with the load or output filter components. An output overload problem should trip the inverter off line in a controlled manner (transferring the load to the bypass supply).
- An Inverter control fault which turns on the Inverter transistors in such a manner as to produce an incorrect output voltage or inappropriate waveform – this is normally due to a Control Board micro-controller problem (which controls the PWM waveform).

This procedure seeks to identify a problem falling into the (a) and (b) categories above; however, due to the inaccessibility of the components on the Control Board when it is in-situ there is little that can be done to troubleshoot the control circuit at component level, and this situation is best remedied by replacing the Control Board and returning the suspect Board for bench testing.

6.8.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following Inverter components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	Input Fuse F3	Short	Open circuit
B	Battery Fuses F1 / F2	Short	Open circuit
C	Inverter transistors Q12 / Q13*	0.42 (diode range)	Short/Open circuit
D	Gate drive resistors R50 / R56**	47 Ohms	Short/Open circuit

* Q12 is in parallel with D38 (E) and Q13 with D34 (F). If a short circuit is found across the transistors it could be due to a faulty diode - replace *both* transistors and *both* diodes if a fault is found.

** If a gate drive resistor is found faulty then replace opto-isolators U7/U8 (G/H) as a precaution, as they too are likely to be damaged.

6.8.3 Power checks

3. If ALL the components listed in steps (2) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger's electrolytic(s).
4. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
5. If the UPS still fails to work correctly:
 - a. replace the Control Board to determine if it is the cause of the problem. If the Inverter operates correctly with the replacement Control Board then replace U1 / U2 / U3 / U5 on the removed Control Board and then refit it to determine if it is now serviceable (if not then return the Control Board for repair).
 - b. If the problem is not rectified by substituting the Control Board then replace the Power Board and return the old board for repair.

Refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then replace the Power Board and Control Board in turn.

6.9 Overtemperature checks

The inverter transistors' heatsink temperature is monitored by a normally-closed thermostat which opens at 90°C to provide the Overtemperature Warning. The UPS is rated at full load over a temperature range of 0-40°C.

6.9.1 Fault characteristics

The heatsink temperature is affected by the of power being demanded by the output load and the amount (and temperature) of cooling air being drawn across the heatsink by the cooling fans.

An overtemperature fault can therefore usually can be attributed to:

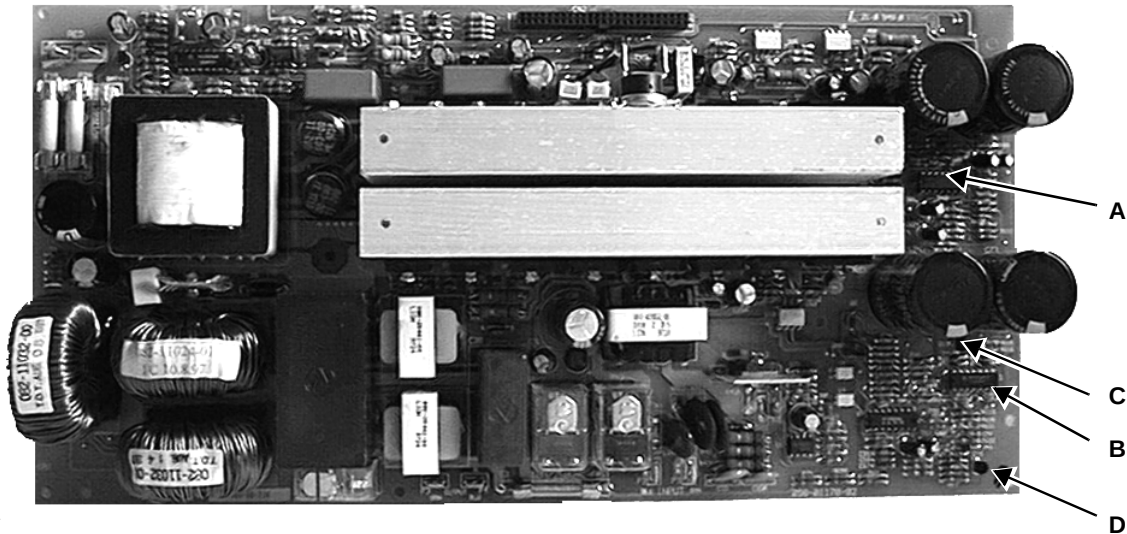
- a. Too high a load demand for an extended period with consideration to the prevailing ambient air temperature.
- b. Excessive ambient air temperature.
- c. Low cooling air flow due to failed fan(s), blocked / obstructed ventilation grill(s).
- d. Faulty thermostat or Control Board electronics.

6.9.2 Check procedure

1. Check the indicated UPS Load and reduce if applicable.
2. Check ambient air temperature, and ensure that the UPS ventilation grills (front / rear) are unobstructed – rectify problem(s) as applicable.
3. Verify that the cooling fans are running (both audibly and by feeling for available airflow). If the fans are not working then turn OFF the UPS, gain internal access (*see paragraph 5.3*) and replace the fan(s) as necessary.
4. If all the above appear to be satisfactory then:
 - a. turn OFF the UPS, gain internal access (*see paragraph 5.3*)
 - b. check the thermostat / wiring for open-circuit fault.
 - c. Replace the thermostat if found faulty, otherwise suspect a problem with the Control Board. Replace the Control Board.

6.10 DC Voltage Feedback loop checks (for 2000/3000VA models see Paragraph 6.18)

Figure 6.7 - DC Feedback component identification*



* Photograph shows 1500VA Power Board. Components are in same relative positions on 700VA & 1000 VA models

6.10.1 Fault characteristics

The DC Busbar voltage feedback circuit provides a signal which controls the regulated outputs of both the PFC Rectifier and DC-DC Converter – i.e. the supply voltage to the Inverter when it is operating in ‘on-mains’ and ‘on-battery’ modes respectively. In extreme circumstances it can prevent the inverter from operating.

A faulty DC Voltage feedback component can lead to:

- a. DC Overvoltage fault condition
- b. DC Undervoltage fault condition
- c. Unbalanced inverter output (with respect to ground).

Carry out the following repair procedure if you have worked through the *PFC Rectifier* or *DC-DC Converter* check procedures without successfully clearing the associated UPS fault.

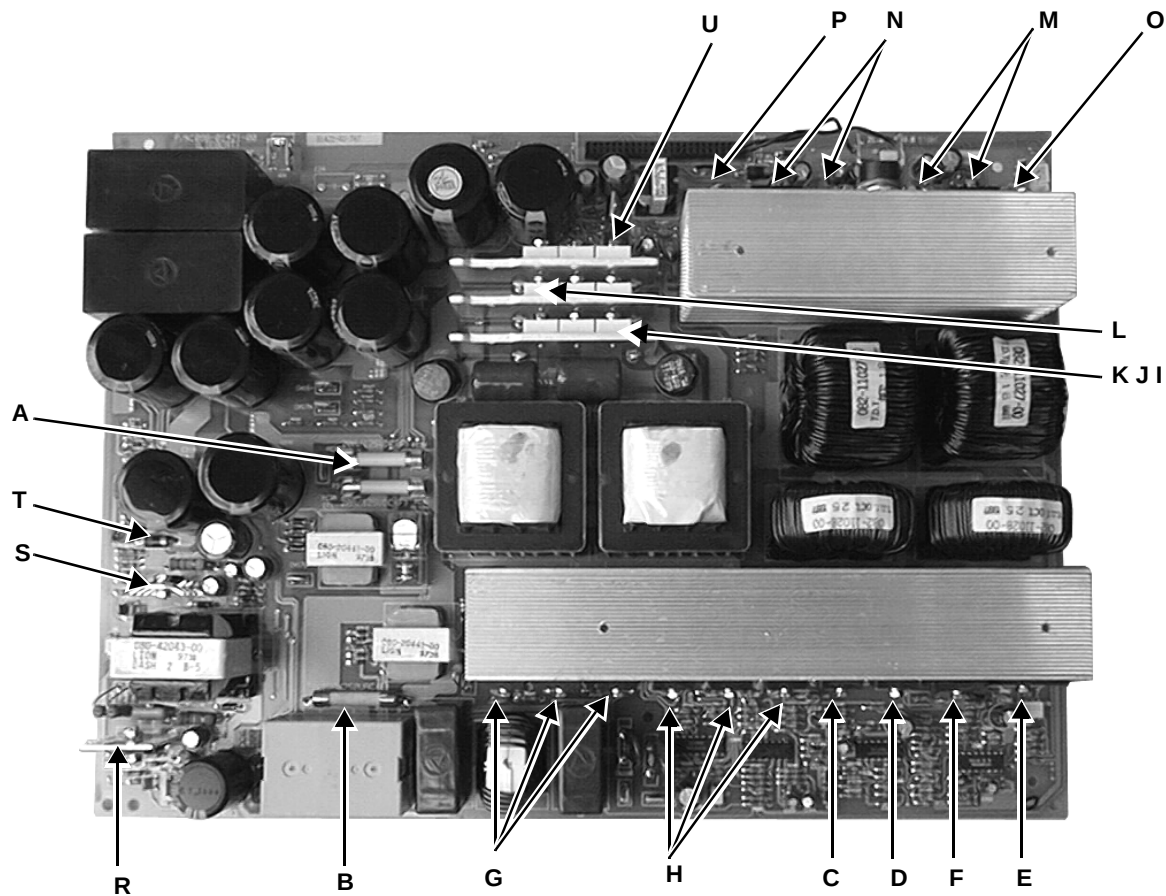
6.10.2 Repair procedure

This procedure assumes that there is a problem with the PFC Rectifier or DC-DC Converter output (DC Busbar voltage) and that the appropriate check procedure has been carried out without curing the problem.

1. Gain internal UPS access and replace the Control Board.
2. If this rectifies the problem then suspect a faulty micro-controller (U6) on the removed Control Board.
3. If replacing the Control Board does not rectify the problem then
 - a. remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
 - b. on the Power Board, replace U9 (A), U12 (B), Q15 (C), Q16 (D).
4. Refit the Power Board and Control Board, and measure the DC Busbar voltage.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger’s electrolytic(s).
5. If the DC Busbar voltage is still incorrect then replace the Power Board and return the faulty board for repair.

6.11 Quick Start (for 700/100/1500VA models see Paragraph 6.3)

Figure 6.8 - 'Quick Start' procedure component location*



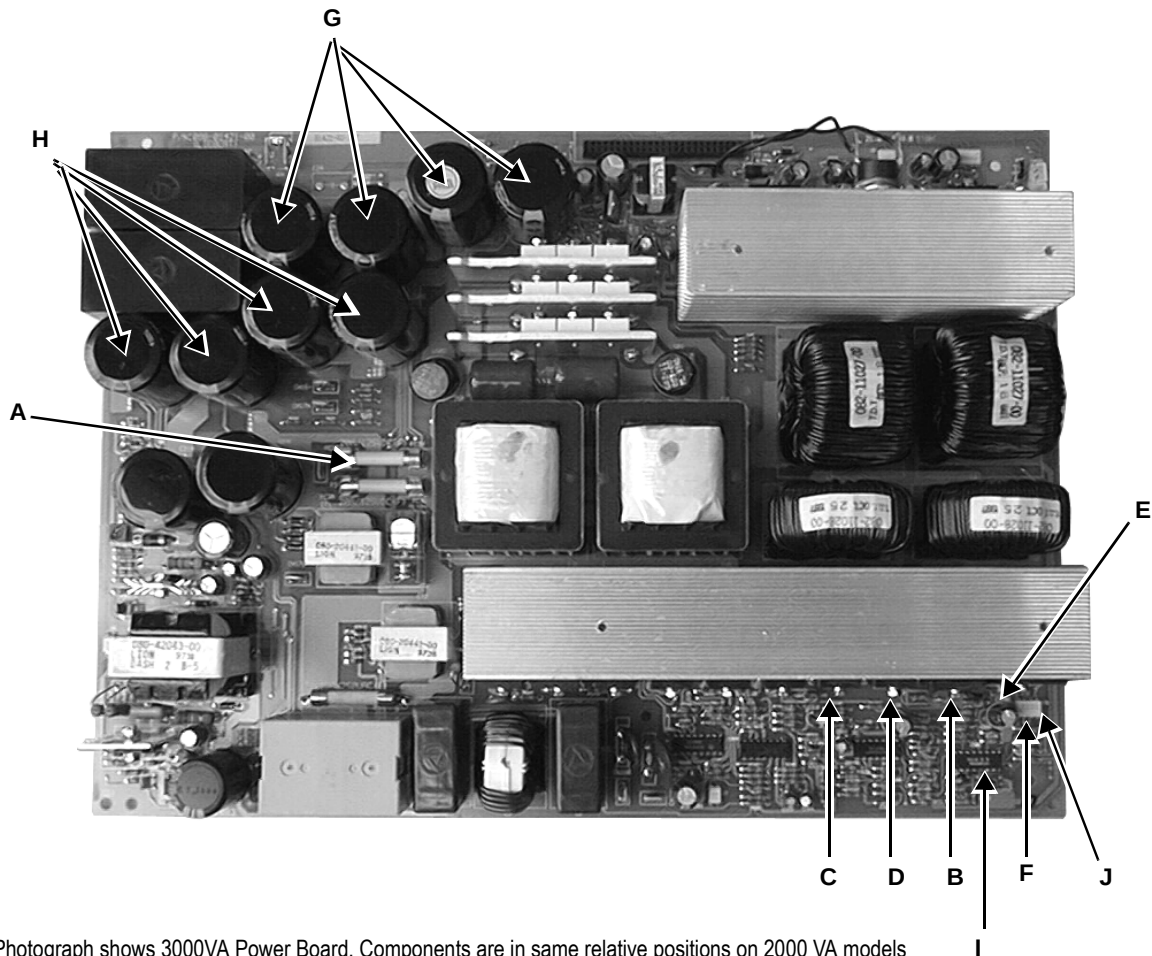
* Photograph shows 3000VA Power Board. Components are in same relative positions on 2000 VA models

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check the Battery Fuses F2/3 (A)
If the battery fuse(s) are ruptured it could be due to:
 - faulty battery; faulty Battery Charger; faulty L.V Power Supply (or problem elsewhere on the board placing a short on the power supply rails)
3. Check the Input Fuse F1 (B)
If the input fuse is blown it could be due to:
 - faulty PFC Rectifier; faulty Control Board; faulty Inverter or severe instantaneous output overload.
4. PFC Rectifier section:
 - Check D509 (C) and D510 (D) for open/short circuit.
 - Check diode bridge BR02 (E) for open/short circuit between any two legs.
 - Check FET Q1A (F) Drain-to-Source for open/short circuit.
5. DC-DC Converter:
 - Check FETs Q501/502/503 (G) Drain-to-Source for open/short circuit (Q501 not fitted to 2000VA model). (Note these devices are connected in parallel and all three should be replaced if any one fails).
 - Check FETs Q504/505/506 (H) Drain-to-Source for open/short circuit (Q504 not fitted to 2000VA model). (Note these devices are connected in parallel and all three should be replaced if any one fails).
 - Check power diodes D501 (I), D502 (J) D503 (K), D504 (L) for open/short circuit. (Note: these are connected in a bridge format across the DC Busbar and the busbar capacitors can be seen charging/discharging depending on the polarity of the meter leads).

6. Inverter:
 - Check FETs Q5/7 (M) and Q12/13 (N) Drain-to-Source for open/short circuit
 - Check power diodes D12 (O), D13 (P) for open/short circuit (Note: these are in parallel with Q5/7 & Q12/13)
7. Battery Charger:
 - Check FET Q208 (R) Drain-to-Source for open/short circuit
 - Check power diodes D511 (S), D202A (T) for open/short circuit
8. DC Power Supply:
 - Check FET Q3 (U) Drain-to-Source for open/short circuit

6.12 PFC Rectifier check procedure (for 700/100/1500VA models see Paragraph 6.4)

Figure 6.9 - 'PFC Rectifier' procedure component location*



* Photograph shows 3000VA Power Board. Components are in same relative positions on 2000 VA models

6.12.1 Fault characteristics

A PFC Rectifier fault usually can be attributed to:

- A faulty PFC power component, which renders the circuit inoperable and likely to rupture the input fuse.
- An overload on the circuit's output DC Busbar(s), due to shorted busbar or inverter problem. Once again, this could rupture the input fuse in extreme cases, or else force the PFC to operate in a current limited mode.
- A PFC Control fault which either fails to turn on the controlling transistor (resulting in low DC Bus volts and perhaps a 'battery on-load' condition) or, conversely, turns on the transistor inappropriately – causing an unbalanced output, or once again rupturing the input fuse.

This procedure seeks to identify a problem falling into the (a) and (b) categories above; however, due to the inaccessibility of the components on the Control Board when it is in-situ there is little that can be done to troubleshoot the control circuit at component level, and this situation is best remedied by replacing the Control Board and returning the suspect Board for bench testing.

6.12.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following PFC Rectifier components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	input Fuse F1	Short circuit	Open circuit
B	PFC Power Controller Transistor Q1A (Drain-Source)	0.46 (diode range)	Short/Open circuit
C/D	Flywheel diode D509 / D510	0.46 (diode range)	Short/Open circuit
E	Resistor R2A	10 Ohms	Short/Open circuit
F	Diode bridge BR02 (between adjacent terminals)	0.46 (diode range)	Short/Open circuit

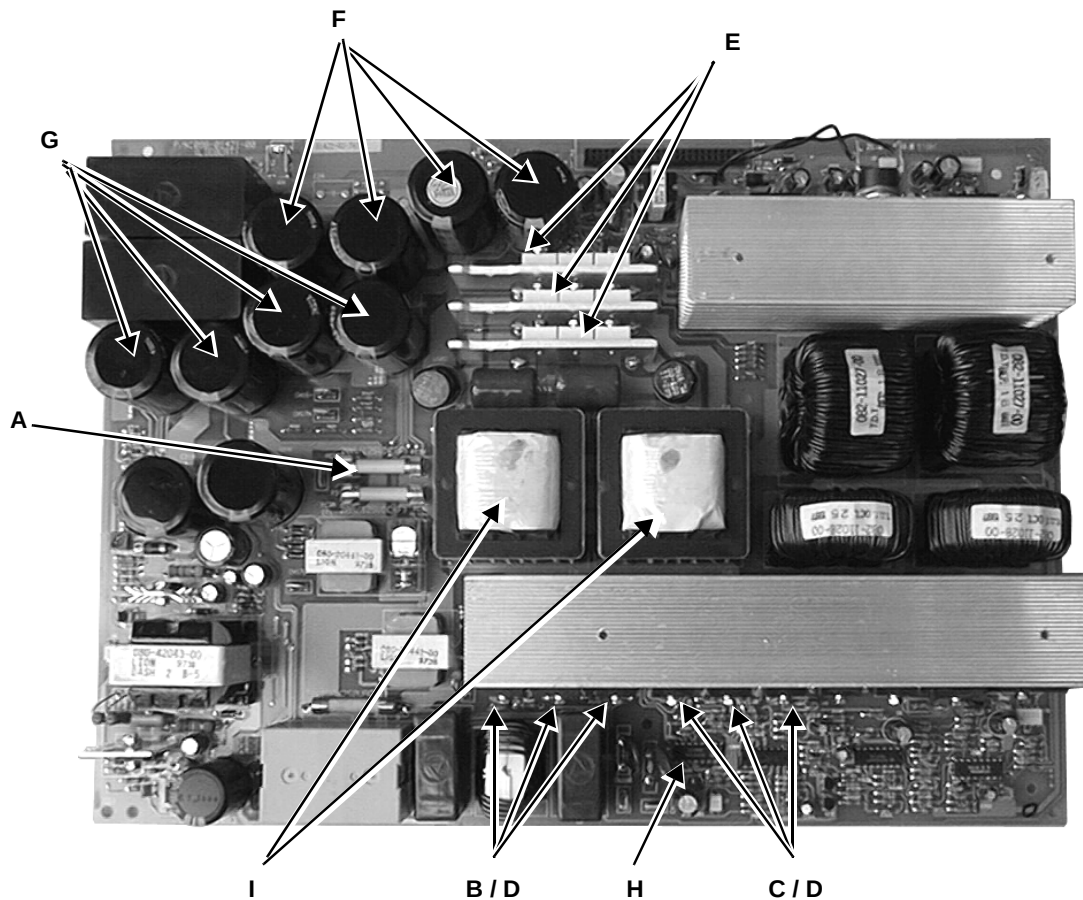
3. Check out the DC Busbar by measuring the resistance across the positive bus capacitors (G) and negative bus capacitors (H) (observe polarity). The result should show typical capacitor charging characteristics to high impedance. If a short-circuit or low resistance is indicated then:
 - a. check for a faulty electrolytic capacitor and replace where necessary.
 - b. if the capacitors are serviceable then there is likely to be a faulty Inverter power component, or short-circuited diode in the DC-DC Converter circuit's output – carry out the Inverter / DC-DC Converter static checks.

6.12.3 Power checks

4. If ALL the components listed in step (2) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuse and damage the charger's electrolytic(s).
5. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
6. If the PFC Rectifier still fails to work correctly.
 - a. remove the Power Board once again (remember to discharge the Charger and DC Busbar capacitors).
 - b. replace U305 (3854) (I) and U10 (TLP250) (J).
 - c. refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then check out the DC Feedback loop components (*see paragraph 6.18*) or replace the Power Board and Control Board in turn.

6.13 DC-DC Converter check procedure (for 700/100/1500VA models see Paragraph 6.5)

Figure 6.10 - DC-DC Converter procedure component identification*



* Photograph shows 3000VA Power Board. Components are in same relative positions on 2000 VA models

6.13.1 Fault characteristics

A DC-DC Converter fault usually can be attributed to:

- A faulty power component, which renders the circuit inoperable. Depending on the failure mode, this is likely to rupture the battery fuses (F2/F3) or render the circuit incapable of sustaining the UPS output when working 'on battery'. A short-circuited DC-DC Converter output diode could also effectively present a short-circuit to the DC Busbar which in turn could affect the PFC Rectifier's operation (with possible input fuse failure).
- An overload on the circuit's output DC Busbar(s), due to shorted busbar or inverter problem. Once again, this could rupture the battery fuses in extreme cases, or else force the DC-DC Converter to operate in a current limited mode, which prevents correct operation when 'on battery'.
Note: if there is a short-circuit fault on the DC Bus / Inverter, it will also affect the PFC Rectifier operation (see paragraph 6.12) under normal circumstances and will affect the DC-DC converter only in the event of an input supply failure.
- A DC-DC Converter control fault which either fails to turn on the controlling transistors (resulting in total inability to run the UPS 'on battery' or, conversely, turns on the transistor inappropriately – causing an unbalanced or excessive DC Busbar voltage, or once again rupturing the battery fuses.

This procedure seeks to identify a problem falling into the (a) and (b) categories above; however, due to the inaccessibility of the components on the Control Board when it is in-situ there is little that can be done to troubleshoot the control circuit at component level, and this situation is best remedied by replacing the Control Board and returning the suspect Board for bench testing.

6.13.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following DC-DC Converter components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	Battery fuses F2/F3	Short circuit	Open circuit
B	Transistors Q501*/502/503 (paralleled) (Drain-Source)	0.43 (diode range)	Short/Open circuit
C	Transistors Q504*/505/506 (paralleled) (Drain-Source)	0.43 (diode range)	Short/Open circuit
D	Gate resistors R510-R516 (10R)	10 Ohms	Short/Open circuit
E	Diodes D510-D508	0.40 (diode range)	Short/Open circuit
	<i>*Q501/Q504 are not fitted to 2000VA model even though they are shown on the circuit diagram</i>		

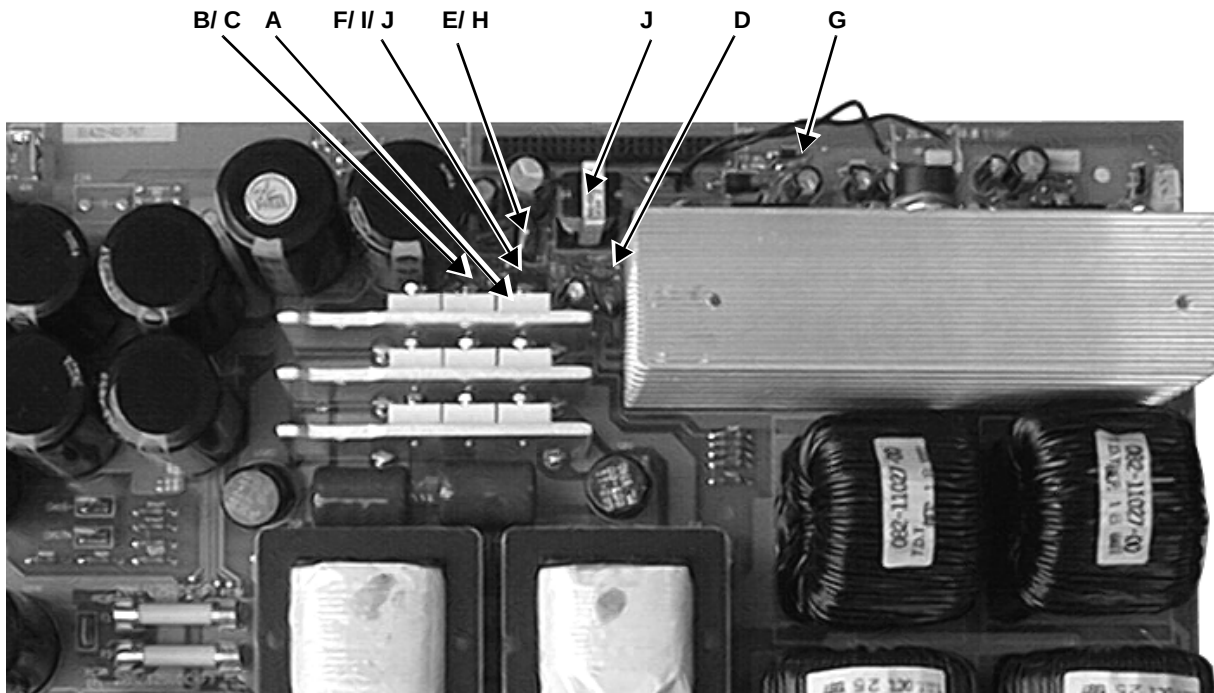
3. Check out the DC Busbar by measuring the resistance across the positive bus capacitors (F) and negative bus capacitors (G) (observe polarity). The result should show typical capacitor charging characteristics to high impedance. If a short-circuit or low resistance is indicated then:
 - a. check for a faulty electrolytic capacitor and replace where necessary.
 - b. if the capacitors are serviceable then there is likely to be a faulty Inverter power component, or short-circuited diode in the DC-DC Converter circuit's output – carry out the Inverter / PFC Rectifier static checks.

6.13.3 Power checks

4. If ALL the components listed in steps (2/3) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger's electrolytic(s).
5. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
6. If the DC-DC converter still fails to work correctly (i.e. the UPS will not operate 'on battery'):
 - a. remove the Power Board once again (remember to discharge the Charger and DC Busbar capacitors).
 - b. replace U501 (3525) (H) and transformer TX501/502 (I).
 - c. refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then check out the DC Feedback loop components (*see paragraph 6.18*) or replace the Power Board and Control Board in turn.

6.14 DC Power Supply check procedure (for 700/100/1500VA models see Paragraph 6.6)

Figure 6.11 - DC Power Supply procedure component identification*



* Photograph shows 3000VA Power Board. Components are in same relative positions on 2000 VA models

6.14.1 Fault characteristics

A DC Power Supply fault will render the UPS totally inoperable to the extent that the UPS totally shuts down and the Operator Panel may appear to be totally 'dead' (no indications) or display 'nonsensical conditions'. This type of fault also prevents the UPS from being started, and if it occurs when on line it could also cause fault repercussions in other areas of the UPS.

A DC Power Supply fault usually can be attributed to:

- a. A faulty Power Supply power component, which renders the circuit inoperable. Depending on the failure mode, this could rupture the battery fuses (F2/F3).
- b. An overload on one of the circuit's output supply rails due to a faulty UPS control circuit component (on either the Power Board or Control Board).
Note: such a problem may affect the operation of *any* of the UPS power blocks and initiate a related error indication.
- c. A problem with the Battery Charger block.
The DC Power Supply is normally powered from the Battery Charger output and if this power source is unavailable it will take its operating power from the battery, thereby causing the battery to discharge.

This procedure seeks to identify a problem falling into the (a) and (b) categories above; the Battery Charger circuit check procedure is provided in Paragraph 6.15.

6.14.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following DC Power Supply components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	Switching transistor Q3 (Drain-Source)	0.43 (diode range)	Short/Open circuit
B	Resistor R402	47 Ohms	Short/Open circuit
C	Resistor R404	1 kOhm	Short/Open circuit
D	Resistor R32	0.5 Ohms	Short/Open circuit
E	Regulator U311 (between Input and Output)	>1 MOhm	Short/Open circuit
F	Controller i.c. (3845) U302: Pin 5-6 Pin 5-7 Pin 5-8 Pin 6-8	>1 MOhm >1 MOhm >1.5 kOhm >1 MOhm	Lower resistance

3. Carry out a resistance check of the power supply rails as detailed below. If the measured resistance is much lower than the suggested figures it indicates that the original problem was due to an overload on one of the Power Supply outputs. Unless the components causing the overload problem can be identified by observation (i.e. shows signs of overheating / distortion) then return the faulty board(s) for repair:
Note: Use the flange of U311 (E) as the 0V reference.

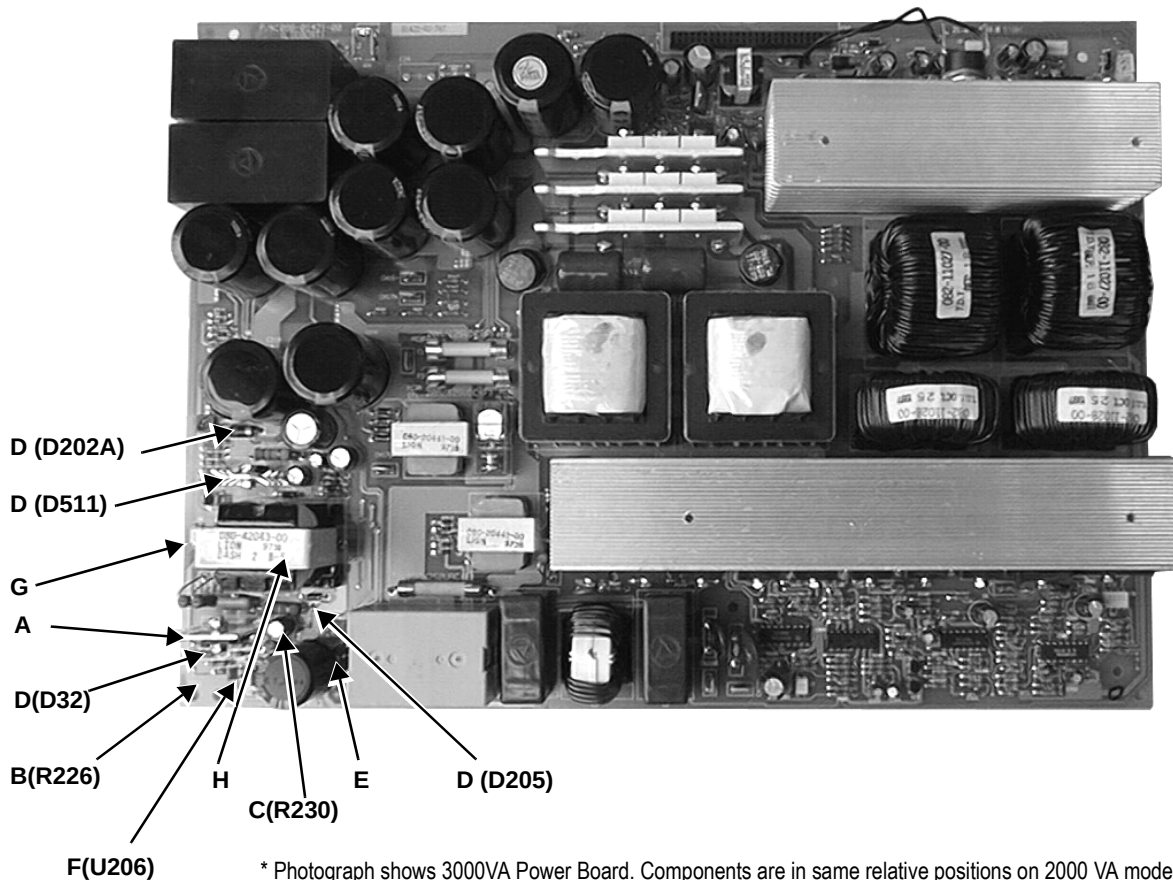
REF	Test Point	Control Board Fitted?	Typical Resistance
G	+24V Rail at D330 cathode	Yes / No	2.4k / 2.4k Ohms
H	+12V Rail at U311 input	Yes / No	>1M / >1M Ohms
I	+5V Rail at U311 output (or C21+)	Yes / No	8.4k / 2.6k Ohms

6.14.3 Power checks

4. If **ALL** the components listed in steps (2/3) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger's electrolytic(s).
5. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
6. If the UPS still fails to work correctly and indicates a Power Supply problem then:
 - a. remove the Power Board once again (remember to discharge the Charger and DC Busbar capacitors).
 - b. replace U302 (3845) (F) and transformer TX305 (J).
 - c. refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then replace the Power Board and Control Board in turn.

6.15 Battery Charger check procedure (for 700/100/1500VA models see Paragraph 6.7)

Figure 6.12 - Battery Charger procedure component identification*



* Photograph shows 3000VA Power Board. Components are in same relative positions on 2000 VA models

6.15.1 Fault characteristics

A Battery Charger malfunction could affect the UPS in several ways:

- If the charger just stop working (e.g. turned OFF by the Control Board) not only would the battery lose its float charge supply but it would also begin to slowly discharge as it is now required to furnish the DC Power Supply operating power.
The same effects would result from a charger overload which causes its output voltage to fold-back under current limit control.
- If the charger operates at too great a voltage it could cause a rise in battery temperature (and battery damage in extreme cases) and the DC Power Supply switching transistor circuitry.
- If the charger develops a short-circuit output it will rupture the Battery fuses F2/F3, the DC Power Supply will also lose its operating power and the UPS would therefore totally shutdown (perhaps in a disorderly manner which triggers failure in other UPS power areas).

A Battery Charger fault usually can be attributed to:

- a. A faulty Battery Charger power component, which renders the circuit inoperable.
- b. An overload on its output supply rail due to a faulty DC Power Supply, or serious battery problem.
Note: a DC Power Supply problem may affect the operation of *any* of the UPS power blocks and initiate a related error indication.
- c. A problem with the Battery Charger control fault which either fails to turn on the controlling transistor (resulting in low output volts and perhaps a 'battery on-load' condition) or, conversely, turns on the transistor inappropriately – causing an excessive charger output voltage.

This procedure seeks to identify a problem falling into the (a) and (b) categories above; a control problem can be identified by carrying out the functional check procedure in Paragraph 5.6

6.15.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following Battery Charger components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	Switching transistor Q208* (Drain-Source)	0.5 (diode range)	Short/Open circuit
B	Resistor R226	47 Ohms	Short/Open circuit
C	Resistor R230	0.75 Ohm	Short/Open circuit
D	Diodes D511/202A/205/32	0.5 - 0.5 (diode range)	Short/Open circuit
E	Diode bridge BR01 (measure across C16)	0.5 (diode range)	Short/Open circuit
F	Controller i.c. (3845) U206: Pin 5-6 Pin 5-7 Pin 5-8 Pin 6-8	45 - 50 kOhm >1 MOhm 3 - 4 kOhm 50 - 60 kOhm	Lower resistance

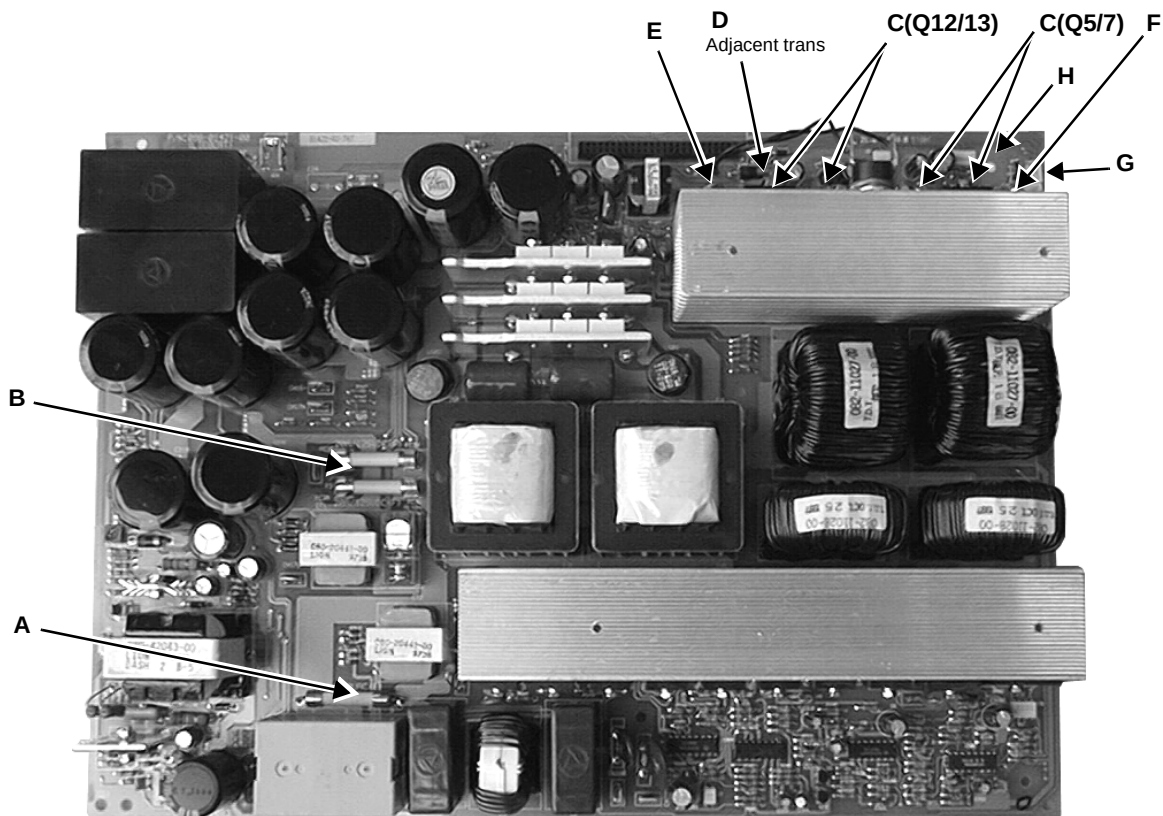
*** If Q208 is faulty then also replace ALL other components listed in the above table.**

6.15.3 Power checks

3. If ALL the components listed in steps (2/3) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger's electrolytic(s).
4. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
5. If the UPS still fails to work correctly:
 - a. remove the Power Board once again (remember to discharge the Charger and DC Busbar capacitors).
 - b. replace U206 (3845)(F), U6 Opto (G) and transformer TX1 (H).
6. Refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then replace the Power Board and Control Board in turn.

6.16 Inverter check procedure (for 700/100/1500VA models see Paragraph 6.8)

Figure 6.13 - Inverter procedure component identification*



* Photograph shows 3000VA Power Board. Components are in same relative positions on 2000 VA models

6.16.1 Fault characteristics

An Inverter fault usually can be attributed to:

- A faulty Inverter power component, which renders the circuit inoperable. In extreme circumstances this could overload the PFC Rectifier to the extent that it could rupture the input fuse.
- An overload on the circuit's output, due to a problem with the load or output filter components. An output overload problem should trip the inverter off line in a controlled manner (transferring the load to the bypass supply).
- An Inverter control fault which turns on the Inverter transistors in such a manner as to produce an incorrect output voltage or inappropriate waveform – this is normally due to a Control Board micro-controller problem (which controls the PWM waveform).

This procedure seeks to identify a problem falling into the (a) and (b) categories above; however, due to the inaccessibility of the components on the Control Board when it is in-situ there is little that can be done to troubleshoot the control circuit at component level, and this situation is best remedied by replacing the Control Board and returning the suspect Board for bench testing.

6.16.2 Static checks

1. Remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
2. Check **ALL** the following Inverter components and replace where necessary:

REF	Component	Normal Value	Fault Value?
A	Input Fuse F1	Short	Open circuit
B	Battery Fuses F2 / F3	Short	Open circuit
C	Inverter transistors Q5 / Q7 / Q12 / Q13	0.42 (diode range)	Short/Open circuit
D	Gate drive resistors R10 / R11 / R30 / R33 **	47 Ohms	Short/Open circuit

*** Q12/13 are in parallel with D12 (E) and Q5/7 with D13 (F). If a short circuit is found across the transistors it could be due to a faulty diode - replace *both* transistors and *both* diodes if a fault is found.**

**** If a gate drive resistor is found faulty then replace opto-isolators U2/U3 (G/H) as a precaution, as they too are likely to be damaged.**

6.16.3 Power checks

3. If ALL the components listed in steps (2) are serviceable (or have been replaced) then refit the Power Board and Control Board, and attempt to start the UPS to see if the fault is rectified.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger's electrolytic(s).
4. If the UPS appears to operate correctly:
 - a. carry out the Functional Check Procedure (*see paragraph 5.6*).
 - b. completely reassemble the UPS and return it to service.
5. If the UPS still fails to work correctly:
 - a. replace the Control Board to determine if it is the cause of the problem. If the Inverter operates correctly with the replacement Control Board then replace U1 / U2 / U3 / U5 on the removed Control Board and then refit it to determine if it is now serviceable (if not then return the Control Board for repair).
 - b. If the problem is not rectified by substituting the Control Board then replace the Power Board and return the old board for repair.

Refit the Power Board and Control Board and attempt to start the UPS. If the fault is still present then replace the Power Board and Control Board in turn.

6.17 Overtemperature checks

The inverter transistors' heatsink temperature is monitored by a normally-closed thermostat which opens at 90°C to provide the Overtemperature Warning. The UPS is rated at full load over a temperature range of 0-40°C.

6.17.1 Fault characteristics

The heatsink temperature is affected by the of power being demanded by the output load and the amount (and temperature) of cooling air being drawn across the heatsink by the cooling fans.

An overtemperature fault can therefore usually can be attributed to:

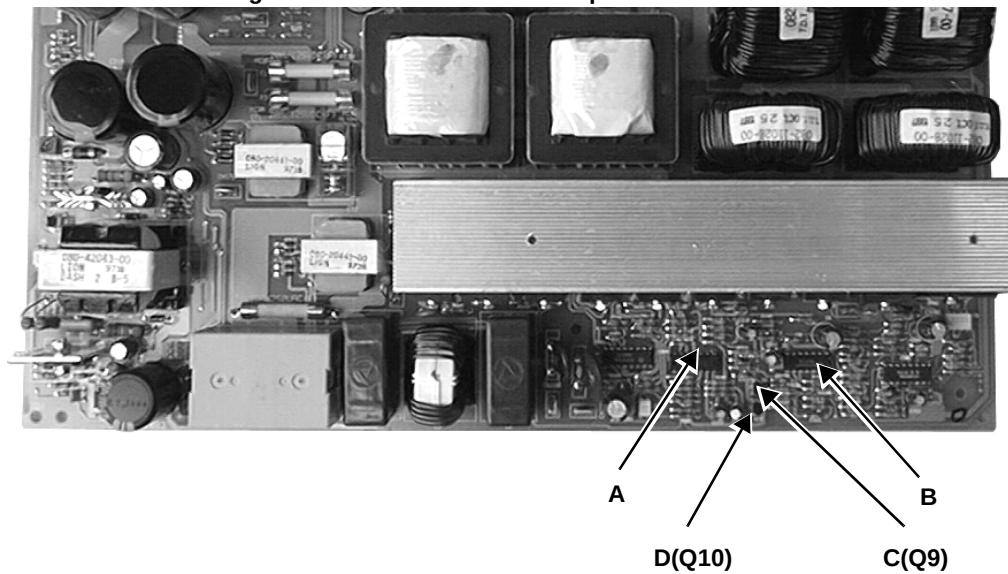
- a. Too high a load demand for an extended period with consideration to the prevailing ambient air temperature.
- b. Excessive ambient air temperature.
- c. Low cooling air flow due to failed fan(s), blocked / obstructed ventilation grill(s).
- d. Faulty thermostat or Control Board electronics.

6.17.2 Check procedure

1. Check the indicated UPS Load and reduce if applicable.
2. Check ambient air temperature, and ensure that the UPS ventilation grills (front / rear) are unobstructed – rectify problem(s) as applicable.
3. Verify that the cooling fans are running (both audibly and by feeling for available airflow). If the fans are not working then turn OFF the UPS, gain internal access (*see paragraph 5.3*) and replace the fan(s) as necessary.
4. If all the above appear to be satisfactory then:
 - a. turn OFF the UPS, gain internal access (*see paragraph 5.3*)
 - b. check the thermostat / wiring for open-circuit fault.
 - c. Replace the thermostat if found faulty, otherwise suspect a problem with the Control Board. Replace the Control Board.

6.18 DC Voltage Feedback loop checks (for 700/100/1500VA models see Paragraph 6.10)

Figure 6.14 - DC Feedback component identification*



* Photograph shows 3000VA Power Board. Components are in same relative positions on 2000 VA models

6.18.1 Fault characteristics

The DC Busbar voltage feedback circuit provides a signal which controls the regulated outputs of both the PFC Rectifier and DC-DC Converter – i.e. the supply voltage to the Inverter when it is operating in ‘on-mains’ and ‘on-battery’ modes respectively. In extreme circumstances it can prevent the inverter from operating.

A faulty DC Voltage feedback component can lead to:

- a. DC Overvoltage fault condition
- b. DC Undervoltage fault condition
- c. Unbalanced inverter output (with respect to ground).

Carry out the following repair procedure if you have worked through the *PFC Rectifier* or *DC-DC Converter* check procedures without successfully clearing the associated UPS fault.

6.18.2 Repair procedure

This procedure assumes that there is a problem with the PFC Rectifier or DC-DC Converter output (DC Busbar voltage) and that the appropriate check procedure has been carried out without curing the problem.

1. Gain internal UPS access and replace the Control Board.
2. If this rectifies the problem then suspect a faulty micro-controller (U6) on the removed Control Board.
3. If replacing the Control Board does not rectify the problem then
 - a. remove the Power Board following the dismantling procedure in Paragraph 5.5 and discharge the Charger and DC Bus capacitors.
 - b. on the Power Board, replace U304 (A), U1 (B), Q9 (C), Q10 (D).
4. Refit the Power Board and Control Board, and measure the DC Busbar voltage.
WARNING: Do not reconnect the batteries before applying the input mains power or the inrush current from the battery to the Charger circuit might rupture the battery fuses and damage the charger’s electrolytic(s).
5. If the DC Busbar voltage is still incorrect then replace the Power Board and return the faulty board for repair.

CHAPTER 7 - Spare Parts

7.1 Spare Parts Kits

GXT700MT-230		
Part Number	Qty	Description
102-00937-00	1	FUSE BUSS/S505 5A 250V CERAMIC (TIME DELAY)
118-20016-00	1	FAN NMB/3110KL-04W-B50- P00 80*80*25
373-00056-00	1	Enclosure, Top
520-00249-00	1	Bezel
710-01110-00	1	PCB SUB-ASSY 1XXX PANEL (LIEBERT) Display Board
710-01116-02	1	PCB SUB-ASSY 10X3 CNTL (LIEBERT) 230V Control Board
710-01126-00	1	PCB SUB-ASSY PSDR-1033 (LIEBERT) Main Power Board

GXT1000MT-230		
Part Number	Qty	Description
094-00046-01	1	FILTER DELTA/06DBDW3S
094-00050-00	1	FILTER DELTA/10DBAG5
100-20045-00	1	FUSE HOLDER EDK/FH-B12 10A 250V 5*20
100-70041-00	1	RECEPTACLE IEC320 C13 WS-045 4/4 10A250V OUTLET
102-00520-00	1	FUSE BUSS/S505 6.3A 250Vac TIME DELAY
108-00310-00	1	POWER CORD AWG12*(180,220) BLK,RED BANANA HEAD 2PAM
108-00311-00	1	POWER CORD AWG12*370 BLK,RED+CORD BANANA HEAD 2 PAF
118-20016-00	1	FAN NMB/3110KL-04W-B50- P00 80*80*25
373-00056-00	1	Enclosure, Top
520-00249-00	1	Bezel
710-01110-00	1	PCB SUB-ASSY 1XXX PANEL (LIEBERT) Display Board
710-01116-02	1	PCB SUB-ASSY 10X3 CNTL (LIEBERT) 230V Control Board
710-01179-01	1	PCB SUB-ASSY 1053 PSDR(LIEBERT)MT Main Power Board

GXT2000RT-230		
Part Number	Qty	Description
092-25050-00	1	NFB JOINTECH/ W28-XQ1A-12 12A 250Vac
102-21150-01	1	FUSE 30A 660V 10*38
118-20026-00	2	FAN NMB/3610KL-04W-B50- L00 12Vdc 92*82.5*25.8
373-02031-00	1	Enclosure, Top
373-02032-00	1	Enclosure, Top/Side
373-02033-00	1	Enclosure, Side
520-00239-00	1	Bezel
710-01108-01	1	PCB SUB-ASSY 1073,1083 EMI (LIEBERT) EMI/MOV Board
710-01110-00	1	PCB SUB-ASSY 1XXX PANEL (LIEBERT) Display Board
710-01116-02	1	PCB SUB-ASSY 10X3 CNTL (LIEBERT) 230V Control Board
710-01402-01	1	PCB SUB-ASSY 1073 PSDR (LIEBERT) Main Power Board

GXT3000RT-230+A28

Part Number	Qty	Description
092-22500-00	1	NFB PROTECTORS/UB2-X-1- 620E-16 1P 16A
092-25010-00	1	NFB JOINTECH/ W28-XQ1A-10 10A 250Vac
102-21150-01	1	FUSE 30A 660V 10*38
118-20026-00	2	FAN NMB/3610KL-04W-B50- L00 12Vdc 92*82.5*25.8
373-02031-00	1	Enclosure, Top
373-02032-00	1	Enclosure, Top/Side
373-02033-00	1	Enclosure, Side
520-00239-00	1	Bezel
710-01108-01	1	PCB SUB-ASSY 1073,1083 EMI (LIEBERT) EMI/MOV Board
710-01110-00	1	PCB SUB-ASSY 1XXX PANEL (LIEBERT) Display Board
710-01116-02	1	PCB SUB-ASSY 10X3 CNTL (LIEBERT) 230V Control Board
710-01421-01	1	PCB SUB-ASSY 1083 PSDR (LIEBERT) Main Power Board

GXT1500RT-230

Part Number	Qty	Description
520-00239-00	1	Bezel
710-01110-00	1	Display Board
710-01116-02	1	Control Board
710-01460-00	1	Main Power Board
373-02031-00		Enclosure, Top
373-02032-00	1	Enclosure, Top/Side
373-02033-00	1	Enclosure, Side
118-20016-00	1	Fan

GXT1000RT-230

Part Number	Qty	Description
520-00239-00	1	Bezel
710-01110-00	1	Display Board
710-01116-02	1	Control Board
710-01440-01	1	Main Power Board
373-02031-00	1	Enclosure, Top
373-02032-00	1	Enclosure, Top/Side
373-02033-00	1	Enclosure, Side
118-20016-00	1	Fan

7.2 GXT700MT-230 BILL OF MATERIALS

Note: The following basic bill of materials for each model, have been included in this manual as supplementary information. They are to be used as a guide only when locally sourcing components.

Qty	Cct Ident	Description	Manufacturer
1		FUSE BUSS/S505 5A 250V CERAMIC (TIME DELAY)	BUSSMANN
1		FILTER DELTA/06GEEG3E	DELTA
1		FILTER DELTA/10DBAG5	DELTA
1		FUSE BUSS/S505 5A 250V CERAMIC (TIME DELAY)	BUSSMANN
2		BATTERY PANASONIC/ LC-R127R2PG1 12V 7.2AH	MATSUSHITA SEMICONDUCTOR
1		FAN NMB/3110KL-04W-B50- P00 80*80*25	HWAN CHONG
1	LD502	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD508	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD509	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD503	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD504	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD505	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD506	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD507	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD510	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD501	LED LTL-3211A RED 5*2	EVERLIGHT
1	SW501	SWITCH TACK TAP 5.0mm 12Vdc 50mA	FORWARD
1	SW502	SWITCH TACK TAP 5.0mm 12Vdc 50mA	FORWARD
1	R10	RES CF 1/4W 510 J	TY-OHM
1	R107	RES CF 1/4W 510 J	TY-OHM
1	R108	RES CF 1/4W 510 J	TY-OHM
1	R109	RES CF 1/4W 510 J	TY-OHM
1	R110	RES CF 1/4W 510 J	TY-OHM
1	R111	RES CF 1/4W 510 J	TY-OHM
1	R112	RES CF 1/4W 510 J	TY-OHM
1	R115	RES CF 1/4W 510 J	TY-OHM
1	R116	RES CF 1/4W 510 J	TY-OHM
1	R117	RES CF 1/4W 510 J	TY-OHM
1	R118	RES CF 1/4W 510 J	TY-OHM
1	R120	RES CF 1/4W 510 J	TY-OHM
1	R129	RES CF 1/4W 510 J	TY-OHM
1	R130	RES CF 1/4W 510 J	TY-OHM
1	R3	RES CF 1/4W 510 J	TY-OHM
1	R35	RES CF 1/4W 510 J	TY-OHM
1	R36	RES CF 1/4W 510 J	TY-OHM
1	R7	RES CF 1/4W 510 J	TY-OHM
1	R70	RES CF 1/4W 510 J	TY-OHM
1	R92	RES CF 1/4W 510 J	TY-OHM
1	R97	RES CF 1/4W 510 J	TY-OHM
1	R106	RES CF 1/4W 2.2K J	KOA
1	R39	RES CF 1/4W 36K J	KOA

Qty	Cct Ident	Description	Manufacturer
1	R23	RES CF 1/4W 470K J	KOA
1	R44	RES CF 1/4W 470K J	KOA
1	R94	RES CF 1/4W 470K J	KOA
1	R101	RES NFMOF 1W 300 J	TY-OHM
1	R121	RES PMF 1/4W 330 F	KOA
1	R122	RES PMF 1/4W 330 F	KOA
1	R41	RES PMF 1/4W 1K F	KOA
1	R48	RES PMF 1/4W 1K F	KOA
1	R53	RES PMF 1/4W 1K F	KOA
1	R89	RES PMF 1/4W 1K F	KOA
1	R90	RES PMF 1/4W 1K F	KOA
1	R91	RES PMF 1/4W 1K F	KOA
1	R114	RES PMF 1/4W 2K F	KOA
1	R1	RES PMF 1/4W 4.99K F	TY-OHM
1	R100	RES PMF 1/4W 4.99K F	TY-OHM
1	R134	RES PMF 1/4W 4.99K F	TY-OHM
1	R14	RES PMF 1/4W 4.99K F	TY-OHM
1	R17	RES PMF 1/4W 4.99K F	TY-OHM
1	R18	RES PMF 1/4W 4.99K F	TY-OHM
1	R19	RES PMF 1/4W 4.99K F	TY-OHM
1	R26	RES PMF 1/4W 4.99K F	TY-OHM
1	R4	RES PMF 1/4W 4.99K F	TY-OHM
1	R55	RES PMF 1/4W 4.99K F	TY-OHM
1	R60	RES PMF 1/4W 4.99K F	TY-OHM
1	R67	RES PMF 1/4W 4.99K F	TY-OHM
1	R69	RES PMF 1/4W 4.99K F	TY-OHM
1	R71	RES PMF 1/4W 4.99K F	TY-OHM
1	R78	RES PMF 1/4W 4.99K F	TY-OHM
1	R79	RES PMF 1/4W 4.99K F	TY-OHM
1	R84	RES PMF 1/4W 4.99K F	TY-OHM
1	R98	RES PMF 1/4W 4.99K F	TY-OHM
1	R99	RES PMF 1/4W 4.99K F	TY-OHM
1	R11	RES PMF 1/4W 10K F	KOA
1	R12	RES PMF 1/4W 10K F	KOA
1	R2	RES PMF 1/4W 10K F	KOA
1	R22	RES PMF 1/4W 10K F	KOA
1	R27	RES PMF 1/4W 10K F	KOA
1	R31	RES PMF 1/4W 10K F	KOA
1	R51	RES PMF 1/4W 10K F	KOA
1	R52	RES PMF 1/4W 10K F	KOA
1	R58	RES PMF 1/4W 10K F	KOA
1	R6	RES PMF 1/4W 10K F	KOA
1	R65	RES PMF 1/4W 10K F	KOA
1	R73	RES PMF 1/4W 10K F	KOA
1	R74	RES PMF 1/4W 10K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R75	RES PMF 1/4W 10K F	KOA
1	R76	RES PMF 1/4W 10K F	KOA
1	R77	RES PMF 1/4W 10K F	KOA
1	R8	RES PMF 1/4W 10K F	KOA
1	R80	RES PMF 1/4W 10K F	KOA
1	R83	RES PMF 1/4W 10K F	KOA
1	R86	RES PMF 1/4W 10K F	KOA
1	R87	RES PMF 1/4W 10K F	KOA
1	R88	RES PMF 1/4W 10K F	KOA
1	R9	RES PMF 1/4W 10K F	KOA
1	R93	RES PMF 1/4W 10K F	KOA
1	R95	RES PMF 1/4W 10K F	KOA
1	R30	RES PMF 1/4W 16.9K F	KOA
1	R119	RES PMF 1/4W 20K F	TY-OHM
1	R13	RES PMF 1/4W 20K F	TY-OHM
1	R20	RES PMF 1/4W 20K F	TY-OHM
1	R21	RES PMF 1/4W 20K F	TY-OHM
1	R33	RES PMF 1/4W 20K F	TY-OHM
1	R54	RES PMF 1/4W 20K F	TY-OHM
1	R57	RES PMF 1/4W 20K F	TY-OHM
1	R38	RES PMF 1/4W 22.6K F	KOA
1	R64	RES PMF 1/4W 27K F	KOA
1	R62	RES PMF 1/4W 30K F	KOA
1	R15	RES PMF 1/4W 49.9K F	KOA
1	R16	RES PMF 1/4W 49.9K F	KOA
1	R25	RES PMF 1/4W 49.9K F	KOA
1	R32	RES PMF 1/4W 49.9K F	KOA
1	R56	RES PMF 1/4W 49.9K F	KOA
1	R66	RES PMF 1/4W 49.9K F	KOA
1	R82	RES PMF 1/4W 49.9K F	KOA
1	R85	RES PMF 1/4W 49.9K F	KOA
1	R103	RES PMF 1/4W 90.9K F	KOA
1	R40	RES PMF 1/4W 100K F	KOA
1	R45	RES PMF 1/4W 100K F	KOA
1	R5	RES PMF 1/4W 100K F	KOA
1	R50	RES PMF 1/4W 100K F	KOA
1	R59	RES PMF 1/4W 100K F	KOA
1	R68	RES PMF 1/4W 100K F	KOA
1	R42	RES PMF 1/4W 150K F	KOA
1	R28	RES PMF 1/4W 200K F	KOA
1	R29	RES PMF 1/4W 200K F	KOA
1	R34	RES PMF 1/4W 200K F	KOA
1	R37	RES PMF 1/4W 220K F	KOA
1	R61	RES PMF 1/4W 220K F	KOA
1	R63	RES PMF 1/4W 220K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R81	RES PMF 1/4W 301K F	KOA
1	R24	RES PMF 1/4W 1M F	KOA
1	R43	RES PMF 1/4W 1M F	KOA
1	R96	METAL GLAZE 1/4W 3.9M J	KOA
1	R72	METAL-GLAZE 1/4W 4.7M J	KOA
1	NTC1	THERMISTOR,NTC 15K	UPPERMOST
1	C9	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C27	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C30	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C39	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C4	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C46	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C47	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C51	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C18	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C45	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C48	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C50	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C14	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C15	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C17	CAP EL-AL 1uF 100V M 5*11RL2 RAD TAP 5mm 85¢J	NIPPON CHEMI-CON
1	C24	CAP EL-AL 1uF 100V M 5*11RL2 RAD TAP 5mm 85¢J	NIPPON CHEMI-CON
1	C7	CAP PE 0.0010uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C8	CAP PE 0.0010uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C10	CAP PE 0.047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C60	CAP MPE 1.000uF 63V J RAD TAP 5mm	TEAPO
1	C40	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C41	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C25	CAP CER MONO 100P 200V J J NPO AXI TAP26mm "101"	AVX CO.,
1	C6	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C1	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C11	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C13	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C2	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C19	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C20	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C21	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C23	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C26	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C29	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C3	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C34	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C38	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C42	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,

Qty	Cct Ident	Description	Manufacturer
1	C43	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C44	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C49	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C5	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C52	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C53	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C54	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C59	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C22	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C28	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C35	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C36	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C55	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C33	CAP CER MONO 223 50V K X7R AXI TAP 26mm "223"	AVX CO.,
1	C12	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C32	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C37	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C61	CAP CER DISC 0.001uF 250Vac K Y-,X-	GRANSTAR
1	TX1	TX 1P 105X 55:49:52:29:44 EE-16	LION
1	U5	IC LINEAR LM339N	MOTOROLA SEMICONDUCTOR C
1	U7	IC LINEAR LM393N	MOTOROLA SEMICONDUCTOR C
1	U3	IC LINEAR TL074BCN	T.I. SEMICONDUCTOR CO.,
1	U13	IC LINEAR TL431AC	SAMSUNG SEMICONDUCTOR CO
1	U8	IC LINEAR UA7812UC	MOTOROLA SEMICONDUCTOR C
1	U4	IC LOGIC MC14013BCP	MOTOROLA SEMICONDUCTOR C
1	U2	IC LOGIC MC14081BCP	MOTOROLA SEMICONDUCTOR C
1	U1	IC LINEAR ULN2003AN	MOTOROLA SEMICONDUCTOR C
1	U19	IC LOGIC HI3-5051-5	HARRIS SEMICONDUCTOR CO.
1	U10	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U11	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U12	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U14	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U16	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U17	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U18	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U9	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	D19	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D20	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D21	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D22	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D1	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D10	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D12	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D13	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D14	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,

Qty	Cct Ident	Description	Manufacturer
1	D15	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D16	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D17	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D18	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D2	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D23	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D24	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D25	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D26	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D27	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D28	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D3	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D4	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D5	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D6	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D7	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D8	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D9	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	Q1	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q6	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q2	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	Q3	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	SW1	SWITCH DIP 2P	
1	XL1	CRYSTAL,CERAMIC 12MHZ	TXC
1	BZ1	BUZZER 20335 3.0-20Vdc	OBO SEAHORN
1		IC CPU MC68HC711K4CFN3/ SC416389CFN3	MOTOROLA SEMICONDUCTOR C
1	R11	RES CF 1/4W 10 J	KOA
1	R24	RES CF 1/4W 100 J	KOA
1	R25	RES CF 1/4W 100 J	KOA
1	R74	RES CF 1/4W 100 J	KOA
1	R38	RES CF 1/4W 510 J	TY-OHM
1	R41	RES CF 1/4W 510 J	TY-OHM
1	R123	RES CF 1/4W 470K J	KOA
1	R34	RES CF 1/4W 470K J	KOA
1	R31	RES SSNF 3W 100 J	TY-OHM
1	R36	RES SSNF 3W 100 J	TY-OHM
1	R53	RES SSNF 3W 100 J	TY-OHM
1	R58	RES SSNF 3W 100 J	TY-OHM
1	R43	RES SSNF 3W 100K J RSS	TY-OHM
1	R46	RES SSNF 3W 100K J RSS	TY-OHM
1	R1	RES PMF 1/4W 300 F	KOA
1	R117	RES PMF 1/4W 300 F	KOA
1	R119	RES PMF 1/4W 300 F	KOA
1	R30	RES PMF 1/4W 470 F	KOA
1	R88	RES PMF 1/4W 1.8K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R73	RES PMF 1/4W 2K F	KOA
1	R67	RES PMF 1/4W 3K F	KOA
1	R68	RES PMF 1/4W 3K F	KOA
1	R16	RES PMF 1/4W 3.3K F	KOA
1	R124	RES PMF 1/4W 3.74K F	KOA
1	R12	RES PMF 1/4W 3.9K F	KOA
1	R27	RES PMF 1/4W 3.9K F	KOA
1	R13	RES PMF 1/4W 4.7K F	KOA
1	R48	RES PMF 1/4W 4.7K F	KOA
1	R109	RES PMF 1/4W 4.99K F	TY-OHM
1	R115	RES PMF 1/4W 4.99K F	TY-OHM
1	R125	RES PMF 1/4W 4.99K F	TY-OHM
1	R2	RES PMF 1/4W 4.99K F	TY-OHM
1	R47	RES PMF 1/4W 4.99K F	TY-OHM
1	R55	RES PMF 1/4W 4.99K F	TY-OHM
1	R85	RES PMF 1/4W 4.99K F	TY-OHM
1	R111	RES PMF 1/4W 6.8K F	KOA
1	R29	RES PMF 1/4W 6.8K F	KOA
1	R59	RES PMF 1/4W 6.8K F	KOA
1	R95	RES PMF 1/4W 6.8K F	KOA
1	R96	RES PMF 1/4W 7.5K F	KOA
1	R110	RES PMF 1/4W 9.1K F	KOA
1	R104	RES PMF 1/4W 10K F	KOA
1	R108	RES PMF 1/4W 10K F	KOA
1	R116	RES PMF 1/4W 10K F	KOA
1	R120	RES PMF 1/4W 10K F	KOA
1	R126	RES PMF 1/4W 10K F	KOA
1	R127	RES PMF 1/4W 10K F	KOA
1	R17	RES PMF 1/4W 10K F	KOA
1	R3	RES PMF 1/4W 10K F	KOA
1	R77	RES PMF 1/4W 10K F	KOA
1	R8	RES PMF 1/4W 10K F	KOA
1	R9	RES PMF 1/4W 10K F	KOA
1	R102	RES PMF 1/4W 10.7K F	KOA
1	R93	RES PMF 1/4W 10.7K F	KOA
1	R84	RES PMF 1/4W 11K F	KOA
1	R94	RES PMF 1/4W 11K F	KOA
1	R19	RES PMF 1/4W 13K F	KOA
1	R118	RES PMF 1/4W 15K F	KOA
1	R72	RES PMF 1/4W 15K F	KOA
1	R76	RES PMF 1/4W 15K F	KOA
1	R97	RES PMF 1/4W 20K F	TY-OHM
1	R75	RES PMF 1/4W 30K F	KOA
1	R28	RES PMF 1/4W 47K F	KOA
1	R99	RES PMF 1/4W 47K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R14	RES PMF 1/4W 49.9K F	KOA
1	R20	RES PMF 1/4W 49.9K F	KOA
1	R44	RES PMF 1/4W 49.9K F	KOA
1	R51	RES PMF 1/4W 49.9K F	KOA
1	R54	RES PMF 1/4W 49.9K F	KOA
1	R6	RES PMF 1/4W 49.9K F	KOA
1	R7	RES PMF 1/4W 49.9K F	KOA
1	R106	RES PMF 1/4W 75K F	KOA
1	R112	RES PMF 1/4W 75K F	KOA
1	R103	RES PMF 1/4W 100K F	KOA
1	R105	RES PMF 1/4W 100K F	KOA
1	R107	RES PMF 1/4W 100K F	KOA
1	R113	RES PMF 1/4W 100K F	KOA
1	R86	RES PMF 1/4W 100K F	KOA
1	R92	RES PMF 1/4W 100K F	KOA
1	R98	RES PMF 1/4W 100K F	KOA
1	R15	RES PMF 1/4W 150K F	KOA
1	R60	RES PMF 1/4W 150K F	KOA
1	R87	RES PMF 1/4W 150K F	KOA
1	R100	RES PMF 1/4W 178K F	KOA
1	R101	RES PMF 1/4W 178K F	KOA
1	R114	RES PMF 1/4W 178K F	KOA
1	R61	RES PMF 1/4W 178K F	KOA
1	R62	RES PMF 1/4W 178K F	KOA
1	R63	RES PMF 1/4W 178K F	KOA
1	R64	RES PMF 1/4W 178K F	KOA
1	R65	RES PMF 1/4W 178K F	KOA
1	R66	RES PMF 1/4W 178K F	KOA
1	R78	RES PMF 1/4W 178K F	KOA
1	R79	RES PMF 1/4W 178K F	KOA
1	R80	RES PMF 1/4W 178K F	KOA
1	R81	RES PMF 1/4W 178K F	KOA
1	R122	RES PMF 1/4W 200K F	KOA
1	R22	RES PMF 1/4W 270K F	KOA
1	R4	RES PMF 1/4W 330K F	KOA
1	R5	RES PMF 1/4W 330K F	KOA
1	R69	RES PMF 1/4W 330K F	KOA
1	R70	RES PMF 1/4W 330K F	KOA
1	R71	RES PMF 1/4W 330K F	KOA
1	R82	RES PMF 1/4W 330K F	KOA
1	R83	RES PMF 1/4W 330K F	KOA
1	R89	RES PMF 1/4W 820K F	KOA
1	R10	RES PMF 1/4W 1M F	KOA
1	R90	RES PMF 1/4W 1M F	KOA
1	R23	RES NRWW 2W 0.22 J (NON-IND)	TY-OHM

Qty	Cct Ident	Description	Manufacturer
1	R45	RESISTOR NRWW 2W 1 J (NON-IND)	TY-OHM
1	R57	RES NRWW 5W 10 J	TY-OHM
1	R18	RES FMF 1/2W 47 J	TY-OHM
1	R32	RES FMF 1/2W 47 J	TY-OHM
1	R33	RES FMF 1/2W 47 J	TY-OHM
1	R39	RES FMF 1/2W 47 J	TY-OHM
1	R40	RES FMF 1/2W 47 J	TY-OHM
1	R42	RES FMF 1/2W 47 J	TY-OHM
1	R50	RES FMF 1/2W 47 J	TY-OHM
1	R52	RES FMF 1/2W 47 J	TY-OHM
1	R56	RES FMF 1/2W 47 J	TY-OHM
1	R21	RES FMF 1/2W 1.0K J	TY-OHM
1	R49	RES FMF 1/2W 1.0K J	TY-OHM
1	VR01	VR 1K 1T 3323PEW-4-102	BOURNS
1	NTC1	THERMISTOR,NTC 10 5A	UPPERMOST
1	C62	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C71	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C5	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C61	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C64	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C67	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C70	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C1	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C10	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C40	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C49	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C30	CAP EL-AL 47uF 450V M 16 *35.5RL2 RAD 7.5mm 105¢J	NIPPON CHEMI-CON
1	C21	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C26	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C28	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C29	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C32	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C12	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C41	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C47	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C51	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C52	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C19	CAP EL-AL 2200uF 16V M 12.5*25RL2 RAD 7.5mm85¢J	NIPPON CHEMI-CON
1	C2	CAP EL-AL 4700uF 35V M 18*40RL2 RAD 7.5mm 85¢J	NIPPON CHEMI-CON
1	C15	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C37	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C66	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C16	CAP MPE 3.3uF 250VAC M RAD X-	OKAYA
1	C22	CAP MPP 0.022uF 1000V J RAD	WIMA
1	C23	CAP MPP 0.022uF 1000V J RAD	WIMA

Qty	Cct Ident	Description	Manufacturer
1	C68	CAP MPE 0.47uF 275VAC M RAD X2-	OKAYA
1	C38	CAP MPE 1.0uF 275VAC M RAD X2-	OKAYA
1	C56	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C55	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C8	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C59	CAP CER MONO 3.9nF 50V J NPO RAD TAP 5mm "392"	AVX CO.,
1	C9	CAP CER MONO 3.9nF 50V J NPO RAD TAP 5mm "392"	AVX CO.,
1	C24	CAP CER MONO 47PF 50V J COG AXI TAP 26mm "470"	AVX CO.,
1	C57	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C11	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C13	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C14	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C27	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C36	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C45	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C48	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C53	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C54	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C6	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C63	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C65	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C69	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C7	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C72	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C75	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C3	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C35	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C4	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C60	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C74	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C39	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C42	CAP CER DISC 470PF 1000V M Z5U TAP 5mm "471"	EVER GRACE
1	C50	CAP CER DISC 470PF 1000V M Z5U TAP 5mm "471"	EVER GRACE
1	C17	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C18	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C20	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C25	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C46	CAP CER DISC 2.2nF 1000V K Y5P TAP 5mm "222"	EVER GRACE
1	C33	CAP CER DISC 0.01uF 1000V M Z5U	EVER GRACE
1	CT1	CT 1:1:1000 EI-28	LION
1	CT2	CT 1:1:1000 EI-28	LION
1	TX3	TX 1030 1P 100:100:48:62 :62 37KHZ FER EEL-16	LION
1	TX2	TX 103X 1P 84:6:6:11:6 37KHZ FER EI-30	LION
1	TX1	TX 103X 1P 2:2:36:36 50KHZ FER EE-42/20	LION

Qty	Cct Ident	Description	Manufacturer
1	L4	CHOKE 105X 600uH 5A 0.7D FER ROD	MYLEE COMPANY LIMITED CO
1	L5	CHOKE 105X 600uH 5A 0.7D FER ROD	MYLEE COMPANY LIMITED CO
1	L3	CHOKE 103X 5.0mH 5A 0.9D FER T22 CM	THE DIANN
1	L1	CHOKE 1033 4mH 3.5A 0.9D 77440-A7 O/P	THE DIANN
1	L2	CHOKE 1033 8mH 3.5A 0.8D 77439-A7 I/P	THE DIANN
1	U9	IC LINEAR LM324N	T.I. SEMICONDUCTOR CO.,
1	U3	IC V. REGULATOR 1A 5V 2% MC78T05ACT	MOTOROLA SEMICONDUCTOR C
1	Q5	IC LINEAR TL431CP TAP	T.I. SEMICONDUCTOR CO.,
1	U1	IC LINEAR SG3525AN MOTOROLA 084-02300-00	MOTOROLA SEMICONDUCTOR C
1	U2	IC LINEAR UC3845N	MOTOROLA SEMICONDUCTOR C
1	U6	IC LINEAR UC3845N	MOTOROLA SEMICONDUCTOR C
1	U11	IC LINEAR UC3854N	UNITRODE SEMICONDUCTOR C
1	U12	IC LOGIC MC14066BCP	MOTOROLA SEMICONDUCTOR C
1	U4	IC PHOTO TLP521-1BL	TOSHIBA
1	U5	IC PHOTO TLP521-1BL	TOSHIBA
1	U10	IC PHOTO TLP250	TOSHIBA
1	U7	IC PHOTO TLP250	TOSHIBA
1	U8	IC PHOTO TLP250	TOSHIBA
1	D14	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D15	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D19	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D20	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D25	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D27	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D32	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D33	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D11	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D12	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D13	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D18	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D23	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D24	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D34	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D38	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	REC1	D. GI/GBU6M 6A 1000V BRIDGE	G.I.
1	D17	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D21	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D22	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D1	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D10	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D2	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D26	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D3	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D35	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D36	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,

Qty	Cct Ident	Description	Manufacturer
1	D37	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D39	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D4	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D40	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D41	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D42	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D43	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D45	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D46	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D7	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D8	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D9	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D5	D. GI/UF5402 3A 200V	G.I.
1	D6	D. GI/UF5402 3A 200V	G.I.
1	D28	D. GI/IN5399GP 1.5A 1000V TAP pitch 25.4mm	GENERALINSTRUMENT SEMICO
1	D29	D. GI/IN5399GP 1.5A 1000V TAP pitch 25.4mm	GENERALINSTRUMENT SEMICO
1	D30	D. GI/IN5399GP 1.5A 1000V TAP pitch 25.4mm	GENERALINSTRUMENT SEMICO
1	D31	D. GI/IN5399GP 1.5A 1000V TAP pitch 25.4mm	GENERALINSTRUMENT SEMICO
1	ZD4	ZD NEC/RD3.3 1/2W 3.3V	NEC SEMICONDUCTOR CO.,
1	ZD2	ZD NEC/RD5.1E 1/2W 5.1V	NEC SEMICONDUCTOR CO.,
1	ZD3	ZD NEC/RD5.1E 1/2W 5.1V	NEC SEMICONDUCTOR CO.,
1	ZD1	ZD NEC/RD12E 1/2W 12V	NEC SEMICONDUCTOR CO.,
1	Q10	TR MOSFET HARRIS/RFP 50N06 50A 60V	HARRIS SEMICONDUCTOR CO.
1	Q11	TR MOSFET HARRIS/RFP 50N06 50A 60V	HARRIS SEMICONDUCTOR CO.
1	Q4	TR MOSFET HARRIS/RFP 50N06 50A 60V	HARRIS SEMICONDUCTOR CO.
1	Q6	TR MOSFET HARRIS/RFP 50N06 50A 60V	HARRIS SEMICONDUCTOR CO.
1	Q2	TR MOSFET HARRIS/IRF620 5A 200V	
1	Q1	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q15	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q16	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q8	TR MOSFET TOSHIBA/ 2SK793 5A 850V	TOSHIBA
1	Q9	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	Q14	TR MOSFET TOSHIBA/ 2SK1723 12A 600V	TOSHIBA
1	Q12	TR IGBT TOSHIBA/GT15Q101 15A 1200V	TOSHIBA
1	Q13	TR IGBT TOSHIBA/GT15Q101 15A 1200V	TOSHIBA
1	RY2	RELAY OMRON/G4W-2212P- VD-TV5 10A 250V C:12Vdc	OMRON
1	RY3	RELAY OMRON/G4W-2212P- VD-TV5 10A 250V C:12Vdc	OMRON
1	RY1	RELAY OMRON/G2R-1-E 16A 250V Coil:12Vdc	OMRON
1	TSA	SWITCH THERMAL WAKO/CS- 7SA NFZ-250-90C	WAKO
1	MOV1	VARISTOR HARRIS/ V320LA20A	HARRIS SEMICONDUCTOR CO.
1	F1A	FUSE CLIP 100057	littelfuse
1	F1B	FUSE CLIP 100057	littelfuse
1	F1	FUSE (AUTO) 40A 32V	LITTEL F
1	F3	FUSE BEL/5FSP5 5A 250Vac (FAST ACTING)	BEL FUSE INC.

7.3 GXT1000MT-230 BILL OF MATERIAL

Qty	Cct Ident	Description	Manufacturer
2		FUSE BUSS/S505 6.3A 250Vac TIME DELAY	BUSS
1		FILTER DELTA/06DBDW3S	DELTA
1		FILTER DELTA/10DBAG5	DELTA
1		FUSE BUSS/S505 6.3A 250Vac TIME DELAY	BUSS
3		BATTERY PANASONIC/ LC-R127R2PG1 12V 7.2AH	MATSUSHITA SEMICONDUCTOR
1		FAN NMB/3110KL-04W-B50- P00 80*80*25	HWAN CHONG
1	LD502	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD508	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD509	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD503	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD504	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD505	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD506	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD507	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD510	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD501	LED LTL-3211A RED 5*2	EVERLIGHT
1	SW501	SWITCH TACK TAP 5.0mm 12Vdc 50mA	FORWARD
1	SW502	SWITCH TACK TAP 5.0mm 12Vdc 50mA	FORWARD
1	R10	RES CF 1/4W 510 J	TY-OHM
1	R107	RES CF 1/4W 510 J	TY-OHM
1	R108	RES CF 1/4W 510 J	TY-OHM
1	R109	RES CF 1/4W 510 J	TY-OHM
1	R110	RES CF 1/4W 510 J	TY-OHM
1	R111	RES CF 1/4W 510 J	TY-OHM
1	R112	RES CF 1/4W 510 J	TY-OHM
1	R115	RES CF 1/4W 510 J	TY-OHM
1	R116	RES CF 1/4W 510 J	TY-OHM
1	R117	RES CF 1/4W 510 J	TY-OHM
1	R118	RES CF 1/4W 510 J	TY-OHM
1	R120	RES CF 1/4W 510 J	TY-OHM
1	R129	RES CF 1/4W 510 J	TY-OHM
1	R130	RES CF 1/4W 510 J	TY-OHM
1	R3	RES CF 1/4W 510 J	TY-OHM
1	R35	RES CF 1/4W 510 J	TY-OHM
1	R36	RES CF 1/4W 510 J	TY-OHM
1	R7	RES CF 1/4W 510 J	TY-OHM
1	R70	RES CF 1/4W 510 J	TY-OHM
1	R92	RES CF 1/4W 510 J	TY-OHM
1	R97	RES CF 1/4W 510 J	TY-OHM
1	R106	RES CF 1/4W 2.2K J	KOA
1	R39	RES CF 1/4W 36K J	KOA
1	R23	RES CF 1/4W 470K J	KOA
1	R44	RES CF 1/4W 470K J	KOA

Qty	Cct Ident	Description	Manufacturer
1	R94	RES CF 1/4W 470K J	KOA
1	R101	RES NFMOF 1W 300 J	TY-OHM
1	R121	RES PMF 1/4W 330 F	KOA
1	R122	RES PMF 1/4W 330 F	KOA
1	R41	RES PMF 1/4W 1K F	KOA
1	R48	RES PMF 1/4W 1K F	KOA
1	R53	RES PMF 1/4W 1K F	KOA
1	R89	RES PMF 1/4W 1K F	KOA
1	R90	RES PMF 1/4W 1K F	KOA
1	R91	RES PMF 1/4W 1K F	KOA
1	R114	RES PMF 1/4W 2K F	KOA
1	R1	RES PMF 1/4W 4.99K F	TY-OHM
1	R100	RES PMF 1/4W 4.99K F	TY-OHM
1	R134	RES PMF 1/4W 4.99K F	TY-OHM
1	R14	RES PMF 1/4W 4.99K F	TY-OHM
1	R17	RES PMF 1/4W 4.99K F	TY-OHM
1	R18	RES PMF 1/4W 4.99K F	TY-OHM
1	R19	RES PMF 1/4W 4.99K F	TY-OHM
1	R26	RES PMF 1/4W 4.99K F	TY-OHM
1	R4	RES PMF 1/4W 4.99K F	TY-OHM
1	R55	RES PMF 1/4W 4.99K F	TY-OHM
1	R60	RES PMF 1/4W 4.99K F	TY-OHM
1	R67	RES PMF 1/4W 4.99K F	TY-OHM
1	R69	RES PMF 1/4W 4.99K F	TY-OHM
1	R71	RES PMF 1/4W 4.99K F	TY-OHM
1	R78	RES PMF 1/4W 4.99K F	TY-OHM
1	R79	RES PMF 1/4W 4.99K F	TY-OHM
1	R84	RES PMF 1/4W 4.99K F	TY-OHM
1	R98	RES PMF 1/4W 4.99K F	TY-OHM
1	R99	RES PMF 1/4W 4.99K F	TY-OHM
1	R11	RES PMF 1/4W 10K F	KOA
1	R12	RES PMF 1/4W 10K F	KOA
1	R2	RES PMF 1/4W 10K F	KOA
1	R22	RES PMF 1/4W 10K F	KOA
1	R27	RES PMF 1/4W 10K F	KOA
1	R31	RES PMF 1/4W 10K F	KOA
1	R51	RES PMF 1/4W 10K F	KOA
1	R52	RES PMF 1/4W 10K F	KOA
1	R58	RES PMF 1/4W 10K F	KOA
1	R6	RES PMF 1/4W 10K F	KOA
1	R65	RES PMF 1/4W 10K F	KOA
1	R73	RES PMF 1/4W 10K F	KOA
1	R74	RES PMF 1/4W 10K F	KOA
1	R75	RES PMF 1/4W 10K F	KOA
1	R76	RES PMF 1/4W 10K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R77	RES PMF 1/4W 10K F	KOA
1	R8	RES PMF 1/4W 10K F	KOA
1	R80	RES PMF 1/4W 10K F	KOA
1	R83	RES PMF 1/4W 10K F	KOA
1	R86	RES PMF 1/4W 10K F	KOA
1	R87	RES PMF 1/4W 10K F	KOA
1	R88	RES PMF 1/4W 10K F	KOA
1	R9	RES PMF 1/4W 10K F	KOA
1	R93	RES PMF 1/4W 10K F	KOA
1	R95	RES PMF 1/4W 10K F	KOA
1	R30	RES PMF 1/4W 16.9K F	KOA
1	R119	RES PMF 1/4W 20K F	TY-OHM
1	R13	RES PMF 1/4W 20K F	TY-OHM
1	R20	RES PMF 1/4W 20K F	TY-OHM
1	R21	RES PMF 1/4W 20K F	TY-OHM
1	R33	RES PMF 1/4W 20K F	TY-OHM
1	R54	RES PMF 1/4W 20K F	TY-OHM
1	R57	RES PMF 1/4W 20K F	TY-OHM
1	R38	RES PMF 1/4W 22.6K F	KOA
1	R64	RES PMF 1/4W 27K F	KOA
1	R62	RES PMF 1/4W 30K F	KOA
1	R15	RES PMF 1/4W 49.9K F	KOA
1	R16	RES PMF 1/4W 49.9K F	KOA
1	R25	RES PMF 1/4W 49.9K F	KOA
1	R32	RES PMF 1/4W 49.9K F	KOA
1	R56	RES PMF 1/4W 49.9K F	KOA
1	R66	RES PMF 1/4W 49.9K F	KOA
1	R82	RES PMF 1/4W 49.9K F	KOA
1	R85	RES PMF 1/4W 49.9K F	KOA
1	R103	RES PMF 1/4W 90.9K F	KOA
1	R40	RES PMF 1/4W 100K F	KOA
1	R45	RES PMF 1/4W 100K F	KOA
1	R5	RES PMF 1/4W 100K F	KOA
1	R50	RES PMF 1/4W 100K F	KOA
1	R59	RES PMF 1/4W 100K F	KOA
1	R68	RES PMF 1/4W 100K F	KOA
1	R42	RES PMF 1/4W 150K F	KOA
1	R28	RES PMF 1/4W 200K F	KOA
1	R29	RES PMF 1/4W 200K F	KOA
1	R34	RES PMF 1/4W 200K F	KOA
1	R37	RES PMF 1/4W 220K F	KOA
1	R61	RES PMF 1/4W 220K F	KOA
1	R63	RES PMF 1/4W 220K F	KOA
1	R81	RES PMF 1/4W 301K F	KOA
1	R24	RES PMF 1/4W 1M F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R43	RES PMF 1/4W 1M F	KOA
1	R96	METAL GLAZE 1/4W 3.9M J	KOA
1	R72	METAL-GLAZE 1/4W 4.7M J	KOA
1	NTC1	THERMISTOR,NTC 15K	UPPERMOST
1	C9	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C27	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C30	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C39	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C4	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C46	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C47	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C51	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C18	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C45	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C48	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C50	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C14	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C15	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C17	CAP EL-AL 1uF 100V M 5*11RL2 RAD TAP 5mm 85¢J	NIPPON CHEMI-CON
1	C24	CAP EL-AL 1uF 100V M 5*11RL2 RAD TAP 5mm 85¢J	NIPPON CHEMI-CON
1	C7	CAP PE 0.0010uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C8	CAP PE 0.0010uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C10	CAP PE 0.047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C60	CAP MPE 1.000uF 63V J RAD TAP 5mm	TEAPO
1	C40	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C41	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C25	CAP CER MONO 100P 200V J J NPO AXI TAP26mm "101"	AVX CO.,
1	C6	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C1	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C11	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C13	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C2	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C19	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C20	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C21	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C23	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C26	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C29	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C3	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C34	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C38	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C42	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C43	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C44	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,

Qty	Cct Ident	Description	Manufacturer
1	C49	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C5	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C52	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C53	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C54	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C59	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C22	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C28	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C35	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C36	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C55	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C33	CAP CER MONO 223 50V K X7R AXI TAP 26mm "223"	AVX CO.,
1	C12	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C32	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C37	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C61	CAP CER DISC 0.001uF 250Vac K Y-,X-	GRANSTAR
1	TX1	TX 1P 105X 55:49:52:29:44 EE-16	LION
1	U5	IC LINEAR LM339N	MOTOROLA SEMICONDUCTOR C
1	U7	IC LINEAR LM393N	MOTOROLA SEMICONDUCTOR C
1	U3	IC LINEAR TL074BCN	T.I. SEMICONDUCTOR CO.,
1	U13	IC LINEAR TL431AC	SAMSUNG SEMICONDUCTOR CO
1	U8	IC LINEAR UA7812UC	MOTOROLA SEMICONDUCTOR C
1	U4	IC LOGIC MC14013BCP	MOTOROLA SEMICONDUCTOR C
1	U2	IC LOGIC MC14081BCP	MOTOROLA SEMICONDUCTOR C
1	U1	IC LINEAR ULN2003AN	MOTOROLA SEMICONDUCTOR C
1	U19	IC LOGIC HI3-5051-5	HARRIS SEMICONDUCTOR CO.
1	U10	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U11	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U12	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U14	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U16	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U17	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U18	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U9	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	D19	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D20	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D21	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D22	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D1	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D10	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D12	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D13	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D14	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D15	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D16	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,

Qty	Cct Ident	Description	Manufacturer
1	D17	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D18	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D2	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D23	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D24	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D25	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D26	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D27	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D28	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D3	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D4	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D5	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D6	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D7	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D8	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D9	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	Q1	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q6	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q2	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	Q3	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	SW1	SWITCH DIP 2P	
1	XL1	CRYSTAL,CERAMIC 12MHZ	TXC
1	BZ1	BUZZER 20335 3.0-20Vdc	OBO SEAHORN
1		IC CPU MC68HC711K4CFN3/ SC416389CFN3	MOTOROLA SEMICONDUCTOR C
1	R11	RES CF 1/4W 10 J	KOA
1	R24	RES CF 1/4W 100 J	KOA
1	R25	RES CF 1/4W 100 J	KOA
1	R74	RES CF 1/4W 100 J	KOA
1	R38	RES CF 1/4W 510 J	TY-OHM
1	R41	RES CF 1/4W 510 J	TY-OHM
1	R124	RES CF 1/4W 3.6K J	KOA
1	R123	RES CF 1/4W 470K J	KOA
1	R34	RES CF 1/4W 470K J	KOA
1	R31	RES SSNF 3W 100 J	TY-OHM
1	R36	RES SSNF 3W 100 J	TY-OHM
1	R53	RES SSNF 3W 100 J	TY-OHM
1	R58	RES SSNF 3W 100 J	TY-OHM
1	R43	RES SSNF 3W 100K J RSS	TY-OHM
1	R46	RES SSNF 3W 100K J RSS	TY-OHM
1	R117	RES PMF 1/4W 300 F	KOA
1	R119	RES PMF 1/4W 300 F	KOA
1	R30	RES PMF 1/4W 300 F	KOA
1	R1	RES PMF 1/4W 1.8K F	KOA
1	R2	RES PMF 1/4W 1.8K F	KOA
1	R3	RES PMF 1/4W 1.8K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R88	RES PMF 1/4W 1.8K F	KOA
1	R73	RES PMF 1/4W 2K F	KOA
1	R67	RES PMF 1/4W 3K F	KOA
1	R68	RES PMF 1/4W 3K F	KOA
1	R12	RES PMF 1/4W 3.9K F	KOA
1	R27	RES PMF 1/4W 3.9K F	KOA
1	R13	RES PMF 1/4W 4.7K F	KOA
1	R48	RES PMF 1/4W 4.7K F	KOA
1	R109	RES PMF 1/4W 4.99K F	TY-OHM
1	R115	RES PMF 1/4W 4.99K F	TY-OHM
1	R125	RES PMF 1/4W 4.99K F	TY-OHM
1	R47	RES PMF 1/4W 4.99K F	TY-OHM
1	R55	RES PMF 1/4W 4.99K F	TY-OHM
1	R111	RES PMF 1/4W 6.8K F	KOA
1	R29	RES PMF 1/4W 6.8K F	KOA
1	R37	RES PMF 1/4W 6.8K F	KOA
1	R59	RES PMF 1/4W 6.8K F	KOA
1	R95	RES PMF 1/4W 6.8K F	KOA
1	R96	RES PMF 1/4W 7.5K F	KOA
1	R110	RES PMF 1/4W 9.1K F	KOA
1	R104	RES PMF 1/4W 10K F	KOA
1	R108	RES PMF 1/4W 10K F	KOA
1	R116	RES PMF 1/4W 10K F	KOA
1	R120	RES PMF 1/4W 10K F	KOA
1	R126	RES PMF 1/4W 10K F	KOA
1	R127	RES PMF 1/4W 10K F	KOA
1	R16	RES PMF 1/4W 10K F	KOA
1	R77	RES PMF 1/4W 10K F	KOA
1	R8	RES PMF 1/4W 10K F	KOA
1	R102	RES PMF 1/4W 10.7K F	KOA
1	R93	RES PMF 1/4W 10.7K F	KOA
1	R84	RES PMF 1/4W 11K F	KOA
1	R94	RES PMF 1/4W 11K F	KOA
1	R19	RES PMF 1/4W 13K F	KOA
1	R118	RES PMF 1/4W 15K F	KOA
1	R72	RES PMF 1/4W 15K F	KOA
1	R75	RES PMF 1/4W 15K F	KOA
1	R9	RES PMF 1/4W 20K F	TY-OHM
1	R97	RES PMF 1/4W 20K F	TY-OHM
1	R76	RES PMF 1/4W 30K F	KOA
1	R99	RES PMF 1/4W 47K F	KOA
1	R14	RES PMF 1/4W 49.9K F	KOA
1	R20	RES PMF 1/4W 49.9K F	KOA
1	R44	RES PMF 1/4W 49.9K F	KOA
1	R51	RES PMF 1/4W 49.9K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R54	RES PMF 1/4W 49.9K F	KOA
1	R6	RES PMF 1/4W 49.9K F	KOA
1	R7	RES PMF 1/4W 49.9K F	KOA
1	R106	RES PMF 1/4W 75K F	KOA
1	R112	RES PMF 1/4W 75K F	KOA
1	R28	RES PMF 1/4W 75K F	KOA
1	R103	RES PMF 1/4W 100K F	KOA
1	R105	RES PMF 1/4W 100K F	KOA
1	R107	RES PMF 1/4W 100K F	KOA
1	R113	RES PMF 1/4W 100K F	KOA
1	R86	RES PMF 1/4W 100K F	KOA
1	R92	RES PMF 1/4W 100K F	KOA
1	R98	RES PMF 1/4W 100K F	KOA
1	R15	RES PMF 1/4W 150K F	KOA
1	R60	RES PMF 1/4W 150K F	KOA
1	R87	RES PMF 1/4W 150K F	KOA
1	R100	RES PMF 1/4W 178K F	KOA
1	R101	RES PMF 1/4W 178K F	KOA
1	R114	RES PMF 1/4W 178K F	KOA
1	R61	RES PMF 1/4W 178K F	KOA
1	R62	RES PMF 1/4W 178K F	KOA
1	R63	RES PMF 1/4W 178K F	KOA
1	R64	RES PMF 1/4W 178K F	KOA
1	R65	RES PMF 1/4W 178K F	KOA
1	R66	RES PMF 1/4W 178K F	KOA
1	R78	RES PMF 1/4W 178K F	KOA
1	R79	RES PMF 1/4W 178K F	KOA
1	R80	RES PMF 1/4W 178K F	KOA
1	R81	RES PMF 1/4W 178K F	KOA
1	R122	RES PMF 1/4W 200K F	KOA
1	R4	RES PMF 1/4W 330K F	KOA
1	R5	RES PMF 1/4W 330K F	KOA
1	R69	RES PMF 1/4W 330K F	KOA
1	R70	RES PMF 1/4W 330K F	KOA
1	R71	RES PMF 1/4W 330K F	KOA
1	R82	RES PMF 1/4W 330K F	KOA
1	R83	RES PMF 1/4W 330K F	KOA
1	R22	RES PMF 1/4W 442K F	KOA
1	R89	RES PMF 1/4W 665K F	KOA
1	R10	RES PMF 1/4W 1M F	KOA
1	R90	RES PMF 1/4W 1M F	KOA
1	R23	RES NRWW 2W 0.5 J (NON-IND)	TY-OHM
1	R45	RESISTOR NRWW 2W 1 J (NON-IND)	TY-OHM
1	R57	RES NRWW 5W 10 J	TY-OHM
1	R17	RES CWW 5W 1K J TYPE/SQM	TY-OHM

Qty	Cct Ident	Description	Manufacturer
1	R26	RES FMF 1/2W 10 J	TY-OHM
1	R32	RES FMF 1/2W 10 J	TY-OHM
1	R33	RES FMF 1/2W 10 J	TY-OHM
1	R35	RES FMF 1/2W 10 J	TY-OHM
1	R39	RES FMF 1/2W 10 J	TY-OHM
1	R40	RES FMF 1/2W 10 J	TY-OHM
1	R18	RES FMF 1/2W 47 J	TY-OHM
1	R42	RES FMF 1/2W 47 J	TY-OHM
1	R50	RES FMF 1/2W 47 J	TY-OHM
1	R52	RES FMF 1/2W 47 J	TY-OHM
1	R56	RES FMF 1/2W 47 J	TY-OHM
1	R21	RES FMF 1/2W 1.0K J	TY-OHM
1	R49	RES FMF 1/2W 1.0K J	TY-OHM
1	VR01	VR 1K 1T 3323PEW-4-102	BOURNS
1	NTC1	THERMISTOR,NTC 10 6A	KETEMA
1	C62	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C71	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C5	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C61	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C64	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C67	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C70	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C1	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C10	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C40	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C49	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C30	CAP EL-AL 47uF 450V M 16 *35.5RL2 RAD 7.5mm 105¢J	NIPPON CHEMI-CON
1	C21	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C26	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C28	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C29	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C32	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C12	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C41	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C47	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C51	CAP EL-AL 220uF 450V M 25*50SN2 RAD 10mm 105¢J	MARCON
1	C52	CAP EL-AL 220uF 450V M 25*50SN2 RAD 10mm 105¢J	MARCON
1	C68	CAP EL-AL 220uF 450V M 25*50SN2 RAD 10mm 105¢J	MARCON
1	C73	CAP EL-AL 220uF 450V M 25*50SN2 RAD 10mm 105¢J	MARCON
1	C19	CAP EL-AL 2200uF 16V M 12.5*25RL2 RAD 7.5mm85¢J	NIPPON CHEMI-CON
1	C2	CAP EL-AL 3300uF 50V M 18*35.5RL2 RAD 7.5mm85¢J	NIPPON CHEMI-CON
1	C15	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C37	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C66	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C16	CAP MPE 4.7uF 250VAC M RAD X-	OKAYA

Qty	Cct Ident	Description	Manufacturer
1	C22	CAP MPP 0.022uF 1000V J RAD	WIMA
1	C23	CAP MPP 0.022uF 1000V J RAD	WIMA
1	C38	CAP MPE 2.2uF 275VAC M RAD X2-	OKAYA
1	C39	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C8	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C59	CAP CER MONO 3.9nF 50V J NPO RAD TAP 5mm "392"	AVX CO.,
1	C9	CAP CER MONO 3.9nF 50V J NPO RAD TAP 5mm "392"	AVX CO.,
1	C24	CAP CER MONO 47PF 50V J COG AXI TAP 26mm "470"	AVX CO.,
1	C56	CAP CER MONO 47PF 50V J COG AXI TAP 26mm "470"	AVX CO.,
1	C57	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C11	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C13	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C14	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C27	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C36	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C45	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C48	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C53	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C54	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C6	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C63	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C65	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C69	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C7	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C72	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C75	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C3	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C35	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C4	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C60	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C74	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C55	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C42	CAP CER DISC 470PF 1000V M Z5U TAP 5mm "471"	EVER GRACE
1	C50	CAP CER DISC 470PF 1000V M Z5U TAP 5mm "471"	EVER GRACE
1	C17	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C18	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C20	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C25	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C46	CAP CER DISC 2.2nF 1000V K Y5P TAP 5mm "222"	EVER GRACE
1	C33	CAP CER DISC 0.01uF 1000V M Z5U	EVER GRACE
1	CT1	CT 1:1:1000 EI-28	LION
1	CT2	CT 1:1:1000 EI-28	LION
1	TX3	TX 1P 105X 100:100:72:62:62 EEL-16	LION
1	TX1	TX 1P 105X 3:3:33:33 EE-55	LION

Qty	Cct Ident	Description	Manufacturer
1	TX2	TX 1053 1P 96:19:7:7:7 40KHZ EE-35 LIEBERT	LION
1	U9	IC LINEAR LM324N	T.I. SEMICONDUCTOR CO.,
1	U3	IC V. REGULATOR 1A 5V 2% MC78T05ACT	MOTOROLA SEMICONDUCTOR C
1	Q5	IC LINEAR TL431AC	SAMSUNG SEMICONDUCTOR CO
1	U1	IC LINEAR SG3525AN MOTOROLA	MOTOROLA SEMICONDUCTOR C
1	U2	IC LINEAR UC3845N	MOTOROLA SEMICONDUCTOR C
1	U6	IC LINEAR UC3845N	MOTOROLA SEMICONDUCTOR C
1	U11	IC LINEAR UC3854N	UNITRODE SEMICONDUCTOR C
1	U12	IC LOGIC MC14066BCP	MOTOROLA SEMICONDUCTOR C
1	U4	IC PHOTO TLP521-1BL	TOSHIBA
1	U5	IC PHOTO TLP521-1BL	TOSHIBA
1	U10	IC PHOTO TLP250	TOSHIBA
1	U7	IC PHOTO TLP250	TOSHIBA
1	U8	IC PHOTO TLP250	TOSHIBA
1	D14	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D15	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D19	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D20	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D25	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D27	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D32	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D33	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D11	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D12	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D13	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D18	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D23	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D24	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D34	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D38	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	REC1	D. GI/GBU8M 8A 1000V BRIDGE	G.I.
1	D17	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D21	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D22	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D1	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D10	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D2	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D26	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D3	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D35	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D36	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D37	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D39	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D4	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D40	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,

Qty	Cct Ident	Description	Manufacturer
1	D41	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D42	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D43	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D45	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D46	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D7	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D8	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D9	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D5	D. GI/UF5402 3A 200V	G.I.
1	D6	D. GI/UF5402 3A 200V	G.I.
1	D28	D. GI/IN5399GP 1.5A 1000V TAP pitch 25.4mm	GENERALINSTRUMENT SEMICO
1	D29	D. GI/IN5399GP 1.5A 1000V TAP pitch 25.4mm	GENERALINSTRUMENT SEMICO
1	D30	D. GI/IN5399GP 1.5A 1000V TAP pitch 25.4mm	GENERALINSTRUMENT SEMICO
1	D31	D. GI/IN5399GP 1.5A 1000V TAP pitch 25.4mm	GENERALINSTRUMENT SEMICO
1	ZD4	ZD NEC/RD3.3 1/2W 3.3V	NEC SEMICONDUCTOR CO.,
1	ZD2	ZD NEC/RD5.1E 1/2W 5.1V	NEC SEMICONDUCTOR CO.,
1	ZD3	ZD NEC/RD5.1E 1/2W 5.1V	NEC SEMICONDUCTOR CO.,
1	ZD1	ZD NEC/RD12E 1/2W 12V	NEC SEMICONDUCTOR CO.,
1	Q2	TR MOSFET HARRIS/IRF620 5A 200V	
1	Q10	TR MOSFET HARRIS/RFP 40N10 40A 100V TO-220	HARRIS SEMICONDUCTOR CO.
1	Q11	TR MOSFET HARRIS/RFP 40N10 40A 100V TO-220	HARRIS SEMICONDUCTOR CO.
1	Q3	TR MOSFET HARRIS/RFP 40N10 40A 100V TO-220	HARRIS SEMICONDUCTOR CO.
1	Q4	TR MOSFET HARRIS/RFP 40N10 40A 100V TO-220	HARRIS SEMICONDUCTOR CO.
1	Q6	TR MOSFET HARRIS/RFP 40N10 40A 100V TO-220	HARRIS SEMICONDUCTOR CO.
1	Q7	TR MOSFET HARRIS/RFP 40N10 40A 100V TO-220	HARRIS SEMICONDUCTOR CO.
1	Q1	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q15	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q16	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q9	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	Q8	TR. MOSFET 2SK1358 9A 90 0V	TOSHIBA
1	Q14	TR MOSFET TOSHIBA/ 2SK1723 12A 600V	TOSHIBA
1	Q12	TR IGBT TOSHIBA/GT15Q101 15A 1200V	TOSHIBA
1	Q13	TR IGBT TOSHIBA/GT15Q101 15A 1200V	TOSHIBA
1	RY2	RELAY OMRON/G4W-2212P- VD-TV5 10A 250V C:12Vdc	OMRON
1	RY3	RELAY OMRON/G4W-2212P- VD-TV5 10A 250V C:12Vdc	OMRON
1	RY1	RELAY OMRON/G2R-1-E 16A 250V Coil:12Vdc	OMRON
1	TSA	SWITCH THERMAL WAKO/CS- 7SA NFZ-250-90C	WAKO
1	MOV1	VARISTOR HARRIS/ V320LA20A	HARRIS SEMICONDUCTOR CO.
1	F1	FUSE LITTEL/322020 20A 65Vdc	INALWAYS
1	F2	FUSE LITTEL/322020 20A 65Vdc	INALWAYS
1	F3	FUSE BEL/5FSP6.3 6.3A 250Vac (FAST ACTING)	BEL FUSE INC.

7.4 GXT1500RT-120 BILL OF MATERIAL

Qty	Cct Ident	Description	Manufacturer
1		FUSE BUSS/ABC-20 20A 250Vac	BUSS
1		FILTER DELTA/20DBAG5	DELTA
1		FILTER DELTA/15DKDG3	DELTA
1		FUSE BUSS/ABC-20 20A 250Vac	BUSS
4		BATTERY PANASONIC/ LC-R127R2PG1 12V 7.2AH	MATSUSHITA SEMICONDUCTOR
2		FAN NMB/3110KL-04W-B50- P00 80*80*25	HWAN CHONG
1		Output Filter FIXED-PLATE,105X,106X "RT" Liebert "91"	Chiah Jyh co.,
1		BAT. COVER-PLATE(□G),1XXX "RT" LIEBERT "05"	Chiah Jyh co.,
1	R10	RES CF 1/4W 510 J	TY-OHM
1	R107	RES CF 1/4W 510 J	TY-OHM
1	R108	RES CF 1/4W 510 J	TY-OHM
1	R109	RES CF 1/4W 510 J	TY-OHM
1	R110	RES CF 1/4W 510 J	TY-OHM
1	R111	RES CF 1/4W 510 J	TY-OHM
1	R112	RES CF 1/4W 510 J	TY-OHM
1	R115	RES CF 1/4W 510 J	TY-OHM
1	R116	RES CF 1/4W 510 J	TY-OHM
1	R117	RES CF 1/4W 510 J	TY-OHM
1	R118	RES CF 1/4W 510 J	TY-OHM
1	R120	RES CF 1/4W 510 J	TY-OHM
1	R129	RES CF 1/4W 510 J	TY-OHM
1	R130	RES CF 1/4W 510 J	TY-OHM
1	R3	RES CF 1/4W 510 J	TY-OHM
1	R35	RES CF 1/4W 510 J	TY-OHM
1	R36	RES CF 1/4W 510 J	TY-OHM
1	R7	RES CF 1/4W 510 J	TY-OHM
1	R70	RES CF 1/4W 510 J	TY-OHM
1	R92	RES CF 1/4W 510 J	TY-OHM
1	R97	RES CF 1/4W 510 J	TY-OHM
1	R106	RES CF 1/4W 2.2K J	KOA
1	R39	RES CF 1/4W 36K J	KOA
1	R23	RES CF 1/4W 470K J	KOA
1	R44	RES CF 1/4W 470K J	KOA
1	R94	RES CF 1/4W 470K J	KOA
1	R101	RES NFMOF 1W 300 J	TY-OHM
1	R121	RES PMF 1/4W 330 F	KOA
1	R122	RES PMF 1/4W 330 F	KOA
1	R41	RES PMF 1/4W 1K F	KOA
1	R48	RES PMF 1/4W 1K F	KOA
1	R53	RES PMF 1/4W 1K F	KOA
1	R89	RES PMF 1/4W 1K F	KOA
1	R90	RES PMF 1/4W 1K F	KOA
1	R91	RES PMF 1/4W 1K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R114	RES PMF 1/4W 2K F	KOA
1	R1	RES PMF 1/4W 4.99K F	TY-OHM
1	R100	RES PMF 1/4W 4.99K F	TY-OHM
1	R134	RES PMF 1/4W 4.99K F	TY-OHM
1	R14	RES PMF 1/4W 4.99K F	TY-OHM
1	R17	RES PMF 1/4W 4.99K F	TY-OHM
1	R18	RES PMF 1/4W 4.99K F	TY-OHM
1	R19	RES PMF 1/4W 4.99K F	TY-OHM
1	R26	RES PMF 1/4W 4.99K F	TY-OHM
1	R4	RES PMF 1/4W 4.99K F	TY-OHM
1	R55	RES PMF 1/4W 4.99K F	TY-OHM
1	R60	RES PMF 1/4W 4.99K F	TY-OHM
1	R67	RES PMF 1/4W 4.99K F	TY-OHM
1	R69	RES PMF 1/4W 4.99K F	TY-OHM
1	R71	RES PMF 1/4W 4.99K F	TY-OHM
1	R78	RES PMF 1/4W 4.99K F	TY-OHM
1	R79	RES PMF 1/4W 4.99K F	TY-OHM
1	R84	RES PMF 1/4W 4.99K F	TY-OHM
1	R98	RES PMF 1/4W 4.99K F	TY-OHM
1	R99	RES PMF 1/4W 4.99K F	TY-OHM
1	R11	RES PMF 1/4W 10K F	KOA
1	R12	RES PMF 1/4W 10K F	KOA
1	R2	RES PMF 1/4W 10K F	KOA
1	R22	RES PMF 1/4W 10K F	KOA
1	R27	RES PMF 1/4W 10K F	KOA
1	R31	RES PMF 1/4W 10K F	KOA
1	R51	RES PMF 1/4W 10K F	KOA
1	R52	RES PMF 1/4W 10K F	KOA
1	R58	RES PMF 1/4W 10K F	KOA
1	R6	RES PMF 1/4W 10K F	KOA
1	R65	RES PMF 1/4W 10K F	KOA
1	R73	RES PMF 1/4W 10K F	KOA
1	R74	RES PMF 1/4W 10K F	KOA
1	R75	RES PMF 1/4W 10K F	KOA
1	R76	RES PMF 1/4W 10K F	KOA
1	R77	RES PMF 1/4W 10K F	KOA
1	R8	RES PMF 1/4W 10K F	KOA
1	R80	RES PMF 1/4W 10K F	KOA
1	R83	RES PMF 1/4W 10K F	KOA
1	R86	RES PMF 1/4W 10K F	KOA
1	R87	RES PMF 1/4W 10K F	KOA
1	R88	RES PMF 1/4W 10K F	KOA
1	R9	RES PMF 1/4W 10K F	KOA
1	R93	RES PMF 1/4W 10K F	KOA
1	R95	RES PMF 1/4W 10K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R30	RES PMF 1/4W 16.9K F	KOA
1	R119	RES PMF 1/4W 20K F	TY-OHM
1	R13	RES PMF 1/4W 20K F	TY-OHM
1	R20	RES PMF 1/4W 20K F	TY-OHM
1	R21	RES PMF 1/4W 20K F	TY-OHM
1	R33	RES PMF 1/4W 20K F	TY-OHM
1	R54	RES PMF 1/4W 20K F	TY-OHM
1	R57	RES PMF 1/4W 20K F	TY-OHM
1	R38	RES PMF 1/4W 22.6K F	KOA
1	R64	RES PMF 1/4W 27K F	KOA
1	R62	RES PMF 1/4W 30K F	KOA
1	R15	RES PMF 1/4W 49.9K F	KOA
1	R16	RES PMF 1/4W 49.9K F	KOA
1	R25	RES PMF 1/4W 49.9K F	KOA
1	R32	RES PMF 1/4W 49.9K F	KOA
1	R47	RES PMF 1/4W 49.9K F	KOA
1	R56	RES PMF 1/4W 49.9K F	KOA
1	R66	RES PMF 1/4W 49.9K F	KOA
1	R82	RES PMF 1/4W 49.9K F	KOA
1	R85	RES PMF 1/4W 49.9K F	KOA
1	R103	RES PMF 1/4W 90.9K F	KOA
1	R49	RES PMF 1/4W 100K F	KOA
1	R5	RES PMF 1/4W 100K F	KOA
1	R50	RES PMF 1/4W 100K F	KOA
1	R59	RES PMF 1/4W 100K F	KOA
1	R68	RES PMF 1/4W 100K F	KOA
1	R45	RES PMF 1/4W 127K F	KOA
1	R42	RES PMF 1/4W 150K F	KOA
1	R28	RES PMF 1/4W 200K F	KOA
1	R29	RES PMF 1/4W 200K F	KOA
1	R34	RES PMF 1/4W 200K F	KOA
1	R40	RES PMF 1/4W 200K F	KOA
1	R37	RES PMF 1/4W 220K F	KOA
1	R61	RES PMF 1/4W 220K F	KOA
1	R63	RES PMF 1/4W 220K F	KOA
1	R24	RES PMF 1/4W 1M F	KOA
1	R43	RES PMF 1/4W 1M F	KOA
1	R46	RES PMF 1/4W 2.2M F	KOA
1	VR1	VR METALIZE 100K 0.7T (SIDE TRIME)	KINGTEK
1	R72	METAL-GLAZE 1/4W 4.7M J	KOA
1	NTC1	THERMISTOR,NTC 15K	UPPERMOST
1	C9	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105CJ	NIPPON CHEMI-CON
1	C27	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C30	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C39	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON

Qty	Cct Ident	Description	Manufacturer
1	C4	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C46	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C47	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C51	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C45	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C48	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C50	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C14	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C15	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C17	CAP EL-AL 1uF 100V M 5*11RL2 RAD TAP 5mm 85¢J	NIPPON CHEMI-CON
1	C7	CAP PE 0.0010uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C8	CAP PE 0.0010uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C10	CAP PE 0.047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C60	CAP MPE 1.000uF 63V J RAD TAP 5mm	TEAPO
1	C40	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C41	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C25	CAP CER MONO 100P 200V J J NPO AXI TAP26mm "101"	AVX CO.,
1	C6	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C1	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C11	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C13	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C2	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C61	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C19	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C20	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C21	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C23	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C26	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C29	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C3	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C34	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C38	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C42	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C43	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C44	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C49	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C5	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C52	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C53	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C54	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C59	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C62	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C16	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C22	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,

Qty	Cct Ident	Description	Manufacturer
1	C28	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C35	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C36	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C55	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C33	CAP CER MONO 223 50V K X7R AXI TAP 26mm "223"	AVX CO.,
1	C12	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C32	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C37	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C63	CAP CER DISC 0.001uF 250Vac K Y-,X-	GRANSTAR
1	TX1	TX 1P 105X 55:49:52:29:44 EE-16	LION
1	U5	IC LINEAR LM339N	MOTOROLA SEMICONDUCTOR C
1	U7	IC LINEAR LM393N	MOTOROLA SEMICONDUCTOR C
1	U3	IC LINEAR TL074BCN	T.I. SEMICONDUCTOR CO.,
1	U13	IC LINEAR TL431AC	SAMSUNG SEMICONDUCTOR CO
1	U4	IC LOGIC MC14013BCP	MOTOROLA SEMICONDUCTOR C
1	U2	IC LOGIC MC14081BCP	MOTOROLA SEMICONDUCTOR C
1	U1	IC LINEAR ULN2003AN	MOTOROLA SEMICONDUCTOR C
1	U19	IC LOGIC HI3-5051-5	HARRIS SEMICONDUCTOR CO.
1	U10	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U11	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U12	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U14	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U16	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U17	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U18	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U9	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	D19	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D20	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D21	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D22	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D1	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D10	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D12	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D13	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D14	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D15	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D16	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D17	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D18	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D2	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D23	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D24	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D25	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D26	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D27	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,

Qty	Cct Ident	Description	Manufacturer
1	D3	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D4	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D5	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D6	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D7	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D8	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D9	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	Q1	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q6	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q2	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	Q3	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	SW1	SWITCH DIP 2P	
1	XL1	CRYSTAL,CERAMIC 12MHZ	TXC
1	BZ1	BUZZER 20335 3.0-20Vdc	OBO SEAHORN
1		IC CPU MC68HC711K4CFN3/ SC416389CFN3	MOTOROLA SEMICONDUCTOR C
1	LD502	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD508	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD509	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD503	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD504	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD505	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD506	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD507	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD510	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD501	LED LTL-3211A RED 5*2	EVERLIGHT
1	SW501	SWITCH TACK TAP 5.0mm 12Vdc 50mA	FORWARD
1	SW502	SWITCH TACK TAP 5.0mm 12Vdc 50mA	FORWARD
1	R11	RES CF 1/4W 10 J	KOA
1	R74	RES CF 1/4W 36 J	KOA
1	R117	RES CF 1/4W 100 J	KOA
1	R119	RES CF 1/4W 100 J	KOA
1	R30	RES CF 1/4W 100 J	KOA
1	R41	RES CF 1/4W 510 J	TY-OHM
1	R124	RES CF 1/4W 3.6K J	KOA
1	R123	RES CF 1/4W 470K J	KOA
1	R34	RES CF 1/4W 470K J	KOA
1	R24	RES NFMOF 1W 100 J	TY-OHM
1	R25	RES NFMOF 1W 100 J	TY-OHM
1	R2	RES NFMOF 1W 2.2K J	TY-OHM
1	R46	RES NFMOF 2W 50K J	TY-OHM
1	R31	RES SSNF 3W 100 J	TY-OHM
1	R36	RES SSNF 3W 100 J	TY-OHM
1	R53	RES SSNF 3W 100 J	TY-OHM
1	R58	RES SSNF 3W 100 J	TY-OHM
1	R43	RES SSNF 3W 100K J RSS	TY-OHM

Qty	Cct Ident	Description	Manufacturer
1	R43A	RES SSNF 3W 100K J RSS	TY-OHM
1	R88	RES PMF 1/4W 1.8K F	KOA
1	R113	RES PMF 1/4W 2K F	KOA
1	R73	RES PMF 1/4W 2K F	KOA
1	R92	RES PMF 1/4W 2K F	KOA
1	R67	RES PMF 1/4W 3K F	KOA
1	R68	RES PMF 1/4W 3K F	KOA
1	R12	RES PMF 1/4W 3.9K F	KOA
1	R27	RES PMF 1/4W 3.9K F	KOA
1	R48	RES PMF 1/4W 4.7K F	KOA
1	R109	RES PMF 1/4W 4.99K F	TY-OHM
1	R115	RES PMF 1/4W 4.99K F	TY-OHM
1	R125	RES PMF 1/4W 4.99K F	TY-OHM
1	R13	RES PMF 1/4W 4.99K F	TY-OHM
1	R47	RES PMF 1/4W 4.99K F	TY-OHM
1	R55	RES PMF 1/4W 4.99K F	TY-OHM
1	R8	RES PMF 1/4W 4.99K F	TY-OHM
1	R111	RES PMF 1/4W 6.8K F	KOA
1	R29	RES PMF 1/4W 6.8K F	KOA
1	R59	RES PMF 1/4W 6.8K F	KOA
1	R95	RES PMF 1/4W 6.8K F	KOA
1	R96	RES PMF 1/4W 7.5K F	KOA
1	R100	RES PMF 1/4W 9.1K F	KOA
1	R110	RES PMF 1/4W 9.1K F	KOA
1	R78	RES PMF 1/4W 9.1K F	KOA
1	R104	RES PMF 1/4W 10K F	KOA
1	R108	RES PMF 1/4W 10K F	KOA
1	R116	RES PMF 1/4W 10K F	KOA
1	R120	RES PMF 1/4W 10K F	KOA
1	R126	RES PMF 1/4W 10K F	KOA
1	R127	RES PMF 1/4W 10K F	KOA
1	R128	RES PMF 1/4W 10K F	KOA
1	R129	RES PMF 1/4W 10K F	KOA
1	R130	RES PMF 1/4W 10K F	KOA
1	R131	RES PMF 1/4W 10K F	KOA
1	R37	RES PMF 1/4W 10K F	KOA
1	R77	RES PMF 1/4W 10K F	KOA
1	R102	RES PMF 1/4W 10.7K F	KOA
1	R93	RES PMF 1/4W 10.7K F	KOA
1	R84	RES PMF 1/4W 11K F	KOA
1	R94	RES PMF 1/4W 11K F	KOA
1	R19	RES PMF 1/4W 13K F	KOA
1	R16	RES PMF 1/4W 15K F	KOA
1	R72	RES PMF 1/4W 15K F	KOA
1	R75	RES PMF 1/4W 15K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R1	RES PMF 1/4W 20K F	TY-OHM
1	R118	RES PMF 1/4W 20K F	TY-OHM
1	R60	RES PMF 1/4W 20K F	TY-OHM
1	R9	RES PMF 1/4W 20K F	TY-OHM
1	R97	RES PMF 1/4W 20K F	TY-OHM
1	R76	RES PMF 1/4W 30K F	KOA
1	R61	RES PMF 1/4W 47K F	KOA
1	R99	RES PMF 1/4W 47K F	KOA
1	R134	RES PMF 1/4W 49.9K F	KOA
1	R14	RES PMF 1/4W 49.9K F	KOA
1	R20	RES PMF 1/4W 49.9K F	KOA
1	R44	RES PMF 1/4W 49.9K F	KOA
1	R51	RES PMF 1/4W 49.9K F	KOA
1	R54	RES PMF 1/4W 49.9K F	KOA
1	R6	RES PMF 1/4W 49.9K F	KOA
1	R7	RES PMF 1/4W 49.9K F	KOA
1	R114	RES PMF 1/4W 56K F	KOA
1	R106	RES PMF 1/4W 75K F	KOA
1	R112	RES PMF 1/4W 75K F	KOA
1	R62	RES PMF 1/4W 75K F	KOA
1	R71	RES PMF 1/4W 75K F	KOA
1	R15	RES PMF 1/4W 90.9K F	KOA
1	R101	RES PMF 1/4W 100K F	KOA
1	R103	RES PMF 1/4W 100K F	KOA
1	R105	RES PMF 1/4W 100K F	KOA
1	R107	RES PMF 1/4W 100K F	KOA
1	R28	RES PMF 1/4W 100K F	KOA
1	R66	RES PMF 1/4W 100K F	KOA
1	R81	RES PMF 1/4W 100K F	KOA
1	R86	RES PMF 1/4W 100K F	KOA
1	R91	RES PMF 1/4W 100K F	KOA
1	R98	RES PMF 1/4W 100K F	KOA
1	R5	RES PMF 1/4W 127K F	KOA
1	R22A	RES PMF 1/4W 150K F	KOA
1	R64	RES PMF 1/4W 150K F	KOA
1	R65	RES PMF 1/4W 150K F	KOA
1	R69	RES PMF 1/4W 150K F	KOA
1	R70	RES PMF 1/4W 150K F	KOA
1	R79	RES PMF 1/4W 150K F	KOA
1	R80	RES PMF 1/4W 150K F	KOA
1	R87	RES PMF 1/4W 150K F	KOA
1	R4	RES PMF 1/4W 178K F	KOA
1	R122	RES PMF 1/4W 200K F	KOA
1	R63	RES PMF 1/4W 200K F	KOA
1	R82	RES PMF 1/4W 200K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R83	RES PMF 1/4W 200K F	KOA
1	R22	RES PMF 1/4W 442K F	KOA
1	R10	RES PMF 1/4W 1M F	KOA
1	R89	RES PMF 1/4W 1M F	KOA
1	R90	RES PMF 1/4W 1M F	KOA
1	R23A	RES NRWW 2W 0.5 J (NON-IND)	TY-OHM
1	R45	RESISTOR NRWW 2W 0.75 J (NON-IND)	TY-OHM
1	R45A	RESISTOR NRWW 2W 0.75 J (NON-IND)	TY-OHM
1	R57	RES NRWW 5W 10 J	TY-OHM
1	R17	RES CWW 5W 1K J TYPE/SQM	TY-OHM
1	R26	RES FMF 1/2W 10 J	TY-OHM
1	R32	RES FMF 1/2W 10 J	TY-OHM
1	R33	RES FMF 1/2W 10 J	TY-OHM
1	R35	RES FMF 1/2W 10 J	TY-OHM
1	R39	RES FMF 1/2W 10 J	TY-OHM
1	R40	RES FMF 1/2W 10 J	TY-OHM
1	R50	RES FMF 1/2W 10 J	TY-OHM
1	R56	RES FMF 1/2W 10 J	TY-OHM
1	R133	RES FMF 1/2W 22 J	TY-OHM
1	R18	RES FMF 1/2W 47 J	TY-OHM
1	R42	RES FMF 1/2W 47 J	TY-OHM
1	R52	RES FMF 1/2W 47 J	TY-OHM
1	R21	RES FMF 1/2W 1.0K J	TY-OHM
1	R49	RES FMF 1/2W 1.0K J	TY-OHM
1	VR01	VR 1K 1T 3323PEW-4-102	BOURNS
1	NTC1	THERMISTOR,NTC 1.0 20A	KETEMA
1	C62	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C71	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C61	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C64	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C67	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C70	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C30	CAP EL-AL 220uF 200V M 18*35.5RL2 RAD 7.5mm105C	NIPPON CHEMI-CON
1	C10	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C32	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C40	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C49	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C1	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C21	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C26	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C28	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C29	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C41	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C47	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C5	CAP EL-AL 220uF 50V M 10 *16RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON

Qty	Cct Ident	Description	Manufacturer
1	C12	CAP EL-AL 470uF 63V M 13*25RL2 RAD 5mm 105¢J	JAMICON
1	C19	CAP EL-AL 2200uF 16V M 12.5*25RL2 RAD 7.5mm85¢J	NIPPON CHEMI-CON
1	C51	CAP EL-AL 1500uF 250V M 35*50SN2 RAD 10mm 85¢J	NIPPON CHEMI-CON
1	C52	CAP EL-AL 1500uF 250V M 35*50SN2 RAD 10mm 85¢J	NIPPON CHEMI-CON
1	C68	CAP EL-AL 1500uF 250V M 35*50SN2 RAD 10mm 85¢J	NIPPON CHEMI-CON
1	C73	CAP EL-AL 1500uF 250V M 35*50SN2 RAD 10mm 85¢J	NIPPON CHEMI-CON
1	C2	CAP EL-AL 1200uF 63V M 18*40RL2 RAD TAP7.5mm105	NIPPON CHEMI-CON
1	C2A	CAP EL-AL 1200uF 63V M 18*40RL2 RAD TAP7.5mm105	NIPPON CHEMI-CON
1	C2B	CAP EL-AL 1200uF 63V M 18*40RL2 RAD TAP7.5mm105	NIPPON CHEMI-CON
1	C15	CAP PE 0.0022uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C37	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C66	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C4	CAP PE 0.1000uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C16	CAP MPE 18uF 180VAC U RAD FALN 70¢J	MARCON
1	C22	CAP MPP 0.33uF 400Vdc 25 0Vac J RAD 100¢J	WIMA
1	C23	CAP MPP 0.33uF 400Vdc 25 0Vac J RAD 100¢J	WIMA
1	C38	CAP MPE 2.2uF 275VAC M RAD X2-	OKAYA
1	C8	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C59	CAP CER MONO 3.9nF 50V J NPO RAD TAP 5mm "392"	AVX CO.,
1	C9	CAP CER MONO 3.9nF 50V J NPO RAD TAP 5mm "392"	AVX CO.,
1	C24	CAP CER MONO 47PF 50V J COG AXI TAP 26mm "470"	AVX CO.,
1	C56	CAP CER MONO 47PF 50V J COG AXI TAP 26mm "470"	AVX CO.,
1	C57	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C76	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C11	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C13	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C14	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C27	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C36	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C45	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C48	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C53	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C54	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C6	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C63	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C65	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C69	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C7	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C72	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C75	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C3	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C35	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C60	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C74	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,

Qty	Cct Ident	Description	Manufacturer
1	C39	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C55	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C42	CAP CER DISC 470PF 1000V M Z5U TAP 5mm "471"	EVER GRACE
1	C50	CAP CER DISC 470PF 1000V M Z5U TAP 5mm "471"	EVER GRACE
1	C17	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C18	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C20	CAP CER DISC 2.2nF 1000V K Y5P TAP 5mm "222"	EVER GRACE
1	C25	CAP CER DISC 2.2nF 1000V K Y5P TAP 5mm "222"	EVER GRACE
1	C46	CAP CER DISC 2.2nF 1000V K Y5P TAP 5mm "222"	EVER GRACE
1	C33	CAP CER DISC 0.01uF 1000V M Z5U	EVER GRACE
1	C33A	CAP CER DISC 0.01uF 1000V M Z5U	EVER GRACE
1	C58	CAP CER DISC 0.01uF 250VAC M Y-,X-	GRANSTAR
1	CT1	CT 1:1:1000 EI-28	LION
1	CT2	CT 1:1:1000 EI-28	LION
1	TX2	TX 1060 1P 6:24:42:7:10 37KHZ EI35/12	LION
1	TX1	TX 1060 1P 4:4:18:18 44KHZ EE55	LION
1	TX3	TX 1P 1060 68:28:22:40: 40 100KHZ EEL16	LION
1	L4	CHOKE 1060 150uH 6A 1.0D FER ROD LIEBERT	LION
1	L5	CHOKE 1060 150uH 6A 1.0D FER ROD LIEBERT	LION
1	L2	CHOKE 1060 700uH 15A 1.5D IRON T184 LIEBERT	TEH DIANN
1	L1	CHOKE 1060 300uH 15A 1.5D IRON T184 LIEBERT	TEH DIANN
1	L3	CHOKE 1060 300uH 15A 1.5D IRON T184 LIEBERT	TEH DIANN
1	U9	IC LINEAR LM324N	T.I. SEMICONDUCTOR CO.,
1	U3	IC V. REGULATOR 1A 5V 2% MC78T05ACT	MOTOROLA SEMICONDUCTOR C
1	Q5	IC LINEAR TL431AC	SAMSUNG SEMICONDUCTOR CO
1	U1	IC LINEAR SG3525AN MOTOROLA	MOTOROLA SEMICONDUCTOR C
1	U2	IC LINEAR UC3845N	MOTOROLA SEMICONDUCTOR C
1	U6	IC LINEAR UC3845N	MOTOROLA SEMICONDUCTOR C
1	U11	IC LINEAR UC3854N	UNITRODE SEMICONDUCTOR C
1	U12	IC LOGIC MC14066BCP	MOTOROLA SEMICONDUCTOR C
1	U13	IC PHOTO TLP521-1BL	TOSHIBA
1	U4	IC PHOTO TLP521-1BL	TOSHIBA
1	U5	IC PHOTO TLP521-1BL	TOSHIBA
1	U10	IC PHOTO TLP250	TOSHIBA
1	U7	IC PHOTO TLP250	TOSHIBA
1	U8	IC PHOTO TLP250	TOSHIBA
1	D14	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D15	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D20	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D25	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D27	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D32	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D33	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D5	D. HARRIS/RHRP860 8A 600V	HARRIS SEMICONDUCTOR CO.
1	D11	D. HARRIS/RHRP1560 15A 600V	HARRIS SEMICONDUCTOR CO.

Qty	Cct Ident	Description	Manufacturer
1	D12	D. HARRIS/RHRP1560 15A 600V	HARRIS SEMICONDUCTOR CO.
1	D23	D. HARRIS/RHRP1560 15A 600V	HARRIS SEMICONDUCTOR CO.
1	D24	D. HARRIS/RHRP1560 15A 600V	HARRIS SEMICONDUCTOR CO.
1	D6	D. MOTOROLA/MUR460 4A 600V ULTRAFast	MOTOROLA SEMICONDUCTOR C
1	REC1	D. 25A 600V BRIDGE	SHINDENGEN
1	D13	D. HARRIS/RHRP3060 30A 600V	HARRIS SEMICONDUCTOR CO.
1	D18	D. HARRIS/RHRP3060 30A 600V	HARRIS SEMICONDUCTOR CO.
1	D34	D. HARRIS/RHRP3060 30A 600V	HARRIS SEMICONDUCTOR CO.
1	D38	D. HARRIS/RHRP3060 30A 600V	HARRIS SEMICONDUCTOR CO.
1	D44	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D47	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D1	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D10	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D2	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D26	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D3	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D35	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D36	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D37	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D39	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D4	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D40	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D41	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D42	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D43	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D45	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D46	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D48	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D7	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D8	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D9	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	REC2	D. GI/2W10G 2A 1000V BRIDGE	G.I.
1	D19	D. SHINDENGEN/D2S6M 2A 60V FAST	SHINDENGEN
1	ZD4	ZD NEC/RD3.3 1/2W 3.3V	NEC SEMICONDUCTOR CO.,
1	ZD2	ZD NEC/RD5.1E 1/2W 5.1V	NEC SEMICONDUCTOR CO.,
1	ZD3	ZD NEC/RD5.1E 1/2W 5.1V	NEC SEMICONDUCTOR CO.,
1	ZD1	ZD NEC/RD12E 1/2W 12V	NEC SEMICONDUCTOR CO.,
1	Q1	TR BIP MOTOROLA/2N5551 0.6A 160V NPN TAP	MOTOROLA SEMICONDUCTOR C
1	Q10	TR MOSFET IR/IRFP260 46A 200V	INTERNATIONAL RECTIFIER
1	Q11	TR MOSFET IR/IRFP260 46A 200V	INTERNATIONAL RECTIFIER
1	Q3	TR MOSFET IR/IRFP260 46A 200V	INTERNATIONAL RECTIFIER
1	Q4	TR MOSFET IR/IRFP260 46A 200V	INTERNATIONAL RECTIFIER
1	Q6	TR MOSFET IR/IRFP260 46A 200V	INTERNATIONAL RECTIFIER
1	Q7	TR MOSFET IR/IRFP260 46A 200V	INTERNATIONAL RECTIFIER
1	Q14	TR MOSFET IR/IRFP264 38A 250V	INTERNATIONAL RECTIFIER

Qty	Cct Ident	Description	Manufacturer
1	Q8	TR MOSFET HARRIS/IRF840 8A 500V	HARRIS SEMICONDUCTOR CO.
1	Q2	TR MOSFET HARRIS/IRF620 5A 200V	
1	Q15	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q16	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q12	TR IGBT TOSHIBA/GT50J102 50A 600V	TOSHIBA
1	Q13	TR IGBT TOSHIBA/GT50J102 50A 600V	TOSHIBA
1	RY2	RELAY 12Vdc,30A 240Vac 1b P&B/T9AS1D12-12	P&B
1	RY1	RELAY OMRON/G2R-1-E 16A 250V Coil:12Vdc	OMRON
1	TS	SWITCH THERMAL WAKO/CS- 7SA NFZ-250-90C	WAKO
1	MOV1	VARISTOR SAS/ SAV-271KD14	AINO AMERICAN SILICON
1	F1	FUSE BUSS/GBB-20 20A 125Vdc/250Vac	BUSSMANN
1	F2	FUSE BUSS/GBB-20 20A 125Vdc/250Vac	BUSSMANN
1	F3	FUSE LITTEL/324020 20A 250Vac (FAST ACTING)	INALWAYS
1	MOV1	VARISTOR SAS 471KD20	AINO AMERICAN SILICON
1	MOV2	VARISTOR SAS 471KD20	AINO AMERICAN SILICON

7.5 GXT3000RT-230 BILL OF MATERIAL

Qty	Cct Ident	Description	Manufacturer
1		FILTER DELTA/16DBDG3	DELTA
1		FUSE BLOCK 13/32" SINGLE POLE 10*38	BUSS
1		FUSE 30A 660V 10*38	FERRAZ
8		BATTERY PANASONIC/ LC-R127R2PG1 12V 7.2AH	MATSUSHITA SEMICONDUCTOR
2		FAN NMB/3610KL-04W-B50- L00 12Vdc 92*82.5*25.8	HWAN CHONG
1	R801	METAL-GLAZE 1/4W 1M F	KOA
1	C801	CAP MPE 0.47uF 275VAC M RAD X2-	OKAYA
1	C802	CAP MPE 0.47uF 275VAC M RAD X2-	OKAYA
1	C805	CAP MPE 0.47uF 275VAC M RAD X2-	OKAYA
1	C806	CAP CER DISC 0.0022uF 250VAC M Y-,X-	MURATA
1	C807	CAP CER DISC 0.0022uF 250VAC M Y-,X-	MURATA
1	LD502	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD508	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD509	LED LTL-3251A YELLOW 5*2	EVERLIGHT
1	LD503	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD504	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD505	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD506	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD507	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD510	LED LTL-3231A GREEN 5*2	EVERLIGHT
1	LD501	LED LTL-3211A RED 5*2	EVERLIGHT
1	SW501	SWITCH TACK TAP 5.0mm 12Vdc 50mA	FORWARD
1	SW502	SWITCH TACK TAP 5.0mm 12Vdc 50mA	FORWARD
1	R10	RES CF 1/4W 510 J	TY-OHM
1	R107	RES CF 1/4W 510 J	TY-OHM
1	R108	RES CF 1/4W 510 J	TY-OHM
1	R109	RES CF 1/4W 510 J	TY-OHM
1	R110	RES CF 1/4W 510 J	TY-OHM
1	R111	RES CF 1/4W 510 J	TY-OHM
1	R112	RES CF 1/4W 510 J	TY-OHM
1	R115	RES CF 1/4W 510 J	TY-OHM
1	R116	RES CF 1/4W 510 J	TY-OHM
1	R117	RES CF 1/4W 510 J	TY-OHM
1	R118	RES CF 1/4W 510 J	TY-OHM
1	R120	RES CF 1/4W 510 J	TY-OHM
1	R129	RES CF 1/4W 510 J	TY-OHM
1	R130	RES CF 1/4W 510 J	TY-OHM
1	R3	RES CF 1/4W 510 J	TY-OHM
1	R35	RES CF 1/4W 510 J	TY-OHM
1	R36	RES CF 1/4W 510 J	TY-OHM
1	R7	RES CF 1/4W 510 J	TY-OHM
1	R70	RES CF 1/4W 510 J	TY-OHM
1	R92	RES CF 1/4W 510 J	TY-OHM

Qty	Cct Ident	Description	Manufacturer
1	R97	RES CF 1/4W 510 J	TY-OHM
1	R106	RES CF 1/4W 2.2K J	KOA
1	R39	RES CF 1/4W 36K J	KOA
1	R23	RES CF 1/4W 470K J	KOA
1	R44	RES CF 1/4W 470K J	KOA
1	R94	RES CF 1/4W 470K J	KOA
1	R101	RES NFMOF 1W 300 J	TY-OHM
1	R121	RES PMF 1/4W 330 F	KOA
1	R122	RES PMF 1/4W 330 F	KOA
1	R41	RES PMF 1/4W 1K F	KOA
1	R48	RES PMF 1/4W 1K F	KOA
1	R53	RES PMF 1/4W 1K F	KOA
1	R89	RES PMF 1/4W 1K F	KOA
1	R90	RES PMF 1/4W 1K F	KOA
1	R91	RES PMF 1/4W 1K F	KOA
1	R114	RES PMF 1/4W 2K F	KOA
1	R1	RES PMF 1/4W 4.99K F	TY-OHM
1	R100	RES PMF 1/4W 4.99K F	TY-OHM
1	R134	RES PMF 1/4W 4.99K F	TY-OHM
1	R14	RES PMF 1/4W 4.99K F	TY-OHM
1	R17	RES PMF 1/4W 4.99K F	TY-OHM
1	R18	RES PMF 1/4W 4.99K F	TY-OHM
1	R19	RES PMF 1/4W 4.99K F	TY-OHM
1	R26	RES PMF 1/4W 4.99K F	TY-OHM
1	R4	RES PMF 1/4W 4.99K F	TY-OHM
1	R55	RES PMF 1/4W 4.99K F	TY-OHM
1	R60	RES PMF 1/4W 4.99K F	TY-OHM
1	R67	RES PMF 1/4W 4.99K F	TY-OHM
1	R69	RES PMF 1/4W 4.99K F	TY-OHM
1	R71	RES PMF 1/4W 4.99K F	TY-OHM
1	R78	RES PMF 1/4W 4.99K F	TY-OHM
1	R79	RES PMF 1/4W 4.99K F	TY-OHM
1	R84	RES PMF 1/4W 4.99K F	TY-OHM
1	R98	RES PMF 1/4W 4.99K F	TY-OHM
1	R99	RES PMF 1/4W 4.99K F	TY-OHM
1	R11	RES PMF 1/4W 10K F	KOA
1	R12	RES PMF 1/4W 10K F	KOA
1	R2	RES PMF 1/4W 10K F	KOA
1	R22	RES PMF 1/4W 10K F	KOA
1	R27	RES PMF 1/4W 10K F	KOA
1	R31	RES PMF 1/4W 10K F	KOA
1	R51	RES PMF 1/4W 10K F	KOA
1	R52	RES PMF 1/4W 10K F	KOA
1	R58	RES PMF 1/4W 10K F	KOA
1	R6	RES PMF 1/4W 10K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R65	RES PMF 1/4W 10K F	KOA
1	R73	RES PMF 1/4W 10K F	KOA
1	R74	RES PMF 1/4W 10K F	KOA
1	R75	RES PMF 1/4W 10K F	KOA
1	R76	RES PMF 1/4W 10K F	KOA
1	R77	RES PMF 1/4W 10K F	KOA
1	R8	RES PMF 1/4W 10K F	KOA
1	R80	RES PMF 1/4W 10K F	KOA
1	R83	RES PMF 1/4W 10K F	KOA
1	R86	RES PMF 1/4W 10K F	KOA
1	R87	RES PMF 1/4W 10K F	KOA
1	R88	RES PMF 1/4W 10K F	KOA
1	R9	RES PMF 1/4W 10K F	KOA
1	R93	RES PMF 1/4W 10K F	KOA
1	R95	RES PMF 1/4W 10K F	KOA
1	R30	RES PMF 1/4W 16.9K F	KOA
1	R119	RES PMF 1/4W 20K F	TY-OHM
1	R13	RES PMF 1/4W 20K F	TY-OHM
1	R20	RES PMF 1/4W 20K F	TY-OHM
1	R21	RES PMF 1/4W 20K F	TY-OHM
1	R33	RES PMF 1/4W 20K F	TY-OHM
1	R54	RES PMF 1/4W 20K F	TY-OHM
1	R57	RES PMF 1/4W 20K F	TY-OHM
1	R38	RES PMF 1/4W 22.6K F	KOA
1	R64	RES PMF 1/4W 27K F	KOA
1	R62	RES PMF 1/4W 30K F	KOA
1	R15	RES PMF 1/4W 49.9K F	KOA
1	R16	RES PMF 1/4W 49.9K F	KOA
1	R25	RES PMF 1/4W 49.9K F	KOA
1	R32	RES PMF 1/4W 49.9K F	KOA
1	R56	RES PMF 1/4W 49.9K F	KOA
1	R66	RES PMF 1/4W 49.9K F	KOA
1	R82	RES PMF 1/4W 49.9K F	KOA
1	R85	RES PMF 1/4W 49.9K F	KOA
1	R103	RES PMF 1/4W 90.9K F	KOA
1	R40	RES PMF 1/4W 100K F	KOA
1	R45	RES PMF 1/4W 100K F	KOA
1	R5	RES PMF 1/4W 100K F	KOA
1	R50	RES PMF 1/4W 100K F	KOA
1	R59	RES PMF 1/4W 100K F	KOA
1	R68	RES PMF 1/4W 100K F	KOA
1	R42	RES PMF 1/4W 150K F	KOA
1	R28	RES PMF 1/4W 200K F	KOA
1	R29	RES PMF 1/4W 200K F	KOA
1	R34	RES PMF 1/4W 200K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R37	RES PMF 1/4W 220K F	KOA
1	R61	RES PMF 1/4W 220K F	KOA
1	R63	RES PMF 1/4W 220K F	KOA
1	R81	RES PMF 1/4W 301K F	KOA
1	R24	RES PMF 1/4W 1M F	KOA
1	R43	RES PMF 1/4W 1M F	KOA
1	R96	METAL GLAZE 1/4W 3.9M J	KOA
1	R72	METAL-GLAZE 1/4W 4.7M J	KOA
1	NTC1	THERMISTOR,NTC 15K	UPPERMOST
1	C9	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C27	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C30	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C39	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C4	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C46	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C47	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C51	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C18	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C45	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C48	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C50	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C14	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C15	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C17	CAP EL-AL 1uF 100V M 5*11RL2 RAD TAP 5mm 85¢J	NIPPON CHEMI-CON
1	C24	CAP EL-AL 1uF 100V M 5*11RL2 RAD TAP 5mm 85¢J	NIPPON CHEMI-CON
1	C7	CAP PE 0.0010uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C8	CAP PE 0.0010uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C10	CAP PE 0.047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C60	CAP MPE 1.000uF 63V J RAD TAP 5mm	TEAPO
1	C40	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C41	CAP CER MONO 22P 200V J NPO AXI TAP 26mm "220"	AVX CO.,
1	C25	CAP CER MONO 100P 200V J J NPO AXI TAP26mm "101"	AVX CO.,
1	C6	CAP CER MONO 470P 100V J NPO AXI TAP26mm "471"	AVX CO.,
1	C1	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C11	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C13	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C2	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C19	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C20	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C21	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C23	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C26	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C29	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C3	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,

Qty	Cct Ident	Description	Manufacturer
1	C34	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C38	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C42	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C43	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C44	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C49	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C5	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C52	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C53	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C54	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C59	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C22	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C28	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C35	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C36	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C55	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C33	CAP CER MONO 223 50V K X7R AXI TAP 26mm "223"	AVX CO.,
1	C12	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C32	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C37	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C61	CAP CER DISC 0.001uF 250Vac K Y-,X-	GRANSTAR
1	TX1	TX 1P 105X 55:49:52:29:44 EE-16	LION
1	U5	IC LINEAR LM339N	MOTOROLA SEMICONDUCTOR C
1	U7	IC LINEAR LM393N	MOTOROLA SEMICONDUCTOR C
1	U3	IC LINEAR TL074BCN	T.I. SEMICONDUCTOR CO.,
1	U13	IC LINEAR TL431AC	SAMSUNG SEMICONDUCTOR CO
1	U8	IC LINEAR UA7812UC	MOTOROLA SEMICONDUCTOR C
1	U4	IC LOGIC MC14013BCP	MOTOROLA SEMICONDUCTOR C
1	U2	IC LOGIC MC14081BCP	MOTOROLA SEMICONDUCTOR C
1	U1	IC LINEAR ULN2003AN	MOTOROLA SEMICONDUCTOR C
1	U19	IC LOGIC HI3-5051-5	HARRIS SEMICONDUCTOR CO.
1	U10	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U11	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U12	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U14	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U16	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U17	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U18	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	U9	IC PHOTO NEC/PS2561-1-V (W)	NEC SEMICONDUCTOR CO.,
1	D19	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D20	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D21	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D22	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D1	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D10	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,

Qty	Cct Ident	Description	Manufacturer
1	D12	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D13	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D14	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D15	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D16	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D17	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D18	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D2	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D23	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D24	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D25	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D26	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D27	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D28	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D3	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D4	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D5	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D6	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D7	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D8	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D9	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	Q1	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q6	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q2	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	Q3	TR MOSFET TOSHIBA/ 2SK941 600mA 100V TAP	TOSHIBA
1	SW1	SWITCH DIP 2P	
1	XL1	CRYSTAL,CERAMIC 12MHZ	TXC
1	BZ1	BUZZER 20335 3.0-20Vdc	OBO SEAHORN
1		IC CPU MC68HC711K4CFN3/ SC416389CFN3	MOTOROLA SEMICONDUCTOR C
1	R381	RES CF 1/4W 51 J	KOA
1	R207	RES CF 1/4W 510 J	TY-OHM
1	R70	RES CF 1/4W 510 J	TY-OHM
1	R229	RES CF 1/4W 470K J	KOA
1	R362	RES CF 1/4W 470K J	KOA
1	R389A	RES NFMOF 2W 12K J	TY-OHM
1	R3	RES SSNF 5W 10 J	TY-OHM
1	R18	RES SSNF 3W 17K J	TY-OHM
1	R18A	RES SSNF 3W 17K J	TY-OHM
1	R14	RES SSNF 3W 100 J	TY-OHM
1	R15	RES SSNF 3W 100 J	TY-OHM
1	R37	RES SSNF 3W 100 J	TY-OHM
1	R507	RES SSNF 3W 100 J	TY-OHM
1	R508	RES SSNF 3W 100 J	TY-OHM
1	R238	RES SSNF 3W 100K J RSS	TY-OHM
1	R503	RES PMF 1/4W 100 F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R71	RES PMF 1/4W 100 F	KOA
1	R352	RES PMF 1/4W 220 F	KOA
1	R358	RES PMF 1/4W 220 F	KOA
1	R336	RES PMF 1/4W 1.5K F	KOA
1	R403	RES PMF 1/4W 1.5K F	KOA
1	R54	RES PMF 1/4W 1.5K F	KOA
1	R363A	RES PMF 1/4W 2K F	KOA
1	R1	RES PMF 1/4W 3K F	KOA
1	R318	RES PMF 1/4W 3.3K F	KOA
1	R234	RES PMF 1/4W 3.74K F	KOA
1	R36	RES PMF 1/4W 3.74K F	KOA
1	R502	RES PMF 1/4W 3.9K F	KOA
1	R390	RES PMF 1/4W 4.7K F	KOA
1	R40	RES PMF 1/4W 4.7K F	KOA
1	R40A	RES PMF 1/4W 4.7K F	KOA
1	R31A	RES PMF 1/4W 4.99K F	TY-OHM
1	R352B	RES PMF 1/4W 4.99K F	TY-OHM
1	R358B	RES PMF 1/4W 4.99K F	TY-OHM
1	R50	RES PMF 1/4W 4.99K F	TY-OHM
1	R335	RES PMF 1/4W 6.8K F	KOA
1	R335A	RES PMF 1/4W 6.8K F	KOA
1	R45	RES PMF 1/4W 6.8K F	KOA
1	R23A	RES PMF 1/4W 7.5K F	KOA
1	R346	RES PMF 1/4W 9.1K F	KOA
1	R310A	RES PMF 1/4W 10K F	KOA
1	R315	RES PMF 1/4W 10K F	KOA
1	R324	RES PMF 1/4W 10K F	KOA
1	R352A	RES PMF 1/4W 10K F	KOA
1	R355	RES PMF 1/4W 10K F	KOA
1	R358A	RES PMF 1/4W 10K F	KOA
1	R359	RES PMF 1/4W 10K F	KOA
1	R373	RES PMF 1/4W 10K F	KOA
1	R373A	RES PMF 1/4W 10K F	KOA
1	R337	RES PMF 1/4W 10.5K F	KOA
1	R313	RES PMF 1/4W 10.7K F	KOA
1	R51	RES PMF 1/4W 10.7K F	KOA
1	R312	RES PMF 1/4W 11K F	KOA
1	R38	RES PMF 1/4W 11K F	KOA
1	R31B	RES PMF 1/4W 15K F	KOA
1	R31C	RES PMF 1/4W 15K F	KOA
1	R31D	RES PMF 1/4W 15K F	KOA
1	R31E	RES PMF 1/4W 15K F	KOA
1	R353	RES PMF 1/4W 15K F	KOA
1	R363	RES PMF 1/4W 15K F	KOA
1	R368	RES PMF 1/4W 15K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R501	RES PMF 1/4W 15K F	KOA
1	R23	RES PMF 1/4W 20K F	TY-OHM
1	R28	RES PMF 1/4W 20K F	TY-OHM
1	R212A	RES PMF 1/4W 30K F	KOA
1	R218A	RES PMF 1/4W 30K F	KOA
1	R364	RES PMF 1/4W 30K F	KOA
1	R12	RES PMF 1/4W 47.5K F	KOA
1	R13	RES PMF 1/4W 47.5K F	KOA
1	R2	RES PMF 1/4W 47.5K F	KOA
1	R21	RES PMF 1/4W 47.5K F	KOA
1	R233	RES PMF 1/4W 47.5K F	KOA
1	R24	RES PMF 1/4W 47.5K F	KOA
1	R331	RES PMF 1/4W 47.5K F	KOA
1	R389B	RES PMF 1/4W 47.5K F	KOA
1	R39	RES PMF 1/4W 47.5K F	KOA
1	R509	RES PMF 1/4W 47.5K F	KOA
1	R513	RES PMF 1/4W 47.5K F	KOA
1	R25	RES PMF 1/4W 75K F	KOA
1	R52	RES PMF 1/4W 75K F	KOA
1	R307	RES PMF 1/4W 100K F	KOA
1	R323	RES PMF 1/4W 100K F	KOA
1	R325B	RES PMF 1/4W 100K F	KOA
1	R345	RES PMF 1/4W 100K F	KOA
1	R361A	RES PMF 1/4W 100K F	KOA
1	R505	RES PMF 1/4W 100K F	KOA
1	R53	RES PMF 1/4W 100K F	KOA
1	R44	RES PMF 1/4W 150K F	KOA
1	R500	RES PMF 1/4W 150K F	KOA
1	R325A	RES PMF 1/4W 178K F	KOA
1	R334	RES PMF 1/4W 178K F	KOA
1	R342	RES PMF 1/4W 178K F	KOA
1	R343	RES PMF 1/4W 178K F	KOA
1	R41	RES PMF 1/4W 178K F	KOA
1	R42	RES PMF 1/4W 178K F	KOA
1	R43	RES PMF 1/4W 178K F	KOA
1	R46	RES PMF 1/4W 178K F	KOA
1	R47	RES PMF 1/4W 178K F	KOA
1	R48	RES PMF 1/4W 178K F	KOA
1	R49	RES PMF 1/4W 178K F	KOA
1	R27	RES PMF 1/4W 200K F	KOA
1	R333	RES PMF 1/4W 200K F	KOA
1	R344	RES PMF 1/4W 200K F	KOA
1	R361	RES PMF 1/4W 200K F	KOA
1	R332	RES PMF 1/4W 220K F	KOA
1	R65	RES PMF 1/4W 220K F	KOA

Qty	Cct Ident	Description	Manufacturer
1	R65A	RES PMF 1/4W 220K F	KOA
1	R66	RES PMF 1/4W 220K F	KOA
1	R67	RES PMF 1/4W 220K F	KOA
1	R68	RES PMF 1/4W 220K F	KOA
1	R68A	RES PMF 1/4W 220K F	KOA
1	R389C	RES PMF 1/4W 270K F	KOA
1	R316	RES PMF 1/4W 330K F	KOA
1	R329	RES PMF 1/4W 330K F	KOA
1	R340	RES PMF 1/4W 330K F	KOA
1	R367	RES PMF 1/4W 1M F	KOA
1	R389	RES PMF 1/4W 1M F	KOA
1	R38A	RES PMF 1/4W 1M F	KOA
1	R61	RES PMF 1/4W 1M F	KOA
1	R230	RES NRWW 2W 0.5 J (NON-IND)	TY-OHM
1	R32	RES NRWW 2W 0.5 J (NON-IND)	TY-OHM
1	R2A	RES FMF 1/2W 10 J	TY-OHM
1	R510	RES FMF 1/2W 10 J	TY-OHM
1	R511	RES FMF 1/2W 10 J	TY-OHM
1	R512	RES FMF 1/2W 10 J	TY-OHM
1	R514	RES FMF 1/2W 10 J	TY-OHM
1	R515	RES FMF 1/2W 10 J	TY-OHM
1	R516	RES FMF 1/2W 10 J	TY-OHM
1	R10	RES FMF 1/2W 47 J	TY-OHM
1	R11	RES FMF 1/2W 47 J	TY-OHM
1	R226	RES FMF 1/2W 47 J	TY-OHM
1	R30	RES FMF 1/2W 47 J	TY-OHM
1	R33	RES FMF 1/2W 47 J	TY-OHM
1	R402	RES FMF 1/2W 47 J	TY-OHM
1	R235	RES FMF 1/2W 1.0K J	TY-OHM
1	R404	RES FMF 1/2W 1.0K J	TY-OHM
1	VR301	VR 1K 1T 3323PEW-4-102	BOURNS
1	NTC1	THERMISTOR,NTC 1.0 20A	KETEMA
1	NTC2	THERMISTOR,NTC 5 5A	DOSHINE
1	C311	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C319	CAP EL-AL 1uF 50V M 5*11 RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C310	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C314	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C322	CAP EL-AL 10uF 50V M 5*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C20	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C222	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C375	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C376	CAP EL-AL 47uF 50V M 6*11RL2 RAD TAP 5mm	NIPPON CHEMI-CON
1	C17	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C318C	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C361	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON

Qty	Cct Ident	Description	Manufacturer
1	C365	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C374	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	CA	CAP EL-AL 100uF 50V M 8* 12RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C219A	CAP EL-AL 100uF 200V M 16*32RL2 RAD 7.5mm 105¢J	NIPPON CHEMI-CON
1	C16	CAP EL-AL 100uF 450V M 22*35*SN2 RAD 10mm 85C	NIPPON CHEMI-CON
1	C223	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C368	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C371	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C503	CAP EL-AL 220uF 35V M 10 *13RL2 RAD TAP 5mm 105¢J	NIPPON CHEMI-CON
1	C313	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C320	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C321	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C332	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C333	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C334	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C335	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C338	CAP EL-AL 330uF 450V M 30*50SN2 RAD 10mm	NIPPON CHEMI-CON
1	C219	CAP EL-AL 1200uF 200V M 30*50SN2 RAD 10mm 105¢J	NIPPON CHEMI-CON
1	C219C	CAP EL-AL 1200uF 200V M 30*50SN2 RAD 10mm 105¢J	NIPPON CHEMI-CON
1	C377	CAP EL-AL 2200uF 16V M 12.5*25RL2 RAD 7.5mm85¢J	NIPPON CHEMI-CON
1	C318B	CAP PE 0.0022uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C18	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C221A	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C23	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C317	CAP PE 0.0047uF 50V J RAD(IND) TAP 5mm	TAIWAN TAI YANG
1	C11	CAP MPE 10uF 250VAC M RAD X-	OKAYA
1	C12	CAP MPE 10uF 250VAC M RAD X-	OKAYA
1	C13	CAP MPP 0.022uF 400V JRA D	TAIWAN TAI YANG
1	C511	CAP MPP 0.22uF 630V K RA D 105¢J	MARCON
1	C512	CAP MPP 0.22uF 630V K RA D 105¢J	MARCON
1	C1	CAP MPE 2.2uF 275VAC M RAD X2-	OKAYA
1	C2	CAP MPE 2.2uF 275VAC M RAD X2-	OKAYA
1	C509	CAP CER MONO 3.9nF 50V J NPO RAD TAP 5mm "392"	AVX CO.,
1	C26	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C318A	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C330	CAP CER MONO 220PF 50V J COG AXI TAP26mm "221"	AVX CO.,
1	C126	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C12A	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C205	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C21	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C210	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C22	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C221	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C224	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C307A	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,

Qty	Cct Ident	Description	Manufacturer
1	C310A	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C315	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C318	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C319A	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31A	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C31B	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C324	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C325	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C363	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C364	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C373	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C4B	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C501	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C502	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C504	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C506	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	CB	CAP CER MONO 0.1uF 50V M Z5U AXI TAP26mm "104"	AVX CO.,
1	C323	CAP CER MONO 103 50V K X7R AXI TAP 26mm "103"	AVX CO.,
1	C220	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C24	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C307	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C327	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C328	CAP CER MONO 102 50V J N NPO AXI TAP 26mm "102"	AVX CO.,
1	C10	CAP CER DISC 470PF 1000V M Z5U TAP 5mm "471"	EVER GRACE
1	C9	CAP CER DISC 470PF 1000V M Z5U TAP 5mm "471"	EVER GRACE
1	C25	CAP CER DISC 1nF 1000V M Y5P TAP 5mm "102"	EVER GRACE
1	C507	CAP CER DISC 2.2nF 1000V K Y5P TAP 5mm "222"	EVER GRACE
1	C508	CAP CER DISC 2.2nF 1000V K Y5P TAP 5mm "222"	EVER GRACE
1	C8	CAP CER DISC 2.2nF 1000V K Y5P TAP 5mm "222"	EVER GRACE
1	CT1	CT 1:1:1000 EI-28	LION
1	CT2	CT 1:1:1000 EI-28	LION
1	TX501	TX 108X 1P 7:7:30:30 50KHZ FER EE-55	LION
1	TX502	TX 108X 1P 7:7:30:30 50KHZ FER EE-55	LION
1	TX1A	TX 1083 1P 67:5:40:5:7 37KHZ EE42-15	LION
1	TX305	TX 108X 1P 80:17:13:27: 27 100KHZ FER ZE6	LION
1	U304	IC LINEAR LM324N	T.I. SEMICONDUCTOR CO.,
1	U311	IC V. REGULATOR 1A 5V 2% MC78T05ACT	MOTOROLA SEMICONDUCTOR C
1	U203	IC LINEAR TL431CP TAP	T.I. SEMICONDUCTOR CO.,
1	U501	IC LINEAR SG3525AN MOTOROLA	MOTOROLA SEMICONDUCTOR C
1	U206	IC LINEAR UC3845N	MOTOROLA SEMICONDUCTOR C
1	U302	IC LINEAR UC3845N	MOTOROLA SEMICONDUCTOR C
1	U305	IC LINEAR UC3854N	UNITRODE SEMICONDUCTOR C
1	U1	IC LOGIC MC14066BCP	MOTOROLA SEMICONDUCTOR C
1	U202	IC PHOTO TLP521-1BL	TOSHIBA
1	U6	IC PHOTO TLP521-1BL	TOSHIBA

Qty	Cct Ident	Description	Manufacturer
1	U7	IC PHOTO TLP521-1BL	TOSHIBA
1	U10	IC PHOTO TLP250	TOSHIBA
1	U2	IC PHOTO TLP250	TOSHIBA
1	U3	IC PHOTO TLP250	TOSHIBA
1	D33	D. MOTOROLA/1N4937 1A 600V FAST	MOTOROLA SEMICONDUCTOR C
1	D20	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D205	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D330	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D333	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D335	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D4	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D61	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D62	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D63	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D64	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D6B	D. GI/1N4937 1A 600V TAP pitch 0.8mm	G.I.
1	D501	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D502	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D503	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D504	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D505	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D506	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D507	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D508	D. HARRIS/RHRP8120 8A1200V	HARRIS SEMICONDUCTOR CO.
1	D511	D. MOTOROLA/MUR860 8A 600V ULTRAFast	MOTOROLA SEMICONDUCTOR C
1	BR02	D. 25A 600V BRIDGE	SHINDENGEN
1	D12	D. HARRIS/RHRG30120 30A 1200V	HARRIS SEMICONDUCTOR CO.
1	D13	D. HARRIS/RHRG30120 30A 1200V	HARRIS SEMICONDUCTOR CO.
1	D509	D. HARRIS/RHRG30120 30A 1200V	HARRIS SEMICONDUCTOR CO.
1	D510	D. HARRIS/RHRG30120 30A 1200V	HARRIS SEMICONDUCTOR CO.
1	D30	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D31	D. GI/1N4007 1A 1000V TAP pitch 0.8mm	GENERALINSTRUMENT SEMICO
1	D10	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D14	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D15	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D16	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D19	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D202B	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D2A	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D301	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D311	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D312	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D313	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D314	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D32	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,

Qty	Cct Ident	Description	Manufacturer
1	D6	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D6A	D. ROHM/1N4148 0.15A 75V ULTRAFast	ROHM SEMICONDUCTOR CO.,
1	D202A	D. GI/UF5402 3A 200V	G.I.
1	D7	D. GI/UF5402 3A 200V	G.I.
1	BR01	D. GI/2W10G 2A 1000V BRIDGE	G.I.
1	ZD2	ZD NEC/RD3.3 1/2W 3.3V	NEC SEMICONDUCTOR CO.,
1	ZD3	ZD NEC/RD5.1E 1/2W 5.1V	NEC SEMICONDUCTOR CO.,
1	ZD4	ZD NEC/RD5.1E 1/2W 5.1V	NEC SEMICONDUCTOR CO.,
1	ZD10	ZD NEC/RD7.5E 1/2W 7.5V	NEC SEMICONDUCTOR CO.,
1	ZD11	ZD NEC/RD7.5E 1/2W 7.5V	NEC SEMICONDUCTOR CO.,
1	ZD1	ZD NEC/RD12E 1/2W 12V	NEC SEMICONDUCTOR CO.,
1	Q8	TR BIP MOTOROLA/2N5551 0.6A 160V NPN TAP	MOTOROLA SEMICONDUCTOR C
1	Q3	TR MOSFET IR/IRF730 5.5A 400V	INTERNATIONAL RECTIFIER
1	Q501	TR MOSFET IR/IRFP264 38A 250V	INTERNATIONAL RECTIFIER
1	Q502	TR MOSFET IR/IRFP264 38A 250V	INTERNATIONAL RECTIFIER
1	Q503	TR MOSFET IR/IRFP264 38A 250V	INTERNATIONAL RECTIFIER
1	Q504	TR MOSFET IR/IRFP264 38A 250V	INTERNATIONAL RECTIFIER
1	Q505	TR MOSFET IR/IRFP264 38A 250V	INTERNATIONAL RECTIFIER
1	Q506	TR MOSFET IR/IRFP264 38A 250V	INTERNATIONAL RECTIFIER
1	Q10	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q9	TR BIP TOSHIBA/2SC1815 150mA 60V NPN TAP	TOSHIBA
1	Q208	TR MOSFET TOSHIBA/ 2SK793 5A 850V	TOSHIBA
1	Q20	TR MOSFET TOSHIBA/ 2SK1112 5A 60V	TOSHIBA
1	Q12	TR IGBT TOSHIBA/GT25Q101 25A 1000V	TOSHIBA
1	Q13	TR IGBT TOSHIBA/GT25Q101 25A 1000V	TOSHIBA
1	Q5	TR IGBT TOSHIBA/GT25Q101 25A 1000V	TOSHIBA
1	Q7	TR IGBT TOSHIBA/GT25Q101 25A 1000V	TOSHIBA
1	Q1A	TR IGBT TOSHIBA/GT60M301 60A 900V	TOSHIBA
1	RLY01	RELAY OMRON/G7L-2A-P 20A 277V 12Vdc	OMRON
1	RLY04	RELAY OMRON/G2R-1-E 16A 250V Coil:12Vdc	OMRON
1	TS1	SWITCH THERMAL WAKO/CS- 12A NFZ-250-95C	WAKO
1	MOV1	VARISTOR HARRIS/ V320LA20A	HARRIS SEMICONDUCTOR CO.
1	FC2AF	FUSE BUSS/GBB-20 20A 125Vdc/250Vac	BUSSMANN
1	FC3AF	FUSE BUSS/GBB-20 20A 125Vdc/250Vac	BUSSMANN
1	F1	FUSE LITTEL/324020 20A 250Vac (FAST ACTING)	INALWAYS

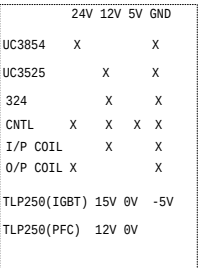
CHAPTER 8 - Specification

PARAMETER	GXT700MT-230	GXT1000MT-230	GXT1000RT-230
Rating VA/KW	700 / 490	1000 / 700	1000 / 700
Physical characteristics			
Unit Dimensions:mm (in)	162 x 397 x 225 (6.4 x 15.6 x 8.9)		177 x 490 x 430 (7.0 x 19.3 x 16.9)
Shipping Dimensions:mm (in)	298 x 526 x 367 (11.73 x 20.72 x 14.44)		340 x 660 x 565 (13.38 x 26.0 x 22.25)
Unit Weight: kg (lbs)	13.2 (29.0)	16.0 (35.2)	25.5 (56.1)
Shipping Weight: kg (lbs)	15.4 (33.9)	18.2 (40.1)	29.2 (64.4)
Input AC Parameters			
Voltage range (typical)	230Vac; variable based on output load		
100% - 90% Loading	164 - 275Vac		
90% - 70% Loading			
70% - 30% Loading	144 - 275Vac		
30% - 0% Loading	124 - 275Vac		
Input frequency (capture range)	47.0 - 52.0Hz or 57.5 - 62.5Hz (Auto sensing)		
Input connector	CEE 22 Socket	CEE 22 Socket	CEE 22 Socket
Output AC Parameters			
Output sockets	(4) CEE 22 Socket	(4) CEE 22 Socket	(4) CEE 22 Socket
Voltage	208/220/230/240 (switch selectable) $\pm 3\%$		
Frequency	50Hz or 60Hz (auto-selected from input frequency)		
Waveform	Sinusoidal		
Mains mode overload	200% for 8 cycles; 130% for 10 secs with transfer to bypass		
Battery Parameters			
Battery type	Valve-regulated, non-spillable, lead acid		
Qty x Voltager x Rating	2 x 12V x 7.0/7.2AH	3 x 12V x 7.0/7.2AH	3 x 12V x 7.0/7.2AH
Environmental			
Operating temperature	0°C to +40°C (+32F to +104F)		
Storage temperature	-15°C to +50°C (+5F to +122F)		
Relative humidity	0% to 95%, non-condensing		
Operating eleavtion	Up to 3000m (10,000ft) at 40°C without derating		
Storage Elevation	15,000m (50,000ft) maximum		
Audible noise	<45dBA, at 1 metre		
Agency compliances			
Safety	EN50091-1, TUV/GS Listed, CE Low Voltage Directive		
RFI / EMI	EN55022, Clas B: CE EMC Directive		
Immunity	IEC 801-2, Level 4 / IEC 801-3, Level 3 / IEC801-4, Level 4 / IEC 801-5, Level 3		

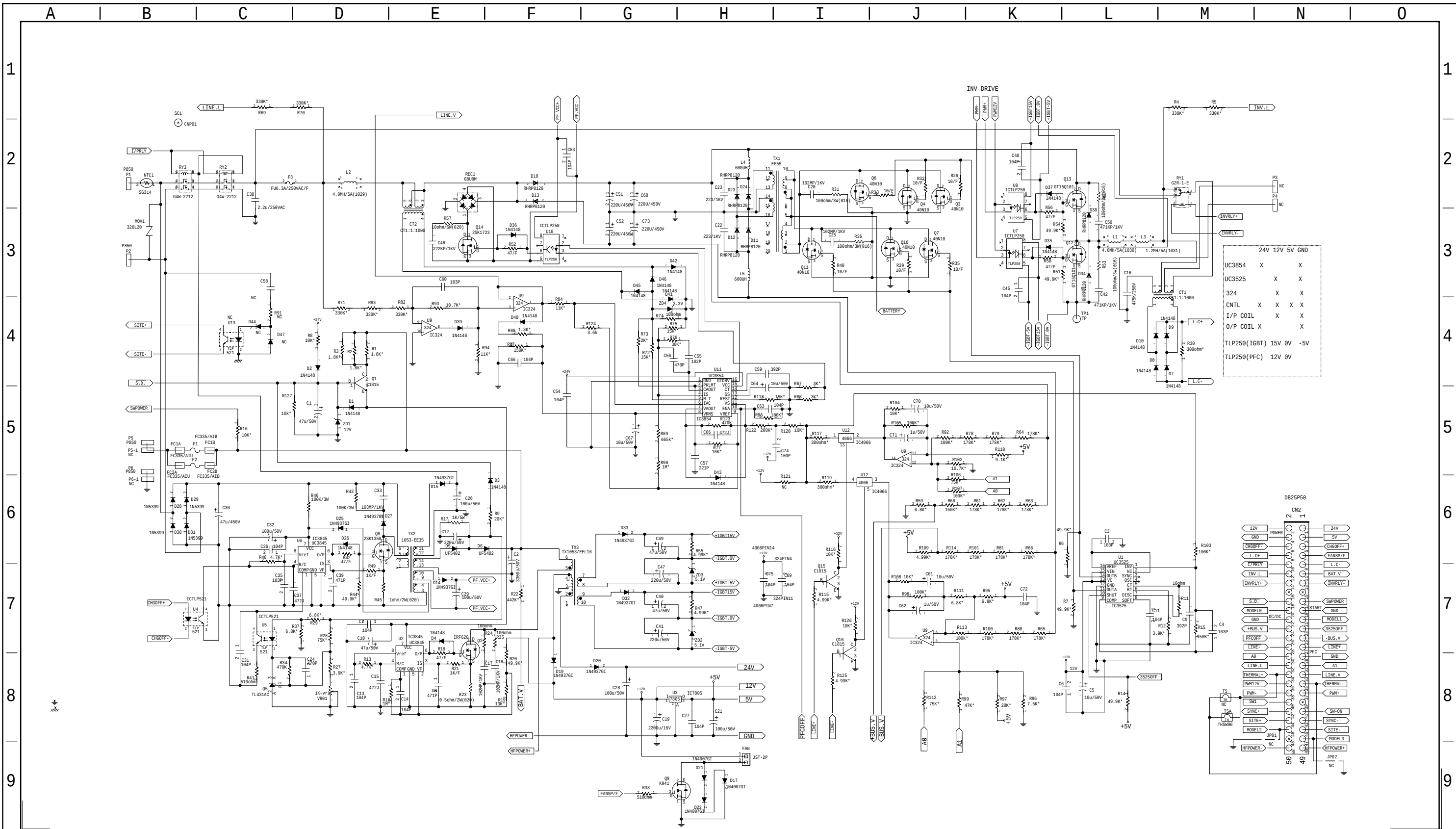
PARAMETER	GXT1500RT-230	GXT2000RT-230	GXT3000RT-230
Rating VA/KW	1500 / 1050	2000 / 1400	3000 / 2100
Physical characteristics			
Unit Dimensions:mm (in)	177 x 490 x 430 (7.0 x 19.3 x 16.9)		
Shipping Dimensions:mm (in)	340 x 660 x 565 (13.38 x 26.0 x 22.25)		
Unit Weight: kg (lbs)	28.6 (62.9)	38.8 (85.4)	40.8 (89.8)
Shipping Weight: kg (lbs)	32.3 (71.2)	42.5 (93.7)	44.8 (98.8)
Input AC Parameters			
Voltage range (typical)	230Vac nominal; variable based on output load		
100% - 90% Loading	191 - 275Vac		
90% - 70% Loading	164 - 275Vac		
70% - 30% Loading	144 - 275Vac		
30% - 0% Loading	124 - 275Vac		
Input frequency (capture range)	47.0 - 52.0Hz or 57.5 - 62.5Hz (Auto sensing)		
Input connector	CEE 22 Socket	CEE 22 Socket	CEE 19 Socket
Output AC Parameters			
Output sockets	(4) CEE 22 Socket	(4) CEE 22 Socket	(4) CEE 22 Socket (1) CEE 19 Socket
Voltage	208/220/230/240 (switch selectable) $\pm$ 3%		
Frequency	50Hz or 60Hz (auto-selected from input frequency)		
Waveform	Sinusoidal		
Mains mode overload	200% for 8 cycles; 130% for 10 secs with transfer to bypass		
Battery Parameters			
Battery type	Valve-regulated, non-spillable, lead acid		
Qty x Voltager x Rating	4 x 12V x 7.0/7.2AH	8 x 12V x 6.5/7.0AH	8 x 12V x 7.0/7.2AH
Environmental			
Operating temperature	0°C to +40°C (+32F to +104F)		
Storage temperature	-15°C to +50°C (+5F to +122F)		
Relative humidity	0% to 95%, non-condensing		
Operating eleavtion	Up to 3000m (10,000ft) at 40°C without derating		
Storage Elevation	15,000m (50,000ft) maximum		
Audible noise	<50dBA, at 1 metre		
Agency compliances			
Safety	EN50091-1, TUV/GS Listed, CE Low Voltage Directive		
RFI / EMI	EN55022, Clas B: CE EMC Directive		
Immunity	IEC 801-2, Level 4 / IEC 801-3, Level 3 / IEC801-4, Level 4 / IEC 801-5, Level 3		

CHAPTER 9 - Drawings

TITLE	Drawing Number
GXT700MT/RT-230 Circuit Diagram	SK8103-3205-00
GXT1000RT-230 Circuit Diagram	SK8103-5209-01
GXT1500RT-230 Circuit Diagram	SK8103-6204-00
GXT2000RT-230 Circuit Diagram	SK8103-7205-00
GXT3000RT-230 Circuit Diagram	SK8103-8204-01
Operator Control Panel Circuit Diagram (Generic all models)	SK8103-3503-00
Control Board Circuit Diagram (Generic all models)	SK8103-3106-01



File Name:0112600E.sch



Liebert

REVISE: 00

Part No.
SK8103-5209-01

SHEET 1 OF 1

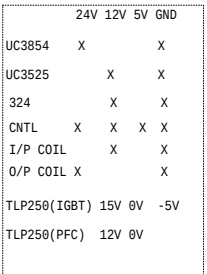
Title:
GXT1000MT(RT)-230

Drawn: Stephen
4/29 '97

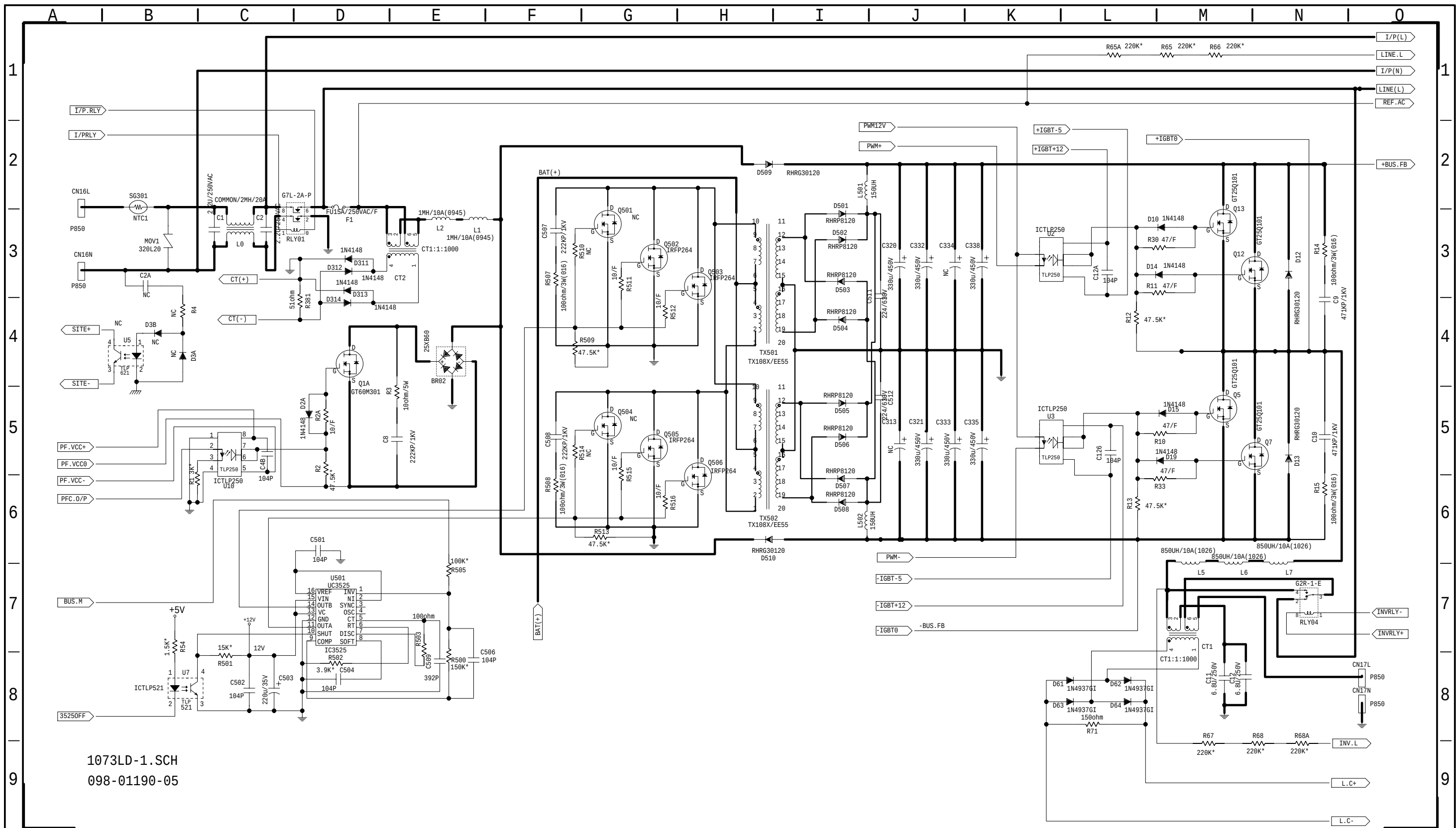
Designer:

Checked:

Approved:



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1073LD-1.SCH
098-01190-05

Liebert

REVISE: 00

Part No.
SK8103-7205-01

SHEET 1 OF 3

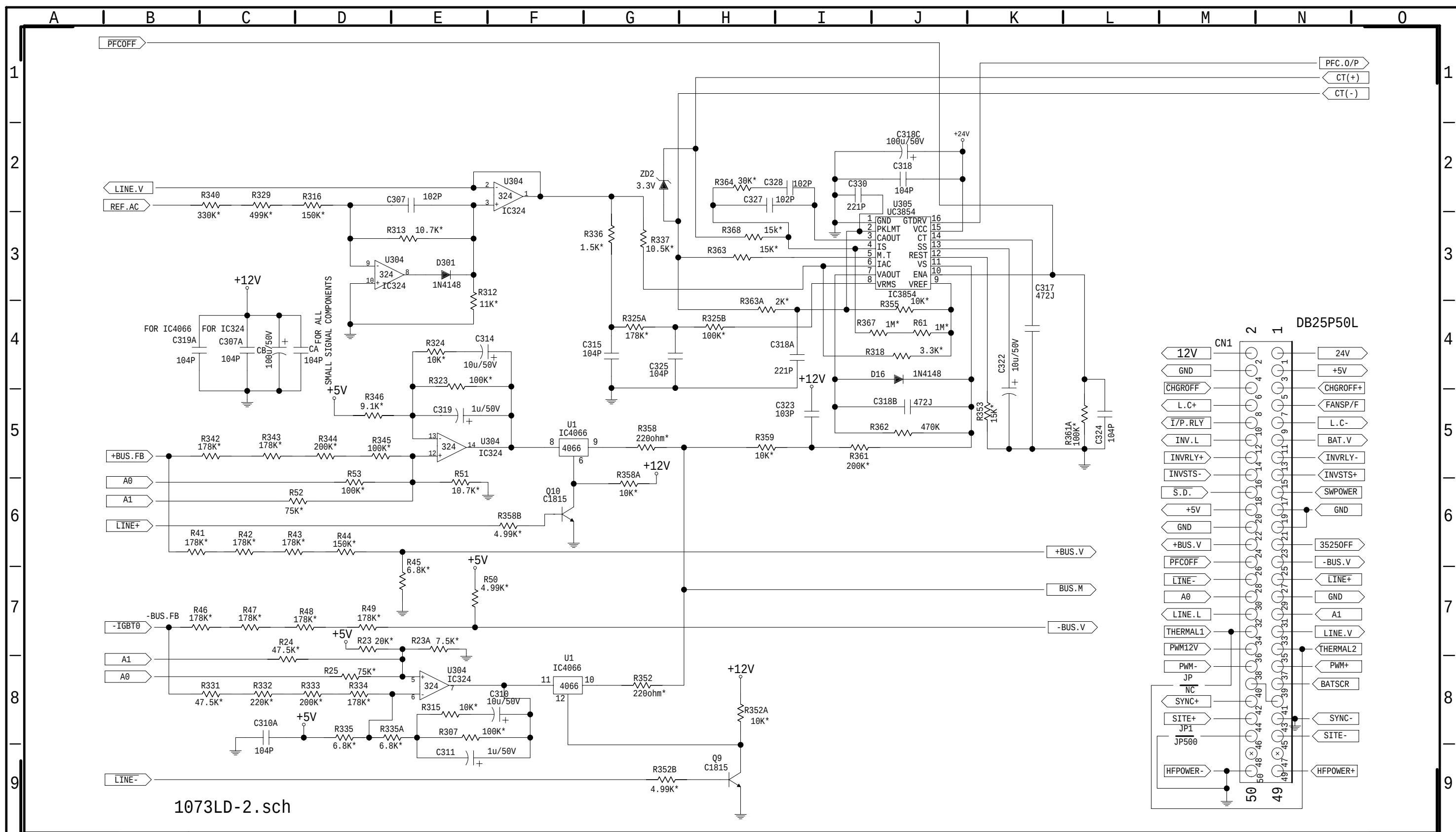
Title: **GXT2000RT-230**

Drawn:

Designer:

Checked:

Approved:



Liebert

REVISION: 00

Part No.

SK8103-7205-01

SHEET 2 OF 3

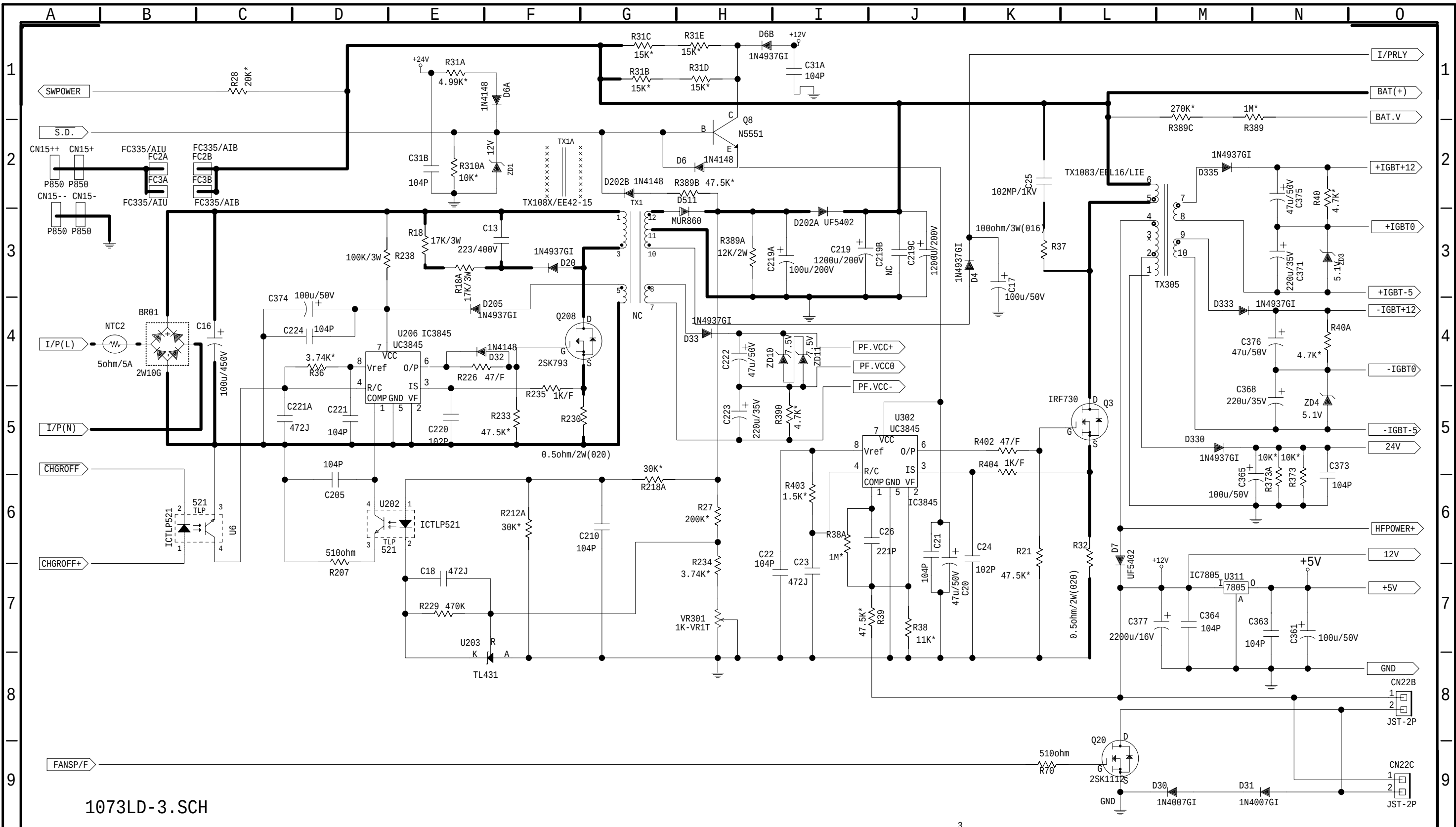
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Drawn:

Designer:

Checked:

Approved:

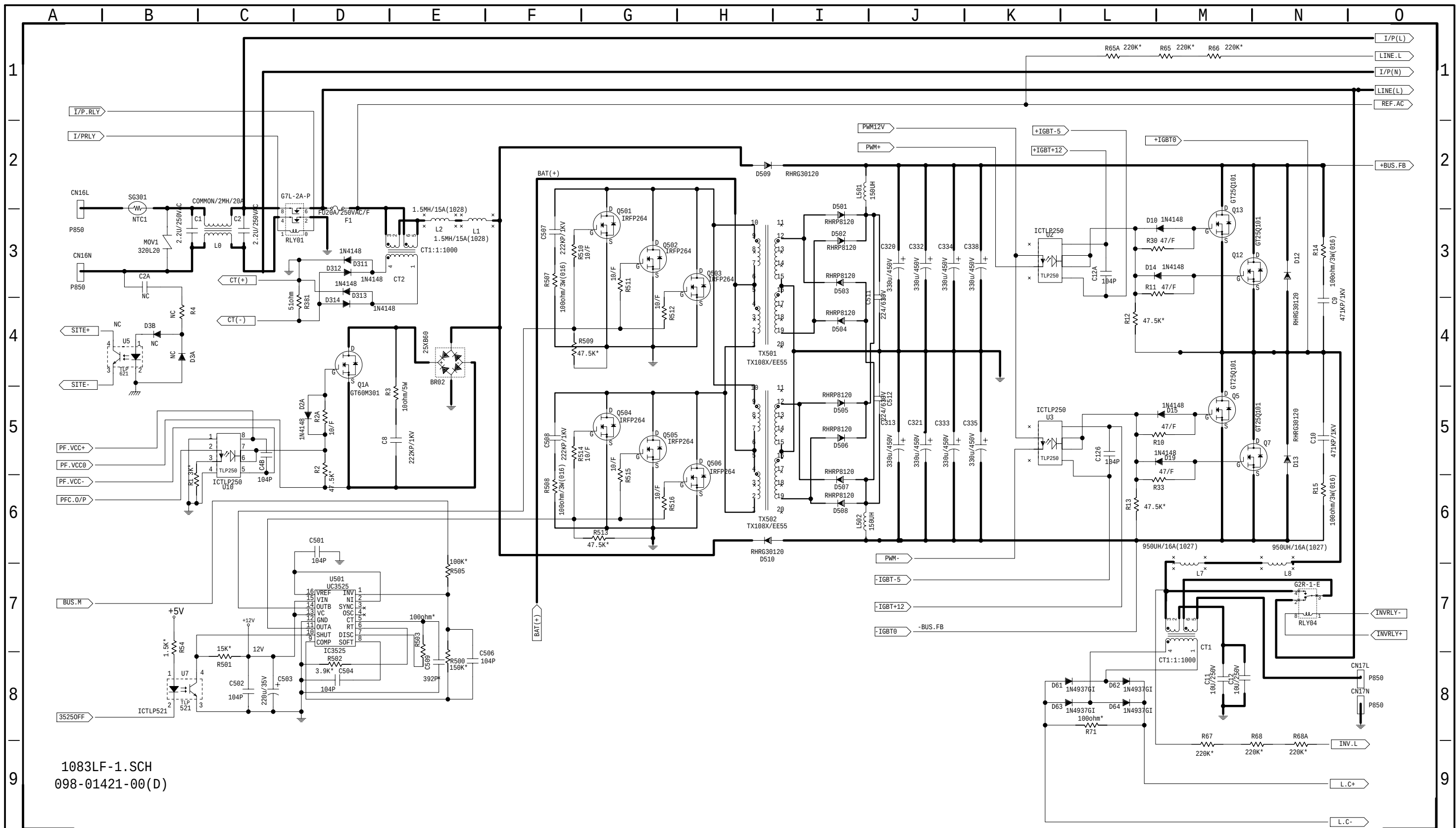


1073LD-3.SCH

Liebert

REVISE: 00

Part No.	SHEET	OF	Title:	Drawn:	Designer:	Checked:	Approved:
SK8103-7205-01	3	3	GXT2000RT-RT				



1083LF-1.SCH
098-01421-00(D)

Liebert

REVISE: 00

Part No.

SK8103-8204-01

SHEET

OF

1

3

Title:

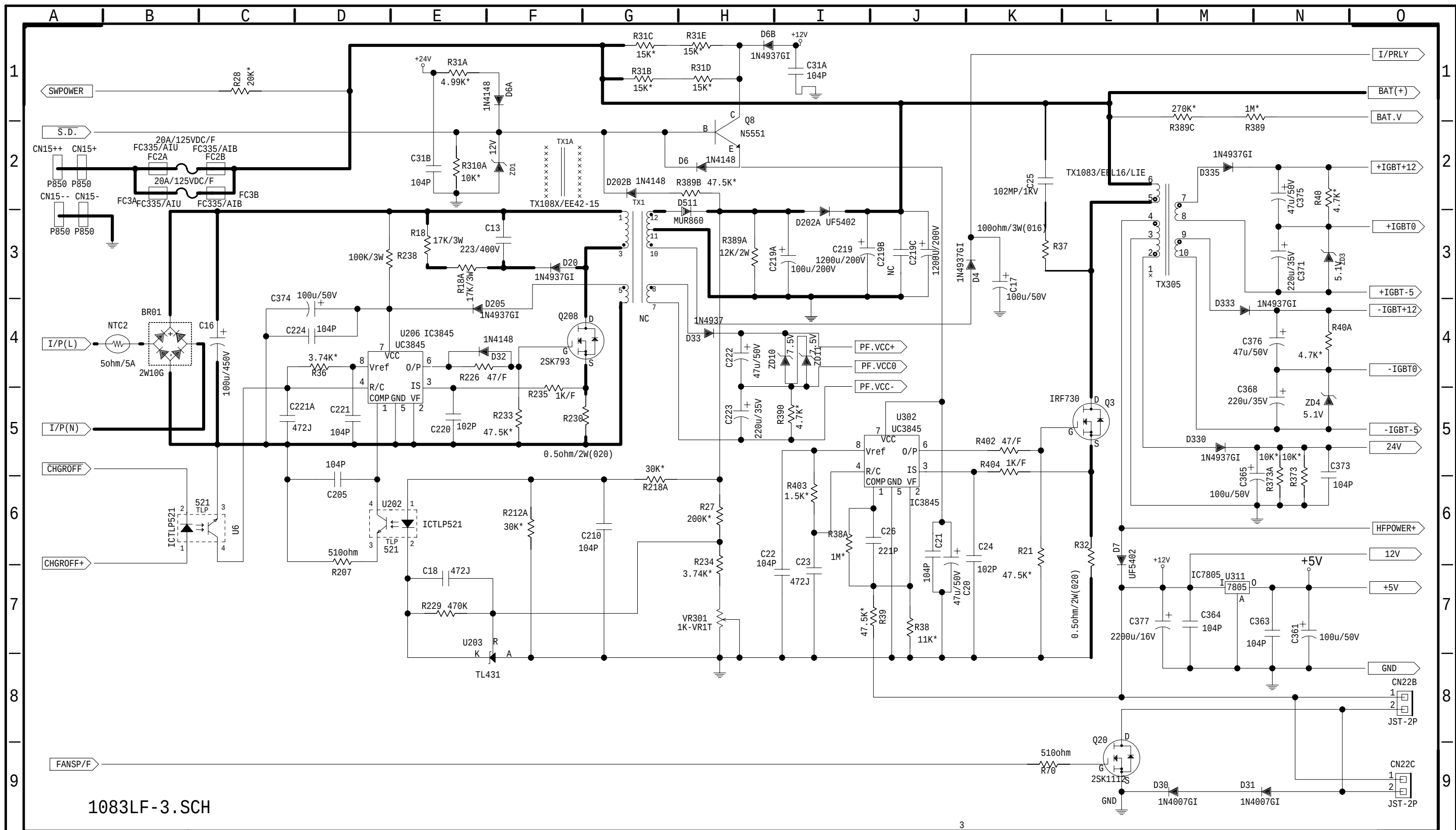
GXT3000RT-230

Drawn:

Designer:

Checked:

Approved:



Liebert

REVISE: 00

Part No.

SK8103-8204-01

SHEET 3 OF 3

Title:

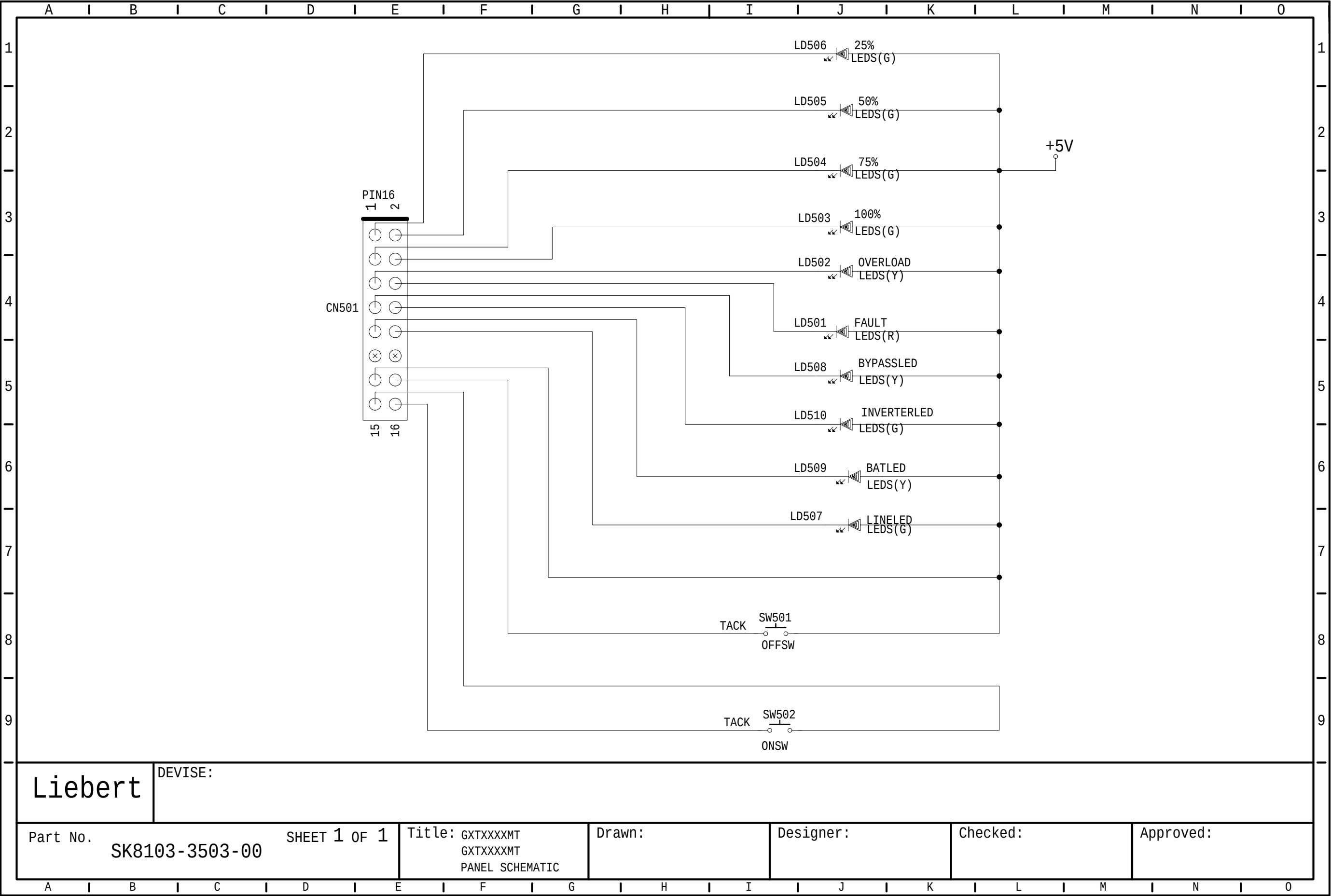
GXT3000RT-230

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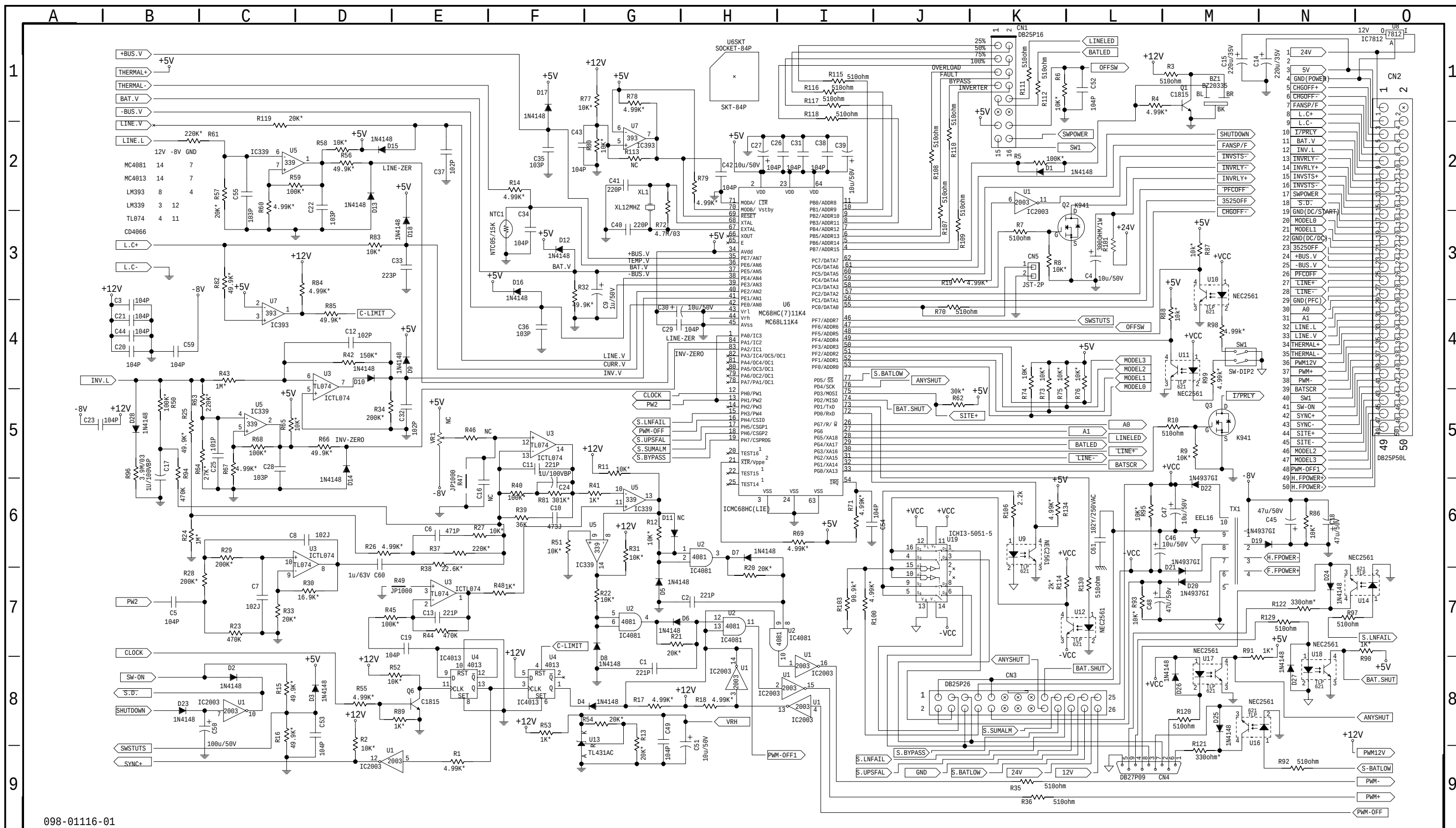
Designer:

Checked:

Approved:



Liebert		DEVISE:					
Part No. SK8103-3503-00		SHEET 1 OF 1	Title: GXTXXXXMT GXTXXXXMT PANEL SCHEMATIC	Drawn:	Designer:	Checked:	Approved:



098-01116-01

Liebert

REVISE: 00

Part No.

SK8103-3106-01

SHEET 1 OF 1

Title:
GXTXXXRT(MT)-230
Control Circuit Diagram

Drawn:
Stephen 5/16 '97

Designer:

Checked:

Approved: