

Instruction Manual

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## Section 1

# Test Instrument Safety

### WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must sometimes be performed where exposed voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. A Voltage as low as 35 volts dc or ac (rms.) should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltages pose an even greater threat because such voltage can more easily produce a lethal current. Your normal work habits should include all accepted practices to prevent contact with exposed high voltage and to steer current away from your heart in case of accidental contact with high voltage. You will significantly reduce the risk factor if you know and observe the following safety precaution.

1. Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high voltage circuits. Discharge high voltage capacitors after removing power.
2. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
3. Use an insulated floor material or a large, insulated floor to stand on and an insulated work surface on which to place equipment and make certain such surfaces are not damp or wet.
4. Use the time proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
5. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as the on-off switch, fuses, power transformer etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.
6. Some equipment with a two-wire ac power cord, including some with polarized power plugs, is the "hot chassis" type. This includes most recent television receivers and audio equipment. A plastic wooden cabinet insulates the chassis to protect the customer. When the cabinet is removed for servicing, a serious shock hazard exists if the chassis is touched. Not only does this present a dangerous shock hazard, but damage to test equipment. Always connect an isolation transformer between the ac outlet and the equipment under test. The B&K Precision Model TR-110 or 1604A Isolation Transformer or Model 1653A or 1655A AC Power Supply is suitable for most applications. To be on the safe side, treat all two-wire ac equipment as "hot chassis" unless you are sure it is isolated chassis or an earth ground chassis.
7. On test instruments or any equipment with a 3-wire ac power plug, use only a 3-wire outlet. This is a safety feature to keep the housing or other exposed elements at earth ground.
8. B&K Precision products are not authorized for use in any application involving direct contact between our product and the human body or for use as a critical component in a life support device or system. Here "direct contact" refers to any connection from or to our equipment via any cabling or switching means. A "critical component" is any component of a life support device or system whose failure to perform can be reasonably expected to cause failure of that device or system or to affect its safety or effectiveness.

Never work all alone. Someone should be nearby to render aid if necessary. Training in CPR (cardiopulmonary resuscitation) first aid is highly recommended.

## **1.1 INTRODUCTION**

### **1.2 FEATURES**

### **1.3 MARKINGS**

### **1.4 INTERFACE**

### **1.5 SPECIFICATION**

## **ORDERING INFORMATION**

### **1.1 INTRODUCTION**

The VSP SERIES power supplies are designed to deliver power in constant voltage and constant current mode by switch mode conversion in sleek 1U high cabinet and in a 19" rack construction.

This series comprises the two device soft switching technology that yields very high efficiency of conversion for dc-to-dc converter part. Also it comprises power factor correction circuitry, which shapes the input current to follow the voltage to maintain almost unity power factor at full load, and limits the current harmonics in the input line.

It provides the user the option of isolated analog voltage, current and resistance programming with built-in isolation amplifiers. It gives the option to monitor the isolated signals with the option to change either from 0 to 5 Volts or from 0 to 10 Volts, for output voltage and current from 0 to full-scale level. It provides the display of the output voltage, over voltage set level and current with 3-digit LED displays. Piggyback series pass device ensures the ripple and noise levels to very low values. Current sharing facility in the module gives the advantage to increase the power with ease and the vents in the front and the rear enables it with absolutely zero stacking. The module can be switched on/off through the front panel ON/OFF switch or remote switch on rear panel.

VSP series provides digital interface options for remote programming from PC. The digital interface provides 12-bit resolution for control as well as monitoring the output.

Some of the features of the power supply are listed below:

## 1.2 FEATURES

- MAINS OPERATED, WITH WIDE INPUT RANGE.
- POWER FACTOR CORRECTED INPUT.
- ISOLATED D.C. OUTPUT.
- 1200-WATT OUTPUT POWER.
- CONSTANT VOLTAGE OPERATION FROM 0 TO FULL-SCALE LEVEL.
- CONSTANT CURRENT OPERATION FROM 0 TO FULL-SCALE LEVEL.
- OVER VOLTAGE CONTROL FACILITY.
- REMOTE SENSING FACILITY.
- PARALLELABLE CURRENT SHARING OUTPUT.
- HIGH OVERALL EFFICIENCY – 80% TYPICAL.
- VERY LOW OUTPUT RIPPLE AND NOISE.
- INPUT EMI FILTERING TO MEET EN55022 CLASS A.
- 20 MILLISECOND HOLD-UP TIME.
- TWO FRONT PANEL DPMS. FOR V / O.V AND I.
- MULTI TURN POTENTIOMETERS FOR V, O.V AND I SET.
- FRONT PANEL OUTPUT TERMINALS FOR MONITORING.
- SLEEK, 1U HIGH, 19 INCH RACK CONSTRUCTION.
- INTERNAL FORCED AIR COOLING WITH ZERO STACKING.
- ISOLATED ANALOG VOLTAGE, CURRENT AND RESISTANCE PROGRAMMING AND MONITORING.
- REMOTE ON/OFF FACILITY.
- RS232/ GPIB/ INTERFACE.

## 1.3 MARKINGS

The unit has the name **PROGRAMMABLE PFC DC SUPPLY** written clearly on the top of the front panel. The Model Number and ratings are also clearly written on the front panel. The ratings are clearly written on the rear panel, just near the output terminals.

## 1.4 INTERFACE

The unit has both local as well as remote controls. For Remote operation, the series offers analog as well as digital interface or both. Both RS 232 or GPIB digital interfaces can be provided.

## 1.5 SPECIFICATIONS

### Output Specification

Model	VSP6020*	VSP2050*	VSP4030*	VSP12010*
Power	1.2KW	1.2KW	1.2KW	1.2KW
Output Voltage	0–60V	0–20V	0–40V	0–120V
Output Current	0–20A	0–50A	0–30A	0–10A
Ripple rms. (10Hz to 1MHz)	≤10mV	≤15mV	≤10mV	≤20mV
Noise (10Hz to 20MHz)	≤45mVpp	≤45mVpp	≤45mVpp	≤45mVpp
<b>Programming Resolution</b>	(Digital Interface), LSB (not LED displays)			
Voltage	20 mV	10 mV	10 mV	100 mV
Current	10 mA	20 mA	10 mA	10 mA

### Output Programming Accuracy (Analog Programming 0 To 5v & 0 To 10)

Voltage	0.5 % of F. S. ± 1 Digit (spec. for all VSP models)
Current	0.5 % of F. S. ± 1 Digit (spec. for all VSP models)

### Meter Accuracy

Voltage	+/- 0.2% of F.S. +/- 3 Digit. (spec. for all VSP models)
Current	+/- 0.2% of F.S. +/- 3 Digit. (spec. for all VSP models)

### Regulation

CV Line Regulation (mV)	0.1 % of F.S (spec. for all VSP models)
CC Line Regulation (mV)	0.1 % of F.S (spec. for all VSP models)
CV Load Regulation (mA)	0.1 % of F.S (spec. for all VSP models)
CC Load Regulation (mA)	0.1 % of F.S (spec. for all VSP models)

### Output Specification

Stability	0.05%
Efficiency <sub>≤</sub>	80% Minimum
Transient Response	250 microseconds for load change from 40% to 90%

### Mode Of Operation

Local Mode	Through front panel potentiometer for voltage, current and over voltage and Push switch for Output ON/ OFF control. Remote Mode Interface Analog programming of voltage and current. Voltage: 0 - 5 volts or 0 – 10 volts for output voltage and current, selection through DIP-switch. Resistance: 0 – 4.85k ohms from 0 to full-scale level.
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\* = Specification also apply to corresponding GPIB model

F.S = Full Scale. Full scale will be different for each model. Example: If you have a VSP2050 and you are measuring the voltage meter accuracy, the meter can not off more than 0.3V (20V + 0.2% +3 digit). Note: 3 digits refferes to the power supply displays least significant digit.

Digital Interface	RS-232 / GPIB
<b>Protections</b>	
Over voltage protection	Programmable through POT in local mode and through digital interface in remote mode.
Over temperature protection	Through 90 °C. Thermal switch on heat sink.
<b>Input specifications</b>	
Mains Input Range	95Vac to 264Vac.
Input Frequency	47 To 63 Hz
Input Power Factor	0.99 On Full Load At Nominal Input.
Inrush Current	Limited By NTC
<b>Operating Environment</b>	
Temperature	0 - 50°C
Relative Humidity	< 80% rh – non condensing
Storage Temperature	- 20°C. to + 70°C.
Warm-up Time	15 minutes.
<b>Safety Standards</b>	
EMI Filtering	EN55022 Class-A
Safety Class	EN60950
<b>Mechanical Specifications</b>	
Weight (approx.)	13.7lbs. (6.2 KG.)
Dimensions (WxHxD)	19 x 1.75 x 18" (483 x 44.5 x 457mm)
Dimensions with rubber feet	19 x 2.13 x 20" (483 x 54 x 457mm)

Note: Specifications and information are subject to change without notice.  
Please visit [www.bkprecision.com](http://www.bkprecision.com) for the most current product information.

## 1.6 ORDERING INFORMATION:

<b>MODEL NO</b>	<b>DESCRIPTION</b>
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<b>VSP6020</b>	60V, 20A power supply with opto-isolated analog interface and RS-232
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<b>VSP6020GPIB</b>	60V, 20A power supply with opto-isolated analog interface and GPIB
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<b>VSP4030</b>	40V, 30A power supply with opto-isolated analog interface and RS-232
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<b>VSP4030GPIB</b>	40V, 30A power supply with opto-isolated analog interface and GPIB
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<b>VSP2050</b>	20V, 50A power supply with opto-isolated analog interface and RS-232
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<b>VSP2050GPIB</b>	20V, 50A power supply with opto-isolated analog interface and GPIB
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<b>VSP12010</b>	120V, 10A power supply with opto-isolated analog interface and RS-232
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<b>VSP12010GPIB</b>	120V, 10A power supply with opto-isolated analog interface and GPIB
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## **Section 3**

### **2.1 INTRODUCTION**

#### **2.2 UNPACKING**

#### **2.3 INPUT POWER REQUIREMENTS**

#### **2.4 SYSTEM CONFIGURATION**

#### **2.5 INSTALLATION**

#### **2.6 TEST EQUIPMENT REQUIREMENTS**

### **2.1 Introduction**

VSP series power supply is configured, calibrated and tested prior to shipment. This unit is therefore ready for immediate use upon receipt. The initial physical inspections should be made to ensure that no damage has been sustained during shipment.

### **2.2 Unpacking**

Inspect the shipping container before accepting it from the carrier. If damage to the container is evident, remove the instrument from the container and visually inspect it for damage to the instrument case and parts.

If damage to the instrument is evident, a description of the damage should be noted on the carrier's receipt and signed by the driver or carrier agent. Save all shipping containers and material for inspection.

Forward a report of any damage to the factory or the agent through which the unit is procured.

Retain the original packing container if subsequent repackaging for return to the factory were required. Repackaging is straightforward and is essentially the reverse of the unpacking. Only subassemblies need to be repackaged for reshipment, use the original containers.

Remove the Source module from its shipping container and inspect for any damage to the front panel and display module. Also check for any optional parts which may have been ordered by you. If the switch or display is heavily damaged or is broken then DO NOT switch-ON the instrument.

Check the rear of the instrument for damage to Sockets or Fuse Holders. Inspect also the POWER-ON switch on the front panel.

## 2.3 Input Power Requirements

The Model VSP power supply is configured at the factory to operate from 95-264 VAC at 47-63 Hz power line.

## 2.4 System Configuration

The Model VSP series power supply comes in ready to use fashion and does not require any configuration in the field for operation in the local mode. For analog interface refer to the connector details for the connections.

## 2.5 Installation

### 1. AC Input Power Connection

Connect a 3-pin power mains cord to the available line supply. Before connecting line ensure the following:

- a) The available line supply is compatible to your unit.
- b) The available line supply point is capable of supplying the maximum peak current and power.

### 2. Load Connections

Refer fig.2.1A for load connection in local and remote sensing mode, the unit has 5mm brass studs on the rear panel for load connections for model up to 30A. The bus bar is provided from 30A onwards.

For remote sensing and the current sharing option it is provided with separate 6 way terminal block. This is required if your load is far away & regulation needs to be maintained at load terminals.

An output cable should be able to handle the full load current and maximum voltage and power under worst case conditions of temperature, humidity, mechanical abuse, and effects of long term aging.

### 3. Analog Interface Connections

A 25 pin D type connector & DIP switch is provided for remote analog interface to the unit. There is 8 pin DIP switch associated with the function of analog interface. Refer to section 3.3.5 of chapter 3 for switch settings.

#### **4. Turn-On**

Switch the POWER ON switch to the ON position. Soon the DPM will be turned on & the output voltage & current are displayed, if output on-off switch is in ON position. Voltmeter should display the voltage set by voltage control.

Check the current meter. It must show zero (very low) current under no load. If not then please switch off the unit and call the service personnel.

For details of TURN ON CHECK refer section 3.5 of CHAPTER 3.

#### **2.6 Test Equipment Requirements**

The following instruments will be required to test the complete installation of the unit.

- 1). A four and half digit or better digital multimeter for verifying the voltage and current output of the unit.
- 2). A 20 MHz dual channel oscilloscope for verifying the Ripple in Output of the Source.
- 3). A Resistive load or an Electronic Load to take an input to suit the maximum output from the unit depending on the model and capacity of the channel of the Source.

**Fig 2.1a: CONNECTION DETAILS IN LOCAL & REMOTE INTERFACE**  
**LOCAL MODE**

## **Section 4**

### **3.1 INTRODUCTION**

#### **3.2 FRONT PANEL DESCRIPTION**

#### **3.3 REAR PANEL DESCRIPTION**

#### **3.4 POWER ON CHECK**

#### **3.5 OPERATING INSTRUCTIONS IN LOCAL MODE**

#### **3.6 OPERATING INSTRUCTIONS IN ANALOG REMOTE INTERFACE**

#### **3.7 OPERATING INSTRUCTIONS IN DIGITAL INTERFACE**

## **TRIP INDICATIONS**

### **3.1 INTRODUCTION**

The VSP series Model is a variable switch mode power supply to provide wide range of DC supply from 0 to full-scale specified voltage. This chapter explains the operating procedure of the unit. The operation is very simple by providing POT control for voltage, current limit and over voltage protection limit and 8 way DIP switch along with 25 Pin D type connector for the remote programming interface.

Optional RS232 interface or GPIB interface can be provided as per the order placed. In case of RS232 interface, a slide switch on the rear panel facilitates either RS232 communication interface or Analog programming.

The unit is internally fan cooled. The air inlet vents are provided on the front panel. The air outlet is a rectangular slotted area on the 1U high rear panel, and is located between the A.C. input and D.C.output connectors.

The instrument front panel and rear panel are described first in detail, explaining the layout, identification, function and usage of each item on the panel. The Turn-on sequence and the procedure to use the major functions and operation of unit in digital interface are also explained. At the end all the ALARM indications, errors and warning signals are explained. In the same section procedures to clear the TRIP and ALARM conditions are discussed.

### **3.2 FRONT PANEL DESCRIPTION**

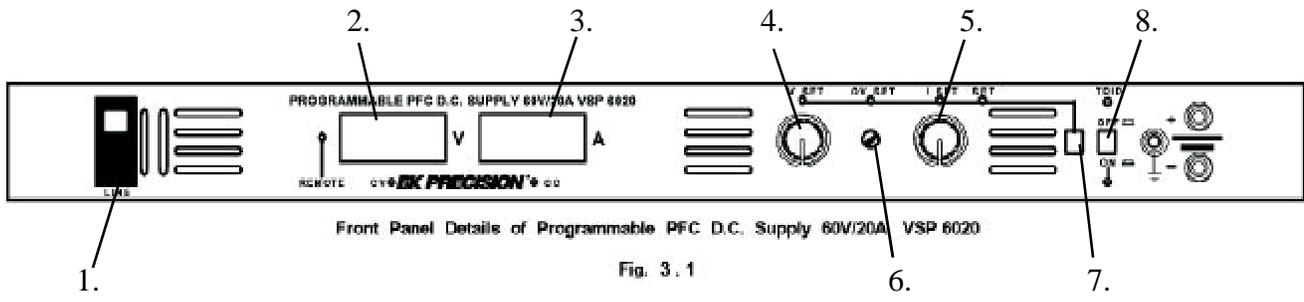
Figure 3.1 shows layout of front panel. On the front panel following controls and indicators are provided.

1. Main ON/OFF switch with neon indication.
2. 3 digit display for Voltage/ Set Voltage/ Set Over Voltage indication
3. 3 digit display for Current/ Set Current indication.
4. 10 turn POT for voltage control.
5. 10 turn POT for current control.
6. 10 turn POT for over voltage protection control.
7. Push switch to view set parameters in SET mode.
8. Latch type Push switch for Output ON/OFF control.
9. LED indications for CV, CC, Output ON, Trip, Remote, V set, I set, O/V set and Set mode.

- The display shows 3 digit value for voltage and current parameters. The resolution of indication is 0.1 volt and 0.1 amp for voltage and current parameters. The display is used to show actual output voltage and current or to show set values of voltage, over voltage and set current limit in the set mode. The set mode is activated using Set key during output OFF condition.
- CV LED indicates the constant voltage operation of power supply.
- CC LED indicates constant current operation of power supply.
- TRIP LED becomes ON either for over voltage trip condition or for over temperature trip condition.
- Output ON/OFF can be controlled by push button switch (latch type) and LED turns ON if output is available.
- Remote LED is provided for the digital interface option. It lights up when the power supply is controlled by external digital interface.
- To view the set values of POT on the display press the SET key. Also LED's for each POT and common SET MODE Led is provided.
- Also monitoring terminals of output are provided on front panel so that user can verify the output with calibrated meter. Additional earth terminal is also provided on front panel.

### **3.3 REAR PANEL DESCRIPTION**

The rear panel of the unit is shown in fig 3.2. The mains input connection is made through a 10A mains cord and is located on the right side of the unit at the rear. A 20A fuse of type 'F' is used for line input range 95Vac to 264Vac) is also provided at input. At the center are the oval shaped ventilation slots for air exhaust, for D.C. output 5mm brass studs or bus bars (as per the current specifications) are provided, next to it is 6 way terminal block for remote sensing and current share bus Further is the 25 pin D-type connector for analog interfacing & the DIP switch for local & remote mode operations. Above the 25 pin D-type connector the provision is made for digital interface connection, which can be either GPIB or RS232.



### 3.3.1 LINE INPUT

The mains input range is clearly indicated on rear panel. The unit comes standard with a U.S. standard plug and a mains input rating of 95VAC to 265VAC, 50/60Hz.

### 3.3.2 INPUT FUSE

This fuse protects the unit against short circuits and over loading. The 10A fuse of type 'F' is used for line input range 176Vac to 264Vac and 20A fuse of type 'F' is used for line input range 95Vac to 264Vac.

### 3.3.3 DC OUTPUT TERMINALS

VSP models with upto 30 amp output ratings have a pair of 5mm brass studs is provided on the rear panel. Models above 30 amps have bus bars are provided. Output polarity is shown near the terminal.

### 3.3.4 REMOTE SENSE CONNECTOR

6 Way terminals block is provided for remote sensing and current share option.

1. **+S:** - Positive Sense terminal for remote sensing.
2. **+Output:** - Positive DC output terminal.
3. **-Output:** - Negative DC output terminal.
4. **-S:** - Negative Sense terminal for remote sensing.
5. **NC**

**CS Bus:** - Current share bus for parallel operation.

### 3.3.5 ANALOG INTERFACE CONNECTOR (Reference Fig. 3.1a and 3.1b in back of manual)

25 Pin D type connector is provided for remote analog interface, it is factory set to operate through the front panel controls.

Pin no. 1: N.C.

Pin no. 2: N.C.

Pin no. 3: VPROGI-1 mA (typical) Current source for voltage programming.

Pin no. 4: VPIN - Input for voltage programming.

Pin no. 5: VPROGR - Resistance programming (0 to 4.85KOhms for full-scale voltage)

Pin no. 6: AGND3 - Common terminal for remote programming.

Pin no. 7: N.C.

Pin no. 8: N.C.

Pin no. 9: IPIN - Input for Current programming.

Pin no.10: IPROGI- 1mA (typical) Current source for Current programming.

Pin no.11: IPROGR - Resistance programming (0 to 4.85KOhms for full-scale current)

Pin no.12: N.C.

Pin no.13: N.C.

Pin no.14: N.C.  
Pin no.15: +12 V- Remote on/off relay supply +ve.  
Pin no.16: AGND3 - Common terminal for remote programming.  
Pin no.17: Remote On/Off - Remote on/off relay.  
Pin no.18: AMX- Output Current monitoring. (Factory set to 0 to 5 volts for full scale)  
Pin no.19: VMX - Output Voltage monitoring. (Factory set to 0 to 5 volts for full scale)  
Pin no. 20: AGND3 - Common terminal for remote monitoring.  
Pin no. 21: N.C.  
Pin no. 22: VPSET - External programming option set for output voltage.  
Pin no. 23: VMSET -External-monitoring option set for monitoring the output voltage.  
Pin no. 24: IPSET - External programming option set for output current.  
Pin no. 25: IMSET - External monitoring option set for current.

### **3.3.6 DIP SWITCH DETAILS.**

DIP Switch is provided on the rear panel to facilitates remote analog interface as well as local mode interface in the power supply by just changing the switch positions  
Switch no. 1 & 2 are associated with voltage programming  
Switch no. 3 & 4 are associated with current programming  
Switch no. 5 is associated with 0-5V & 0-10V programming  
Switch no. 6 is associated 0-5V & 0-10V monitoring  
Switch no. 7 is don't care  
Switch no. 8 is associated with remote ON-OFF.

### **3.3.7 DIGITAL COMMUNICATION INTERFACE (optional)**

Digital communication interface either GPIB or RS-232 interface can be incorporated with the system as per the order placed. As per the ordered digital communication interface, the slots are available on the rear panel  
The slide switch selects the RS232 interface & 9 pin D-Type connector is provided on rear panel to connect the unit to PC.

**NOTE:** Refer Chapter 5 For Details Of Digital Communication Interface.

### **3.3 POWER ON CHECK**

**Keep the DIP switch settings for local mode operation. (Refer to 3.3.5)**

After switching ON the unit, the display will show the actual voltage and current at the output if output ON/OFF switch is in pressed position. If the switch is in OFF position then the output voltage goes to 0V & displays zero. Also LED associated with key shows the condition of output. If TRIP LED is ON then display show zero values and LED associated with ON/OFF key remains off.

### 3.5 OPERATING INSTRUCTIONS IN LOCAL MODE

These are the instructions for operating the source in local mode. Refer following for DIP switch settings to operate in Local mode.

#### 3.5.1 Local Mode

Switch No.	1	2	3	4	5	6	7	8
Position	On	On	On	On	On	OFF	X	On

Refer fig. 2.1a for connection details in local & remote interface

Normally user can vary the V SET POT to change the output voltage while working in constant voltage mode operation. I SET POT is used to set the output current while working in constant current mode operation.

#### 3.5.2 SET MODE OPERATION IN LOCAL MODE

User can view the set parameters using set mode operation before turning the output ON. To enter the SET mode, switch off the ON OFF switch.

When SET key is pressed for the first time then SET LED turns ON and display shows OVP value and OVP POT LED keeps on flashing. In this mode the OVP POT can be used to change the over voltage limit

On pressing the SET key again the display shows the set voltage and VSET POT LED keeps on flashing. In this mode the VSET POT can be used to change the output voltage.

On pressing the SET key again the display shows the set current and ISET POT LED keeps on flashing. In this mode the ISET POT can be used to change the output current.

Set mode operation ends after pressing SET key fourth time & displays zero if the output on off switch is off. At any instant, while in set mode, if output on off switch is pressed the display displays the output voltage & current.

### 3.6 OPERATING INSTRUCTIONS IN ANALOG REMOTE INTERFACE

#### Remote Mode

Following are the positions of switches for the operating the source in remote mode by external analog voltage and resistance.

#### 3.6.1 Voltage Programming

Apply the input programming voltage of 0 to 5Volts or 0 to10 Volts between pin 4 & common control pin 6 of 25 pin D type connector for voltage programming & for current programming between 9 & 6 (common control pin) of 25 pin D-Type connector.

8 pin DIP switch on rear panel:

Switch No.	1	2	3	4	5	6	7	8
Position	Off	Off	Off	Off			X	On

ON for 0-5V programming  
OFF for 0-10V programming

OFF for 0-5V monitoring  
ON for 0-10V monitoring

Don't Care

Refer fig. 3.1a for remote voltage and current programming and monitoring  
It also explains load connections required in this mode.

**Note: Factory** set for 0 to 5 volts for full scale output programming and monitoring.

#### 3.6.2 Resistance Programming

For resistance programming standard resistor used is 4.85KOhms.

Following shows the DIP switch configuration required in this mode & explains the connection of the resistor to the 25 pin D-type connector.

8 pin DIP switch on rear panel:

Switch No.	1	2	3	4	5	6	7	8
Position	Off	On	Off	On	On		X	On

OFF for 0-5V monitoring  
ON for 0-10V monitoring

Don't Care

Refer figure 3.1b for external resistance programming 0 to 4.85kohms for full scale voltage and current . It also shows the load connections required in this mode. As shown in the figure for Voltage Control connect the resistance of 4.85 K ohms at pin 4 & common control pin 6 of 25 pin D Type connector & for Current control connect resistance between pin 9 & pin 6 (common control pin) of 25 pin D Type connector.

### **3.6.3 Remote ON/OFF:**

A 25 pin D type connector & DIP switch is provided for remote analog interface to the unit. There is 8 pin DIP switch associated with the function of analog interface.

SW no. 8 on the rear 8 pin DIP switch is Remote ON/OFF control & must be always on for terminal voltage ON when operated from the local controls. For the remote control keep SW no. 8 OFF and connect switch across pin no. 16 & 17 of 25 pin D type connector.

## **3.6 OPERATING INSTRUCTIONS IN DIGITAL INTERFACE**

To enable remote interface, the command for system to enter remote mode must be entered through remote P.C. This will cause the remote LED on front panel to glow; now no key on front panel will be detected. However the display will be updated to indicate the entered value.

In GPIB interface proper address must be given.

To change the output voltage while working in constant voltage mode operation or to set the output current while working in constant current mode operation, user has just to enter command (as specified in chapter 5) through remote PC. There are simple commands to take the unit either in remote or local mode. The status of the power supply can be easily read using specific commands. The output can be turned ON or OFF as per requirements. Output ON is indicated by ON LED on the front panel. Also the over voltage limit can be set. Whenever the output voltage exceeds this maximum limit the trip condition occurs thereby resetting the output.

The command summary is given in detail in chapter 5.

## **3.8 TRIP INDICATIONS**

The VSP series power supplies has provision of Over Voltage & Over Temperature protection. If at any time one of these conditions occurs, the unit will be tripped. This means that the output voltage is made to be zero. This condition is indicated by the Trip LED blinking.

### **3.8.1 RESETTING THE TRIP CONDITION**

Assess as to why the trip has occurred. Then isolate the fault e.g., over voltage trip condition can be reset by lowering the output voltage than OV trip level & then **toggling the input power** will reset trip condition.

For resetting the over temp condition allow some time for cooling the heat sinks to change the status of thermal switch.

## **4.1 INTRODUCTION**

### **4.2 PREVENTIVE MAINTENANCE**

### **4.3 SERVICE INFORMATION**

#### **4.1 Introduction**

This chapter contains the problems that may occur in the field in the event of long use. The procedure to test the unit is explained under the proper section.

The individual is advised to use the correct procedure provided for the purpose of operating the particular sequence to set proper voltages and current required to test the proper working of the unit.

This unit has few boards and interconnections and the reliability is very high. However, if a failure occurs the user himself might be able to fix the unit by following the remedies given under particular complaint.

**Read the manual completely in order to understand your unit better.**

#### **4.2 Preventive Maintenance**

Please follow the following preventive steps to ensure the proper operation of your instrument.

- \* Allow enough natural cooling (ventilation) around the unit.
- \* Avoid keeping tools, equipment etc. on the top cover.
- \* Keep the working area neat and clean always.
- \* Do not exceed the input/output limits at any time.

#### **4.3 Complaints and Service Information**

Some of the common problems that may occur and the remedy to put back the instrument back in to a working condition as fast as possible are given below:

### **When the unit is not turning ON.**

Check if the power ON/OFF switch is turned ON. Check whether fuse mounted on the rear panel is OK? If fuse is good then check the power cord. Please make sure that the power cord connecting to the unit is properly connected. Please also check the mains switch. Check the switch 8 on rear panel, it must be always in ON position for terminal voltage ON.

### **When the Trip LED turns On and output turns OFF**

Check the settings of the over voltage potentiometer. It should not be less than the output set potentiometer. Check the loads at the output. Check whether the temperature inside the unit is not increased abnormally.

### **No Voltage Output available at the output Terminal**

The possibility is that the Output module itself has failed. The output series pass section may be faulty, therefore check the series pass device & control IC.

### **No display on the front panel meters**

Check the input conditions and the actual output on the terminals. If it is OK, then the supply to the meters may not be proper or displays may be damaged.

Further service information is provided in “Service Information” located at the end of this instruction manual.

- 5.1 INTRODUCTION**
- 5.2 RS232C INTERFACE**
- 5.3 RS232C OPERATION**
- 5.4 IEEE-488 OPERATION**
- 5.5 INTRODUCTION TO SCPI LANGUAGE**
- 5.6 COMMAND SUMMARY**
- 5.7 MANDATORY COMMANDS**
- 5.8 INSTRUMENT COMMANDS**
- 5.9 IEEE-488 COMPLIANCE INFORMATION**
- 5.10 SRQ HANDLING DETAILS**
- 5.11 ERROR MESSAGES & REPORTING**
- 5.12 APPLICATION PROGRAM EXAMPLES**

## **5.1 Introduction**

VSP series power supplies are configured for either RS232C or GPIB as per the order placed (refer chapter 1 for ordering information). When the unit is first TURNED ON it will enter into LOCAL mode of operation.

If the unit is configured for RS232 interface, then by proper slide switch setting & by connecting a serial port of P.C to 9- pin D-type connector on rear panel of the unit, executing RS232 interface commands can operate the power supply.

If the unit is configured for GPIB interface, proper address settings are required. Standard commands, which are defined in following sections, through remote PC can operate the power supply.

Following sections cover each interfaces separately & explains the operations, configurations & commands of each interface.

To use any of the digital interfaces mentioned above, proper setup is required. For RS232 interface setup requirement is a PC with functioning serial port whereas for GPIB interface PC with functioning parallel port is necessary.

## 5.2 **RS232C INTERFACE:**

The basic principle of RS232C operation is achieved by 3-wire interface. The 3-wire interface comprises of transmit pin (abbreviated as TXD), receive pin (abbreviated as RXD) and a common ground pin (GND). TXD pin of host is connected to the RXD pin of the instrument and the RXD pin of the host is connected to the TXD pin of the instrument and the third line connects the GROUNDS of the two sides. I.e. the TXD and RXD lines are cross-connected to the Host controller.

Hardware HANDSHAKE lines are not used.

The RS232C communications is based on the SEND and RECEIVE signals only. It does not provide the handshaking protocol. The instrument is designed to receive all data without missing any of them with the baud rate specified. Standard baud rate being 9600. The host or the controller (Central Computer) should take care to read the data at the same speed of the instrument as defined by the baud rate. The following communication parameters are FIXED for this particular instrument when operating in the RS232C mode. :

POWER ON BAUD RATE	9600 BAUD
CHARACTER LENGTH	8 BITS
STOP BITS	1 BIT
PARITY	NO PARITY
HANDSHAKING	NO HANDSHAKING

## 5.3 **RS232C Operation**

The default communication parameters for RS232C are as follows:

### **1) BAUD RATE:**

The default baud rate is 9600 Baud.

At present the provision for changing the baud rate in LOCAL mode is not available.

### **2) CHARACTER LENGTH:**

The character length is 8 BITS. This is also fixed and cannot be changed by instrument commands.

### **3) STOP BITS:**

The instrument generates 1 stop BIT after each character transmission and checks for the same during reception. This parameter is also fixed.

### **4) PARITY:**

No PARITY checking is provided. This default configuration is also fixed.

### **5) HANDSHAKING:**

No HANDSHAKING is provided. So the host can send all the data at the defined baud rate. And at the same time it should be ready to receive the data or response without any delay.

### 5.3.1 RS232 Data Format

One Start Bit      8 Data Bits      No Parity Bit      1 Stop Bit

### 5.3.2 RS232 Connector Details

On the rear panel of the unit, a 9 pin D-type male connector is provided for the RS232 communication. The DSR and DTR handshake lines are not used. The connector definition of the 'COMM INTF' (as marked on the rear panel) are given below:

<b>PIN NUMBER</b>	<b>DESCRIPTION</b>
PIN 2	Receive Data (RXD)
PIN 3	Transmit Data (TXD)
PIN 5	Ground (GND)



Fig. 5.1

Since the RS232 communication does not use the handshaking the DSR input of the controller should be tied up to a signal that is always TRUE. However this implies that your BUS CONTROLLER must always be ready to accept the data. So the interface cable might need to be a customized one. Refer fig 5.1.

### 5.3.3 INSTALLATION OF RS232 CARD

The RS232 Interface (ISO\_RS232\_CONV-1103 Card) card may come already installed, if ordered. If this interface is to be installed later, the card can be mounted on the rear panel of the unit using L-clamp provided on the card itself & following cards & cables shall be provided along.

#### **Cards:**

- ◆ ISO\_RS232\_CONV-1103
- ◆ VSP-FP-DAC-1003

#### **Cables:**

- ◆ 3 PIN serial communication (Tx, Rx) data cable (J10) on ISO\_RS232\_CONV-1103
- ◆ +10V supply cable to be connected on 3 PIN connector (J3) on ISO\_RS232\_CONV-1103

#### **Following is the procedure to install the card. :**

- ◆ Release the TOP COVER of the unit by unscrewing 6 screws at the top & 6 screws at the side panel of the unit.
- ◆ Remove the TOP COVER (upper plate) of the unit by sliding it out.
- ◆ You will see a number of cards inside the unit. Please do not touch any of these.
- ◆ Remove the existing communication card / Connector, which is connected to the slot at the back of the unit marked as 'DIGITAL INTF'.
- ◆ Fit the card "ISO\_RS232\_CONV-1103" on the rear panel of the unit using L-clamp provided on the card itself.
- ◆ Check if the link at JP1 is open
- ◆ Initially disconnect the 26-pin cable from J4 on "VSP-DPM CONT1003" card.
- ◆ Insert the card "VSP-FP-DAC-1003" onto the "VSP-DPM CONT-1003" such that 16-pin DIL female (J3) & 26-pin DIL female (J1) on "VSP-FP-DAC-1003" are plugged in 16-pin DIL male (J7) & 26-pin DIL male (J4) on the "VSP-DPM CONT-1003" card respectively.
- ◆ Now connect the 26-pin flat cable, which was removed from J4 on "VSP-DPM CONT-1003" to the 26-pin DIL male (J2) on "VSP-FP-DAC-1003" card. So now the 26-pin DIL male (J1) on "VSP-POT-IMON-0703" is connected to 26-pin DIL male (J2) on "VSP-FP-DAC-1003" card.
- ◆ Do not change the connection between 26-pin DIL male (J2) on "VSP- POT-IMON-0703" & 26-pin DIL male (J6) of "VSPDDC-1.2KW-1003D"
- ◆ Connect 3-pin SIL connector (J3) on "VSP-POT-IMON-0703" to the 3-pin SIL connector (J2) on "ISO\_RS232\_CONV-1103" card, which is connected to the switch on rear panel, which decides to select either remote or RS 232 interface.
- ◆ Two connectors are connected to 4-pin SIL connector (J2) on the "VSPDDC-1.2KW-1003D" one of which is 4-pin SIL connector (J4) on "VSP-POT-IMON-0703" & other is 3-pin SIL connector (J3) on "ISO\_RS232\_CONV-1103" card
- ◆ Using 3-pin SIL connector connect J10 of on the "ISO\_RS232\_CONV-1103" card with J10 on "VSP-DPM CONT-1003" card, which are the Transmit & receive signals along with common ground signal.
- ◆ Verify the signal connections again & select RS232 Interface using slide switch provided on rear panel.
- ◆ Turn on the unit & test its functionality. Replace the TOP COVER and close the instrument.

### 5.3.4 RS232 Commands

Following section deals with the commands set for RS232 interface. It specifies the syntax of each command, which reads the status of power supply or configures it to the requirements of users.

NOTE: The command uses following notations

<SP> = Indicates Null or space character (20H)  
<AARD> = Indicates Arbitrary ASCII Response Data  
<NR.DATA> = Indicates Numeric Data  
<EOS> = Indicates End of string character (ODH)

#### 1. Command : READ? <EOS>

Description: Read Output Voltage and Current Query.

Function: This command reads back the output voltage & current of the unit in <AARD> format. The units for Voltage and Current are VOLTS and AMPS respectively. If the unit is in CV (Constant Voltage) or in CC (Constant Current) mode of operation, this status is also indicated on console. The entire response is terminated with <EOS> byte.

For example if the Query sent is  
READ? <EOS>

Then the response can be as follows:

+14.99V 00.02A CV<EOS> or +14.00V 10.00A CC<EOS>

#### 2. Command : VOLT<SP><NR.DATA><EOS>

Description: Set the Output Voltage for that Channel(s).

Function: This command sets the Output Voltage of the Power Supply output with the <NR.DATA> given in the command in Volts. The input VOLTAGE data is in Numeric Data format.

For example to set 10.5 Volts then send the command as  
VOLT 10.50<EOS>

**3. Command : CURR<SP><NR.DATA><EOS>**

Description: Set the Output Current Limit for that Channel(s).

Function: This command sets the Output Current of the Power Supply output with the <NR.DATA> given in the command in AMPS. The input CURRENT data is in Numeric Data format.

For example to set 2.3 Amps send the command as  
CURR 02.30<EOS>

**4. Command: VOLT: PROT<SP><NR.DATA><EOS>**

Description: Set Over Voltage Protection Limit of OUTPUT

Function: This command sets the Over Voltage Protection Limit of the Power Supply output with the <NR.DATA> given in the command in Volts. The input VOLTAGE data is in Numeric Data format. Once this OVP limit is set, any time if the actual Output Voltage of the channel exceeds the OVP limit, the OUTPUT will be 'TRIPed'. I.e. the OVP operates to protect the output and the O/P voltage will be made zero and the OUTPUT ON/OFF relay will be switched OFF.

For example to set OVP of 31.50 V for output, send the command as

VOLT: PROT 31.50<EOS>

**5. Command : OUTP<SP>ON<EOS>**

Description: Turn ON the output of power supply.

Function: This command is used to make the OUTPUT available at the output terminals.

**6. Command : OUTP<SP>OFF<EOS>**

Description: Turn OFF the output of power supply.

Function: This command is used to switch OFF the output & thus to make the OUTPUT zero at the output terminals.

**7. Command : SYST: REM<EOS>**

Description: Takes the instrument into Remote Mode of operation

Function: This command will explicitly take the unit to remote mode. All the front panel controls are disabled.

**8. Command : SYST: LOC<EOS>**

Description: Take the instrument to Local mode of Operation.

Function: This command will take the unit to Local mode of operation & ALL the front panel controls are enabled.

**9. Command : STAT? <EOS>**

Description: Read Status Query.

Function: This command reads the status of various events occurred in the system. The definition of events is given below

B0: Over voltage Trip

B1: Over Temperature Trip

B2: Power On event (Sets when unit is turn ON. The bit gets cleared after the query.)

B3: Internal Failure

B4: Always 1 (THIS STATUS BIT MAY BE CHANGED IN FUTURE)

B5: Always 1 (THIS STATUS BIT MAY BE CHANGED IN FUTURE)

B6: Command Error (Sets if invalid command received by unit. The bit gets cleared after the query.)

B7: Always 0

The response to the query is single character followed by EOS.

For example after power On condition the response to the query

STAT?

Will be

4<EOS>. If Over voltage trip condition occurs then the response will be

1<EOS>.

#### **5.4 IEEE-488 OPERATION:**

The IEEE-488 (GPIB) interface option allows the instrument to connect and form part of an Automated Test System. The instruments are instructed over a Parallel Data Bus, so that their facilities can be selected remotely. The ADDRESS concept, Parallel Data Bus and Handshaking are the main advantages over the RS23C interface, by which at a time more than one instrument (up to 31 instruments) can be connected on the IEEE-488 bus and only the Addressed instrument can be made to LISTEN or TALK without losing any data. The communication will be faster because of parallel data transfer.

The IEEE-488 bus has standard 24 PIN flat cable, in which each line is dedicated to a special BUS activity. The CONTROLLER can send messages or receive responses from all or any one instrument by proper BUS activation and handshaking.

#### **5.4 IEEE-488 Interface Configuration**

The IEEE-488 Interface is a parallel BUS for Communication in the Programmable Instruments. Multiple instruments can be connected on the same BUS and can be hooked up to a single HOST controller or computer. In order that instruments from different manufacturers can be built into the same system, it was necessary that all interfaces be compatible. To ensure this, the interfaces were made to conform to a standard specification as detailed in the publication ANSI/IEEE Std. 488-1978 called 'IEEE Standard Digital Interface for Programmable Instrumentation' (And also to ANSI/IEEE std.488.1-1987) and this came to be known as IEEE-488 or GPIB Interface.

The following list highlights the salient characteristics of the IEEE-488 Interface:

DATA RATE	1 MB/Sec. MAX.
NO. OF DEVICES	31 MAX.
BUS LENGTH	20 Meters. MAX.
DATA LENGTH	8 BITS / 1 BYTE

### 5.4.1 IEEE-488 Connector Details

The instrument provides a standard 24 pin GPIB connector (marked as COMM INTF on the rear panel of the instrument) to connect it with the standard GPIB (IEEE-488) bus. Refer FIG. 5.3 for connector types definition diagram. Description of the GPIB Signals is given below.

PIN NO.	NAME	DESCRIPTION
1	DIO 1	Data Input Output Line 1
2	DIO 2	Data Input Output Line 2
3	DIO 3	Data Input Output Line 3
4	DIO 4	Data Input Output Line 4
5	EOI	<b>End or Identify</b>
6	DAV	Data Valid
7	NRFD	Not ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Screening on cable (connected to Instrument Safety Ground).
13	DIO 5	Data Input Output Line 5
14	DIO 6	Data Input Output Line 6
15	DIO 7	Data Input Output Line 7
16	DIO 8	Data Input Output Line 8
17	REN	Remote Enable
18	GND 6	Gnd wire of twisted pair with DAV.
19	GND 7	Gnd wire of twisted pair with NRFD.
20	GND 8	Gnd wire of twisted pair with NDAC.
21	GND 9	Gnd wire of twisted pair with IFC.
22	GND 10	Gnd wire of twisted pair with SRQ.
23	GND 11	Gnd wire of twisted pair with ATN.
24	LOGIC GND	Instrument Logic Ground.

TABLE 5.1

## 5.4.2 IEEE-488 Operational Sequence Guidelines

Most interface communication tasks require a sequence of coded messages to be sent over the interface. It is recommended that a careful study of the available controller capabilities be made many of them assigning one programming instruction to these sequences. Different controllers will not necessarily have identical sequences or program instructions.

The following sequences are recommendations only.

### DATA TRANSFER

ATN	DATA	FUNCTION
1	UNL	Inhibits all current listeners
1	(LAD) 1	Each address sent enables a specific device receives future data bytes
1	(LAD) n	More than one address may be sent if multiple listeners desired.
0	(TAD)	The address sent enables a specific device to send data
0	(DAB)	Data bytes sent by currently enabled talker to all currently enabled listeners.
1	UNT	Disables the talker on receipt of last character.

UNL = Unlisten  
LAD = Listen address of specific device  
TAD = Talk address of specific device  
DAB = Data bytes  
UNT = Untalk

### SERIAL POLL

ATN	DATA	FUNCTION
1	UNL	Prevents other devices listening to status sent
1	SPE	Puts interface into serial poll mode during which all devices send status instead of data when addressed.
1	(LAD) n	More than one address may be sent if multiple listeners desired.
0	(TAD)n	Enable a specific device to send status. Within these loop devices should be sequentially enabled.
1	SBN or SBA	Status byte sent by enabled device. If SBN sent, loop should be repeated. If SBA sent, the enabled device is identified as having sent SRQ over the Interface and will automatically remove it.
1	SPD	Disables Serial Poll mode
1	UNT	Disable Last Talker.

UNL = Unlisten  
 SPE = Serial Poll Enable  
 SPD = Serial Poll Disable  
 SBN = Status Byte Negative, where BIT 6 = 0 (BIT 7 is the MSB)  
 SBA = Status Byte Affirmative, where BIT 6 = 1 (BIT 7 is the MSB)

### 5.4.3 Installation of IEEE-488 (GPIB) Card

The IEEE-488 Interface (INSTR TO GPIB Card) card may come already installed if ordered. If the IEEE-488 interface card has been provided or ordered as a spare following cards & cables

Will be provided

#### Card

- ◆ INSTR TO GPIB -1
- ◆ SBC-IEB-0603 -1

#### Cables

- ◆ 26 PIN FRC CABLES on SBC-IEB-0603 -2
- ◆ 16 PIN FRC CABLES on SBC-IEB-0603 -2
- ◆ 3 PIN supply cable on SBC-IEB-0603 -1
- ◆ 4 PIN mode select cable on SBC-IEB-0603-1

Follow the procedure given below to install the card. :

- ◆ Release the TOP COVER of the unit by unscrewing the screws at the back of the unit on the top side or on the top side itself.
- ◆ Remove the TOP COVER (upper plate) of the unit by sliding it out.
- ◆ You will see a number of cards inside the unit. Please do not touch any of these.
- ◆ Remove the existing communication card / Connector (if any), which is connected to the slot at the back of the unit marked as 'DIGITAL INTF'.
- ◆ Replace the card "INSTR TO GPIB" in the position of the previous card using the screws provided for the purposes.
- ◆ Place the card "SBC-IEB-0603" just behind the controller card "VSP- DPM CONT-1003", which is stacked with the display board, on the screws provided.
- ◆ Check if the link at JP1 is shorted. Also using shorting link provided connect it to J3 on VSP-POT-IMON-07-3
- ◆ Using 26-pin FRC cable connect the 26-pin DIL male connector (J1) on "INSTR TO GPIB" with 26-pin DIL male connector on (J6) of "SBC-IEB-0603".
- ◆ Using 16 pin Flat cables connect 16-pin DIL male (J2) & 16-pin male (J3) of "SBC-IEB-0603" with 16-pin DIL male (J7) & 16-pin DIL male (J5) of "VSP-DPM CONT-1003" respectively.
- ◆ Connect 26-pin DIL male (J8) of "SBC-IEB-0603" with 26-pin DIL male (J1) of "VSP-POT-IMON" using 26-pin FRC cable already available there (WHICH WAS CONNECTED BETWEEN 26-pin DIL male (J1) of "VSP-POT-IMON" & 26-pin DIL male (J4) of "VSP-DPM CONT-1003B").
- ◆ Connect 4-pin SIL male (J5) on of "SBC-IEB-0603" to 4-pin SIL male connector (J4) (Check the signal polarity) of "VSPDDC-1.2KW-1003D".

- ◆ Connect the power supply cable for ( $\pm 10V$ ) using 3-pin SIL male connector to J7 of “SBC-IEB-0603” with 3-pin SIL male connector to J7 on “VSPDDC-1.2KW-1003D” card.
- ◆ Replace the TOP COVER and close the instrument.
- ◆ Set the Switch settings on the card from outside the unit as shown in section 5.3.4 on Address Selection.

#### **5.3.4 IEEE-488 Instrument Address Selection**

The instrument address is set manually using an eight way miniature switch near the interface connector on the rear panel. This DIP switch is normally marked with A0 to A7 to identify the proper switch. In our system, we refer A0 as switch 1 and an A7 as switch 8. The OPEN (OFF) condition of the switches will simulate logic 1 and CLOSE (ON) condition will simulate logic 0. These states are marked on the panel as ON (0) and OFF (1).

Five of the switches (A0 to A4) are used to set the address using the binary code. This enables any address in the range 00 (00 HEX) to 31 (1F HEX) to be used. E.g. 11010 is address 26 (1A HEX).

The switch no A5 is not used. The remaining two switches (A6, A7) are used to say whether the installed IEEE-488 Interface card has to be honored or not. In easy terms, if switches A6 and A7 are CLOSED (ON) simultaneously, the installed IEEE-488 Interface card is ENABLED. If switches A6 and A7 are not simultaneously CLOSED (ON), then the IEEE-488 Interface card will be DISABLED even if the address is set properly.

**NOTE:**

*THE CONFIGURATION OF IEEE-488 INTERFACE CARD AND THE ADDRESS SETTING OF THE INSTRUMENT HAS TO BE DONE BEFORE THE INSTRUMENT IS SWITCHED ON. AFTER POWER ON, CHANGING OF THE SWITCH SETTINGS ON THE IEEE-488 INTERFACE CARD WILL NOT HAVE ANY EFFECT ON REMOTE OPERATION OF THE INSTRUMENT.*

## ADDRESS SWITCHES

SWITCHES			5-BIT DECIMAL CODE			
HEX CODE			A1	A0		
A4	A3	A2				
0	0	0	0	0	00	00
0	0	0	0	1	01	01
0	0	0	1	0	02	02
0	0	0	1	1	03	03
0	0	1	0	0	04	04
0	0	1	0	1	05	05
0	0	1	1	0	06	06
0	0	1	1	1	07	07
0	1	0	0	0	08	08
0	1	0	0	1	09	09
0	1	0	1	0	10	0A
0	1	0	1	1	11	0B
0	1	1	0	0	12	0C
0	1	1	0	1	13	0D
0	1	1	1	0	14	0E
0	1	1	1	1	15	0F
1	0	0	0	0	16	10
1	0	0	0	1	17	11
1	0	0	1	0	18	12
1	0	0	1	1	19	13
1	0	1	0	0	20	14
1	0	1	0	1	21	15
1	0	1	1	0	22	16
1	0	1	1	1	23	17
1	1	0	0	0	24	18
1	1	0	0	1	25	19
1	1	0	1	0	26	1A
1	1	0	1	1	27	1B
1	1	1	0	0	28	1C
1	1	1	0	1	29	1D
1	1	1	1	0	30	1E

TABLE 5.2

The Other three switches (A7 A6 A5) must be kept to 000 (ON, ON, ON).

### 5.4.5 Special Notes For the Controller Software Writer

This section will provide some valuable hints to the controller software program writer for interfacing this Programmable Unit, through the communication interface.

- 1). Normal communication is in ASCII. The unit will accept both the lower case and upper case characters.
- 2). All commands for the units are in the IEEE-488.2 and SCPI format.
- 3). All mandatory commands for IEEE-488.2 are implemented in the unit.
- 4). Also the command has to be sent with proper terminator (The Program Message Terminator is either = 0AH (NEWLINE) OR EOI message OR both of the above). Else the command processing will not start.
- 5). For the responses of query commands, the Response Message Terminator or EOS character will be OAH (New Line) character.
- 6). For all commands <AARD> means Arbitrary ASCII Response Data and <NR.DATA> means Numeric Data.
- 7). For wrong commands, the command error bit will be set & an error message is put into Error Queue.
- 8). Unit will go to remote mode for all valid commands. Queries will not force the unit into remote mode.
- 9). The GPIB 'GTL' command will send the unit into Local mode.
- 10). IEEE-488 device clear commands 'SDC' & 'DCL' will generate a communication soft reset to the unit. Present communication buffer will be flashed out. But, the unit will maintain the last settings.
- 11). When the unit has received MLA (My Listen Address) with REN line true, it will go to remote mode as per the RL2 function requirements.
- 12). The unit provides complete SRQ function. Refer section 5.10 for details. When the controller polls the SRQ response byte, it is found in case of some controllers that this response byte gets latched in the controllers data in buffer causing an extra character while reading the next message through GPIB. So, it is advisable to give a dummy listen to the controller GPIB controller chip with sufficient time-out to flash out such character if pending any.

- 13). Before sending the unit into talk mode it is also advisable to Flush out the controller's data-in buffer by giving a dummy read. This is required because some controller can keep the last data latched into its data-in Buffer.
- 14). If you send more than one query in a <PROGRAM MESSAGE>, only the LAST correct query will be processed and response will be given for last query.
- 15). No response can be read without giving a query. Otherwise the query error bit will be set & an error message is generated.

## **5.5 An Introduction to SCPI Language**

Standard Commands for Programmable Instruments (SCPI) defines how you communicate with an instrument from a BUS controller. The SCPI language uses a hierarchical structure similar to the file systems used by many bus controllers. The command "TREE" is organized with root-level commands (also called "SUB-SYSTEMS") positioned at the top, with multiple levels below each root level command. You must specify the complete path to execute the individual lower-level commands.

### **USING A COLON (:)**

When a colon is the first character of a command keyword, it indicates that the next command mnemonic is a root-level command. When a colon is inserted between two-command mnemonics, the colon moves the path down one level in the present path (for the specified root-level command) of the command tree. You must separate the command mnemonics from each other using a colon. You can OMIT the leading COLON if the command is the first of a new program line.

### **USING A SEMICOLON (;)**

Use a semicolon to separate two commands within the same command string. The semicolon does not change the present path specified. For example the following two statements are equivalent.

```
: SOURce:VOLTage 10.55:SOURce:CURRent 2.50
```

```
: SOURce: VOLTage 10.55;CURRent 2.50
```

### **USING A COMMA (,)**

If a command requires more than one parameter, you must separate the adjacent parameters using a comma.

## **USING WHITESPACE**

You must use Whitespace characters, [tab], or [space] to separate a parameter from a command keyword. Whitespace characters are generally ignored only in parameter lists.

## **USING “?” COMMANDS**

The BUS controller may send commands at any time, but an SCPI instrument may only send responses when specifically instructed to do so. Only QUERY commands (commands that end with a “?”) will instruct the instrument to send a response message. Queries return either measured values or internal instrument settings or some ERROR messages.

### **CAUTION**

IF YOU SEND MORE THAN ONE QUERY COMMAND WITHOUT READING THE RESPONSE FROM THE EARLIER ONES, AND THEN ATTEMPT TO READ THE RESPONSE FROM THE LAST QUERY, YOU MAY OR MAY NOT RECEIVE SOME DATA FROM THE EARLIER RESPONSES. BUT YOU WILL RECEIVE COMPLETE RESPONSE FOR THE LAST QUERY. TO AVOID THIS DO NOT SEND A NEXT QUERY COMMAND BEFORE READING THE RESPONSE FROM THE FIRST ONE.

## **USING “\*” COMMANDS**

Commands starting with a “\*” are called Common Commands (Mandatory commands for IEEE-488.2). They are required to perform the identical function for all instruments that are compliant with the IEEE-488.2 Interface Standard. The “\*” Commands are used to control reset, Self-Test and status operation and reporting in the present instrument.

### **5.5.1 SCPI Data Types**

The SCPI language defines the different data formats for use in program messages and response messages. Instrument is flexible listeners and can accept commands and parameters in various formats. However, SCPI instruments are PRECISE talkers. This means that the SCPI instruments will always respond to a particular query in a predefined, rigid format.

#### **NUMERIC PARAMETERS:**

Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, decimal points and scientific notation. Special values for numeric parameters like MAXimum, MINimum and DEFault are also accepted. You can also send engineering unit suffixes (M, k, or u) with numeric parameters. If only specific

numeric values are accepted, the instrument will automatically round the input numeric parameters.

#### **DISCRETE PARAMETERS:**

Discrete parameters are used to program settings that have a limited number of values (like BUS, EXTERNAL, NORMAL, and INVERTED). They have a short form and a long form just like command keywords. You can mix upper case and lower-case letters. Query responses will always return the short form in upper-case letters.

#### **BOOLEAN PARAMETERS:**

Boolean Parameters represent a single binary condition that is either TRUE or FALSE. For a false condition the instrument will accept "OFF" or "0". For a true condition this instrument will accept "ON" or "1". When you query a Boolean setting, the instrument will always return a "0" or "1".

#### **STRING PARAMETERS:**

String Parameters can contain virtually any set of ASCII characters. A STRING must begin and end with matching quotes, either with a single quote or with a double quote. You can include the quote delimiter as part of the string by typing it twice without any characters in between.

### **5.5.2 Input Message Terminators**

Program Messages sent to an SCPI instrument must terminate with a < NEWLINE > character. The IEEE-488 EOI (END OR IDENTITY) signal is interpreted as a < NEWLINE > character and may also be used to terminate a message in place of the < NEWLINE > character. Many programming languages allow you to specify a message terminator character or EOI state to be automatically sent with each BUS transaction. Message termination will always set the current path back to the root-level.

### **5.4.3 SCPI Goals**

The goal of Standard Commands for Programmable Instruments (SCPI) is to reduce Automatic Test Equipment (ATE) program development time. SCPI accomplishes this goal by providing a consistent programming environment for instrument control and data usage. This consistent

Programming environment is achieved by the use of defined program messages, instrument responses and data formats across all SCPI instruments, regardless of manufacturer.

The advantage of SCPI for the ATE system programmer is reducing the time learning how to program new SCPI instruments after programming their first SCPI instrument.

By providing a consistent programming environment, replacing one SCPI instrument with another SCPI instrument in an ATE system will usually require less effort than with non-SCPI instruments.

## 5.5 SCPI Status Model

All SCPI instruments implement status registers in the same way. The status system records various instrument conditions in three register groups:

The Status Byte register

The Standard Event register and

The Questionable Data register.

The status byte register records high level summary information reported in the other register groups.

The diagram on the next page illustrates the SCPI status system.

### **Event Registers:**

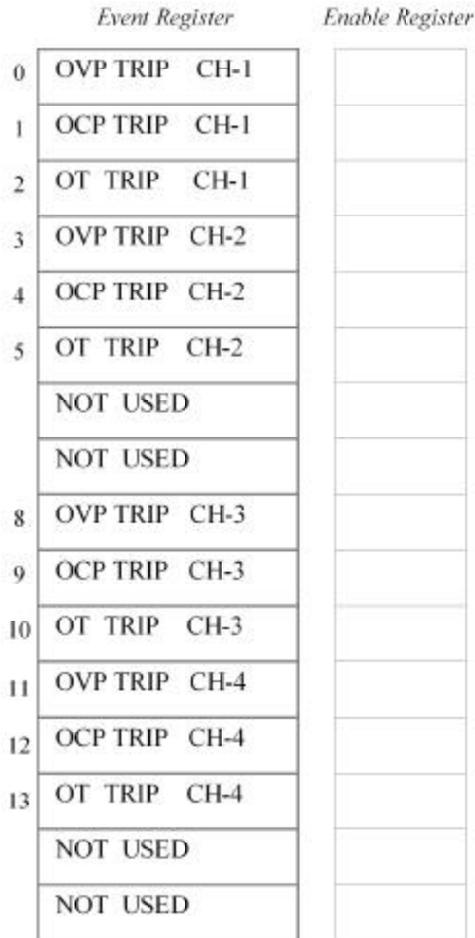
The standard and the questionable data registers have event registers. An event register is a read-only register that reports defined conditions within the instrument. Bits in the event registers are latched. Once an event bit is set, subsequent state changes are ignored. Bits in an event register are automatically cleared by a query of that register (such as \*ESR? or STAT: QUES: EVEN?) or by sending the \*CLS (clear status) command. A reset (\*RST) or device clear will not clear bits in event registers. Querying an event register returns a decimal value, which corresponds, to the binary weighted sum of all bits set in that register.

### **Enable Registers:**

An enable register defines which bits in the corresponding event register are logically Ored together to form a single summary bit. Enable registers are both readable and writable. The \*CLS (clear status) command does not clear enable registers but it does clear the bits in the event registers. The STATus:PRESet command will clear the questionable data enable register. Querying an enable register will not clear it. To enable bits in an enable register, you must write a decimal value, which corresponds, to the binary weighted sum of bits you wish to enable in a register.

# SCPI STATUS SYSTEM

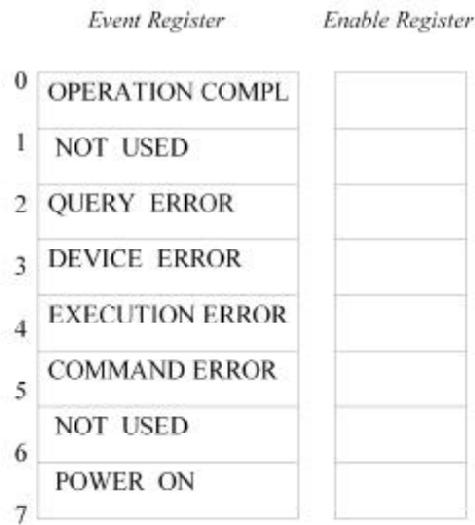
## QUESTIONABLE DATA



## BINARY WEIGHTS

0	1	8	256
1	2	9	512
2	4	10	1024
3	8	11	2048
4	16	12	4096
5	32	13	8192
6	64	14	16384
7	128	15	32768

## STANDARD EVENT



## STATUS BYTE



## OUTPUT BUFFER



## The Status Byte Register

The status byte summary register reports conditions from other status registers. Query data that is waiting in the instrument's output buffer is immediately reported through the "message available" bit (bit 4). Bits in the summary registers are not latched. Clearing an event register will clear the corresponding bits in the status byte summary register. Reading all messages in the output buffer, including any pending queries will clear the message available bit.

### BIT DEFINITIONS-STATUS BYTE REGISTER

BIT VALUE	DESCRIPTION DEFINITION	DECIMAL	
0	Not Used	1	Always set to 0.
1	Not Used	2	Always set to 0.
2	Questionable Data register (bits must be "enabled" in enable Register)	4	One or more bits are set in the Questionable Data register
3	Not Used	8	Always set to 0.
4	Message Available	16	Data is available in the Instrument's output buffer.
5	Standard Event (bits must be "enabled" in enable register)	32	One or more bits are Set in the Standard Event register
6	Request Service Poll).	64	The Instrument is requesting the SERVICE (Serial Poll).
7	Not Used	128	Always set to 0.

The Status byte summary register is cleared when:

- ◆ You execute a \*CLS (clear status) command.
- ◆ Querying the standard event and questionable data registers will clear only the respective bits in the summary register.

The status byte enable register (request service) is cleared when:

- \* You turn on the power to the instrument.
- \* You execute a \*SRE 0 command.

### USING \*STB? TO READ THE STATUS BYTE

The \*STB? (Status byte query) command is similar to a serial poll except it is processed like any other instrument command. The \*STB? Command returns the same result as an IEEE-488 serial poll except that the "request service" bit (bit 6) is not cleared if a serial poll has occurred. The \*STB? Command is not handled automatically by the IEEE-488 bus interface hardware and the command will be executed only after previous commands have completed. Polling is not possible using the \*STB? Command. Using the \*STB? Command does not clear the status byte summary register.

## **TO INTERRUPT YOUR BUS CONTROLLER USING SRQ**

- \* Send a bus device clear message.
- \* Clear the event registers with the \*CLS (clear status) command.
- \* Set the \*ESE (standard event register) & \*SRE (status byte register) enable masks.
- \* Send the \*OPC? (Operation complete query) command and enter the result to assure synchronization.
- \* Enable your bus controller's IEEE-488 SRQ interrupt.

## **TO DETERMINE WHEN A COMMAND SEQUENCE IS COMPLETED.**

- \* Send a device clear message to clear the instrument's output buffer.
- \* Clear the event registers with the \*CLS (clear status) command
- \* Enable "operation complete" using the \*ESE 1 command (standard event register)
- \* Send the \*OPC? (Operation complete query) command and enter the result to assure synchronization.
- \* Send your programming command string and place the \*OPC (Operation complete) command as the last command.
- \* Use a serial poll to check to see when bit 5 (standard event) is set in the status byte summary register. You could also configure the instrument for an SRQ interrupt by sending \*SRE 32 (status byte enable register, bit 5).

## **HOW TO USE THE MESSAGE AVAILABLE BIT (MAV)**

You can use the status byte "message available" bit (bit 4) to determine when data becomes available to read into your bus controller. The instrument sets bits 4 when the first reading becomes ready (which can be READ?). The instrument subsequently clears bit 4 only after all messages have been read from the output buffer.

The message available (MAV) bit can only indicate when first reading is available following a READ? Or following a \*TST? Query command. This can be helpful because you do not know when the Self-Test will be completed after the \*TST? Command is given.

## **THE STANDARD EVENT REGISTER**

The standard event register reports the following types of instrument events: power-on detected, command syntax errors, command execution errors, self-test or calibration errors, query errors, or when an \*OPC command is executed. Any or all of these conditions can be reported in the standard event summary bit through the enable register. You must write a decimal value using the \*ESE (event status enable) command to set the enable register mask.

**Note:** An error condition (standard event register bits 2,3,4 or 5) will always record one or more errors in the instrument's error queue. Read the error queue using SYSTem: ERRor?

The standard event register is cleared when:

- \* You send a \*CLS (clear status) command.
- \* You query the event register using the \*ESR? (Event status register) command.

The standard event enable register is cleared when:

- \* You turn on the power to the instrument.
- \* You execute a \*ESE 0 command.

### **BIT DEFINITIONS-STANDARD EVENT REGISTER**

<b>BIT VALUE</b>	<b>DESCRIPTION DEFINITION</b>	<b>DECIMAL</b>	
0	Operation Complete	1	All commands prior to and including an *OPC command have been executed.
1	Not Used	2	The instrument tried to read the output buffer but it was empty. Or a new command line was received before a previous query has been read. Or, both the input and output buffers are full.
2	Query Error	4	The controller tried to read the O/P buffer of the instrument without giving the Query first or wrong Channel list was supplied in query.
3	Device Error	8	A Self-Test, Calibration Or Channel TRIP error occurred.
4	Execution Error	16	An execution error occurred.
5	Command Error	32	A command syntax error has occurred.
6	Not Used	64	Always set to 0.
7	Power On	128	Power has been turned off and on since the last time the event register was read or cleared.

### **THE QUESTIONABLE DATA REGISTER**

The Questionable Data Register provides information about the FAULTS on the different CHANNELS of the Source unit. When a CHANNEL TRIP occurs the reason as to what caused the TRIP on that CHANNEL could be obtained from this register. The CHANNEL can have Over Voltage trip or Over Current trip or Over Temperature trip. Any or all of these conditions can be reported in the questionable data summary bit through the enable register. You must write a decimal value to enable that particular event using the command STATus: QUEStionable: ENABle < DATA >

## BIT DEFINITIONS-QUESTIONABLE DATA REGISTER

BIT VALUE	DESCRIPTION DEFINITION	DECIMAL
0	OVP trip	1 Channel 1 Over Voltage Trip
1	OCP trip	2 Channel 1 Over Current Trip
2	OT trip	4 Channel 1 Over Temperature Trip
3	OVP trip	8 Channel 2 Over Voltage Trip
4	OCP trip	16 Channel 2 Over Current Trip
5	OT trip	32 Channel 2 Over Temperature Trip
6	<b>Not Used</b>	<b>64</b> Always Set to 0
7	<b>Not Used</b>	<b>128</b> Always Set to 0
8	OVP trip	256 Channel 3 Over Voltage Trip
9	OCP trip	512 Channel 3 Over Current Trip
10	OT trip	1024 Channel 3 Over Temperature Trip
11	OVP trip	2048 Channel 4 Over Voltage Trip
12	OCP trip	4096 Channel 4 Over Current Trip
13	OT trip	8192 Channel 4 Over Temperature Trip
14	<b>Not Used</b>	<b>16384</b> Always Set to 0
15	<b>Not Used</b>	<b>32768</b> Always Set to 0

The questionable data event register is cleared when:

- \* You execute a \*CLS (clear status) command.
- \* You query the event register using STATus: QUEStionable: EVENT?

The questionable data enable register is cleared when:

- \* You turn on the power to the instrument.
- \* You execute the STATus: PRESet command
- \* You execute the STATus: QUEStionable: ENABle 0 command.

## 5.6 COMMAND SUMMARY

This section summarizes the SCPI commands available for this Programmable Instrument. Refer to the later sections in this chapter for more complete details on each command.

Throughout this manual, the following conventions are used for SCPI command syntax. Square brackets ([ ]) indicate optional keywords or parameters. Braces ({} ) enclose parameters within a command string. Triangle brackets (< >) indicate that you must substitute a value for the enclosed parameter.

**SR NO. IEEE-488.2 COMMON COMMANDS**

- 1 \*CLS
- 2 \*ESE<SP><NR.DATA>
- 3 \*ESE?
- 4 \*ESR?
- 5 \*IDN?
- 6 \*OPC
- 7 \*OPC?
- 8 \*RST
- 9 \*SRE<SP><NR. DATA>
- 10 \*SRE?
- 11 \*STB?
- 12 \*TST?
- 13 \*WAI

**SR NO. STATUS REPORTING COMMANDS**

- 1 SYSTem: ERRor?
- 2 STATus: QUEStionable: EVENt?
- 3 STATus: QUEStionable: ENABle?
- 4 STATus: QUEStionable: CONDition?
- 5 STATus :QUEStionable:ENABle<SP><NR.DATA>
- 6 STATus: OPERation: EVENt?
- 7 STATus: OPERation: ENABle?
- 8 STATus: OPERation: CONDition?
- 9 STATus:OPERation:ENABle<SP><NR.DATA>
- 10 STATus:PRESet
- 11 \*CLS
- 12 \*ESE<SP><NR.DATA>
- 13 \*ESE?
- 14 \*ESR?
- 15 \*OPC
- 16 \*OPC?
- 17 \*SRE<SP><NR.DATA>
- 18 \*SRE?

**SR NO. SYSTEM RELATED COMMANDS**

- 1 READ?
- 2 [SOURce:] VOLTage<SP><NR.DATA><Channel\_list>
- 3 [SOURce:] CURRent<SP><NR.DATA> <Channel\_list>
- 4 [SOURce:] VOLTage:LIMit<SP><NR.DATA>  
<Channel\_list>
- 5 [SOURce:] CURRent:LIMit<SP><NR.DATA>  
<Channel\_list>
- 6 [SOURce:] VOLTage:PROTection<SP><NR.DATA>

<Channel_list>	7	[SOURce:] CURRent:PROTection<SP><NR.DATA>
<Channel_list>	8	OUTPut[:STATe]<SP>ON<Channel_list>
	9	OUTPut[:STATe]<SP>OFF<Channel_list>

**NOTE:**

<SP>	= Null or space character (20H)
<AARD>	= Arbitrary ASCII Response Data
<NR.DATA>	= Numeric Data
<EOS>	= End of string character (OAH)
<Channel_list>	= Channel Number operation.

The format for giving the channel list is

(@1)	: Channel number 1
(@1,2)	: Channel nos. 1 & 2.
(@1,2:4)	: Channel numbers 1,2,3,4.

Brackets are compulsory.

**5.6.1 SPECIAL NOTES ON THE COMMANDS FOR VSP SERIES:**

- 1). All commands for the unit are in the IEEE-488.2 and SCPI format.
- 2). All mandatory commands for IEEE-488.2 are implemented in unit.
- 3). Also the command has to be sent with proper terminator. Else the command processing will not start.
- 4). For the responses of query commands, the Response Message Terminator or EOS character will be OAH (New Line) character.
- 5). For all commands <AARD> means Arbitrary ASCII Response Data and <NR.DATA> means Numeric Data.
- 6). For wrong commands, the command error bit will be set & an error message is put into Error Queue.
- 7). Unit will go to remote mode for all valid commands. Queries will not force the unit into remote mode.
- 8). If you send more than one query in a <PROGRAM MESSAGE>, only the LAST correct query will be processed and response will be given for last query.
  
- 12). The Channel list in the command is optional for single channel power supply.

- 9). No response can be read without first giving a query. Otherwise the query error bit will be set & an error message is generated.
- 10). The local lockout can be set when the instrument is in remote mode of operation.
- 11). The address of the IEEE-488 interface is default set to 0.

## 5.7 MANDATORY COMMANDS

This section explains in detail the IEEE-488.2 and SCPI MANDATORY common commands, which are supported by this Programmable Instrument.

### NOTE:

<SP>	= Null or space character (20H)
<AARD>	= Arbitrary ASCII Response Data
<NR.DATA>	= Numeric Data
<EOS>	= End of string character (OAH)
<Channel_list>	= Channel Number operation.

The format for giving the channel list is

(@1)	: Channel number 1
(@1,2)	: Channel nos. 1 & 2.
(@1,2:4)	: Channel numbers 1,2,3,4.

Brackets are compulsory.

1. **Command** : \*CLS  
**Description** : Clear Status command  
**Function** : This will clear status Data Structure & forces the Instrument to OCIS and OQIS state.
2. **Command** : \*ESE<SP><NR.DATA>  
**Description** : Standard Event Status Enable command.  
**Function** : This <NR.DATA> is from 0-255 & will set or reset the bits of Standard Event Status Enable Register.
3. **Command** : \*ESE?  
**Description** : Standard Event Status Enable Query  
**Function** : This query command reads the contents of Standard Event Status Enable register in < NR.DATA>(0-255) data format.

4. **Command** : **\*ESR?**  
**Description** : Standard Event Status Register Query  
**Function** : This query command reads the contents of the Standard Event Status Register in <NR.DATA> Numeric Data (0-255) format.
5. **Command** : **\*IDN?**  
**Description** : Identification Query  
**Function** : This query command will read back the specific information about device. There are 4 fields in the response separated by commas.  
Field 1: Manufacturer (DEL)  
Field 2: Model number (XXXXXXX)  
Field 3: Serial number (0 if not available)  
Field 4: Version number (XX.YY)
6. **Command** : **\*OPC**  
**Description** : Operation complete command  
**Function** : This command tells the device to generate the operation complete message in the Standard Event register when all the pending selected device operations have been completed.
7. **Command** : **\*OPC?**  
**Description** : Operation Complete Query  
**Function** : When this query is sent if the <NR.DATA> response received is '1', then it implies that the device has completed all pending operations.
8. **Command** : **\*RST**  
**Description** : Reset Command  
**Function** : This Reset command performs a Device reset & forces the device into OCIS state & OQIS state and sets the device specific functions to a known state. (Please refer to section 5.7.1 for the Details of \*RST Conditions.)
9. **Command** : **\*SRE<SP><NR.DATA>**  
**Description** : Service Request Enable Command.  
**Function** : This command sets the bits in the Service Request Enable Register as per the data sent in the <NR.DATA> (0-255) data format.

10. **Command** : \*SRE?  
**Description** : Service Request Enable Query.  
**Function** : This query command reads back the contents of the Service Request Enable Register in the <NR.DATA> Numeric data format (0-255).
11. **Command** : \*STB?  
**Description** : Read Status Byte Query.  
**Function** : This query command reads back the contents of the Status Byte Register in the <NR.DATA> Numeric Data format ranging from 0-255.
12. **Command** : \*TST?  
**Description** : Self-Test Query.  
**Function** : This query command causes an internal Self Test & reports whether the Test was completed successfully ( <NR.DATA> = 0 ) or detected any of the errors in the Self Test ( <NR.DATA> = non-zero ), which are discussed in detail under section 5.11 of this chapter.

**NOTE:** Before running the Self-Test with the \*TST? Command set the OVP and OCP Limits to maximum. Or else the unit will TRIP.

13. **Command** : \*WAI  
**Description** : Wait to continue command.  
**Function** : This command shall prevent the device from executing any further commands or readings till the No-operation pending Flag is set true.
14. **Command** : **SYSTEM: ERRor?**  
**Description** : System Error condition Query.  
**Function** : This command returns the error number & error description from the error queue of the instrument.  
If the ERROR QUEUE is empty, 0, "No error" will be the response. The error queue can hold up to 6 messages. If the entire buffer is full and an ERROR occurs at this moment then the last message in the Error Queue will be replaced with  
-350, "Queue overflow"

When a message is read from the queue using the SYSTEM:ERRor? Query, the first one is cleared and all the messages are shifted one to the start again.

15. **Command** : **STATus:QUESTIONable:EVENT?**  
**Description** : Status Questionable Event Register Query.  
**Function** : This query command returns the <NR.DATA> format (0-32767) value of the Questionable Event Register, (16 bit register) specific to instrument, to give the reason for Error. After this QUERY reads the register, the contents of the Status Questionable Data Event Register are cleared.
16. **Command** : **STATus:QUESTIONable:ENABLE<SP> <NR.DATA>**  
**Description** : Set Enable bits for status Questionable Enable Register.  
**Function** : This command takes <NR.DATA> input & puts the corresponding HEX data to status Questionable Enable Register (to enable the corresponding events in Status Questionable Event Register). Since the enable register is also a 16-bit register, the <NR.DATA> can be in the 0-32767 range. If the input data is out of range then an "Execution error" will be generated.
17. **Command** : **STATus:QUESTIONable:ENABLE?**  
**Description** : Read Status Questionable Enable Register Query.  
**Function** : This query command reads the contents of the Status Questionable Enable Register, in the <NR.DATA> (0-32767) format, whose corresponding HEX value represents the bit pattern of the Register.
18. **Command** : **STATus:QUESTIONable:CONDition?**  
**Description** : Read Status Questionable condition register query.  
**Function** : This query will give the contents of status questionable condition register in <NR.DATA> (0-32767) format, whose HEX value represents the Bit pattern of the register. This will always read as '0' (ZERO).
19. **Command** : **STATus:OPERation:EVENT?**  
**Description** : Read Status operation Event Register Query.  
**Function** : This query returns the contents of the Status Operation Event register in <NR.DATA> format (0-32767) whose 16 Bit HEX value represents the Bit pattern of register. This will always read as '0' (ZERO).
20. **Command** : **STATus:OPERation:ENABLE<SP> <NR.DATA>**  
**Description** : Set the Enable Bits of status operation Enable Register.  
**Function** : This command takes <NR.DATA> input and puts the corresponding HEX data to Status Operation Enable Register (to enable the corresponding events in Status Operation Event Register). Since the enable register is also a 16-bit register, the <NR.DATA> can be in the 0-32767 range. If the input data is out of range then an "Execution error" will be generated.

21. **Command** : **STATus:OPERation:ENABle?**  
**Description** : Read Status Operation Enable Register Query.  
**Function** : This query command reads the contents of the Status Operation Enable Register, in the <NR.DATA> (0-32767) format, whose corresponding HEX value represents the bit pattern of the Register.
22. **Command** : **STATus:OPERation:CONDition?**  
**Description** : Read Status Operation condition register query.  
**Function** : This query will give the contents of Status Operation Condition Register in <NR.DATA> (0-32767) format, whose HEX value represents the Bit pattern of the register. This will always read as '0' (ZERO).
23. **Command** : **STATus:PRESet**  
**Description** : Resets the Enable Bits of Status Operation and Questionable Enable Register.  
**Function** : This command puts the data as '0' (ZERO) so that corresponding HEX data (00 Hex) will CLEAR the Status Operation Enable and Status Questionable Enable Registers. (to disable all the corresponding events in the Status Operation Event Register and Status Questionable Data Event Register).

### 5.7.1 \*RST Conditions

The following conditions are defined for the PROGRAMMABLE DC POWER SUPPLY on receiving the \*RST command and execute it.

- 1). The Baud Rate of the instrument for RS232 operation is set to 9600 BAUD, which is variable through Remote mode commands.
- 2). The output Voltage, Current, OVP Limit and OCP Limit for all the Channels are set to the same values as programmed in the Configuration setup, stored in the EEPROM installed inside the unit.
- 3). The output ON/OFF relays for all the Programmable Channels are switched to 'OFF' position.

## 5.8 INSTRUMENT (SYSTEM RELATED) COMMANDS

This section explains in detail the Instrument Specific or the System Related Commands, which are used to Program different parameters of the system. All commands, except the last two commands (For selecting the Internal or External SENSE for the output) are SCPI APPROVED commands. But the last two are SCPI CONFIRMED commands. For this instrument there is NO command, which are not part of the SCPI definition.

**NOTE:**

<SP> = Null or space character (20H)  
<AARD> = Arbitrary ASCII Response Data  
<NR.DATA> = Numeric Data  
<EOS> = End of string character (OAH )  
<Channel\_list> = Channel Number operation.

The format for giving the channel list is

(@1) : Channel number 1  
(@1,2) : Channel nos. 1 & 2.  
(@1,2:4) : Channel numbers 1,2,3,4.

Brackets are compulsory.

- 1. Command :** **READ?<Channel\_list>**  
**Description :** Read Output Voltage and Current Query.  
**Function :** This command reads back the output voltage & current of the unit in <AARD> format. The units for Voltage and Current are VOLTS and AMPS respectively. If the specified CHANNEL(S) is in CV (Constant Voltage) mode of operation, no special indication is given. But if it is in CC (Constant Current) mode of operation then the word 'CC' is put at the end of the response. The entire response is terminated with <EOS> byte.  
Response is in Arbitrary ASCII Response Data format. <Channel\_list> indicates for which all CHANNELS the DATA has to be read. The responses of two channels are separated by the RMUS (Response Message Unit Separator), which is SEMICOLON (;). The sequence of the Response for more than one channel is the same as the Sequence of the channel numbers specified in the <Channel\_list>. If no such <Channel\_list> is provided the READ? query will always read from channel 1.  
For example if the Query sent is  
READ?(@2,1)  
then the response can be as follows:  
+14.99V 00.02A;+00.35V 01.99A CC<EOS>  
which indicates that CHANNEL 1 is in CC mode.
- 2. Command :** **[SOURce:]VOLTage<SP><NR.DATA>**  
**<Channel\_list>**  
**Description :** Set the Output Voltage for that Channel(s).  
**Function :** This command sets the Output Voltage of the Power Supply output with the <NR.DATA> given in the command in

Volts. The input VOLTAGE data is in Numeric Data format. The <Channel\_list> above, indicates for which all CHANNELS the DATA has to be SET. The same data will be set on all the specified CHANNEL(S). If no such <Channel\_list> is provided the SOURce command will always SET to channel 1.

For example to set 10.5 Volts on Channel 2, send the command as:

SOURce:VOLTage 10.50(@2)

For example to set 30 Volts on Channels 1&2, send the command as: VOLTage 3.00 E+1(@1:2)

**3. Command : [SOURce:]CURRent<SP><NR.DATA>  
<Channel\_list>**

**Description :** Set the Output Current Limit for that Channel(s).

**Function :** This command sets the Output Current of the Power Supply output with the <NR.DATA> given in the command in AMPS. The input CURRENT data is in Numeric Data format. The <Channel\_list> above, indicates for which all CHANNELS the DATA has to be SET. The same data will be set on all the specified CHANNEL(S). If no such <Channel\_list> is provided the SOURce command will always SET to channel 1.

For example to set 2.3 Amps on Channels 1&2 send the command as:

SOURce: CURRent 2.300 E+0(@1,2)

For example to set 1 Amp on Channel 1 only, send the command as:

CURR 1

For example to set 1.99 Amps on Channel 2, send the command as:

SOUR:CURR 199 E-2(@2)

**4. Command : [SOURce:]VOLTage:LIMit<SP>  
<NR.DATA><Channel\_list>**

**Description :** Set the Upper Limit of O/P Voltage for that Channel(s).

**Function :** This command sets the Soft Upper Limit for Output Voltage of the specified CHANNEL(S) of the Power Supply output with the <NR.DATA> given in Volts. The input VOLTAGE data is in Numeric Data format. The <Channel\_list> above,

indicates for which all CHANNELS the LIMIT has to be SET. The same data will be set on all the specified CHANNEL(S). Once this limit is set, from that point onwards the output voltage can not be set to higher values than this. If you try to set higher value using SOURce:VOLTage command, the “ Execution error “ will be generated. At the same time the LIMITS can not be set to a value, which is more than the MAXimum ratings of the CHANNEL(S). Also the read value of Voltage is checked with the Soft Limit Voltage value all the time and if the reading exceeds the Channel will be TRIPPed, giving the reason for TRIP as S/W OVP TRIP.

For example to set Limit of 30.80 Volts on Channel 2, send the command as :

```
SOURce:VOLTage:LIMit 30.80(@2)
```

OR

```
VOLT:LIM 3.08 E+1(@2)
```

5. **Command :** **[SOURce:]CURRENT:LIMit<SP>**  
**<NR.DATA> <Channel\_list>**

**Description :** Set the Upper Limit for O/P Current for that Channel(s).

**Function :** This command sets the Soft Upper Limit for Output Current of the specified CHANNEL(S) of the Power Supply unit with the <NR.DATA> given in the command in Amps. The input CURRENT data is in Numeric Data format. The <Channel\_list> above, indicates for which all CHANNELS the LIMIT has to be SET. Once this limit is set, from that point onwards the output current can not be set to higher values than this. If you try to set higher value using SOURce:CURRENT command, the “ Execution error “ will be generated. At the same time the LIMITS can not be set to a value, which is more than the MAXimum rating of the CHANNEL. Also the Current reading is checked against Limit set, to generate the S/W OCP TRIP when the reading exceeds.

For example to set Limit of 2.0 Amps on Channels 1&2, send the command as :

```
SOURce:CURRENT:LIMit 2.0(@1:2)
```

6. **Command** : **[SOURce:]VOLTage:PROTection<SP>  
<NR.DATA><Channel\_list>**
- Description** : Set Over Voltage Protection Limit for that Channel(s).
- Function** : This command sets the Over Voltage Protection Limit for that CHANNEL of the Power Supply output with the <NR.DATA> given in the command in Volts. The input VOLTAGE data is in Numeric Data format. The <Channel\_list> above, indicates for which all CHANNELS the OVP has to be SET. The same data will be set on all the specified CHANNEL(S). If no such <Channel\_list> is provided the PROTection command will always SET to channel 1 OVP. Once this OVP limit is set on a channel, any time if the actual Output Voltage of the channel exceeds the OVP limit, the CHANNEL(S) will be 'TRIPed'. I.e. the OVP operates to protect the channel and the O/P voltage will be made zero and the OUTPUT ON/OFF relay will be switched OFF.

For example to set OVP of 31.50 V on Channel 2, send the command as :

SOURce:VOLTage:PROTection 31.50(@2)

7. **Command** : **[SOURce:]CURRent:PROTection<SP>  
<NR.DATA><Channel\_list>**
- Description** : Set Over Current Protection Limit for that Channel(s).
- Function** : This command sets the Over Current Protection Limit for that CHANNEL of the Power Supply output with the <NR.DATA> given in the command in Amps. The input CURRENT data is in Numeric Data format. The <Channel\_list> above, indicates for which all CHANNELS the OCP has to be SET. The same data will be set on all the specified CHANNEL(S). If no such <Channel\_list> is provided the PROTection command will always SET to channel 1 OCP. Once this OCP limit is set on a channel, any time if the actual Output Current of the channel exceeds the OCP limit, the CHANNEL(S) will be 'TRIPed'. I.e. the OCP operates to protect the channel and the O/P voltage will be made zero and the OUTPUT ON/OFF relay will be switched OFF. Display gives 'TRIP' message and OCP bit for that Channel would be set in QUESTIONABLE DATA register, if it is enabled.

For example to set OCP of 2.4 Amps on Channels 1&2 send the command as:

SOURce:CURRent:PROTection 02.40(@1,2)

8. **Command** : **OUTPut[:STATe]<SP>ON <Channel\_list>**  
**Description** : Set the Output relay to ON state for the specified channels.  
**Function** : This command is used to switch on the output relay & thus to make the OUTPUT available at the output terminals.
9. **Command** : **OUTPut[:STATe]<SP>OFF<Channel\_list>**  
**Description** : Set the Output relay to OFF state for the specified channels.  
**Function** : This command is used to switch OFF the output relay & thus to disconnect the OUTPUT available at the output terminals.
10. **Command** : **SYSTem:REMOte**  
**Description** : Takes the instrument into Remote Mode of operation  
**Function** : This command will explicitly take the unit to remote mode. All the front panel controls are disabled. It is advisable to put the unit into REMOTE mode of operation using this command, before using the instrument in Remote mode.
11. **Command** : **SYSTem:LOCal**  
**Description** : Take the instrument to Local mode of Operation.  
**Function** : This command will take the unit to Local mode of operation & ALL the front panel controls are enabled.

## 5.9 IEEE-488 COMPLIANCE INFORMATION

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<b>Dedicated Hardware Lines:</b>	<b>Universal Commands:</b>
ATN Attention	DCL Device Clear
IFC Interface Clear	ATN Attention
REN Remote Enable	IFC Interface Clear
SRQ Service Request Interrupt	LLO Local Lock-Out
 <b>Addressed Commands:</b>	
SDC Selected Device Clear	
END End Message	
GTL Go to Local	

---

## IEEE-488 INTERFACE COMPATIBILITY :

Although the IEEE-488 Interface specification is called a standard, variations in implementation within the specifications are permitted. These variations determine the capabilities of the particular interface and a list of abbreviations are defined in the Standard Document to indicate to the User which Interface capabilities have been designed in. The TABLE 5.3 below gives the options, which are implemented in this instrument.

<b>CODE</b>	<b>INTERFACE FUNCTION</b>
SH1	Source Handshake Complete Capability
AH1	Acceptor Handshake Complete Capability
T6	Talker Function.(Basic Talker, Serial Poll, Unaddressed to Talk if Addressed to Listen).
TE0	No Address Extension Talker Mode
L4	Listener Function.(Basic listener, Unaddressed to listen if Addressed to Talk).
LE0	No Address Extension Listener Mode
SR1	Service Request Complete Capability
RL1	Remote / Local Complete Capability (Including Local Lock Out).
PP0	No Parallel Poll Capability.
DC1	Device Clear Complete Capability (Accepts DCL & SDC commands and generates a communication soft reset and flashing out the buffer).
DT0	No Device Trigger Capability
C0	No Controller Capability
E1	Tristate driver (Jumper selectable between tristate and open collector).

TABLE 5.3

### 5.10 SRQ HANDLING DETAILS

This Programmable Instrument has been configured for SR1 function (Complete SRQ Capability). To make use of this feature you must configure your BUS controller to respond to the IEEE-488 Service Request (SRQ) Interrupt. This unit does not support Parallel Poll capability.

#### THE SERVICE REQUEST ENABLE (SRE) REGISTER

The Service Request Enable (SRE) register will enable only those events in the Status Byte Register to generate an SRQ, when the corresponding bit in the SRE register is set to '1'. Thus by writing the required data in the SRE register using the command \*SRE<SP><NR.DATA>, the reasons to generate an SRQ can be defined. The following table gives the bit definitions of the Service Request Enable (SRE) Register.

## BIT DEFINITIONS-SERVICE REQUEST ENABLE (SRE) REGISTER

BIT	DESCRIPTION	DECIMAL	VALUE DEFINITION
0	Not Used	1	Always write with 0.
1	Not Used	2	Always write with 0.
2	Questionable Data	4	If this bit is set, an SRQ will be raised when one or more bits are set in the Questionable Data register (bits must be “enabled” in enable Register)
3	Not Used	8	Always write with 0.
4	Message Available	16	If this bit is written with ‘1’ then an SRQ is raised when the data is available in the Instrument’s output buffer.
5	Standard Event	32	If this bit is written with ‘1’ then an SRQ is raised when one or more bits are Set in the Standard Event register (bits must be “enabled” in enable register).
6		64	Always write with 0.
7	Not Used	128	Always write with 0.

The Service Request Enable (SRE) register is cleared when:

- \* You turn on the power to the instrument.
- \* You execute a \*SRE 0 command.

### **ENABLING THE SRQ GENERATION:**

First use the Service Request Enable ( SRE ) Register to select which summary Bits of the Status Byte Register will set the low-level IEEE-488 SRQ Signal. Now write the correct data in the SRE register, for enabling the SRQ reason in the Status Byte Register. For this the command \*STB<SP><NR.DATA> can be used. After that the query \*SRE? Command will return the same value, which was sent above. Now enable your BUS controller’s SRQ interrupt.

When the Status Byte Register “ REQUEST SERVICE “ bit (Bit 6) is set, an IEEE-488 SRQ Interrupt message is automatically sent to the BUS controller. The BUS controller may then POLL the instruments on the bus to identify which one of the instruments has raised the SRQ. The controller asks all the instruments on the BUS to place their SRQ message one by one. The one with Bit 6 SET in its Status Byte Register has requested the SERVICE. Now controller may take necessary action to service or cancel the SRQ. Reading the status byte using an IEEE-488 Serial Poll only clears the “REQUEST SERVICE” bit or by reading the Event Register whose Summary Bit (in the Status Byte) is causing the service request.

To read the Status Byte Summary Register, send the IEEE-488 Serial Poll Message. Querying the Summary Register will return a Decimal value, which corresponds, to the binary - weighted sum of the bits, set in the register. Serial Poll will automatically clear the "REQUEST SERVICE" bit in the Status Byte Summary Register. No other bits are affected. Performing a Serial Poll will not affect the instrument functioning.

### **USING SERVICE REQUEST (SRQ) AND SERIAL POLL**

For example when the Self-Test is performed on this instrument using the command \*TST? (using the IEEE-488 Remote interface), it takes time for the instrument to conduct the test and report the results to the BUS controller. The response will be given at the end of the Self-Test. Here user may have to keep reading from the Output Buffer of the instrument to know the result. But by using the SRQ function one can do this task in a better way as explained below. :

- 1) Enable your BUS controller's SRQ interrupt.
- 2) Enable the SRQ reason "MAV" (Message Available Bit) in the Status Byte Register by sending the command as \*SRE 16.
- 3) Send the command \*TST? from remote for the Self-Test.
- 4) Wait till your BUS Controller detects an SRQ on the bus.
- 5) When an SRQ is detected, poll the SRQ from this instrument to read the SRQ response message as 80 (50 Hex). This means that the RQS bit is set and the MAV bit is set in the Status Byte Summary Register.
- 6) Now read the Output Buffer of the instrument from your BUS controller to get the Response Message of the Self-Test, which will be a 3 digit decimal number like 620 or 603 and so on.

This unit provides complete SRQ function. When the Controller polls the SRQ Message, it is found that in case of some Controllers that this Response byte gets latched in the Controller's Data-out buffer causing addition of an extra character in the next message which is read against some query command. So it is advisable to give a Listen to the Controller Chip with sufficient time-out to flush out such character pending, if any.

## **5.11 ERROR MESSAGES AND REPORTING**

This section explains in short the Error Messages, which are stored in the ERROR QUEUE. and are reported when read through the SYSTem:ERRor?. The messages are stored when query command syntax or hardware errors have been detected. A record of up to 6 errors is stored in the instrument's error queue. Errors are retrieved in first-in-first-out (FIFO) order.

- \* No method is available to read the error queue from the front panel menu.
- \* The error queue is cleared when power has been off or after a \*CLS (clear status) command has been executed.
- \* To read the error queue from the remote interface, send query as:  
**SYSTEM:ERRor?**
- \* Errors have the following format (the error string may contain up to 40 characters):

**-100, "Command error"**

**ERROR QUEUE:**

As the errors and events are detected, they are placed in the queue. This queue is FIRST IN - FIRST OUT. If the queue overflows, the last error or event in the queue is replaced with the error

**-350, "Queue overflow"**

Any time the queue overflows, the least recent errors remain in the queue, and the most recent error or event is discarded. Reading an error from the head of the queue removes that error from the queue, and opens a position at the tail of the queue for a new error, if one is subsequently detected.

When all errors have been read from the queue, further queries for this queue will return

**0, "No error"**

till another error is recorded in the error queue.

The error or event queue is cleared when any of the following occur:

- \* Upon Power up.
- \* Upon receipt of a \*CLS command.
- \* Upon reading the last item from the error queue.

## **COMMAND ERRORS**

Message: **-100, "Command error"**

An invalid command was found in the command string. You may have inserted a character such as #, \$, or % in the command header or within a parameter or you have sent a command which is not supported by the instrument. This error is given for syntax errors, missing parameter, wrong header, and numeric data error etc.

## **EXECUTION ERRORS**

Message: **-200,"Execution error"**

A valid command could not be executed because of the unrecoverable TRIP condition in the related channel(s) or the numeric data given in the command exceeds the maximum allowed hard limits or the Soft Upper Limits which were set by the Limit commands. In such cases the instrument generates the Execution error.

## **DEVICE-SPECIFIC ERRORS**

Message: **-300,"Device-specific error"**

A Device specific failure has occurred or some fault is detected on any one or more channels of the instrument. When the CHANNEL is 'Tripped because of the Over Voltage Protection, Over Current Protection or Over Temperature Protection, this error is generated. To read the exact cause of the TRIP on that channel the Status Questionable Data Event Register contents have to be read.

Message: **-330,"Self-test failed"**

The instruments complete self-test failed from the remote interface (\*TST? command). The result of the self-test is separately reported in the response of the \*TST? query command. The decimal number, which is in response to the above query, indicates what exactly has failed in the Self-test. Refer to next page for more details.

## **QUERY ERRORS**

Message: **-400,"Query error"**

A Query error is reported when the controller tries to read the instrument's OUTPUT BUFFER without first, sending the query. For every response to be received, a query command has to be sent first. Also in the READ? query, if the <Channel\_list> does not contain any valid CHANNEL number then also the Query error is recorded.

Fig. 3.13

**REMOTE VOLTAGE AND CURRENT PROGRAMMING AND MONITORING**

Factory set for 0 to 5 volts for full scale output programming and monitoring.

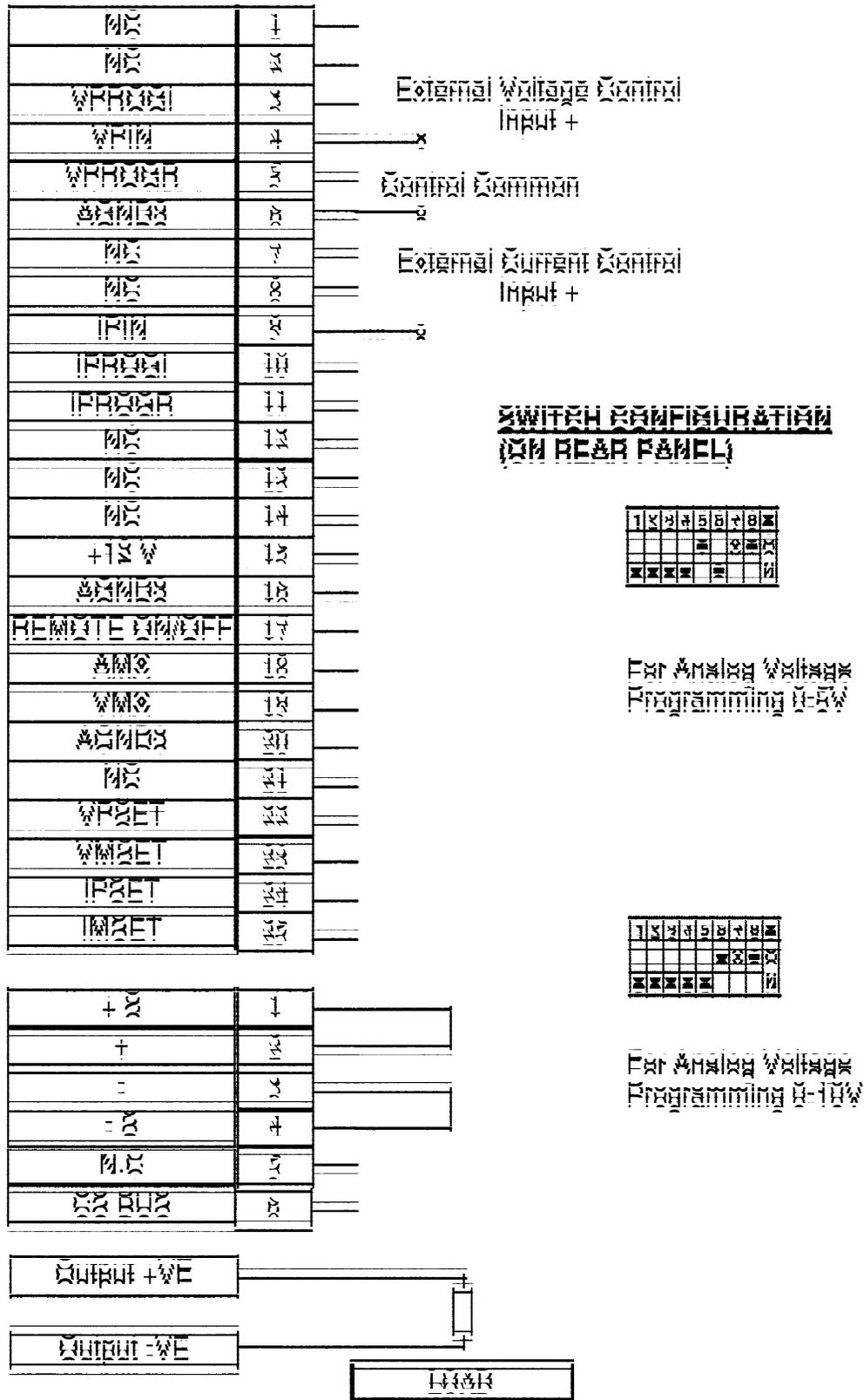
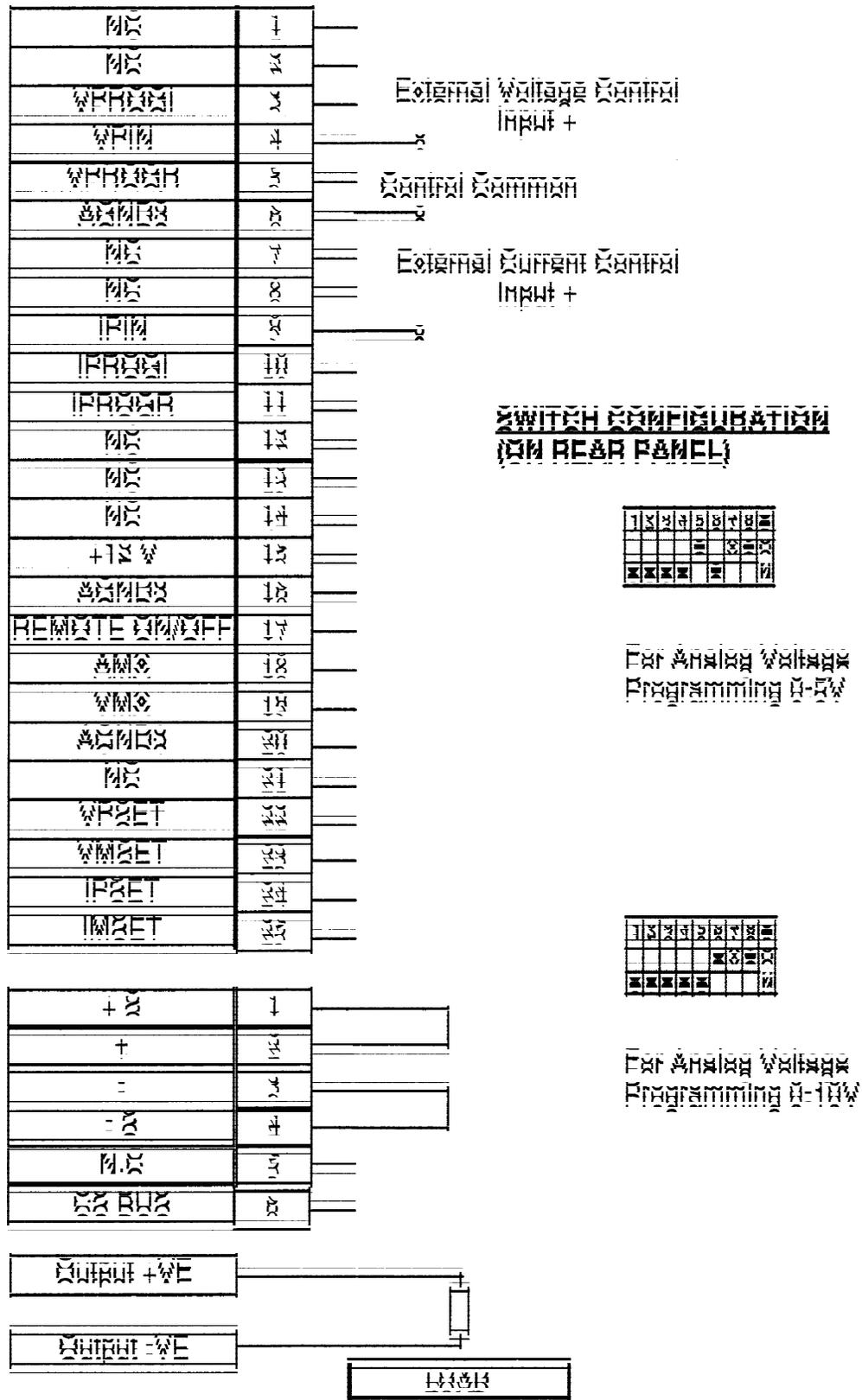


Fig. 3.16

**REMOTE VOLTAGE AND CURRENT PROGRAMMING AND MONITORING**

Factory set for 0 to 5 volts for full scale output programming and monitoring.



## Section 7

# Customer Support

B&K Precision offers courteous, professional technical support before and after the sale of their test instruments. The following services are typical of those available from our toll-free telephone number.

**1-800-462-9832**

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- Technical advice on selecting the test instrument for a given task.
- Information on optional accessories for your instrument.
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(Pacific Daylight Time Summer)



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B&K Precision Corp. warrants to the original purchaser that its product and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

B&K Precision Corp. will, without charge, repair or replace, at its' option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing and mailing the enclosed warranty card to B&K Precision Corp., 22820 Savi Ranch Parkway, Yorba Linda, CA 92887 within fifteen (15) days from proof of purchase.

**Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alternations or repairs. It is void if the serial number is alternated, defaced or removed.**

B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

Model Number: \_\_\_\_\_

Date Purchased: \_\_\_\_\_

22820 Savi Ranch Parkway  
Yorba Linda, CA 92887  
[www.bkprecision.com](http://www.bkprecision.com)



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**Warranty Service:** Please return the product in the original packaging with proof of purchase to the below address. Clearly state in writing the performance problem and return any leads, connectors and accessories that you are using with the device.

**Non-Warranty Service:** Return the product in the original packaging to the below address. Clearly state in writing the performance problem and return any leads, connectors and accessories that you are using with the device. Customers not on open account must include payment in the form of a money order or credit card. For the most current repair charges contact the factory before shipping the product.

Return all merchandise to B&K Precision Corp. with pre-paid shipping. The flat-rate repair charge includes return shipping to locations in North America. For overnight shipments and non-North America shipping fees contact B&K Precision Corp..

B&K Precision Corp.  
22820 Savi Ranch Parkway  
Yorba Linda, CA 92887

Email: [service@bkprecision.com](mailto:service@bkprecision.com)

Include with the instrument your complete return shipping address, contact name, phone number and description of problem.

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