



**Wayne Kerr PDD3502A**  
**35V 2A Dual Bench Power Supply**  
with Digital Meters & Parallel/Tracking modes

**User Manual**

**Part N° 9HPDD3502A**

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# 1. SAFETY

## 1.1 General

This equipment has been designed to meet the requirements of EN61010 "Safety requirements for electrical equipment for measurement, control & laboratory use", and has left the factory in a safe condition.

This product is not intended for use in atmospheres which are explosive, corrosive or adversely polluted (e.g. containing conductive or excessive dust). It is not intended for use in safety critical or medical applications.

The remainder of this section on safety provides information and warnings which must be followed by the user to ensure safe operation and maintain the equipment in a safe condition otherwise protection provided by the equipment may be impaired.

**OPERATOR** - Person who uses this equipment for its intended purpose. This person should be suitably trained and aware of the hazards. Operators should be capable of fuse replacement providing the normal precautions are taken.

## 1.2 A.C. Power Supply

- 1) It is necessary to fit a suitable a.c. power plug to the power cable. The user must observe the following colour codes:

LIVE terminal to BROWN lead

NEUTRAL terminal to BLUE lead

EARTH terminal to GREEN/YELLOW lead.

The user must also ensure that the protective earth lead would be the last to break should the cable be subject to excessive strain.

- 2) If the power cable electrical connection to the a.c. power plug is through screw terminals then, to ensure reliable connections, any solder tinning of the cable wires must be removed before fitting the plug.
- 3) **WARNING!** Any interruption of the protective earth conductor inside or outside the equipment or disconnection of the protective earth terminal is likely to make the equipment dangerous. Intentional interruption is prohibited.
- 4) Before switching on the equipment, ensure that it is set to the voltage of the local a.c. power supply.

## 1.3 Adjustment, Replacement of Parts, Maintenance and Repair

- 1) When the equipment is connected to the local a.c. power supply internal terminals may be live and the opening of the covers or removal of parts - including fuse holders - (except those to which access can be gained by hand) is likely to expose live parts. **The equipment must be disconnected from all voltage sources before it is opened for any adjustments, replacement (e.g. fuses), maintenance or repair.**
- 2) Capacitors inside the equipment may still be charged even if the equipment has been disconnected from all voltage sources.

- 3) Any adjustment, maintenance and repair of the opened equipment powered up must be carried out by a skilled person who is aware of the hazards involved
- 4) Servicing personnel should be trained against unexpected hazards.
- 5) Ensure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and short circuiting of fuse holders is prohibited.

### **1.4 Static Electricity**

The unit supplied may use static sensitive devices and service personnel should be alerted to components which require handling precautions to avoid damage by static electrical discharge.

Before handling circuit board assemblies containing these components, personnel should observe the following precautions:

- 1) The work surface should be a conductive grounded mat.
- 2) Soldering irons must be grounded and tools must be in contact with a conductive surface to ground when not in use.
- 3) Any person handling static sensitive parts must wear a wrist strap which provides a leaky path to ground, impedance not greater than 1 megaohm.
- 4) Components or circuit board assemblies must be stored in or on conductive foam or mat while work is in progress.
- 5) New components should be kept in the supplier's packaging until required for use.

### **1.5 Disposal Hazards**

Service personnel should be aware that batteries should be disposed of intact and never incinerated.

### **1.6 Load Inductance**

Low voltage D.C. power supply products connected to large inductive loads can store sufficient energy in the load to cause an electrical hazard. Extreme caution is recommended when switching such circuits as back EMFs can reach dangerous levels.

## **WARNING**

---

**This equipment is intended for use by suitably trained and competent persons.**

**This product can cause hazards if it is not used in accordance with these instructions. Read them carefully and follow them in all respects. Double check connections to the unit before use.**

**DO NOT USE THIS EQUIPMENT IF IT IS DAMAGED.**

---

## 2. SCHEDULE OF EQUIPMENT

The Power Supply has been carefully packed to prevent damage in transit.

The complete equipment comprises:-

| Description                | Part N°     | Qty |
|----------------------------|-------------|-----|
| Power Supply 35V 2A        | 1EAPDD3502A | 1   |
| IEC Mains Lead             | HC22V2      | 1   |
| Users Manual               | 9HPDD3502A  | 1   |
| Spare fuse O/P 3A F Type   | FF3A005MF   | 1   |
| Spare fuse I/P 2.5A T Type | FT2A50123   | 1   |
| Spare fuse Reg. 4A T Type  | FT4A00S503  | 1   |
| Shorting Link              | 7SU0002     | 1   |

---

**Note:** In the event of damage in transit or shortage in delivery, separate notices in writing should be given to both the carriers and Wayne Kerr Electronics Limited, within three days of receipt of the goods, followed by a complete claim within five days. All goods which are subject of any claim for damage in transit or shortage in delivery should be preserved intact as delivered for a period of seven days after making the claim, pending inspection or instructions from Wayne Kerr Electronics Ltd., or an agent of this company.

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### 3. INSTALLATION

#### 3.1 Supply Voltage

Internal changes to the supply voltage settings should only be carried out by competent persons. It is essential that any changes are marked on the back panel as incorrect settings can damage the unit.

Confirm by reference to the back panel controls that the Wayne Kerr PDD3502A is set to match the local mains supply. The power supply is normally factory set for 240V ac operation.

If this is unsuitable for the local supply then refer to the chart below. There are two tap adjustments. One is integral with the fuse drawer and is the minor tap. The other is a switch mounted on the transformer housing and the covers have to be removed to access it, this is the major tap.

| Switch Position | Fuse Drawer Position | Input Voltage  | Fuse 'T' type |
|-----------------|----------------------|----------------|---------------|
| 220/240V        | 240/130V             | 240V $\pm$ 10% | 2.5A          |
| 220/240V        | 220/110V             | 220V $\pm$ 10% | 2.5A          |
| 110/130V        | 240/130V             | 130V $\pm$ 10% | 4A            |
| 110/130V        | 220/110V             | 110V $\pm$ 10% | 4A            |

To change the minor tap setting proceed as follows:-

- DISCONNECT mains lead from supply.
- Remove the fuse holder, which is integral with the IEC socket on the back plate.
- Replace the fuse holder having rotated it through 180°.
- The fuse holder should now read the correct voltage, the right way up, either 220V or 240V. RECONNECT the IEC lead, the supply is ready for use.

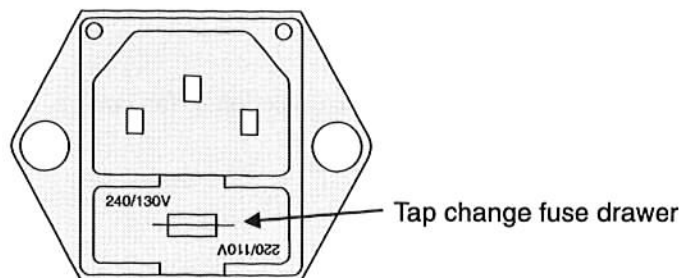
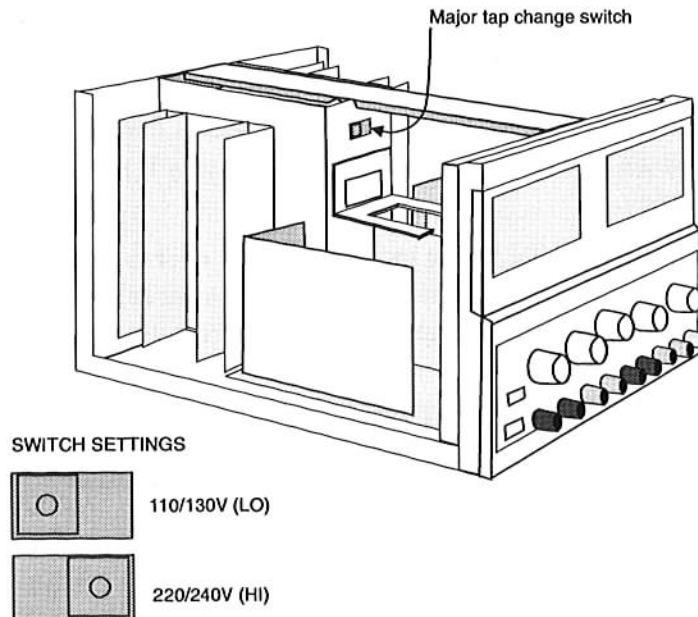


Fig 3.1 IEC Connector, Fuse & Minor Tap Change Assembly

To change the major tap setting:

- Ensure that the unit is off and the mains is disconnected.
- Remove the handle
- Turn unit upside down and remove the screws along each side that hold the lid.
- Spread the side panels and lift the lid clear. Take care not to strain the earth wire connected to the case.

- e) Locate the switch on the transformer housing. Change its position.
- f) Replace the covers. Ensure that the earth to the cover is intact. Replace the handle.
- g) **It is essential that the unit's fuse is changed and the rear panel is correctly marked.**



*Fig 3.2 Major tap change*

### 3.2 Mains Connection

The unit is provided with a mains lead terminated in a standard IEC connector at one end. The free end should be connected to a suitable plug. (Note any solder tinning of wires must be removed before connecting to the plug). The PDD3502A is classified as Safety Class 1 equipment and it is imperative that the earth lead (green/yellow) is connected to a known integrity earth, otherwise the chassis may float to a dangerous potential.

### 3.3 Location

The Wayne Kerr PDD3502A is convection & fan cooled. Care should be taken not to obstruct any inlet or outlet vents.

## 4. INTRODUCTION

The Wayne Kerr PDD3502A is a twin output power supply with an output range for each half of 0 to 35V and 0 to 2A. Other features include:

- Simultaneous monitoring of voltage, current and power with a custom LCD.
- Parallel mode switched from the front panel which provides up to 4A at 35V as a single output.
- Series mode switched from the front panel which provides up to 60V at 2A as a single output.
- Tracking mode, useful for op amp supplies where the 'slave' supply tracks the voltage of the 'master'. Also switched from the front panel.
- Over Voltage Crowbar provided on each output. This function also protects the user and supply alike from abuse of the mode switch.

## 5. SPECIFICATIONS

### Mains Input

|               |                                                                                                                                                                    |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Frequency:    | 50/60Hz $\pm 10\%$ .                                                                                                                                               |
| Voltages:     | 240V or 220V $\pm 10\%$ (Factory set option 130V or 110V $\pm 10\%$ )                                                                                              |
| Range Change: | Position of fuse drawer on IEC mains connector socket selects minor tap position $\pm 20V$ .<br>Factory set internal switch determines main tap position 220/110V. |
| Connection:   | Via IEC lead 2.0 metres long (supplied).                                                                                                                           |
| VA Rating:    | 400VA                                                                                                                                                              |

### Output

#### Output Modes

Twin isolated outputs: 0.2-35V and 20mA to 2.0A.

By switch selection, operation is possible in the following modes:

|                   |                                                                                             |
|-------------------|---------------------------------------------------------------------------------------------|
| Independent (IND) | Both outputs float completely independent of each other.                                    |
| Parallel (PAR)    | A single output, 0.2-35V and 20mA to 4.0 A and a single meter are controlled by the master. |
| Series (SER)      |                                                                                             |

The "-ve master" output is internally connected to the "+ve slave" output, creating a centre tap. Output is taken across "-ve slave" and "+ve master" and is determined by the sum of both master and slave voltage settings. For improved regulation a shorting link is placed between "-ve master" and "+ve slave".

#### Tracking (TRACK)

Again the "-ve master" to "+ve slave" tap but this time the slave output tracks the master voltage setting. For improved regulation a shorting link is placed between "-ve master" and "+ve slave".

The mode rotary switch is protected by an SCR crowbar which fires if the switch is used with the output switches on.

### Output Switches

Both outputs have an ON/OFF switch. With the switch in its OFF state, the meter displays the prospective volts and current settings. The "Preview" legend indicates that the output is off.

### Output Terminals

4 mm binding posts providing the output terminals, sense terminals and functional earth. Shorting links are provided to connect sense and output, also to connect together master and slave for tracking and series modes.

### Remote Sense

Compensates for up to 0.5V drop per load lead.

### Line Regulation

CV Less than 0.01% + 1mV for 10% line voltage change from nominal.

CI Less than 0.01% + 100 $\mu$ A for 10% line voltage change from nominal.

**Load Regulation**

Constant Voltage Mode: (open circuit to full load change)

Independent and Parallel - 2mV maximum. Typically less than 1mV.

Series Load Regulation - Less than 150mV in the total voltage without the front panel link. 2mV maximum with the LINK fitted, typically 1mV.

Tracking Load Regulation - With the LINK fitted 2mV maximum in each output. Typically less than 1mV.

Constant Current Mode (short circuit to full load change)

Independent and parallel -  $< 0.1\% + 1\text{mA}$  (2mA in parallel) for zero to 35V change.

Series and Tracking -  $< 0.1\% + 1\text{mA}$  both outputs set to 35V 2A, 36V to 69V change.

**Output Ripple and Noise**

**CV mode:** (@ Full load maximum voltage.)

|                      | RMS Ripple        |                   | Pk-Pk   |         |
|----------------------|-------------------|-------------------|---------|---------|
|                      | Maximum           | Typical           | Maximum | Typical |
| Series & Independent | 300 $\mu\text{V}$ | 250 $\mu\text{V}$ | 2.0mV   | <1.0mV  |
| Tracking             | 700 $\mu\text{V}$ | 550 $\mu\text{V}$ | 2.5mV   | <1.5mV  |
| Parallel             | 400 $\mu\text{V}$ | 350 $\mu\text{V}$ | 2.5mV   | 1.5mV   |

**CI mode:** (@ Full load maximum voltage.)

|                               | RMS Ripple       |                   | Pk-Pk   |         |
|-------------------------------|------------------|-------------------|---------|---------|
|                               | Maximum          | Typical           | Maximum | Typical |
| Tracking Series & Independent | 12 $\mu\text{A}$ | 7.5 $\mu\text{A}$ | 0.2mA   | 0.15mA  |
| Parallel                      | 14 $\mu\text{A}$ | 10 $\mu\text{A}$  | 0.2mA   | 0.15mA  |

**Temperature Coefficient**

For a variation in temperature of -5 to 35°C a maximum variation in voltage or current of 1%.

**Controls**

Volts control 0.02% resolution. 10 turn.

Current Control less than 0.001% resolution at low currents. Single turn logarithmic progression.

Overvolt control 1% resolution. 20 turn

**Transient response**

For a 10% to 100% load change variation does not exceed 0.05% of nominal. (Settles completely within 250mSec.)

**Protection**

a) Variable current limit.

b) DC output fuses (accessible through a trap door on the base).

c) Reverse voltage protection by parallel diode.

d) Forward voltage protection by diode.

Maximum protection voltage 65V.

e) SCR Crowbar, user programmable. Max steady state current 5.0A.

f) Regulator short circuit fuses - Fuse holders in the base.

Works in conjunction with the SCR.

**Float Voltage**

The maximum impulse free (see IEC664) dc float voltage must be such that any output terminal does not exceed a dc potential of 60V with respect to ground (including output volts).

|                              |                                                                                                                                                                                                                                                                                                                      |                                                                        |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| <b>Meters And Indicators</b> | Custom LCD display driven by microprocessor. Simultaneous presentation of both volts and amps in 10mm high digits and analogue bar graph user selectable to indicate volts, amps or power. Back lighting is used to enhance contrast.<br><i>NOTE:- The display is still viewable in event of back light failure.</i> |                                                                        |
| <b>Voltmeter</b>             | fsd, 39.99 V<br>Resolution 10mV<br>Accuracy $\pm$ (0.2% of reading + 0.1% fsd).                                                                                                                                                                                                                                      |                                                                        |
| <b>Ammeter</b>               | fsd, 4.000A<br>Resolution 1mA<br>Accuracy $\pm$ (0.3% of reading + 0.2% fsd).                                                                                                                                                                                                                                        |                                                                        |
| <b>Indicators</b>            | CV, CI and OVL                                                                                                                                                                                                                                                                                                       |                                                                        |
| <b>Bar graph</b>             | 24 segment user selectable to display volts, amps or power. (Intended for use as a trend indicator).<br>Bar graph full scale depends on the output mode:                                                                                                                                                             |                                                                        |
|                              | Parallel -<br>(Master)                                                                                                                                                                                                                                                                                               | Power fsd = 140W<br>Amps fsd = 4A<br>Volts fsd = 35V                   |
|                              | Independent Series & Tracking -<br>(Master and Slave )                                                                                                                                                                                                                                                               | Power fsd = 70W<br>Amps fsd = 2A<br>Volts fsd = 35V                    |
| <b>Mechanical</b>            | Physical Size (mm)                                                                                                                                                                                                                                                                                                   | H - 170 x W - 215 x D - 330                                            |
|                              | Weight                                                                                                                                                                                                                                                                                                               | 7.4 Kg                                                                 |
| <b>Accessories Provided</b>  | 2.0 metre IEC mains lead with free end.<br>Handbook.<br>Spare fuses.<br>Shorting link.                                                                                                                                                                                                                               |                                                                        |
| <b>Safety</b>                | Complies with the requirements of EN61010.                                                                                                                                                                                                                                                                           |                                                                        |
| <b>Isolation</b>             | Each unit is checked for insulation in the following places:-<br>Input (Live and Neutral linked) to output (terminals joined together and to earth) at 1500V ac to be less than 10mA.<br>Outputs (linked together) and earth at 500V dc to be more than 10M ohm.                                                     |                                                                        |
| <b>Environmental</b>         | Operating ambient -                                                                                                                                                                                                                                                                                                  | -5 °C to +50 °C<br>( Derate current linearly to zero from 35 to 50°C ) |
|                              | Storage -                                                                                                                                                                                                                                                                                                            | -40 °C to +70 °C                                                       |
|                              | Operating RH -                                                                                                                                                                                                                                                                                                       | 0% to 90% non condensing                                               |
|                              | Altitude                                                                                                                                                                                                                                                                                                             | <2000m                                                                 |
|                              | Installation category                                                                                                                                                                                                                                                                                                | II. - Connected to supply via plug & socket.                           |
|                              | Atmosphere                                                                                                                                                                                                                                                                                                           | Non explosive, non-corrosive                                           |
|                              | Pollution degree                                                                                                                                                                                                                                                                                                     | 2 - Mainly non-conducting                                              |
|                              | Indoor use only                                                                                                                                                                                                                                                                                                      |                                                                        |

**EMC**

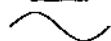
Complies with EN50081-1 and EN50082-1 generic emissions and immunity standards by meeting the requirements of EN55022, IEC801.2, IEC 801.3 & IEC 801.4

Note: 801.3 This unit may exhibit deviance of up to 0.1V in a 3V/m field.

Note: 801.4 When exposed to fast transients the overvoltage trip circuit may be triggered if the output is near the limit.

**Panel Symbols Used**

Refer to handbook.



Alternating current



Earth (ground) terminal



CAUTION - Risk of electric shock.



On



Off

## 6. OPERATING INSTRUCTIONS

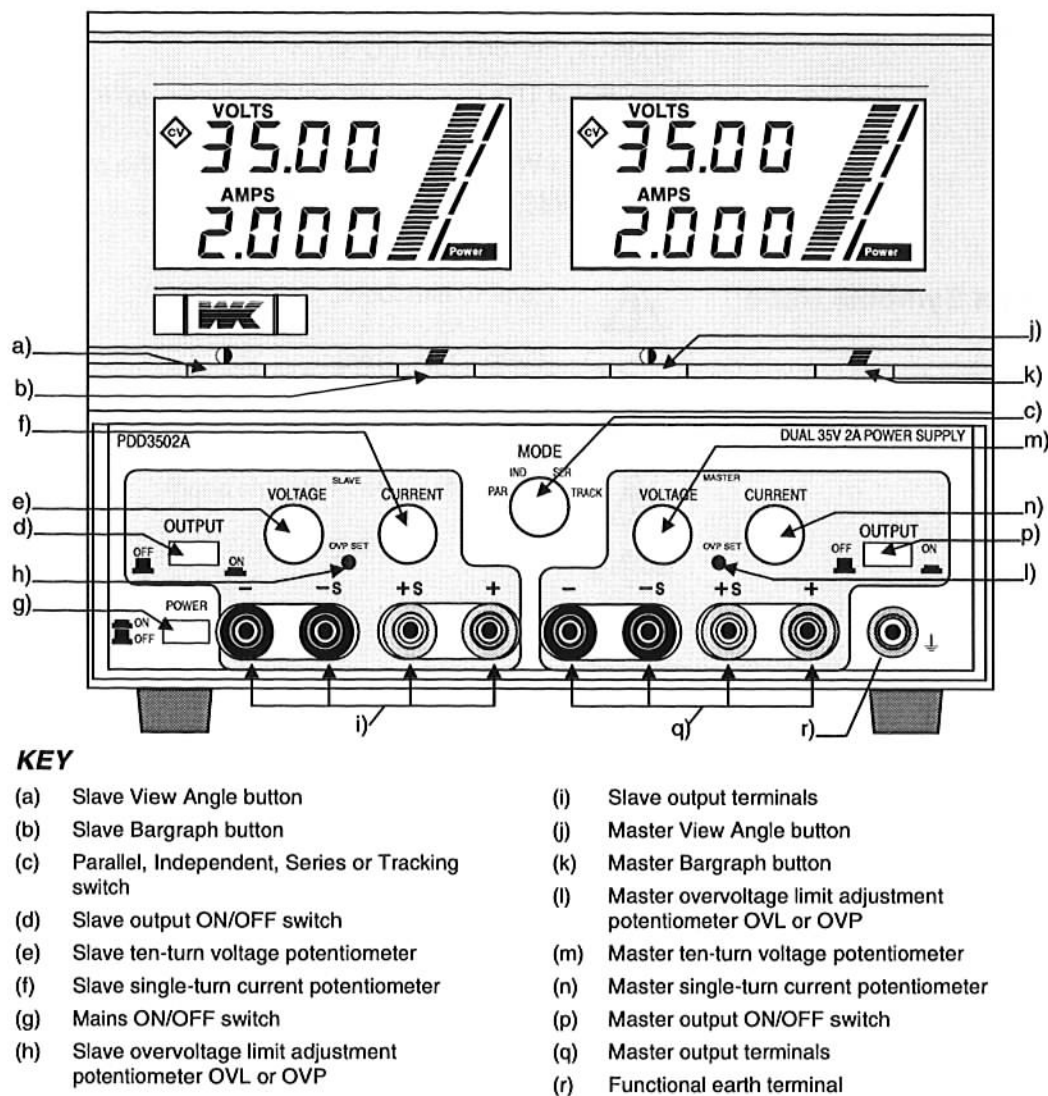


Fig 6.1 The front panel

### 6.1 First Time Operation

Before turning ON confirm that the unit is set to the correct mains input voltage and the correct rating of mains fuses are fitted. It is essential that the mains earth lead is connected to ground.

With both OUTPUT switches (*d* & *p*) and the mains INPUT switch (*g*) set to OFF connect to the local mains supply.

Select independent operation, and turn current and voltage controls fully anticlockwise. Ensure links are in place between each sense terminal and to adjacent output terminals.

Depress mains input switch to ON the meters will display a voltage and current setting. These are the preview values displayed whenever the output switch is OFF and is indicated by the "Preview" legend.

On the LH output (slave) rotate the voltage control (*e*) clockwise and note the increasing reading of the voltage display. This increase can also be viewed on the bar graph by

depressing the Bar graph button (*b*) until VOLTS are displayed. With the VOLTS control fully clockwise a reading of at least 35.00 volts should be displayed.

By rotating the CURRENT control (*f*) clockwise note that the ammeter display increases until at least 2.000 A is displayed.

Switch the slave output ON by depressing switch (*d*), note that the ammeter display has reduced to almost 0.000 and that the CV indicator is presented.

---

NOTE: The OVL is factory set for 36.5 volts.

---

If the OVL flag appears, the current is at the limit setting and the voltage falls to around 1V then the OVERVOLT potentiometer needs rotating clockwise to raise the trip level. This is accessed through a hole in the front panel (*h*).

Reduce the output voltage to approximately 5 volts and place a short circuit across the Slave Output terminals (*i*). Note that the voltmeter reading reduces and that the ammeter now reads the current flowing. Note too that the CV legend is extinguished and that the CI legend is presented.

Remove the short and set the voltage to approximately 30V. Use a small screwdriver to rotate the overvoltage potentiometer (*h*) anticlockwise which will reduce the trip level. This is accessed through a hole in the front panel. When it trips the OVL flag in the display will come on, the voltage will reduce to around 1V and the current will increase to the limit setting. To reset, reduce the output voltage and switch the slave output OFF then ON again (*d*).

A similar process can be followed on the RH side output ie. the Master.

The unit is now ready for use.

## 6.2 Connecting the Load

Connection can be made with bare wires to the binding post or by 4mm banana plugs.

The general rule is to use a wire gauge greater than the minimum necessary to carry the current, in order to maintain adequate regulation at the load.

Where voltage regulation is critical then remote sensing can be used.

## 6.3 Setting Voltage & Current with the Load Connected

A feature of the Wayne Kerr PDD3502A is that both the voltage and current levels can be set without the need to disconnect the load. When the output switch is OFF (*d* & *p*) the display previews the output settings, the "Preview" legend will be visible.

Upon depression of the output switch the load is electrically connected to the power supply and the meter gives simultaneous indication of the voltage and current flowing. The CV and CI legend indicates whether the output is driven in constant voltage or constant current modes respectively.

## 6.4 CV and CI Operation

The PDD3502A provides automatic changeover from CV (Constant Voltage) to CI (Constant Current), with status indication provided on the LCD meter.

### Constant Voltage Legend - CV

The CV mode of operation is the more usual, where the power supply delivers Constant Voltage until such times as the load current demand exceeds the current limit setting.

### Constant Current Legend - CI

At this point, the power supply operates in CI and the output voltage falls to a level determined by: (load resistance)x(current limit). On removal of the overload (ie. load demand less than current limit setting) the power supply reverts to CV operation.

---

NOTE: Although the current control can be used to limit the dc current in the range from maximum down to 1% of maximum, it must be remembered that the instantaneous current is independent of any such setting. This is due to the output capacitance, which is needed to stabilise the output. The instantaneous current is thus a function of output voltage, capacitor value, lead and source impedance and the load impedance.

---

## 6.5 Overvolt Protection

The Wayne Kerr PDD3502A features a SCR crowbar which protects each output against the following conditions:

- Turning the VOLTAGE setting pot too high.
- Placing an external voltage eg a battery, on the output which exceeds the trip level. This will blow the output fuse (F3 or F4) if the internal resistance of the external source is low enough. (3A F type)
- Regulator failure, ie regulator short circuit. This will blow the transformer secondary fuse F102 or F103. (4A T type)
- Rotating the mode switch on load. This protects both the load and the switch.

### OVL Programming

The setting potentiometer is accessed with a small screwdriver through a hole in the front panel between the voltage and current controls (*Fig 6.1 h & l*) rotating this clockwise increases the trip level. There are 20 turns from the minimum to the maximum value ie about 1.9V/turn. However there are no end stops which means over winding the pot will make it seem to require more than this. (Maximum OVL trip level is nominally 38.5V)

First set the output voltage slightly above the required limit (~0.5V) and, with the load removed, switch the output ON.

- If the OVL flag comes on and the voltage collapses then the setting is already too low. Rotate the pot several turns clockwise, reset (by switching the output OFF then ON again) and repeat until the OVL doesn't trip. Proceed as below.
- Reduce the level steadily by turning the pot anticlockwise until the OVL flag comes on, the voltage collapses to about 1V and the output goes into constant current. Turn the output OFF, reduce the preset voltage to that required and switch back ON.

### Safety Points

The SCR that performs the crowbar has been designed to withstand up to 12A for very short periods of time and up to 4A sustained current.

- When charging batteries any current over 3A (6A in parallel) will blow the output fuses. This would be provided by the shorting of the batteries through the SCR. In some cases this current might not be available to the battery owing to its internal resistance, but it may still be a fire hazard. Extra protection would then be required.
- Avoid leaving the PDD3502A in tripped out state for long periods of time.

## 6.6 Modes of Operation

The Wayne Kerr PDD3502A can be switch selected (c) to provide 4 different modes of operation, Parallel, Independent, Series and Tracking. Any operation of the switch while either of the output switches are ON will cause the OVL to trip. This is designed to protect both the load and the supply. To reset the output switch the output OFF then back ON.

### Parallel

This mode allows the MASTER section to provide up to 35 volts and up to 4 A, with control provided by the MASTER and the display indicating voltage and current up to 4A.

The slave controls are ineffective, the slave meter reads 'PArALLEL'.

### Independent

In this mode both outputs are completely isolated from each other with independent control of voltage, current and output ON/OFF.

### Series -

The outputs are put in series by internally connecting the "+ve slave" terminal to the "-ve master" terminal, with the output being taken across "-ve slave" and "+ve master".

The output voltage is set by using both the master and slave voltage controls and is the sum of both. True CI operation is limited to the voltage swing of the side with the lowest limit setting. This setting will be the current delivered. Short circuit current protection will, however, be the higher of the two settings. Hence in practice both limits need to be set close to one another.

Eg: CI operation is possible between 30V and 50V total output at 1.00A if the slave is set to 20V, 1.0A and the master to 30V, 1.1A. In short circuit or below 30V the current will rise to 1.1A.

---

NOTE: For improved output regulation place the provided shorting link between "+ve slave" and "-ve master".

---

### Tracking

The “+ve slave” is again connected to the “-ve master” and form the centre tap of the tracking arrangement. The output voltage is set by the master voltage control with the slave tracking this voltage. The current controls continue to work independently.

With the slave output switched OFF the slave voltmeter displays “OFF”. The preset voltage on the slave is that displayed on the master meter. The slave voltmeter displays the actual voltage when the slave output is turned ON.

---

NOTE: For improved output regulation place the provided shorting link between “+ve slave” and “-ve master”.

---

## 6.7 Remote Sensing

The facility can compensate for up to 0.5V drop in each load lead whilst maintaining specified regulation at the load. To use this facility disconnect the links between output and sense terminals.

Using a wire gauge that will handle the current whilst producing a volt drop of less than 0.5V, connect the output terminals to the load. Connect the sense terminals to the load ensuring “+ve sense” is taken to “+ve load” (the wire gauge is not important since there is negligible current flow).

To maintain general performance it is recommended that positive and negative sense leads should be twisted together and that the leads should be decoupled by at least a 0.47 $\mu$ F capacitor connected directly across the load (See Fig 6.2). Optionally twist together the load leads.

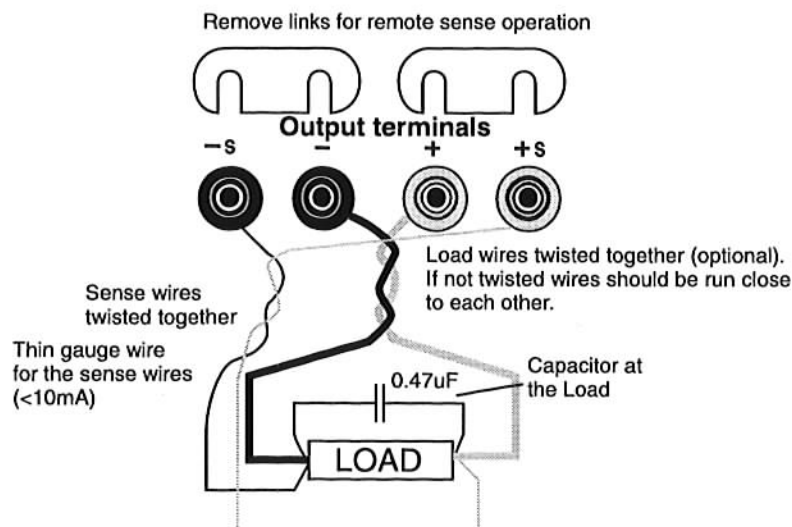


Fig 6.2 Remote Sense

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NOTE: Remote sensing can only be used in either Independent or Parallel modes. In Series or Tracking the shorting links should be left in place.

---

## 6.8 Earthing the Load

As supplied, each output is floating from the chassis (earth) and can be floated up to a maximum dc potential of 60V (including output volts) from the chassis.

If desired either the +ve or -ve terminal can be connected to the earth terminal to provide an output negative or positive with respect to ground.

### Capacitive coupling to earth

For flexibility the power supply terminals are not de-coupled to earth. However there is, inevitably, some coupling to the supply - in the order of pico farads. This appears as a common mode 50Hz signal that can upset some sensitive applications. To remedy this problem decouple the output to earth with 250V 0.1uF capacitor.

## 6.9 The LCD Display

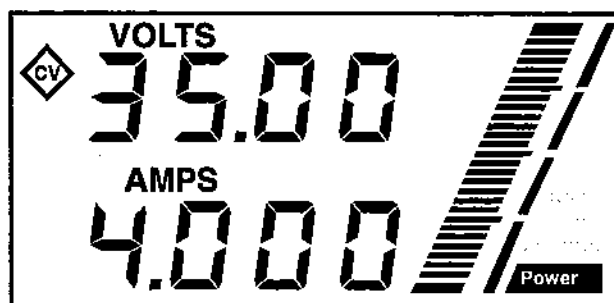


Fig 6.3 The LCD display

### Adjusting the Viewing Angle

Pressing the button marked  will step the display through four different levels of view angle.

### Bar graph

A 24 segment bar graph is provided as a trend indicator and can be selected to show either voltage, current or power. To change function depress and release the button marked  to step through the scales.

Full scale on the bar graph is used to indicate maximum power of 70W, a maximum voltage of 35V and maximum current of 2A, except when in parallel mode where the maximum power is 140W and maximum current is 4A.

## 7. CIRCUIT DESCRIPTION

### 7.1 The Mains Rectifier Circuits (Circuit Diagram: 3SZV0074)

Raw mains is supplied to the primary input of a torroid via mains switch and a tap change built into the IEC connector. All of these components are part of the transformer assembly. The mains switch is operated via a push rod from the front panel. The unit can be used at 220 or 240V ac nominal mains  $\pm 10\%$ .

As a factory fitted option, the transformer primary windings can be connected in parallel so that the unit will operate at 110V or 130V  $\pm 10\%$ .

The live input is fuse protected by F101 which is built into the IEC connector. The torroid TX101 then provides suitable output voltages for the unit, two 47V windings for the series regulator transistors with a 23.5V centre tap, two 18V windings for the display boards and two further 22V windings for the control board. The two 47V windings have been fused at 4A, (F102 & F103) the holders have been mounted on the base of the unit. These protect against regulator failure and the subsequent crowbar action of the SCR.

### 7.2 Reservoir/Switch Board (Circuit diagram: 2SZX0699)

#### Rectification and Smoothing

Bridge rectifier BR1 and reservoir capacitors C2 & C3 provide unregulated dc from either the 47V or 23.5V tap of one of the secondary windings depending on the position of relay RL1-A, the positive feeding the master series regulator, whilst the negative is taken via a protection fuse F3 to the negative output terminal of the master.

The slave side is set up in the same way via BR2, C7 & C8.

Bridge rectifier BR3 & C13 provide unregulated dc which is split to provide power for the master LCD back lighting and regulated to 12V through U5 for the display control circuit.

The slave side is identical the unregulated dc being supplied by BR4 & C17.

15V is provided via D3, C21 & U3 for the master control card and D4, C23 & U4 for the slave.

#### Output Series Regulators and Parallel Control

The master control signal (S5 5) is further amplified in two stages, first by Q1 and then by the other series regulators.

The slave control signal is amplified similarly by Q2. The output from this stage is routed via a pole of the rotary switch. In the parallel position Q1 is connected to the slave regulators instead of Q2.

The master output from the series regulator is taken via emitter sharing resistors through the current monitoring parallel resistors R58 to R65 to the output ON/OFF switch which interrupts the feed to the positive terminal. Since the series regulators are responsible for the bulk of heat dissipation, they are mounted on heat sink assemblies at the rear.

A pole of the rotary switch is in the path of the slave emitter series regulator output. In the parallel position this connects together the slave and master regulators. Otherwise the slave regulators are connected to the current monitoring parallel resistors R50 to 57 and on to the output in a similar way to the master.

Hence with the switch in the parallel position the bases and emitters of both slave and master supplies are connected together. Another two poles of the switch couple the commons together. The result is a single supply capable of delivering in excess of 4A. The output appears at the master terminals and is controlled by the master potentiometers. A further pole of the rotary switch changes the current scaling on the master control board. The 'slave meter mode' pole meanwhile generates a flag which is OR'd via D11 and sent to the slave display (S4 9), and opto isolated by U2, R37 & R36 to the master display (S3 9). Each display goes into parallel mode. The slave displaying "PARALLEL" and the master being re-scaled to 0 to 4A, 0 to 140W. An additional pole is required to connect together the tap change relay drive putting both under master control.

### Tracking Feedback Chain

R25 and P1 form the top half of a tracking feedback chain. The top of this is connected to the +Sense of the master and the bottom is connected, via R43 on the control board to -Sense of the slave. When in the tracking position a pole of the switch connects the centre of this chain to the voltage amplifier on the slave control board. In addition to this connection the +ve output of the slave is connected to the -ve output of the master.

As R25 and P1 substitutes for R42 on the control board the reference input, usually provided by the pot on the front panel, is now provided by the master output voltage. The gain of the system is 1 (See the notes on the voltage control circuit); the resistors are set with P1 to be the same at the top and the bottom of the chain. The potential across R25 & P1 will be the same as that across R43 on the control board, hence the slave automatically tracks the master.

The meter mode pole of the rotary switch generates a flag to inform the slave display that it is in tracking mode via D12 and S4 10. With the output of the slave disabled the resultant interconnection forces the internal level of the slave output to around half that programmed by the master. This isn't helpful so the voltage part of the display shows "OFF" whilst the output is disabled and the actual voltage when enabled. Meanwhile, the current part of the display shows the prospective and actual current as normal.

### Switch Protection

The rotary switch is not designed to switch maximum load current at the full output voltage. Various techniques have been employed to ensure that no damage can occur to the switch due to careless use. Firstly the link between the output terminals has been carried out with two parallel poles. This also helps to reduce the regulation in series and tracking modes. This increases the current that can be carried to 4A. These poles are also on a make before break wafer which is more durable. The MBB wafer introduces a phase delay on these vulnerable poles which gives time for the second line of protection.

The 'slave meter mode' pole of the switch produces flags for the meter via D12 and D11. It is also connected via D7,D8,D9 and D10 to Q5 which inverts the signal and level shifts it to operate the OVL level line (S8 6) through D18 on the slave. Also with opto-isolator U1 and D17 to operate the OVL line (S6 6) on the master. The result of this is that any rotation of the switch will trigger an overvoltage if either of the outputs are on. Since the main current carrying poles are phase shifted the trip will occur before any arc can be struck.

### Positive Sense Protection

If the +ve sense line is allowed to be more than 0.5V below the output then D15 on the master and D16 on the slave have been included to clamp the lines together. Pulling the +ve sense above the output can cause the regulators to be pulled on. The diodes will again clamp the output to 0.5V above the +ve sense line.

### Output Components

These are the same for each output.

- |                    |                                                                                                                                                                   |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output capacitance | - 122 $\mu$ F Required to stabilise the output. Note that this capacitance is behind the output switch and therefore doesn't appear to any load before switch-on. |
|                    | - 0.32 $\mu$ F High frequency noise rejection. Aids stability.                                                                                                    |
| Output resistance  | - 470k Provides a minimum load current.                                                                                                                           |
| Diode              | - MR752 To protect against reverse polarity connection of external sources, eg batteries.                                                                         |
| SCR                | - TIC126B Provides an overvoltage crowbar.                                                                                                                        |

### Relay Tap Change

To reduce the thermal dissipation from the internally fitted heat sinks the voltage overhead on the main regulators is automatically switched by a relay (RL1,2) from 23.5V (nom) for low output voltages (ie 0 to 16V) to 47V (nom) for high voltages (ie 35V to 14V). The control of this is performed on the control board.

Q6,7 are rugged ZTX451 drivers for the 48V relay coils. R75 and 76 current limit the base drive and allow the two transistors to be driven together by the master control board in parallel mode. The secondary voltage can rise as high as 60V so a current limiting resistor (R72,73) has been added. D22,23 protects against back emf damage to the transistor during switching. The relay can only be activated when the voltage across it exceeds its pull in value (~34V) however the turn off or 'drop out' voltage is much less than this (~5V). Hence the relay can only be energised when in the 47V normally connected position. But, it can be held indefinitely in the 23.5V normally open position. When turned on with the controls set for a low output voltage the voltage on the regulators is initially 47V, a fraction of a second later the relay will be energised and the voltage will fall back to 23.5V.

### 7.3 The Control Board (Circuit diagram: 3SZX0698)

Two identical control cards are mounted on to the Reservoir/Switch circuit board by F pins. Where external components are mentioned the description is of the master side unless mentioned otherwise.

#### Power Supply

The 15V supply appears at S1 12 and S2 1 across R1, Z1 and Z3. This provides a nominal positive 9.9V line and a negative 5.1V line, about the junction of Z1 and Z3. The junction of R1 and Z1 provides a further nominal positive 2.45V line.

#### Voltage control

An operational amplifier (U1-A) is used in the voltage control loop. The inverting input is taken to the -ve of the band gap reference zener (Z1) and forms the +ve sense line. The positive of Z1 is connected across the front panel voltage control potentiometer (P10) and feeds a proportion of the reference voltage, dependent upon its angular position, to the top end of a potential divider formed by R42 and R43. These are connected by a link on the Res/Switch board (a switch in the case of the slave). The top of R43 is connected to the non-inverting input of the amplifier and the other end to -ve sense.

The operational amplifier will endeavour to keep the junction of R42 and R43 and the +ve sense line at the same potential. Hence the output voltage is given by:

$$V1 \times \frac{R43}{R42}$$

Where V1 is the voltage at the wiper on the front panel voltage control potentiometer (P10).

C8/R7, C6/R8 provides compensation for the voltage loop.

#### Current Control

The current control loop uses another operational amplifier and a 2.45V band gap reference zener Z2 potted down by R23 and R22. A voltage is available at the wiper of the current control potentiometer (P8) which is dependent upon its angular position. This voltage is fed to the non-inverting input. The inverting input is taken to one side of the parallel current sensing resistors, R58-R65 (effective resistance 0.125Ω), and the other side forms the +ve output. R23 and R22 have been chosen to achieve a maximum current of 2.12A. Since the zener diode Z2 isn't connected to the control common (+ve sense) this topology is known as a "floating reference".

As long as the voltage across the sense resistors is less than the voltage on the non-inverting input D9 is reverse biased and control is maintained by the voltage loop. As soon as the voltage across the sense resistor equals the reference voltage the op-amp changes state and takes control of the series regulator via D9. This holds the output current constant.

Depending on the state of the output of the amplifier the function of Z4, R16 and R17 changes state from zero to 5V to indicate either constant current mode or constant voltage mode respectively on the display.

On the master side of the unit only, R19 and an external pot (P12) are put in parallel with R23 by a pole on the rotary switch, when in parallel mode. This changes the current scaling factor by 2. Hence the same setting on the pot will produce twice the current. P12 limits the maximum current in this mode.

### Current Preview

An auxiliary pole on the output switch is used to enable the current preview facilities and provide a logic flag for the display and overvoltage circuit. The switch pulls the "enable" pin (S2 12) down to -5V when closed.

With the output switch open the analogue gate U3-C is short circuit. This causes U3-B to become open circuit and U3-A to become short circuit so the voltage on the wiper of the current control potentiometer (P8) is applied to meter input in the place of the potential dropped across the sense resistor. The reading is in effect the preview of the current that will be available. Small amounts of offset on U4 can cause a discrepancy between the readings, hence an OP07 is used which has a typical specification of less than 1mV.

The base of PNP transistor Q1 floats up to line volts and holds the transistor off. A 0V signal is sent to the display on pin S2 11.

When the output switch is closed U3-A and U3-C become open circuit. U3-B becomes short circuit and the voltage developed across the sense resistors is indicated on the display scaled in amps.

The base of Q1 is pulled down, so turning on, and the potential divider R35 and R36 produces 5V on S2 11.

Protection for the analogue switches is provided by diodes D5-8.

### Overvoltage Limit Circuit

This circuit compares the output voltage to a preset level and provides a latching gate current to the SCR when this level is exceeded. However this will only occur when the output is enabled and should be reset when the output is switched OFF then back ON.

The key component in this circuit is the LM339 quad comparator. This is an open collector output device which pulls down when the inverting input is greater than the non-inverting.

R35 and R44 form a potential divider across the power supply output which takes the non-inverting input of U2-A from 0 to -4.7V at maximum output voltage. This is compared with an external signal on S2 6 which is either the trip flag from the rotary switch or the output from a potentiometer connected across the 0 to -5V rail. R39 and C5 form a filter which stop overshoot transients causing a trip. U3-D is used to short out R35 and gives a small time delay when the outputs are enabled. R36 provides some positive feedback introducing some hysteresis into the comparator action. The output of U2-A will be low (-5V) when a trip occurs and otherwise high at 2.5V as a result of the pot chain R28 R29. C10, C13 and R58 filter out short spikes which can occur on the power supplies and cause spurious trips.

U2-C latches and inverts a low signal. It achieves this by using large amounts of hysteresis which makes the level on the non-inverting input of the comparator unobtainable by the high on U2-A. To reset the latch the output of U2-C has to be pulled low by U2-E. D4, R37 and R31 level shift the output of U2-C to provide a -0.5V and +5V logic flag for the display.

U2-D inverts U2-C and provides a pull down for the base of Q2 via R32 and R38. These components have been selected to drive a constant current of around 20mA into the SCR connected to S2 9 when the non-inverting input is held high. R46,47 have been chosen to ensure that the U2-C output rises high enough to latch before triggering the SCR.

U2-E provides the reset to the latch. It pulls the output of U2-C down when its non-inverting input is taken to 0V. This is connected to the logic signal developed for the display, by Q1, indicating that the output is OFF. Otherwise the output of U2-E is held high by the pull up resistors connected to U2-C. The reference level of 2.5V for U2-E is provided by the pot chain R33 and R34. C4 ensures that the circuit is latched off when powered up.

### **Tap Change Control Circuit**

As mentioned when describing the reservoir board the purpose of this circuit is to reduce the heat dissipation of the series regulators by reducing the voltage overhead. To do this a relay is switched between the 47V and 23.5V transformer taps. The 23.5V tap is selected by driving Q3 on (ie the op-amp, U1-B, output low). R49 and 50 form a potential divider that produces a nominal -2.5V at the non-inverting terminal. This is modified by R55 which provides around 0.3V of hysteresis which appears at the output as around 2V. The output is monitored by R51, 52 which are selected for a voltage of -2.5V at the inverting terminal when the output is around 17V. With the hysteresis, the comparator action of the op-amp will switch the relay up to the 47V tap at 17V and back to the 23.5V tap at 15V. R53 provides current limiting. Z5 ensures that the transistor can be turned off. R54 current limits the drive to the relay transistor.

## 7.4 The LCD Meter

### General

The LCD (Liquid Crystal Display) meter module utilises a unique custom designed display, which is back-lit to give good visibility and pleasant appearance. The display is driven by a micro-controller which also serves as the analogue to digital converter reading the inputs to the meter.

### S4 Pin Out

| Pin | Description |                                        |
|-----|-------------|----------------------------------------|
| 1   | Volts LO    | ANALOGUE INPUTS                        |
| 2   | Volts HI    | 400mV ( $\pm 5\%$ ) for full scale     |
| 3   | Amps HI     | Inputs can float $\pm 1V$ from COMM    |
| 4   | Amps LO     |                                        |
| 5   | COMM        | Analogue and Logic common (+S).        |
| 6   | OV          | Return current bulbs and the rest.     |
| 7   | ON/OFF      | Flag. OFF - Pulled low                 |
| 8   | CV/CI       | Flag. CV - Pull up resistor            |
| 9   | Tracking    | High - 5V Low - Pull down resistor     |
| 10  | Parallel    | High - 5V Low - Pull down resistor     |
| 11  | OVL         | High - 5V Low - Pull down resistor     |
| 12  | Slave       | MASTER pulled Low<br>SLAVE pulled high |
| 13  |             | n/c                                    |
| 14  |             | n/c                                    |
| 15  | +12V bulbs  | 6W @ 12V = 0.5A, run at 11.3V          |
| 16  | +12V meter  | 50mA max                               |

### LCD Control board (Circuit Diagram: 2SZX0695)

#### Power Supplies

Two 12V supplies are used, via socket S2, one is used solely for the two lamps which give the back lighting, and is in fact set to 11.3V to extend the life of the filaments and give greater resilience to mechanical shock. The other supply is decoupled and split to generate +5v and -7v rails using a -5v regulator (U8). The +5V supply is used by the digital ICs U1, U6 and U7, the other analogue ICs require the split supply.

#### Microcontroller

The microcontroller (U1) used is an 8031 which combines a microprocessor with data memory, input and output ports, and a 16 bit timer/counter. The programme memory is stored in the PROM (read only memory) U7. The address lines for the PROM are multiplexed by the microcontroller to save pins. This requires the use of a simple latch U6, to demultiplex them.

Power on reset is provided by C17 and R20 to pin 9, and the system clock is generated by the crystal VX1 (5MHz). The crystal driver circuit is provided within U1.

All other pins of the microcontroller used are for input or output to the rest of the circuit.

### *Analogue Input Circuit*

The meter reads two analogue input channels, the volts and the amps. Both these inputs are scaled to the same full range absolute value of 400mV.

The LO input for amps is tied to the analogue ground of the meter circuit, however, the inputs for voltage are left floating. This is because the voltage measurement has to allow for common mode voltage differences caused by the drop generated in output leads when using remote sense. The voltage input is also inverted with respect to the current.

These inputs are connected to U5 which is an analogue multiplexer controlled by the microcontroller. This applies a BCD code to pins 9 and 10 of U5 which results in any of the four pairs of inputs, (1,12; 5,14; 11,4; 2,15), being connected to the output of U5 (pins 3 and 13). The output can then be volts input, amps input, reference input (-200mV from Z1), or ground.

### *Analogue To Digital Conversion*

The signal conversion is performed by a dual slope convertor with auto-zero to eliminate circuit offset errors, and with common mode signal rejection.

The signal output from the multiplexer is buffered by the FET input op-amp U3 to give a consistent low impedance to the integrator circuit formed by the op-amp U4-A, R21 and C5. Capacitor C4 is the auto-zero capacitor linked to the virtual earth of the integrator and to the switched ground output of the multiplexer and so gives the common-mode rejection.

The output from the integrator is compared with the system ground by the op-amp U4-B which is acting as a comparator, the output of which is directly read by the microcontroller.

During a conversion cycle the auto-zero is performed first. The input to the buffer/integrator is grounded and the output of the comparator/op-amp is shorted to the auto-zero capacitor by the analogue switch U2-A, the capacitor is then charged to compensate for the offset errors of the three op-amps.

The next phase is integrate, and the desired parameter, volts or amps, is switched in. The auto-zero short by U2-A is removed. The integration period is a fixed time length determined by the microcontroller.

The input is then switched to the negative fixed reference, the integrator then de-integrates and the output of the comparator U4-A is monitored by the microcontroller. This time the interval until the integrator output has returned to the starting level directly relates to the input signal level.

The microcontroller then processes this information and uses it to update the LCD display.

### *Status Inputs*

Socket 2 pins 7, 8, 11 & 12 are 0 - 5V logic inputs. Pins 9, 10, 13 & 14 are multiplexed by the two remaining analogue gates in U2 to provide further logic inputs on the IC U1-A. The multiplexing is also controlled by U1. The function of each of these inputs is shown in Table 6.1. Zener diodes Z2 - Z5 provide protection for the analogue gates from external spurious voltage transients.

### LCD Drive

S3 connects the LCD control board to the LCD display board which carries the LCD and its driver circuit. All the data to the driver is transmitted in a serial format.

### LCD Display Board (Circuit Diagram: 4SZX0612)

#### General

The LCD display board carries the custom LCD panel and the driver IC (U1). The selector switches for the bar graph and the preset viewing angles (with associated circuitry) are also mounted on this board. The circuit board material also performs the function of diffuser to the back-light. SW1 drives the interrupt line for the micro controller. In practice this steps through the bargraph functions defined in the software.

#### LCD Driver

U1 directly drives the LCD panel in the 1:4 multiplex mode required, this is set by software at power ON. R3-5, C1-3 & P1 and the multiplexer U3 with R10-12 determine the drive voltage levels for the back planes of the LCD, hence P1 controls the global view angle. The multiplexer can switch through 4 levels of view angle when driven from the counter circuit U2, R8,9, C7,8 and SW2. C8 and R9 provide the initial start up positive signal to reset the dual D-type flip flop (U2) so that the multiplexer IC (U3) resets to zero providing a short through Y0. This represents zero ohms on the "preset view angle" potentiometer (P1) so the view angle is automatically set to 90° or "straight on". Hence pressing the switch steps through the angles.

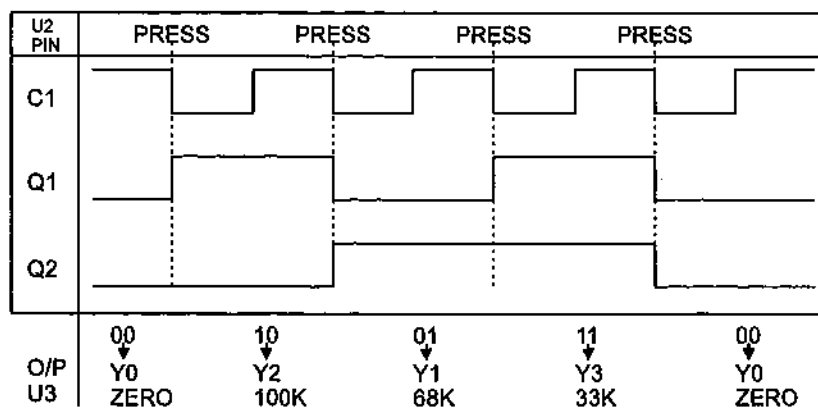


Fig 7.1 View Angle Control

R2 and C4 reset the driver IC (U1) at power on and R1 sets the multiplex rate.

## 7.5 Mode Switch Summary

### Parallel

- a) The emitters are connected together of all the series regulators.
- b) The slave series regulator bases are connected to the master control amplifiers.
- c) A new scaling factor for the current is implemented by switching in parallel resistor in the floating reference circuit.
- d) The common terminals for master and slave are connected together.
- e) A flag is sent to both master and slave display circuits putting them in the appropriate mode.
- f) The drive for the slave tap changing relay is connected to that of the master.

### Independant

The rotary switch disengages both sides of the supply so that they can float with respect of each other and work independantly.

### Series

The positive output of the slave is connected to the negative output of the master. All other aspects are independant.

### Tracking

- a) The non-inverting input of the slave voltage amplifier is connected to a new gain resistor connected in turn to the master +Sense. The gain is now 1.
- b) The positive output of the slave is connected to the negative output of the master.
- c) A flag is set for the slave display informing it that it is in tracking mode.

## 7.6 Potential Map

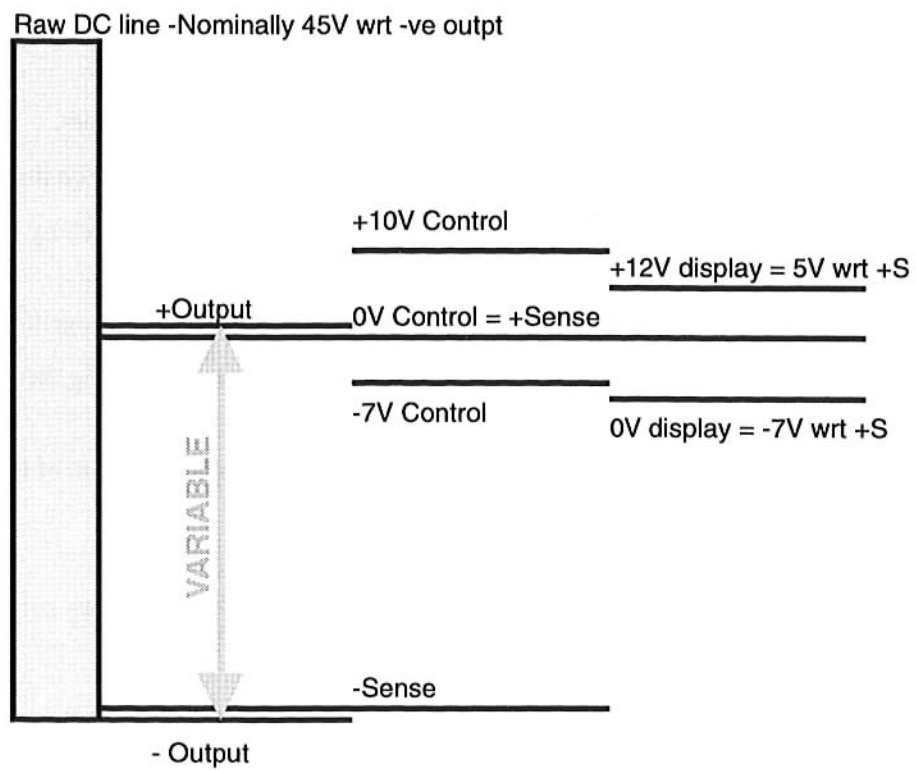


Figure 7.1 Potential Map

## 8. MAINTENANCE & RECALIBRATION

### 8.1 Maintenance

The Wayne Kerr PDD3502A is designed as a minimum maintenance product.

Recommended maintenance is limited to the removal of dust from within the unit and heatsink area by blowing and brushing. Periodically the outside of the unit can be wiped with a cloth dampened with a mild detergent.

If preventative maintenance is required then we recommend after 5,000 hours operation that all fuses are replaced along with the LCD back light lamps. It should be noted that the LCD meters are still viewable even if both lamps fail.

#### Fuse positions

---

**WARNING!** Isolate unit from mains supply and disconnect any load from the output terminals.

---

Mains input fuse - (2A T type 5x20mm) Fuse drawer integral with the IEC mains inlet socket on the rear.

Regulator fuses - (4A T type 5x20mm) On the base of the unit. Unscrew from housing with a coin or flat bladed screw driver.

Output fuses - (3A F type 5x20mm) Mounted on the bottom of the circuit board labelled F3 and F4 for the master and slave halves respectively. Remove the trap door which is held by four 'posidrive' screws. The fuses should be protected by plastic covers which should be re-used when a new fuse is fitted.

#### Gaining Access to the PDD3502A

---

**WARNING!** Isolate unit from mains supply and disconnect any load from the output terminals.

---

Using a 'posidrive' screwdriver remove the carrying handle. Turn the unit upside down. Unscrew the 3 'posidrive' screws down each side of the cover. Flexing the cover outwards lift off. A further 4 screws secure the trap door that can be removed to gain access to the under side of the main (Reservoir/Switch) circuit board.

#### Replacing Bulbs

Carefully detach the rear meter board from the 4 spacers and remove the bulb from its holder. The replacement must be an identical type and is available from Wayne Kerr Electronics Limited (Wayne Kerr Part No. LF12V025).

## 8.2 Safety Checks

Each year the unit should be given a simple safety check.

### Equipment required:

25A Earth bond tester (e.g. Megger PAT 2)

Insulation tester @ 500V D.C. (e.g. Megger BM 7)

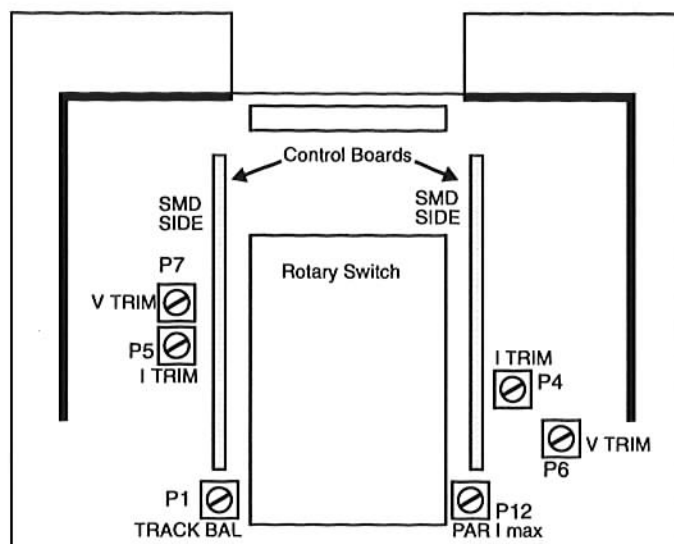
### Tests

1. Inspect the unit for dents or missing parts which might pose a threat to the unit's safe operation. Look for any signs of overheating or evidence that foreign objects might have entered the unit.
2. Earth bond. Ensure that 25A D.C. can flow from exposed metal parts of the unit to earth terminal with an impedance of less than 100m $\Omega$ .
3. Insulation test at 500V D.C. the input (LIVE & NEUTRAL) to earth, the output (Wired together) to earth and the input to output. Readings of greater than 1M $\Omega$  are acceptable.

## 8.3 Recalibration

**WARNING!** This operation must only be carried out by qualified personnel who are aware of the hazards when working on live equipment. The engineer must ensure that he takes all required precautions to protect himself and others from any hazard.

If required the PDD3502A can be returned to Wayne Kerr Electronics Limited or their agents for repair and recalibration.



PDD3502A Reservoir Switch Board - Looking from above

Fig 8.1 Pot positions

## Display

1. Two potentiometers for each display can be adjusted on the Res/Switch board using an insulated tool, from above once the cover has been removed.

Master display - P4 AMPS ; P6 VOLTS

Slave display - P5 AMPS ; P7 VOLTS

2. Set the mode select switch to 'Independent' and ensure that the output switches are 'OFF'. Turn the voltage control potentiometers fully anticlockwise. Turn the outputs 'ON' and measure the output voltages with a reference DVM. Check that the outputs are less than 50mV.

3. Turn the output potentiometer on the master to maximum and use the DVM to trim the voltage display with P6 to within  $\pm 20\text{mV}$ . Repeat with the slave output and pot P7. Ensure for these tests that the CV annunciator on the display is on.

4. Connect the master output to a load capable of handling 2A with a reference ammeter of known accuracy in series with the -ve terminal. Turn the current control potentiometer fully clockwise and set the load to approximately 2A. Set the ammeter displays to read an identical current  $\pm 2$  digits using P4. Turn the current control potentiometer anticlockwise and ensure the unit goes into constant current mode indicated by the 'CI' legend replacing the 'CV'. Repeat for the slave output using P5.

## Parallel Current Limit

Set mode select switch to 'Parallel' and ensure the slave ammeter reads "PARALLEL". Connect the master output to a load capable of handling 4.5A with a reference ammeter in series with the -ve lead. Turn the current control potentiometer on the master fully clockwise. Reduce load resistance until reference ammeter indicates 4.2A. Adjust P12 on the reservoir/switch circuit board until the CI legend is energised indicating that the current limit point has been reached.

## Tracking Balance

Set the mode select switch to 'Tracking' and ensure that the slave voltmeter reads 'OFF' when the output is 'OFF'. Switch both the master and slave outputs 'ON' and ensure that the slave voltmeter is tracking the master voltmeter. If not, adjust P1 on the reservoir/switch board with an insulated trimming tool to achieve the same reading on both voltmeters.

## 8.4 Guarantee

The equipment supplied by Wayne Kerr Electronics Limited is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of dispatch. In the case of material or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factory prior to dispatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the Service Manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions of working, accident, misuse, neglect or wear and tear.

## 8.5 Service

In the event of difficulty, or apparent circuit malfunction, it is advisable to telephone (or fax) the Service Department or your local Sales Engineer or Agent (if overseas) for advice before attempting repairs.

For repairs and maintenance it is recommended that the complete instrument be returned to:

The Service Department,  
Wayne Kerr Electronics Ltd.  
Durban Road,  
Bognor Regis,  
West Sussex PO22 9RL  
Tel 01243 825811 Fax 01243 824 698

Please ensure adequate care is taken with packing and arrange insurance cover against transit damage or loss.

## 9. COMPONENT SCHEDULES

Main Unit Item Number : PDD3502A

Description: Twin 35V 2A Bench PSU

Important explanation - Please read before ordering parts.

Due to limitations in the number of character spaces available the information in the circuit reference field has been abbreviated and the following notes are provided as a guide to its interpretation.

1. Where a component is used more than once on an assembly the alphabetic portion of the circuit reference for its second and subsequent locations has been omitted; eg. the circuit reference information for a component located at R1 and R6 will appear as: R1 6
2. The circuit reference numbers are presented in ascending decade blocks delimited by colons; second and subsequent numbers within a decade block represent only the unit value of the location (the tens and hundreds values being implied); eg. for a component located at R54, R57, R59, R82, R82, R87, R102, R110 and R112 the circuit reference entry will be: R54 7 9:82 7 9:82 7:102:10 2.
3. Where components are used in a series of neighbouring circuit reference locations the circuit reference numbers are represented as inclusive blocks using a hyphen; eg. for a component located at R16, R19, R21, R24, R25, R26, R31, R37, R38, R39, R40, R44, and R46 will be represented as R16 9:21 4-6: 31 37-40 4 6 (An exception to the rules occurs when a series crosses a decade block in which case the tens value is inserted.
4. Comments are preceded by a semicolon.

When ordering replacement parts please be sure to quote the part number provided.

## Component Schedules

| Part No      | Description                    | Iss | Qty  | Man | Man Part No      | Reference                                   |
|--------------|--------------------------------|-----|------|-----|------------------|---------------------------------------------|
| 2EAPDD3502A  | BENCH P/S 0-35V/2A TWIN O/P    | D   | 1    |     |                  |                                             |
| 31PDD        | PDD3502 CASING ASM             | A   | 1    |     |                  |                                             |
| 7SU0002      | SHORTING LINK                  | 4   | 1    | 00F | 4SUCJ0002        |                                             |
| 7SU4504      | COVER.....                     | B   | 1    | 00F | 1SUDJ4504        |                                             |
| FF3A005MF    | FUSE 3 AMP QUICK BLOW          | 2   | 60L  |     | 5MF/3A           | SPARES                                      |
| FT2A50123    | FUSE 2 AMP ANTI-SURGE          | 2   | 03B  |     | S502             | SPARES                                      |
| HA04517      | WHITE HANDLE                   | A   | 1    | 89B | 3SU004517        |                                             |
| HC22V2       | PLUG & LEAD 22V/2              | 1   | 50C  |     | 22-V-2           |                                             |
| HM0108       | HANDLE RETAINER MOULDING       | A   | 2    | 72H | 3SV10008(M75B)   |                                             |
| HR0514       | L30 HANDLE RET                 | A   | 2    | 22P | ASUAE0514        |                                             |
| JPN55        | BRN MANILLA ENV 4X3 GUM FLAP   | 1   | 06U  |     | 43LP             |                                             |
| 4NPD3502FP   | PDD3502 FRONT PANEL ASM        | C   | 1    |     |                  | 4                                           |
| 4SPLCD       | P SERIES DISPLAY ASM           | A   | 2    |     |                  | 4                                           |
| 5SPLCD       | LCD METER CB ASM. P' SERIES    | C   | 1    |     |                  | 5                                           |
| 5UPLCD       | LCD METER CB ASM. P' SERIES    | A   | 1    |     |                  |                                             |
| PAOMIT       | POTENTIOMETERS OMITTED         | 1   | 00F  |     | PAOMIT           | P1                                          |
| RAOMIT       | RESISTORS OMITTED              | 1   | 00F  |     | RAOMIT           | R7                                          |
| UBC1523      | LCD METER PCB P' SERIES        | D   | 1    | 01K | 1N189M15230      |                                             |
| UCC4220KA0KC | 2N2F 10% 50V 1206 COG          | 3   | 08V  |     | 1206A222JXAT     | C1-3                                        |
| UCC5220KA0KX | 22NF 10% 50V 1206 X7R          | 1   | 08V  |     | 1206Y223KXAT     | C7                                          |
| UCC6100KA0KX | 0U1F 10% 50V 1206 X7R          | 4   | 08V  |     | 1206Y104KXAT     | C4-6 8                                      |
| UIDP44013BT  | 4013BT SO-14                   | 1   | 01P  |     | HEF4013BT+S014   | U2                                          |
| UIDP44051    | SMD IC 4051 SO PACKAGE         | 1   | 01P  |     | HEF4051BT        | U3                                          |
| UIDPF7225    | INT CCT 52PIN FLAT PACK        | 1   | 35N  |     | UPD7225G00       | U1                                          |
| URM00A0      | LINK 1206                      | 5   | 18P  |     | RC01             | LK1-5                                       |
| URM5100GA0   | 10KR 2% 1206                   | 2   | 18P  |     | RC-01            | R6 8                                        |
| URM5330GA0   | 33KR 2% 1206                   | 1   | 18P  |     | RC-01            | R12                                         |
| URM5680GA0   | 68KR 2% 1206                   | 1   | 18P  |     | RC-01            | R10                                         |
| URM6100GA0   | 100K 2% 1206                   | 6   | 18P  |     | RC-01            | R2-5 9:11                                   |
| URM6180GA0   | 180K 2% 1206                   | 1   | 18P  |     | RC-01            | R1                                          |
| 7SP5912      | LCD DEFUSER                    | A   | 1    | 00F | 4SU005912        |                                             |
| LC17182      | LCD LPH1718-2 2SC0267          | 1   | 01P  |     | LPH1718-2        | LD1                                         |
| MF4601       | DIFFUSER P SERIES              | B   | 1    | 27P | 4SU004601        | MUST BE FREE OF BLEMISHES                   |
| SBSKH        | PUSH BUTTON SWITCH SKH         | 2   | 19T  |     | SKH-HAK          | SW1 2                                       |
| TBS2508SMD   | 8WAY SMD TERMINAL              | 1   | 25B  |     | SSM-108-T-SV     | S1                                          |
| 5SPLCDC      | LCD CONTROL CB P SERIES        | C   | 1    |     |                  | 5                                           |
| BC1531       | LCD CONTROL P SERIES           | C   | 1    | 01K | 1N18BT15310      | B                                           |
| CC222P0LG    | 22PF 2% 100V N150 RP050        | 2   | 18P  |     | 683+34229        | C6:19                                       |
| CEB33U0EM1   | 33UF 20% 16V FC +5MM           | 1   | 134N |     | SMVB             | C17                                         |
| CEC220UGM    | 220UF 20% 25V R050             | 1   | 134N |     | KMYB             | C1                                          |
| CR41N00LM    | 1n00F 20% 100V KC 3X08 R05.0   | 1   | 159W |     | FKS2             | C20                                         |
| CR510N0LM    | 10n0F 20% 100V KT 3X08 R05.0   | 8   | 159W |     | FKS2MIN          | C7-14                                       |
| CR610N0KM    | 100nF 20% 63V MKT 3X08 R05.0   | 5   | 159W |     | MKS2MIN          | C2 3:15 6 8                                 |
| CR6150NKK    | 150nF 10% 63V MKT 4X08 R05.0   | 1   | 159W |     | MKS2             | C5                                          |
| CR6150NKK    | 150nF 10% 63V MKT 4X08 R05.0   | 3   | 159W |     | MKS2             | C4:21 2                                     |
| CR6150NKK    | 150nF 10% 63V MKT 4X08 R05.0   | 8   | 23N  |     | 1N4148           | D1-8                                        |
| OG4148       | DIODE                          | 1   | 43G  |     | ZN4589           | Z1                                          |
| DZ12V45C1    | 2.45 1.43% 0W30                | 1   | 31I  |     | ZPD5.1           | Z2-5                                        |
| DZ15V10E     | 5.1V 5% 0W50                   | 4   | 37L  |     | 102071           | LP1 2                                       |
| FH102071     | FUSE HOLDER CLIP 6.3MM PCB MTG | A   | 1    | 07A | 2-345295-2       | S2                                          |
| HC0221       | P SERIES CABLE ASSY 4SC0221    | 1   | 37E  |     | 12.0M4811E       | VX1                                         |
| IVX12M04811E | 12MHZ CRYSTAL DO NOT WASH      | 2   | 01I  |     | LF12V025         | LP1 2                                       |
| LF12V025     | BULB 12V 0.25A 1.25 X 0.25     | 2   | 00F  |     | PAOMIT           | P1 2                                        |
| PAOMIT       | POTENTIOMETERS OMITTED         | 2   | 00F  |     | RAOMIT           | R5:12                                       |
| RAOMIT       | RESISTORS OMITTED              | 4   | 18P  |     | MRS25            | R16-19                                      |
| RM212R0FF    | 12R0 1% 0W60 50PPM 250V        | 1   | 18P  |     | MRS25            | R15                                         |
| RM3560RFF    | 560R 1% 0W60 50PPM 250V        | 1   | 18P  |     | MRS25            | R10                                         |
| RM41K00FF    | 1K00 1% 0W60 50PPM 250V        | 1   | 18P  |     | MRS25            | R13                                         |
| RM41K60FF    | 1K60 1% 0W60 50PPM 250V        | 1   | 18P  |     | MRS25            | R21                                         |
| RM43K30FF    | 3K30 1% 0W60 50PPM 250V        | 1   | 18P  |     | MRS25            | R20                                         |
| RM46K20FF    | 8K20 1% 0W60 50PPM 250V        | 1   | 18P  |     | MRS25            | R1 2 4:11                                   |
| RM510K0FF    | 10K0 1% 0W60 50PPM 250V        | 1   | 18P  |     | MRS25            | R14                                         |
| RM520K0FF    | 20K0 1% 0W60 50PPM 250V        | 1   | 25S  |     | TSW-108-19-T-S   | S3                                          |
| TBS2508TS    | 8WAY PIN HEADER 2.54mm         | 1   | 70H  |     | CA3140E          | U3                                          |
| VA3140E      | OP AMP SINGLE STATIC           | 1   | 70H  |     | CA3240E          | U4                                          |
| VA3240E      | OP AMP DUAL STATIC             | 1   | 23N  |     | LM79L05ACZ       | U8                                          |
| VA79L05ACZ   | REGULATOR                      | 1   | 23N  |     | CD4052B          | U5                                          |
| VD4052B      | BCMOS 2X4CH MUXPLXER STATIC    | 1   | 23N  |     | CD4053BCN        | U2                                          |
| VD4053B      | BCMOS 3X2CH MUXPLXER STATIC    | 1   | 01T  |     | SN74HC373N       | U6                                          |
| VD74HC373    | HCMOS OCTAL D-TYP T-LACH STATI | 1   | 01P  |     | PCF80C31BH-2-12P | U1                                          |
| VD80C31      | MICRO 8BIT 8031 STATIC         | 2   | 08R  |     | ICO-183-S8A-T    | U2 5                                        |
| VS16L        | IC SKT 16WAY                   | 1   | 27F  |     | 612-93-628       | U7                                          |
| VS28C        | 28W CARRIER 612-92-628         | 1   | 08R  |     | ICO-408-S8A-T    | U1                                          |
| VS40L        | IC SKT 40 WAY                  | 2   | 08R  |     | ICO-083-S8A-T    | U3 4                                        |
| VS8P         | IC SKT 8WAY                    | 2   | 08T  |     | KP3M8            |                                             |
| KP3M8        | SCREW M3 X 6 PAN HD POZI       | A   | 1    | 33P | 4SU004566        |                                             |
| MF4556       | LIGHT REFLECTOR                | 4   | 01H  |     | R100911C         |                                             |
| NR3M25TH     | SPACER M3 X 25MM THR'D HEX     | 8   | 24L  |     | LS508/54         |                                             |
| WW3M         | WAVEY WASHER M3                | 1   | 1    |     |                  | 5                                           |
| 5NP3502M     | PDD3502 MAIN CB ASM            | A   | 2    |     |                  | S11 2                                       |
| 5NP3502D     | PDD3502 DAUGHTER CB ASM        | A   | 1    | 01K | BC20870          |                                             |
| BC2087       | PDD3502 CURRENT SENSE CB       | 8   | 18P  |     | MRS25            | R1-8                                        |
| RM11R00FF    | 1R00 1% 0W60 100PPM 250V       | 1   | 07A  |     | 163740-4         | S1                                          |
| TP7404       | 6WAY STAKED MALE CONTACT       | D   | 1    |     |                  | 5                                           |
| 5NP3502MR    | PDD3502 MAIN CB RADIAL         | D   | 1    |     |                  | 5 (DO NOT KIT STAGE 1 COMPS CB MUST BE K/M) |
| 5NP3502MA    | PDD3502 MAIN CB AXIAL          | G   | 1    | 01K | 1N18BT15370      | B                                           |
| BC1537       | RESERVOIR SWITCH BOARD POD'S   | 4   | 11G  |     | 1N4003           | D3 4:22 3                                   |
| DG4003       | DIODE                          | 13  | 23N  |     | 1N4148           | D7-12 7 8:21 24-27                          |
| DG4148       | DIODE                          | 2   | 01P  |     | BZV85-C39        | Z8 7                                        |
| DZ239V0H     | 39V 5% 1W30                    | 1   | 00F  |     | RAOMIT           | R35                                         |
| RAOMIT       | RESISTORS OMITTED              | 4   | 18P  |     | MRS25            | R1 7:13 8                                   |
| RM11R00FF    | 1R00 1% 0W60 100PPM 250V       | 2   | 18P  |     | MRS25            | R2:10                                       |
| RM13R90FF    | 3R90 1% 0W60 100PPM 250V       | 4   | 18P  |     | MRS25            | R3 6:14 9                                   |
| RM212R0FF    | 12R0 1% 0W60 50PPM 250V        | 2   | 18P  |     | MRS25            | R46 7                                       |
| RM3100RFF    | 100R 1% 0W60 50PPM 250V        | 3   | 18P  |     | MRS25            | R4:72 3                                     |
| RM3680RFF    | 680R 1% 0W60 50PPM 250V        | 6   | 18P  |     | MRS25            | R27:37:70 1 7 8                             |
| RM41K00FF    | 1K00 1% 0W60 50PPM 250V        | 5   | 18P  |     | MRS25            | R36:65-8:74                                 |
| RM42K20FF    | 2K20 1% 0W60 50PPM 250V        | 2   | 18P  |     | MRS25            | R31 2                                       |
| RM42K70FF    | 2K70 1% 0W60 50PPM 250V        |     |      |     |                  |                                             |

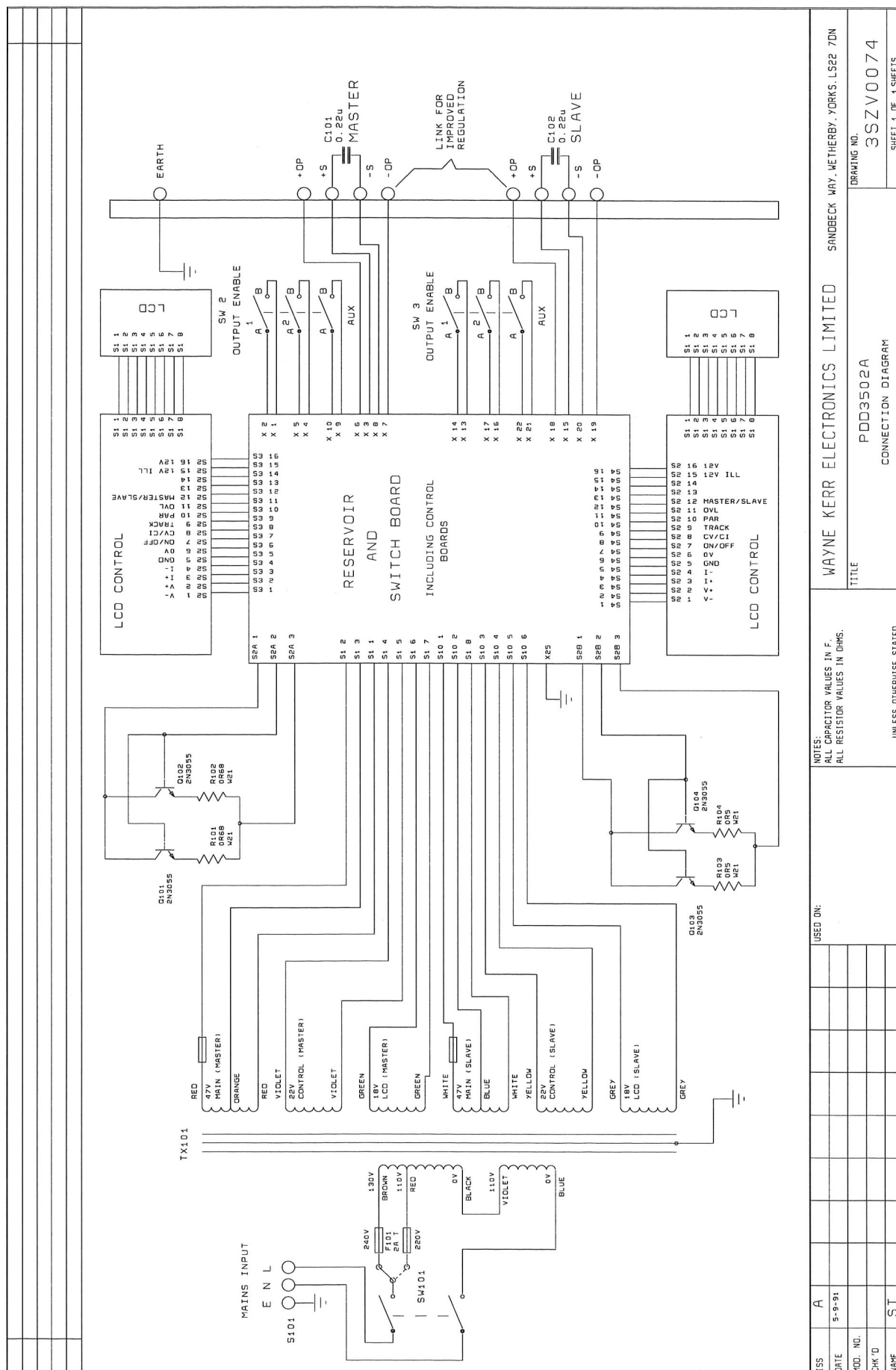
| Part No    | Description                    | Iss | Qty  | Man  | Man Part No           | Reference                       |
|------------|--------------------------------|-----|------|------|-----------------------|---------------------------------|
| RM43K30FF  | 3K30 1% 0W60 50PPM 250V        |     | 2    | 18P  | MRS25                 | R44 6                           |
| RM43K90FF  | 3K90 1% 0W60 50PPM 250V        |     | 2    | 18P  | MRS25                 | R5:12                           |
| RM51K0KFF  | 10K0 1% 0W60 50PPM 250V        |     | 5    | 18P  | MRS25                 | R8:11 6:20:34                   |
| RM51K1KFF  | 11K0 1% 0W60 50PPM 250V        |     | 2    | 18P  | MRS25                 | R38 9                           |
| RM53K0KFF  | 36K0 1% 0W60 50PPM 250V        |     | 2    | 18P  | MRS25                 | R40 1                           |
| RM58K0KFF  | 68K0 1% 0W60 50PPM 250V        |     | 2    | 18P  | MRS25                 | R75 6                           |
| RM5100KFF  | 100K 1% 0W60 50PPM 250V        |     | 1    | 18P  | MRS25                 | R48                             |
| RM6220KFF  | 220K 1% 0W60 50PPM 250V        |     | 1    | 18P  | MRS25                 | R25                             |
| RM6330KFF  | 330K 1% 0W60 50PPM 250V        |     | 2    | 18P  | MRS25                 | R42 3                           |
| RM8470KFF  | 470K 1% 0W60 50PPM 250V        |     | 2    | 18P  | MRS25                 | R29:30                          |
| YT22       | T/C WIRE 22SWG                 |     | .001 | 55M  | 22SWG                 | SEE PI                          |
| CEC100UKM  | 100UF 20% 63V R050             |     | 2    | 134N | KMVB                  | C25 7                           |
| CR6100NKM  | 100nF 20% 63V MKT 3X08 R05.0   |     | 2    | 159W | MKS2MIN               | C38 9                           |
| CR6100NLM  | 100nF 20% 100V MKT 3X10 R07.5  |     | 4    | 159W | MKS3                  | C15 6 9:20                      |
| CR6100NSK  | 100nF 10% 400V MKT 6X18 R15.2  |     | 2    | 18P  | 368-51104             | C26 8 FIT ON MC1 BEADS          |
| CR6470NKK  | 470nF 10% 63V MKT 6X08 R05.0   |     | 2    | 159W | MKS2                  | C36 7                           |
| CRA1U00KM  | 1U00F 20% 63V MKT 5X13 R10.0   |     | 2    | 159W | MKS4                  | C40 1                           |
| CRA1U00KM1 | 1U00F 20% 63V MKT 6X08 R05.0   |     | 4    | 159W | MKS2                  | C1:12:22 4                      |
| MC1        | CERAMIC BEAD SMALL             |     | 4    | 57M  | IPB/1                 | FIT ON C26 8                    |
| PM41K00KV  | 1K00 10% PRESET VERT STURN     |     | 3    | 02S  | 63P                   | P6 7:12                         |
| PM510K0KH  | 10K0 10% PRESET HORIZ MTURN    |     | 2    | 02S  | 43P                   | P2 3                            |
| PM520K0KV  | 20K0 10% PRESET VERT STURN     |     | 2    | 02S  | 63P                   | P4 5                            |
| PM550K0KV  | 50K0 10% PRESET VERT STURN     |     | 1    | 02S  | 63P                   | P1                              |
| VS6L       | IC SKT 6WAY                    |     | 2    | 08R  | ICO-063-S8A-T         | U1 2                            |
| VT212PKCR  | BC212PK T05 JOG/CROP           |     | 1    | 03Z  | BC212PK35             | Q5                              |
| VTNMGP     | ZTX451 BC487A TO92(3SC0147)N   | A   | 2    | 03Z  | ZTX451-K(3SC0147)     | Q8 7                            |
| 6P10422    | SNPD350M MAIN CB WIRE PREP     | A   | 1    |      |                       |                                 |
| 7SU4212    | CONTROL BKT...                 | C   | 1    | 00F  | 3SUCB4212             |                                 |
| 7SU4520    | HEATSINK D.....                | B   | 1    | 00F  | 3SUBA4520             |                                 |
| 7SU4521    | HEATSINK E.....                | B   | 1    | 00F  | 3SUBA4521             |                                 |
| CAOMIT     | CAPACITORS OMITTED             |     | 1    | 00F  | CAOMIT                | C29                             |
| CEB10U0JM1 | 10UF 20% 50V                   |     | 2    | 134N | KMVB                  | C 48 9                          |
| CEB10U0JM2 | 10UF 20% 50V FC +5MM           |     | 4    | 134N | KMVB                  | C44-47                          |
| CEB22U0LM  | 22UF 20% 100V R050             |     | 2    | 134N | KMVB                  | C42 3                           |
| CEC220UJM  | 220UF 20% 50V R050             |     | 2    | 134N | KMVB                  | C21 3                           |
| CED1M00JQ  | 1M00F 20% 50V 16x032 R07.5     |     | 2    | 134N | KMVB                  | C13 7                           |
| CED1M00KM  | 1M00F 20% 63V 18x036 R07.5     |     | 2    | 134N | KMVB+                 | C3 8                            |
| CED2M20KM  | 2.2MF 20% 63V S100             |     | 2    | 92B  | ALC20A2228D063        | C2 7                            |
| CL510N0WM  | 10n0F 20% 1K0V MKT             |     | 1    | 47L  | MKT1.5                | C35                             |
| DBB80      | BR. RECT. 25MM LDS 125V 5A     |     | 2    | 11G  | 680C/5000/3300        | BR1 2                           |
| DBW02M     | BRIDGE RECTIFIER               |     | 2    | 11G  | W02G                  | BR3 4 (MC1 X1/L)                |
| DG233600   | 600V 10A 150NS TO220           |     | 1    | 29S  | 8Y233-600             | D15                             |
| DG4148     | DIODE                          |     | 1    | 23N  | 1N4148                | (ISSUE D PCB SEE PI)            |
| DG5408     | DIODE                          |     | 4    | 11G  | 1N6408/P300M          | D5:16 8:20                      |
| DG752      | DIODE                          |     | 1    | 02M  | MR762                 | D6                              |
| DS126B     | S.C.R.                         |     | 2    | 01T  | TIC126D               | D13 4                           |
| FF3A005MF  | FUSE 3 AMP QUICK BLOW          |     | 2    | 50L  | 5MF3A                 | F3 4                            |
| FH5229     | FUSE HOLDER 5 X 20MM PCB MTG.  |     | 2    | 14T  | 5229                  | F3 4                            |
| FH5201     | FUSE COVER 5 X 20MM            |     | 2    | 14T  | 5201                  | F3 4                            |
| KP25M10    | SCREW M2.5 X 10 PAN HD POZI    |     | 8    | 05T  | XP25M10               |                                 |
| KP4N38B    | SCREW NO 4 X3/8 PAN POZI B     |     | 1    | 05T  | XP4N38B               |                                 |
| MB0217     | TOP HAT BUSH M2.5              |     | 8    | 40P  | 043-4227              |                                 |
| MM103C     | TRANSISTOR MICA TO220          |     | 8    | 24M  | M16108                |                                 |
| NF25M      | FULL NUT M2.5                  |     | 8    | 05T  | NF25M                 |                                 |
| PM0244     | 5K0R 10% LOG S/TURN            | B   | 2    | 10B  | 4SC0244               | P8 9                            |
| PW0243     | 5K0R 5% LIN M/TURN             | B   | 2    | 02S  | 534-4172-502(4SC0243) | P10 1                           |
| RAOMIT     | RESISTORS OMITTED              |     | 1    | 00F  | RAOMIT                | R23                             |
| RM3680RFF  | 680R 1% 0W60 50PPM 250V        |     | 1    | 18P  | MRS25                 | R9 (ISSUE E PCB ONLY)           |
| RW3680RMJ  | 680R 5% 6W00                   |     | 1    | 04E  | 58ER                  | R9 (MC2x1/L) (ISSUE D PCB ONLY) |
| SB6363     | 5A MAINS 3 POLE MAKE PC-MNT    |     | 2    | 31S  | 636.3+(5A)            | SW2 3                           |
| SR310048   | POWER 48VDC SPCO 16AAC PC MNT  | A   | 2    | 44P  | 11-794-135-880        | RL1 2                           |
| SW0091     | WAFER SWITCH (3ST0091)         | A   | 1    | 45L  | PT6531(3ST0091)       | SW1                             |
| TBA3903PSS | 3W PIN WAFER FRICTION LOCK SQU |     | 2    | 07A  | 640445-3              | S2 9                            |
| TBA3906PSS | 6WAY FRICTION LOCK SQUARE      |     | 1    | 07A  | 640445-6              | S10                             |
| TBA3908PSS | 8W PIN WAFER FRICTION LOCK SQU |     | 1    | 07A  | 640445-8              | S1                              |
| TBM2512H01 | 12 WAY SINGLE ROW RECEPTACLE   |     | 4    | 23M  | 5224+22-02-3124       | S5 6 7 8                        |
| TK12150796 | 16 WAY SOCKET                  |     | 2    | 07A  | 1-215079-6            | S3 4                            |
| TM1670     | TERMINAL PRESTINCERT           |     | 6    | 61I  | L1670E                |                                 |
| VA17AQ     | OPTO COUP HFE SEL CTR 45-90    | C   | 2    | 11Q  | 3SC0139               | U1 2                            |
| VA7812CT   | REGULATOR                      |     | 2    | 23N  | LM340T12              | U5 8                            |
| VA7815CT   | REGULATORCT                    |     | 2    | 02M  | MCT7815CT             | U3 4                            |
| VT3055T    | MJE3055T                       |     | 4    | 02M  | MJE3055T              | Q1-4                            |
| WF25M      | FLAT WASHER M2.5               |     | 8    | 05T  | WF25M                 |                                 |
| WS25M      | SPRING WASHER M2.5             |     | 8    | 05T  | WS25M                 |                                 |
| YL22070    | LINK 7MM TC22SWG               |     | 2    | 00F  | TC22SWG+7MM           | LK1 2 SLEEVE LINKS              |
| YT22       | T/C WIRE 22SWG                 |     | .022 | 55M  | 22SWG                 |                                 |
| 7SM0106    | DOUBLE BEZEL SCREENED          | A   | 1    | 00F  | 2SZY0377              |                                 |
| HM0106     | DOUBLE FRONT BEZEL A           | A   | 1    | 72H  | 2SV10006(M91)         |                                 |
| 7SU0002    | SHORTING LINK                  |     | 4    | 00F  | 4SUCJ0002             |                                 |
| 7SU4516    | FRONT PANEL...                 | D   | 1    | 00F  | 3SUWF4516             |                                 |
| CR6220NLM  | 220nF 20% 100V MKT 4X13 R10.0  |     | 2    | 159W | MKS4                  | C X2                            |
| HK0246     | P SERIES KNOB BEIGE            | A   | 4    | 01S  | 4SC0246               |                                 |
| HK0247     | P SERIES KNOB BEIGE +LINE      | A   | 1    | 01S  | 4SC0247               |                                 |
| HK0248     | P SERIES KNOB CAP BEIGE        | A   | 5    | 01S  | 4SC0248               |                                 |
| HM0100     | FRONT MOULDING P SERIES        | A   | 1    | 72H  | 1SV0100(M90)          |                                 |
| HM0101     | BUTTON P SERIES                | A   | 4    | 72H  | 3SV0101(M95)          |                                 |
| KP1442     | PLAZ TITE FORM SCREW POZI PAN  |     | 8    | 24P  | WN1442KB30X6Z         |                                 |
| MT9473     | TAPE DOUBLE SIDED 12mm WIDE    |     | .18  | 18M  | 9473                  |                                 |
| TC1418782  | FASTON TAB .25 DOUBLE          |     | 8    | 07A  | 141878-2              |                                 |
| TM2BLK     | TERMINAL BLACK                 |     | 4    | 50C  | TP2+(BLK)             |                                 |
| TM2EGRN    | TERMINAL GREEN                 |     | 1    | 50C  | TP2E+(GREEN)          |                                 |
| TM2RED     | TERMINAL RED                   |     | 4    | 50C  | TP2+(RED)             |                                 |
| 4NPDDTX    | PDD3502 MAINS BOX ASM          | C   | 1    |      |                       | 4                               |
| 7SM10004   | FUSE HOLDER SCREENED           | A   | 1    | 00F  | 4SUVO10004            | F101                            |
| FH192761   | FUSE CARRIER                   |     | 1    | 50C  | CL192761              |                                 |
| 7SU4498    | MAINS HOUSING                  | D   | 1    | 00F  | 2SUCB4498             |                                 |
| 7SU4503    | HEATSINK SUPPORT               | B   | 1    | 00F  | 2SUCB4503             |                                 |
| FH520TP    | FUSE HOLDER 5 X 20MM P/MTG UL  |     | 2    | 12A  | TO333UL               | F102 3                          |
| FS9820     | FUSE HOLDER SHROUD 5 X 20MM    |     | 2    | 28B  | 9820                  |                                 |
| FT2A50123  | FUSE 2.5 AMP ANTI-SURGE        |     | 1    | 03B  | S502                  | F101(KIT TO TEST DEPT)          |
| FT4A00S503 | FUSE 4 AMP ANTI-SURGE          |     | 2    | 03B  | S503                  | F102 3 KIT TO TEST DEPT         |

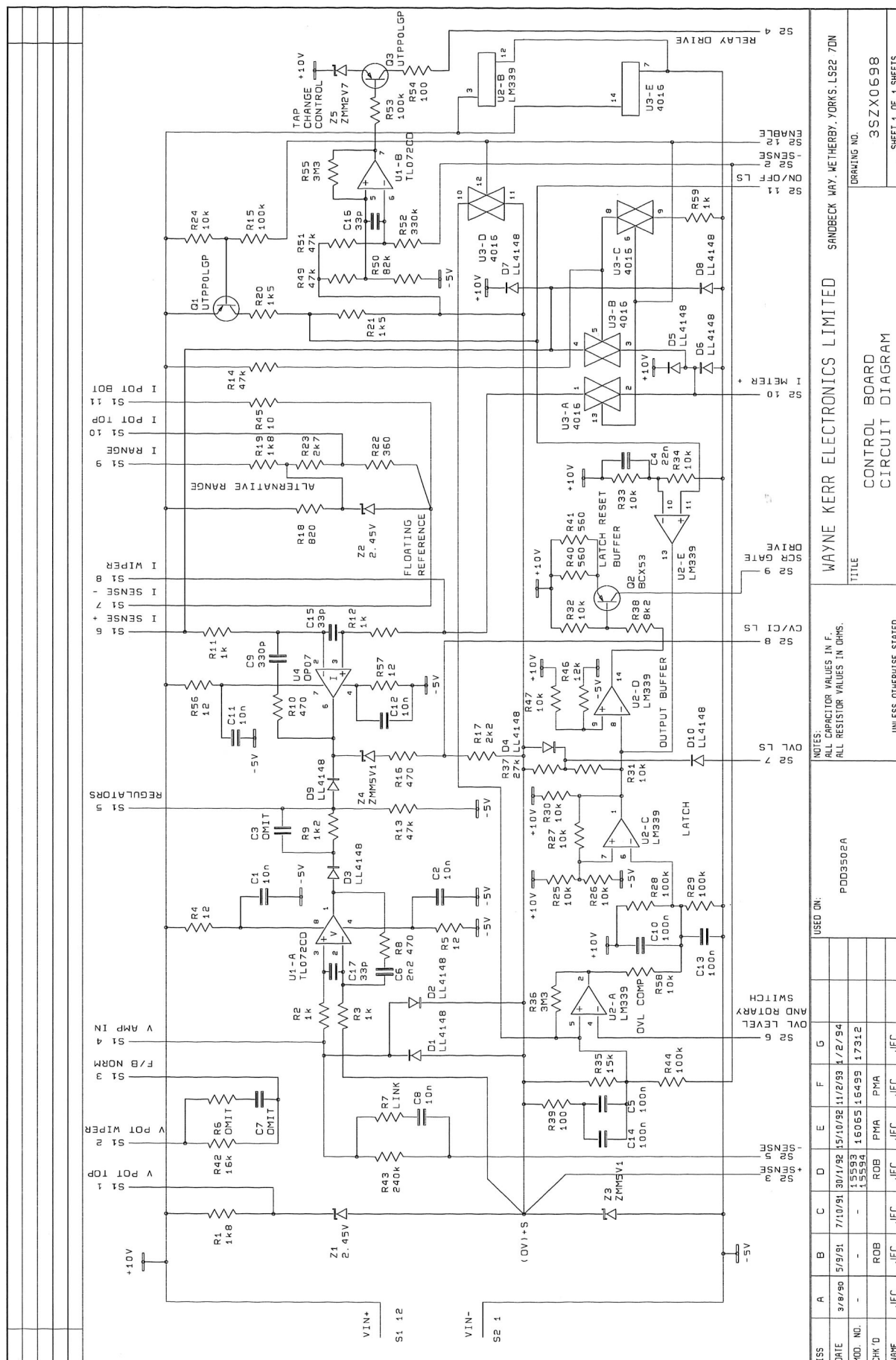
| Part No      | Description                   | Iss | Qty | Man | Man Part No          | Reference                         |
|--------------|-------------------------------|-----|-----|-----|----------------------|-----------------------------------|
| GRM79H       | GROMMET 11/2X1 M79H           |     | 1   | 60M | M79H                 |                                   |
| KF4N38B      | SCREW NO4 X 3/8 FLANGE POZI   |     | 2   | 05H | KF4N38B              |                                   |
| KP4M10       | SCREW M4 X 10 PAN HD POZI     |     | 2   | 05T | KP4M10               |                                   |
| SB5040       | MAINS SWITCH 4 WAY            |     | 1   | 45L | PBMS5040             | SW101                             |
| SST2225B     | SLIDE SW T2225B UNMARKED      |     | 1   | 12A | T2225B               | SW102                             |
| TK192710     | IEC INLET FUSED WITH LUGS     |     | 1   | 50C | CL192710             | S101                              |
| TV19285      | IEC INLET 6HROUD              |     | 1   | 50C | CL19285              | S101                              |
| WW4M         | WAVEY WASHER M4               |     | 2   | 24L | LS508/56             |                                   |
| ZR0335       | TORROID EAPDD 3502A REF Z1504 | C   | 1   | 01B | 3SR0335              | TX101                             |
| 6P10065      | ZR0335 WIRE PREP              | C   | 1   |     |                      |                                   |
| TBA3906HS    | 6W HOUSING WITH STRAIGHT LOCK |     | 1   | 07A | 640250-6             |                                   |
| TBA3908HS    | 8W HOUSING WITH STRAIGHT LOCK |     | 1   | 07A | 640250-8             |                                   |
| TC39AMP      | CRIMP TERMINAL                |     | 12  | 06A | 342392-6             |                                   |
| TC3ME        | RING TERMINAL M3 UNINSULATED  |     | 1   | 07A | 180344-2             |                                   |
| YP16028KV    | 18/0.2 BLACK 105              |     | .42 | 10P | VX350                |                                   |
| YP16028LV    | 18/0.2 BLUE 105               |     | .21 | 10P | 16/0.2+VX            |                                   |
| YP1602GYV    | 18/0.2 GREY 105               |     | .42 | 10P | 16/0.2+VX            |                                   |
| YP1602ORV    | 16/0.2 ORANGE 105             |     | .21 | 10P | 16/0.2+VX            |                                   |
| YP1602RDV    | 18/0.2 RED 105                |     | .42 | 10P | 16/0.2+VX            |                                   |
| YP1602VIV    | 18/0.2 VIOLET 105             |     | .42 | 10P | 16/0.2+VX            |                                   |
| YP1602WHV    | 18/0.2 WHITE 105              |     | .42 | 10P | 16/0.2+VX            |                                   |
| YP1602YLV    | 18/0.2 YELLOW 105             |     | .42 | 10P | 16/0.2+VX            |                                   |
| YP24028KV    | 24/0.2 BLACK 105              |     | .28 | 10P | 24/0.2+VX            |                                   |
| YP24028LV    | 24/0.2 BLUE 105               |     | .28 | 10P | 24/0.2+VX            |                                   |
| YP24028NV    | 24/0.2 BROWN 105              |     | .23 | 10P | 24/0.2+VX            |                                   |
| YP2402GNV    | 24/0.2 GNYL 105               |     | .18 | 10P | 24/0.2+VX            |                                   |
| YP2402RDV    | 24/0.2 RED 105                |     | .23 | 10P | VX450                |                                   |
| YP2402VIV    | 24/0.2 VIOLET 105             |     | .23 | 10P | 24/0.2+VX            |                                   |
| 4SPDHS       | PDA/PDD 3502A HEATSINK ASM    | A   | 2   |     |                      | 4                                 |
| 7SU4506      | HEATSINK A.....               | B   | 1   | 00F | 3SUBA4506            | HEATSINK A                        |
| 7SU4507      | HEATSINK B.....               | B   | 1   | 00F | 3SUBA4507            | HEATSINK B                        |
| 7SU4508      | HEATSINK C.....               | C   | 1   | 00F | 3SUBA4508            | HEATSINK C                        |
| KP25M16      | SCREW M2.5 X 16 PAN HD POZI   |     | 1   | 05H | KP25M16              |                                   |
| KP3M16       | SCREW M3 X 16 PAN HD POZI     |     | 4   | 05T | KP3M16               |                                   |
| MB00159      | M3 INSULATING BUSH            | E   | 4   | 72H | 4SV0000159(M9)       |                                   |
| MB1820       | TOP HAT BUSH M2.5             |     | 2   | 14W | BQ1820               |                                   |
| MC1          | CERAMIC BEAD SMALL            |     | 8   | 57M | IPB/1                |                                   |
| MM3055       | TRANSISTOR MICA TO3           |     | 2   | 70H | DF377A               |                                   |
| NF25M        | FULL NUT M2.5                 |     | 1   | 05T | NF25M                |                                   |
| NF3M         | FULL NUT M3                   |     | 4   | 05T | NF3M                 |                                   |
| NV410D       | POP RIVET 3.2MM DIA DOMED HD. |     | 2   | 08T | TAPD+410+BS          |                                   |
| TS6B43       | SOLDER TAG 6BA STC402307DM    |     | 4   | 05R | HC43/69A             |                                   |
| VT3055S      | 2N3055H SEMELAB PART          |     | 2   | 24S | 2N3055H              | Q101 2 OR Q103 4                  |
| WF25M        | FLAT WASHER M2.5              |     | 2   | 05T | WF25M                |                                   |
| WF3M         | FLAT WASHER M3                |     | 2   | 05T | WF3M                 |                                   |
| WS25M        | SPRING WASHER M2.5            |     | 1   | 05T | WS25M                |                                   |
| WS3M         | SPRING WASHER M3              |     | 4   | 05T | WS3M                 |                                   |
| 5NPD3502C    | PDD3502 CONTROL CB ASM        | B   | 2   |     |                      | BOARD TO BE TESTED BEFORE FIT     |
| 5UPD3502C    | PDD3502 CONTROL CB ASM        | G   | 2   |     |                      | SMD                               |
| CAOMIT       | CAPACITORS OMITTED            |     | 5   | 00F | CAOMIT               | C3 7:15-17                        |
| RAOMIT       | RESISTORS OMITTED             |     | 1   | 00F | RAOMIT               | R6                                |
| UBC1536      | P SERIES CONTROL PDD3502A     | G   | 1   | 01K | 1NIRBT15360          | SMD                               |
| UCC3330JA0KC | 330PF 5% 60V 1206 COG         |     | 1   | 08V | 1206A331JXAT         | C9                                |
| UCC4220KA0KX | 2N2F 10% 50V 1206 X7R         |     | 1   | 08V | 1206Y222KXAT         | C6                                |
| UCC5100KA0KX | 10NF 10% 50V 1206 X7R         |     | 5   | 08V | 1206Y103KXAT         | C1 2 8:11 2                       |
| UCC5220KA0KX | 22NF 10% 50V 1206 X7R         |     | 1   | 08V | 1206Y223KXAT         | C4                                |
| UCC6100KA0KX | 0U1F 10% 50V 1206 X7R         |     | 4   | 08V | 1206Y104KXAT         | C5:10 3 4                         |
| UDGC0LL4148  | LL4148 MINI-MELF              |     | 10  | 31I | LL4148               | D1-10 X1 (X1 ISSUE E ONLY SEE PI) |
| UDZ1270C0    | ZMM2.7 2V7 MINI MELF          |     | 1   | 31I | ZMM217               | Z5                                |
| UDZ1510C0    | ZMM5.1 5V1 MINI MELF          |     | 2   | 31I | ZMM5-1               | Z3 4                              |
| UIAP3OP07    | SMD OP AMP AD/PMI             |     | 1   | 55A | OP07CR/S             | U4                                |
| UIAP3TL072   | TL072CD SO-8                  |     | 1   | 01T | TL072CD              | U1                                |
| UIAP4LM339   | LM339 SO-14                   |     | 1   | 01T | LM339                | U2                                |
| UIOP44016    | SMD IC 4016 SO16              |     | 1   | 01P | HEF4016BT            | U3                                |
| URM00A0      | LINK 1206                     |     | 1   | 18P | RC01                 | R7                                |
| URM2100GA0   | 10R 2% 1206                   |     | 1   | 18P | RC-01                | R45                               |
| URM2120GA0   | 12R 2% 1206                   |     | 4   | 18P | RC-01                | R4 5:56 7                         |
| URM3100GA0   | 100R 2% 1206                  |     | 2   | 18P | RC-01                | R39:54                            |
| URM3470GA0   | 470R 2% 1206                  |     | 3   | 18P | RC-01                | R8:10 6                           |
| URM3560GA0   | 560R 2% 1206                  |     | 2   | 18P | RC-01                | R40 1                             |
| URM3820GA0   | 820R 2% 1206                  |     | 1   | 18P | RC-01                | R18                               |
| URM4100GA0   | 1K0R 2% 1206                  |     | 6   | 18P | RC-01                | R2 3:11 2:59                      |
| URM4120GA0   | 1K2R 2% 1206                  |     | 1   | 18P | RC-01                | R9                                |
| URM4150GA0   | 1K5R 2% 1206                  |     | 2   | 18P | RC-01                | R20 1                             |
| URM4180GA0   | 1K8R 2% 1206                  |     | 2   | 18P | RC-01                | R1:19                             |
| URM4220GA0   | 2K2R 2% 1206                  |     | 1   | 18P | RC-01                | R17                               |
| URM4270GA0   | 2K7R 2% 1206                  |     | 1   | 18P | RC-01                | R23                               |
| URM4820GA0   | 8K2R 2% 1206                  |     | 1   | 18P | RC-01                | R38                               |
| URM5100GA0   | 10KR 2% 1206                  |     | 11  | 18P | RC-01                | R24-27:30-34:47:58                |
| URM5120GA0   | 12KR 2% 1206                  |     | 1   | 18P | RC-01                | R46                               |
| URM5150GA0   | 15KR 2% 1206                  |     | 1   | 18P | RC-01                | R35                               |
| URM5270GA0   | 27KR 2% 1206                  |     | 1   | 18P | RC-01                | R37                               |
| URM5470GA0   | 47KR 2% 1206                  |     | 4   | 18P | RC-01                | R13 4:49:51                       |
| URM5820GA0   | 82KR 2% 1206                  |     | 1   | 18P | RC-01                | R50                               |
| URM6100GA0   | 100K 2% 1206                  |     | 4   | 18P | RC-01                | R15:28 9:53                       |
| URM6330GA0   | 330K 2% 1206                  |     | 1   | 18P | RC01                 | R52                               |
| URM7330JA0   | 3M3R 5% 1206                  |     | 2   | 18P | RC-01                | R38:55                            |
| UTTP0LGP     | SOT23#45V#A80#100G#180F(0144) | A   | 2   | 01P | BC807-25/40(3SC0144) | Q1 3                              |
| UTTP2MGP     | BCX53/80V/1A0 AKAM            |     | 1   | 01P | BCX53/T1             | Q2                                |
| DZ12V45C1    | 2.45 1.43% 0W30               |     | 2   | 43G | 2N458B               | Z1 2                              |
| RM3360RFF    | 360R 1% 0W60 50PPM 250V       |     | 1   | 18P | MRS25                | R22                               |
| RM516KOFF    | 16K0 1% 0W60 50PPM 250V       |     | 1   | 18P | MRS25                | R42                               |
| RM6100KFF    | 100K 1% 0W60 50PPM 250V       |     | 1   | 18P | MRS25                | R44                               |
| RM6240KFF    | 240K 1% 0W60 50PPM 250V       |     | 1   | 18P | MRS25                | R43                               |
| TP7401       | 12WAY STAKED MALE CONTACT     |     | 2   | 07A | 1-163740-1           | S1 2                              |
| 6P10084      | WIRE PREP PDD3503A            | E   | 1   |     |                      |                                   |
| MH181BLK     | HEATSHRINK 3.2MM X 25MM BLACK |     | 1   | 52E | E98271+ULCSA         |                                   |
| TBA3903HS    | 3W HOUSING WITH STRAIGHT LOCK |     | 2   | 07A | 640250-3             |                                   |
| TC1547181    | FASTON RECEPTACLE .25         |     | 8   | 07A | 154718-6             |                                   |
| TC154719     | FASTON BOOT .25 BLACK         |     | 8   | 07A | 154719               |                                   |
| TC39AMP      | CRIMP TERMINAL                |     | 8   | 06A | 342392-6             |                                   |

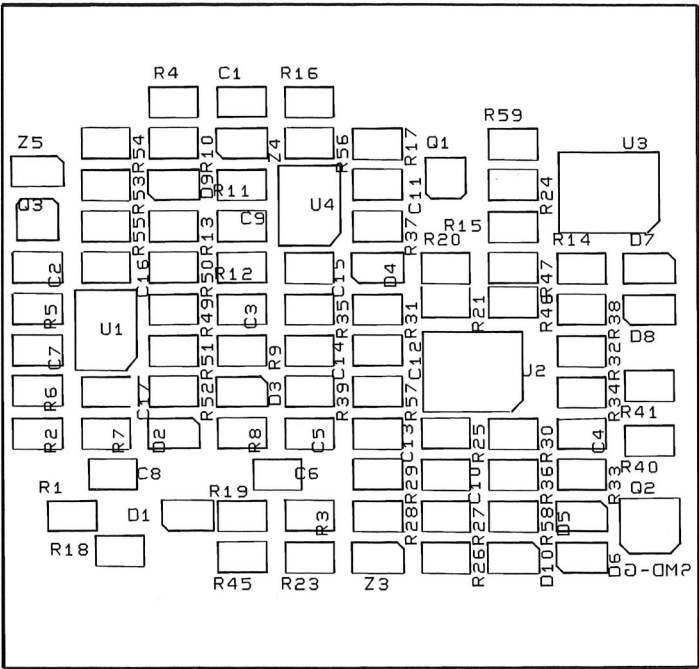
| Part No    | Description                   | Iss | Qty | Man  | Man Part No                                 | Reference                               |
|------------|-------------------------------|-----|-----|------|---------------------------------------------|-----------------------------------------|
| TC3BARR    | RING TERMINAL M4 RED 22-16AWG |     | 2   | 07A  | 2-342103-1                                  |                                         |
| TC3ME      | RING TERMINAL M3 UNINSULATED  |     | 4   | 07A  | 180344-2                                    |                                         |
| TC6BARR    | RING TERMINAL 6BA RED REEL    |     | 1   | 07A  | 2-342101-1                                  |                                         |
| TCM47060   | WIRE TO BOARD TERMINAL 16-18  |     | 8   | 23M  | 4706-0.02-09-2105                           |                                         |
| YP1602RDV  | 16/0.2 RED 105                |     | .17 | 10P  | 16/0.2+VX                                   |                                         |
| YP1602WHV  | 16/0.2 WHITE 105              |     | .17 | 10P  | 16/0.2+VX                                   |                                         |
| YP1902GN   | 19/0.2 GREEN UL1371 PTFE      |     | .62 | 77B  | 19/0.2+GRN                                  |                                         |
| YP1902ORG  | 19/0.2 ORANGE UL1371 PTFE     |     | .68 | 77B  | 19/0.2+PTFE                                 |                                         |
| YP1902PK   | 19/0.2 PINK UL1371 PTFE       |     | .58 | 77B  | 19/0.2+PTFE                                 |                                         |
| YP2402BKV  | 24/0.2 BLACK 105              |     | .22 | 10P  | 24/0.2+VX                                   |                                         |
| YP2402BLV  | 24/0.2 BLUE 105               |     | .16 | 10P  | 24/0.2+VX                                   |                                         |
| YP2402BNV  | 24/0.2 BROWN 105              |     | .16 | 10P  | 24/0.2+VX                                   |                                         |
| YP2402GNV  | 24/0.2 GN/YL 105              |     | .72 | 10P  | 24/0.2+VX                                   |                                         |
| YP2402ORV  | 24/0.2 ORANGE 105             |     | .16 | 10P  | 24/0.2+VX                                   |                                         |
| YP2402ROV  | 24/0.2 RED 105                |     | .22 | 10P  | VX450                                       |                                         |
| YP2402V/V  | 24/0.2 VIOLET 105             |     | .22 | 10P  | 24/0.2+VX                                   |                                         |
| YP2402YLV  | 24/0.2 YELLOW 105             |     | .22 | 10P  | 24/0.2+VX                                   |                                         |
| 7SB4496    | ROD LINK                      | C   | 1   | 00F  | 3SUBA4496                                   |                                         |
| 7SU10036   | BOARD RETAINER                | A   | 1   | 00F  | 3SUBA10036                                  |                                         |
| 7SU4499    | HANDLE SUPPORT                | B   | 1   | 00F  | 3SUBB4499                                   |                                         |
| 7SU4519    | CHASSIS.....                  | D   | 1   | 00F  | 1SUBB4519                                   |                                         |
| 7SU4527    | COVER PLATE                   | A   | 1   | 00F  | 2SUBB4527                                   |                                         |
| HFSTD      | FOOT 103-E119700              |     | 4   | 37F  | 103-E1197-00                                |                                         |
| HL9X30     | BLANK 9X30 P120               |     | 1   | 51D  | P120                                        |                                         |
| HM0103     | LENS MOULDING P SERIES        | A   | 1   | 72H  | 2SV10001(M92)                               |                                         |
| HL70X210   | PROTECTIVE FILM 70 X 210      |     | 1   | 76A  | 2835+TRANS+POLYTHENE FREE ISSUE TO MOULDERS |                                         |
| HM0104     | PUSH ROD P SERIES             | A   | 1   | 72H  | 3SV10002(M94)                               |                                         |
| HM0109     | LINK P SERIES                 | A   | 1   | 72H  | 4SV10009(M96)                               |                                         |
| HW4205     | FIXING PLATE                  | A   | 3   | 17H  | 4SUCB4205                                   |                                         |
| JD396BLU   | SPOT BLU SMC396 3/16          |     | 1   | 00F  | SMC396                                      |                                         |
| JPPDA3502A | PACKING BOX PDA3502A          |     | 1   | 108K | PDA3502A                                    |                                         |
| MT4780BLK  | TAPE 2M BLK 781/4780          |     | .05 | 49B  | 781/4780+BLK                                | 1 REEL ONLY PER BATCH                   |
| NR3M22TH   | SPACER M3 X 22MM THR'D HEX    | B   | 2   | 02F  | 4SUCF0652                                   |                                         |
| RW0R500JJ  | OR50 5% 2W50                  |     | 2   | 04E  | 74ER                                        | R103 4                                  |
| RW0R880JJ  | OR88 5% 2W50                  |     | 2   | 02W  | W21                                         | R101 2                                  |
| SA0249     | SWITH BUTTON P SERIES         | A   | 3   | 01S  | 4SC0249                                     |                                         |
| VO27C25820 | EPROM 32KX8 200NS 28-D STATIC |     | 2   | 01P  | 27C256-20N                                  | U7 PASS DIRECT TO PRODUCTION (PDD3502A) |

## 10. CIRCUIT DIAGRAMS

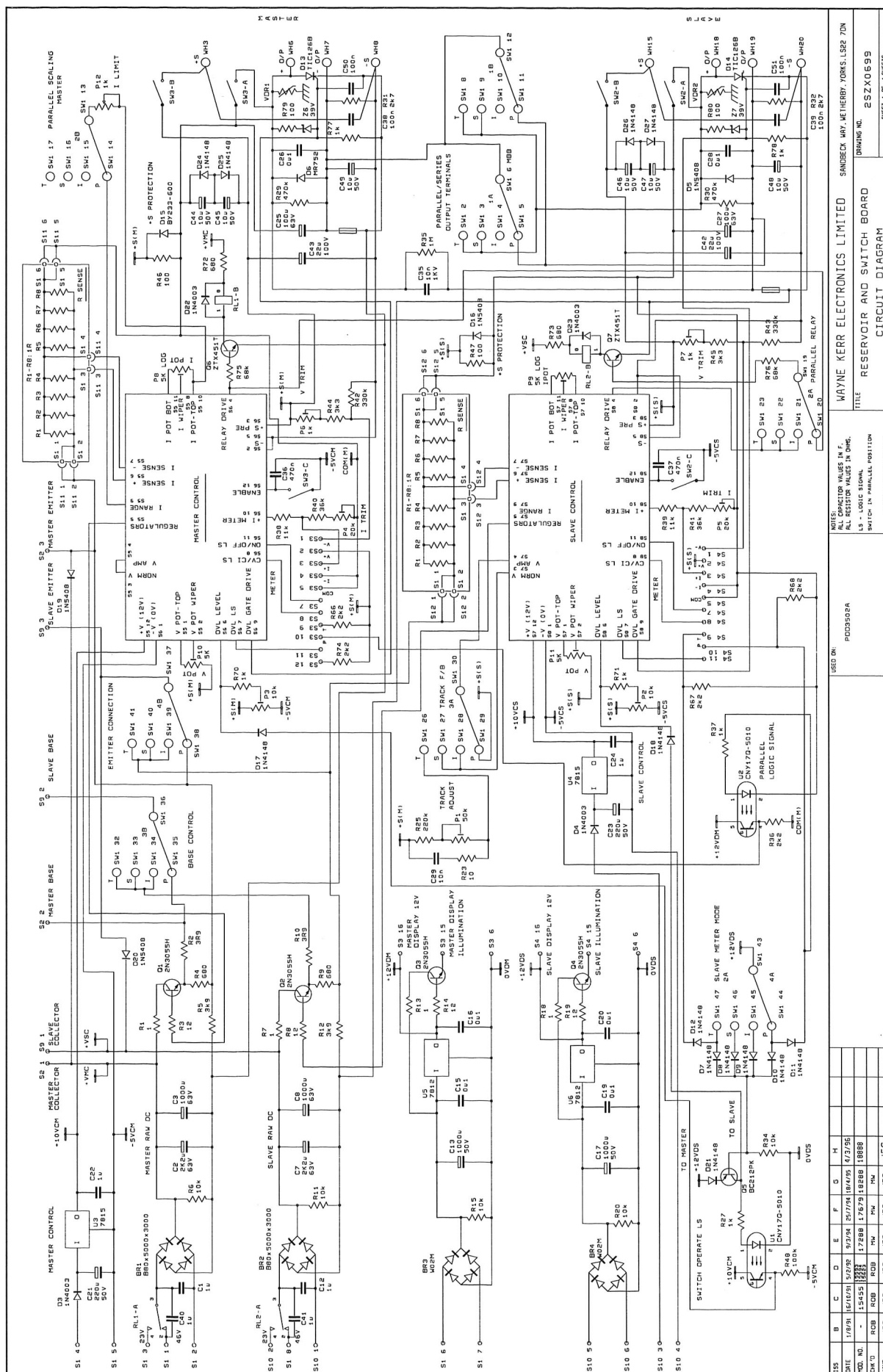
|          |                             |
|----------|-----------------------------|
| 3SZV0074 | PDD3502B Connection Diagram |
| 2SZX0699 | Reservoir and Switch Board  |
| 3SZX0698 | Control Board               |
|          | Control board ident         |
| 4SZX0612 | LCD Display Board           |
| 2SZX0695 | LCD Control Board           |

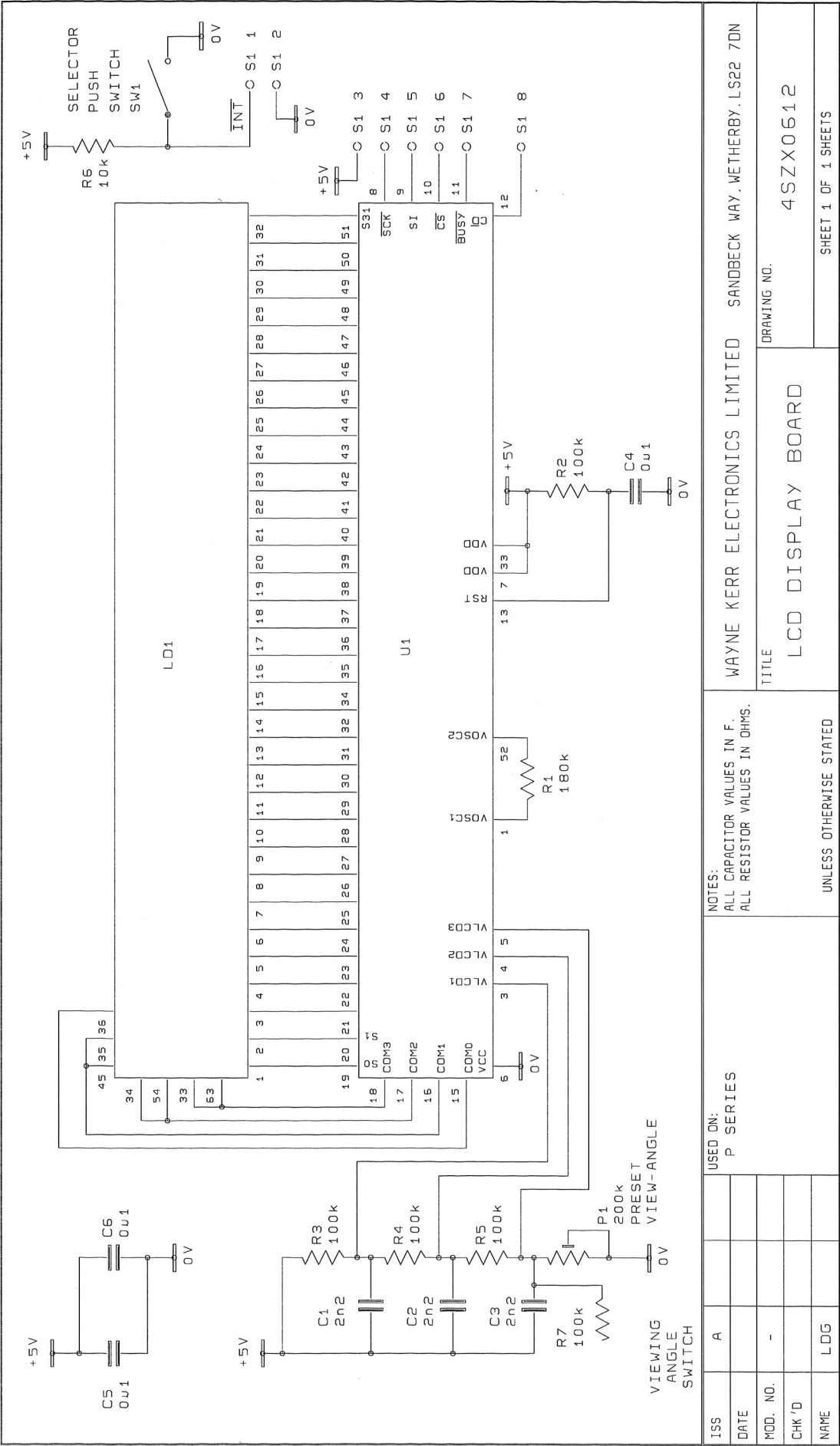


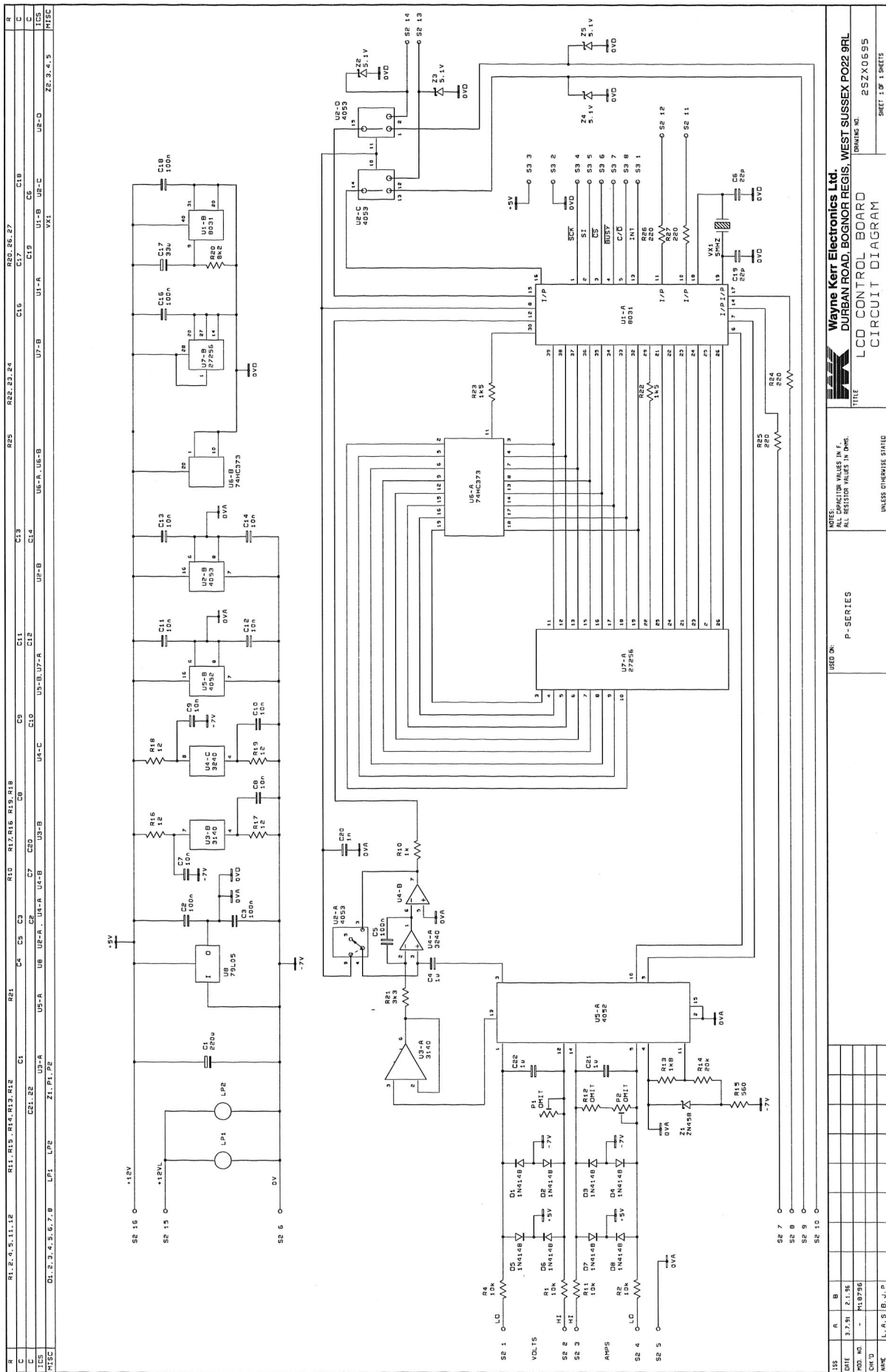




Control Board (BC1536) SMD Ident







**Wayne Kerr Electronics Ltd**  
 DURBAN ROAD, BONGIOR REGIS, WEST SUSSEX PO22 9RL  
 PHONE NO. 01323 810695  
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 WWW: WWW.WKELECTRONICS.CO.UK

**Legend:**

| Ref | Value   | Part      | Notes |
|-----|---------|-----------|-------|
| R1  | 10k     | Resistor  |       |
| R2  | 10k     | Resistor  |       |
| R3  | 10k     | Resistor  |       |
| R4  | 10k     | Resistor  |       |
| R5  | 10k     | Resistor  |       |
| R6  | 10k     | Resistor  |       |
| R7  | 10k     | Resistor  |       |
| R8  | 10k     | Resistor  |       |
| R9  | 10k     | Resistor  |       |
| R10 | 10k     | Resistor  |       |
| R11 | 10k     | Resistor  |       |
| R12 | 10k     | Resistor  |       |
| R13 | 10k     | Resistor  |       |
| R14 | 10k     | Resistor  |       |
| R15 | 10k     | Resistor  |       |
| R16 | 10k     | Resistor  |       |
| R17 | 10k     | Resistor  |       |
| R18 | 10k     | Resistor  |       |
| R19 | 10k     | Resistor  |       |
| R20 | 10k     | Resistor  |       |
| R21 | 10k     | Resistor  |       |
| R22 | 10k     | Resistor  |       |
| R23 | 10k     | Resistor  |       |
| R24 | 10k     | Resistor  |       |
| R25 | 10k     | Resistor  |       |
| C1  | 100n    | Capacitor |       |
| C2  | 100n    | Capacitor |       |
| C3  | 100n    | Capacitor |       |
| C4  | 100n    | Capacitor |       |
| C5  | 100n    | Capacitor |       |
| C6  | 100n    | Capacitor |       |
| C7  | 100n    | Capacitor |       |
| C8  | 100n    | Capacitor |       |
| C9  | 100n    | Capacitor |       |
| C10 | 100n    | Capacitor |       |
| C11 | 100n    | Capacitor |       |
| C12 | 100n    | Capacitor |       |
| C13 | 100n    | Capacitor |       |
| C14 | 100n    | Capacitor |       |
| C15 | 100n    | Capacitor |       |
| C16 | 100n    | Capacitor |       |
| C17 | 100n    | Capacitor |       |
| C18 | 100n    | Capacitor |       |
| C19 | 100n    | Capacitor |       |
| U1  | 74HC00  | IC        |       |
| U2  | 74HC04  | IC        |       |
| U3  | 74HC14  | IC        |       |
| U4  | 74HC20  | IC        |       |
| U5  | 74HC273 | IC        |       |
| U6  | 74HC373 | IC        |       |
| U7  | 74HC595 | IC        |       |
| U8  | 74HC596 | IC        |       |
| U9  | 74HC595 | IC        |       |
| U10 | 74HC596 | IC        |       |

**Legend:**

| Ref | Value   | Part      | Notes |
|-----|---------|-----------|-------|
| R1  | 10k     | Resistor  |       |
| R2  | 10k     | Resistor  |       |
| R3  | 10k     | Resistor  |       |
| R4  | 10k     | Resistor  |       |
| R5  | 10k     | Resistor  |       |
| R6  | 10k     | Resistor  |       |
| R7  | 10k     | Resistor  |       |
| R8  | 10k     | Resistor  |       |
| R9  | 10k     | Resistor  |       |
| R10 | 10k     | Resistor  |       |
| R11 | 10k     | Resistor  |       |
| R12 | 10k     | Resistor  |       |
| R13 | 10k     | Resistor  |       |
| R14 | 10k     | Resistor  |       |
| R15 | 10k     | Resistor  |       |
| R16 | 10k     | Resistor  |       |
| R17 | 10k     | Resistor  |       |
| R18 | 10k     | Resistor  |       |
| R19 | 10k     | Resistor  |       |
| R20 | 10k     | Resistor  |       |
| R21 | 10k     | Resistor  |       |
| R22 | 10k     | Resistor  |       |
| R23 | 10k     | Resistor  |       |
| R24 | 10k     | Resistor  |       |
| R25 | 10k     | Resistor  |       |
| C1  | 100n    | Capacitor |       |
| C2  | 100n    | Capacitor |       |
| C3  | 100n    | Capacitor |       |
| C4  | 100n    | Capacitor |       |
| C5  | 100n    | Capacitor |       |
| C6  | 100n    | Capacitor |       |
| C7  | 100n    | Capacitor |       |
| C8  | 100n    | Capacitor |       |
| C9  | 100n    | Capacitor |       |
| C10 | 100n    | Capacitor |       |
| C11 | 100n    | Capacitor |       |
| C12 | 100n    | Capacitor |       |
| C13 | 100n    | Capacitor |       |
| C14 | 100n    | Capacitor |       |
| C15 | 100n    | Capacitor |       |
| C16 | 100n    | Capacitor |       |
| C17 | 100n    | Capacitor |       |
| C18 | 100n    | Capacitor |       |
| C19 | 100n    | Capacitor |       |
| U1  | 74HC00  | IC        |       |
| U2  | 74HC04  | IC        |       |
| U3  | 74HC14  | IC        |       |
| U4  | 74HC20  | IC        |       |
| U5  | 74HC273 | IC        |       |
| U6  | 74HC373 | IC        |       |
| U7  | 74HC595 | IC        |       |
| U8  | 74HC596 | IC        |       |
| U9  | 74HC595 | IC        |       |
| U10 | 74HC596 | IC        |       |