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OPERATING MANUAL

AGILENT 603xA FAMILY AUTORANGING SYSTEM DC POWER SUPPLIES



Agilent Technologies

Agilent Part Number 5959-3342
Microfiche Part No. 5959-3343

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CERTIFICATION

Agilent Technologies certifies that this product met its published specifications at time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

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Edition 1__September, 1990
Edition 2__January, 1992
Update 1__February, 2000
Update 2__September, 2004

Safety Summary

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

GENERAL

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operating instructions.

Any LEDs used in this product are Class 1 LEDs as per IEC 825-1.

This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme à la norme NMB-001 du Canada.

ENVIRONMENTAL CONDITIONS

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage, the correct fuse is installed, and all safety precautions are taken. Note the instrument's external markings described under "Safety Symbols".

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the ac power supply mains through a three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. For instruments designed to be hard-wired to the ac power lines (supply mains), connect the protective earth terminal to a protective conductor before any other connection is made. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury. If the instrument is to be energized via an external autotransformer for voltage reduction, be certain that the autotransformer common terminal is connected to the neutral (earthed pole) of the ac power lines (supply mains).

ATTENTION: Un circuit de terre continu est essentiel en vue du fonctionnement sécuritaire de l'appareil. Ne jamais mettre l'appareil en marche lorsque le conducteur de mise … la terre est d,branch,.

FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT EXCEED INPUT RATINGS

This instrument may be equipped with a line filter to reduce electromagnetic interference and must be connected to a properly grounded receptacle to minimize electric shock hazard. Operation at line voltages or frequencies in excess of those stated on the data plate may cause leakage currents in excess of 5.0 mA peak.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modifications to the instrument. Return the instrument to an Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

SAFETY SYMBOLS

	Direct current
	Alternating current
	Both direct and alternating current
	Three-phase alternating current
	Earth (ground) terminal
	Protective earth (ground) terminal
	Frame or chassis terminal
	Terminal is at earth potential. Used for measurement and control circuits designed to be operated with one terminal at earth potential.
	Terminal for Neutral conductor on permanently installed equipment
	Terminal for Line conductor on permanently installed equipment
	On (supply)
	Off (supply)
	Standby (supply). Units with this symbol are not completely disconnected from ac mains when this switch is off. To completely disconnect the unit from ac mains, either disconnect the power cord or have a qualified electrician install an external switch.
	In position of a bi-stable push control
	Out position of a bi-stable push control
	Caution, risk of electric shock
	Caution, hot surface
	Caution (refer to accompanying documents)
WARNING	The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.
Caution	The CAUTION sign denotes a hazard. It calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

Agilent Technologies	**DECLARATION OF CONFORMITY** According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014	CE

Manufacturer's Name and Address

Responsible Party
Agilent Technologies, Inc.
550 Clark Drive, Suite 101
Budd Lake, New Jersey 07828
USA

Alternate Manufacturing Site
Agilent Technologies (Malaysia) Sdn. Bhd
Malaysia Manufacturing
Bayan Lepas Free Industrial Zone, PH III
11900 Penang,
Malaysia

Declares under sole responsibility that the product as originally delivered

Product Names
a) 1 kW Single Output System dc Power Supplies
b) 1 kW Single Output dc Power Supplies
c) 200 W Single Output System dc Power Supplies

Model Numbers
a) 6030A; 6031A; 6032A; 6035A
b) 6010A; 6011A; 6012B; 6015A
c) 6033A 6038A
(and other customized products based upon the above)

Product Options This declaration covers all options and customized products based on the above products.

Complies with the essential requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly.

EMC Information ISM Group 1 Class A Emissions

As detailed in Electromagnetic Compatibility (EMC), Certificate of Conformance Number CC/TCF/00/078 based on Technical Construction File (TCF) HPNJ5, dated Oct. 29, 1997

Assessed by: Celestica Ltd, Appointed Competent Body
Westfields House, West Avenue
Kidsgrove, Stoke-on-Trent
Straffordshire, ST7 1TL
United Kingdom

Safety Information and Conforms to the following safety standards.

IEC 61010-1:2001 / EN 61010-1:2001
UL 1244
CSA C22.2 No. 1010.1:1992

This DoC applies to above-listed products placed on the EU market after:

January 1, 2004
Date

Bill Darcy/ Regulations Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor, or
Agilent Technologies Deutschland GmbH, Herrenberger Straße 130, D71034 Böblingen, Germany

To obtain the latest Declaration of Conformity, go to http://regulations.corporate.agilent.com and click on "Declarations of Conformity."

Acoustic Noise Statement

Herstellerbescheinigung

Diese Information steht im Zusammenhang mit den Anforderungen der Maschinenlärminformationsverordnung vom 18 Januar 1991.

* Schalldruckpegel Lp < 70 dB(A) * Am Arbeitsplatz * Normaler Betrieb * Nach DIN 45635 T. 19 (Typprüfung)

Manufacturer's Declaration

This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991. This product has a sound pressure emission (at the operator position) < 70 dB.

* Sound Pressure Lp < 70 dB(A) * At Operator Position * Normal Operation * According to ISO 7779 (Type Test).

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1

General Information

Introduction

This manual contains specifications, installation instructions, and operating instructions for System Power Supply Models: Agilent 6030A, 6031A, 6032A, 6033A, 6035A, and 6038A. Refer to "Related Documents" for other information concerning these products.

Description

This system power supply is an autoranging GP-IB power supply. It uses power MOSFETs in a 20 kHz switching converter to provide an autoranging output characteristic with laboratory performance. Output voltage and current are continuously indicated on individual meters. LED indicators show the complete operating state of the unit. Front-panel controls allow the user to set output voltage, current and overvoltage protection trip levels. Overvoltage protection (OVP) protects the load by quickly and automatically interrupting energy transfer if a preset trip voltage is exceeded. Foldback protection can be selected to disable the power supply output if the unit switches from Constant Voltage (CV) to Constant Current (CC) mode or vice-versa.

The power supply can be both a listener and talker on the GP-IB, and can be programmed directly in volts and amps. Power supply status can be read over the GP-IB, and the power supply can be instructed to request service for any of ten conditions. Upon command, the power supply will measure its output voltage, output current, or OVP trip voltage and put the value on the GP-IB. New output values can be put on hold and triggered later, allowing the controller to synchronize multiple power supplies at one time.

The following parameters and features can be controlled via the GP-IB:

- Output voltage setting (12 bits)
- Output current setting (12 bits)
- Trigger (update output)
- Output disable/enable
- OVP reset
- "Soft" voltage and current limits
- Status reporting
- Service request capability
- Foldback protection
- Output voltage measurement (12 bits)
- Output current measurement (12 bits)
- OVP setting measurement
- Machine state initialization
- 16 machine state presets
- Self test

Output connections are made to rear-panel screw-on terminals. Either the positive or negative output terminal may be grounded or the output may be floated up to + 550 Vdc (including output voltage) from chassis ground. Output voltage can be locally or remotely sensed.

The power supply is fan cooled and is packaged in an Agilent Technologies System ll-compatible modular enclosure which is sturdy, attractive and provides easy access for servicing.

A fault indicator (FLT) and remote inhibit (INH) circuit provides additional shutdown protection, should either the GP-IB and/or controller fail.

The FLT circuit provides the user with a means of knowing the status of any unmasked fault register bit independently of the SRQ function available through the GP-IB. You don't have to rely on the controller to inform you of a fault within the power supply.

The INH circuit (which is also independent of the GP-IB) controls the RI bit in the fault registers, and provides a way to disable the supply remotely (i.e. a "panic button"). This gives you a means to bypass the controller and/or GP-IB to disable the supply.

Safety Considerations

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The instrument and this manual should be reviewed for safety markings and instructions before operation. Refer to the Safety Summary page at the beginning of this manual for a summary of general safety information. Safety information for specific procedures is located at appropriate places in this manual.

Options

Options are standard factory modifications or accessories that are delivered with the supply. The following options are available. Note lower output power and voltage specifications for Option 100, which is described in Appendix A.

Option	Description
001	Blank Front Panel for line Options 120, 220, and 240 Vdc
100	Input power: 100 Vac + 6%, -10%; 48-63 Hz single phase.
120	Input power: 120 Vac +6%, -13%. 48-63 Hz single phase.
220	Input Power: 220 Vac +6%, -13%; 48-63 Hz, single phase.
240	Input power: 240 Vac +6%, -13%; 48-63 Hz, single phase.
800	Rack mount kit for two units side by side (Agilent 6033A and Agilent 6038A only)
908	Rack mounting kit
909	Flanges with Handles
0L2	One additional Operating Manual
0B3	Service Manual

Accessories

The System-II cabinet accessories listed below may be ordered with the power supply or separately from your local Agilent Technologies Sales and Support Office (see list of addresses at rear of this manual).

For 6030A, Agilent 603lA, Agilent 6032A, Agilent 6035A only

Agilent Part No	Description
5062-3989	Front handle kit for 5-1/4 inch high cabinets
1460-1345	Tilt stand (1) snaps into standard foot on; must be used in pairs
5062-3977	Rack flange kit for 5-1/4 inch high cabinet (will be shipped with supply if ordered as Option 908)
5062-3983	Rack mount flange kit with handles

1494-0060	Rack slide kit, non tilting
5060-2865	Service kit, includes extenders for control and power mesh boards, three cables to allow GP-IB and PSI boards to lie on table outside unit, and control board test connector.
5060-2866	FET service kit. Includes FETs and all components that should be replaced with FETs.
59510A	Relay Accessory
59511A	Relay Accessory (Polarity Reversing)
5062-3960	Rack mounting adapter kit for side mounting one 7-inch high cabinet, includes one rack flange and one half-module width extension adapter. (Will be shipped with instrument if ordered as Option 908). This rack mounting adapter kit is not compatible with front handle kit Agilent P/N 5061-3990).
5062-3961	Rack mounting adapter kit for center mounting one 7-inch high cabinet, includes one rack flange and one quarter-module width extension adapter (two kits required), there will be surplus of hardware.
5062-3978	Rack flange kit for 7-inch high cabinet. Must be used with another half-module width unit of equal depth with lock link kit 5061-9694. (Will be shipped if instrument is ordered as Option 800).
5061-9694	Lock link kit for joining units of equal depth, contains hardware for three side-by-side joints (four units) and two over-under joints (three units). Locking cabinets together horizontally in a configuration wider than one full module is not recommended. 5062-3978 and 5061-9694 will be shipped if Option 800 is ordered.
5062-3990	Front handle kit for 7-inch high cabinets. Corresponding flange kit is 5061-2072. This front handle kit is not compatible with rack mounting adapter kit (Agilent PIN 5062-3960) or Option 908.
5061-2072	Flange kit to be used with front handle kit 5062-3990.
5062-3984	Rack mounting flange kit with handles for 7-inch high cabinet. Must be used with another half-module width unit of equal depth with lock link kit 5061-9694.
5062-4003	Bail handle kit for carrying 7-inch high, half-module width cabinet.
1460-1345	Tilt stand (1) snaps into standard foot on instrument, must be used in pairs.
5062-3998	Support shelf bit for mounting on or more 7-inch high cabinets of any depth to 20 inches.
5062-4027	Front filler panel, half-module width, for 7-inch high cabinet on support shelf.
1494-0065	Slide kit for 5061-0098 support shelf.
06033-60005	Service kit, includes extenders for control and power mesh boards, three cables to allow GP-IB and PSI boards to lie on table outside unit, and control board test connector.
5060-0138	GP-IB connector non-metric to metric conversion kit.
5060-2860	FET service kit, includes FETs and all components that should be replaced with FETs.
59510A	Relay Accessory
59511A	Relay Accessory (Polarity Reversing)

Instrument and Manual Identification

Agilent Technologies power supplies are identified by a unique two-part serial number, such as 3023A-06181. The first part is the prefix, which denotes the date of the last significant design change and the country of manufacture. Adding 1960 to the first two digits gives the year of the change (30 = 1990, 31 = 1991, etc.) and the second two digits identify the week of that year. The letter indicates the country of manufacture (A = U.S.A.). The second part of the serial number consists of a 5-digit number sequentially assigned to each power supply.

The serial number prefixes listed on the front of this manual indicate the versions of the supplies that were available when the manual was issued. If the serial prefix of your supply is not listed in this manual, the manual may include a yellow "Manual Change" sheet. That sheet updates this manual by defining any differences between the version of your supply and the versions included here, and may also include information for correcting any manual errors. Note that because not all changes to the product require changes to the manual, there may be no update information required for your version of the supply.

GP-IB Interconnection Cables and Connectors

Cables for interconnecting GP-IB devices are available in four different lengths. The connector block at both ends of each GP-IB cable has a plug on one side and a matching receptacle on the other, so that several cables may be connected in parallel, thus simplifying system interconnection. Lock screws provide secure mounting of each connector block to a GP-IB instrument, or to another cable connector block.

Model
Agilent 10833A GP-IB Cable, 1 m (3.3 ft.)
Agilent 10833B GP-IB Cable, 2 m (6.6 ft.)
Agilent 10833C GP-IB Cable, 4 m (13.2 ft.)
Agilent 10833D GP-IB Cable, 0.5 m (1.6 ft.)
Agilent 10834A GP-IB Connector Extender
Agilent 5080-2148 Serial Link Cable, 2 m (6.6 ft)

The Agilent 10834A extender was designed to help in cases where rear panel space results in difficult cabling situations. The extender provides clearance by extending the first connector block 2.3 cm away from the rear panel of the instrument.

Serial link cables may be used to connect power supplies together when programming with SCPI. With serial link cables, you can connect up to 15 additional power supplies per GP-IB address. See Appendix C for more information

GP-IB Compatibility

The system power supplies implement the following GP-IB interface functions:

SH1(Source Handshake)
AH1(Acceptor Handshake)
T6(Talker)
L4(Listener)
SR1(Service Request)
RL1(Remote Local)
PP1(Parallel Poll)
DC1(Device Clear)
DT1(Device Trigger)

Ordering Additional Manuals

One Operating manual is shipped with each power supply. Additional manuals may be purchased directly from your local Agilent Technologies Sales office. Specify the model number, serial number prefix, and the manual part number provided on the title page. (When ordered at the same time as the power supply, additional manuals may be purchased by adding Option 910 to the order. Each Option 910 includes one Operating and one Service Manual).

Related Documents

The following documents may be useful for your GP-IB systems. The Agilent documents can be ordered from your local Agilent Sales Office.

Agilent 6033A/38A Service Manual, Agilent part number 5959-3346.

Agilent 6030A/31A/32A/35A Service Manual, Agilent part number 5959-3344.

Tutorial Description of the Agilent Technologies Interface Bus, Agilent Part Number 5952-0156, November 1987

ANSI/IEEE Std 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation, available from:

IEEE
345 East 47th Street
New York NY 10017 USA

Specifications

Specifications for the power supply fall into two major categories: performance specifications and supplemental characteristics. Performance specifications (see Table 1-1) describe the supply's warranted performance. The power supply Service Manual has procedures for verifying the performance specifications.

Supplemental characteristics (see Table 1-2) give typical but nonwarranted performance parameters. Supplemental characteristics are useful in accessing applications for the power supply.

Table 1-1. Performance Specifications

Agilent Technologies Model		6033A	6038A
DC Output: Voltage, current and power spans indicate range over output may be varied using front panel controls.	**Volts**	**0-20 V**	**0-60 V**
	Amps	**0-30 A**	**0-10 A**
	Maximum Power	**200-240 W**	**200-240 W**
Load Effect (Load Regulation) Voltage load effect is given for a load current change equal to the current rating of the supply. Current load effect is given for a load voltage change equal to the voltage rating of the supply.	Voltage	0.01% + 2 mV	0.01% + 3 mV
	Current	0.01% + 9 mA	0.01% + 5 mA
Source Effect (Line Regulation): Given for a change within the rated line voltage for any output within the rated output voltage, current and power of the supply	Voltage	0.01% + 1 mV	0.01% + 2 mV
	Current	0.01% + 6 mA	0.01% + 2 mA
PARD (Ripple and Noise): Measured at any line voltage and under any load condition within rating (rms 10 Hz to 10 Mhz/p-p 10 Hz to 20 MHz)	Voltage	3 mV/30 mV	3 mV/30 mV
	Current	30 mA/[1]	5 mA/[1]
Load Effect Transient Recovery: Maximum time required for output voltage to recover with the specified band around the nominal output voltage following a 10% step change in output current while operating in the constant voltage mode	Time	1 ms	1 ms
	Level	50 mV	75 mV
Programming: (25 ± 5°C) Given for control of the output over the GP-IB or with front panel controls	Voltage Accuracy	0.035% + 9 mV	0.035% + 40 mV
	Current Accuracy	0.15% +20 mA	0.085% + 10 mA
Remote Voltmeter: (25 ± 5°C) Refers to data read back to the controller over the GP-IB	Accuracy	0.07% + 6 mV	0.07% + 50 mV
Remote Ammeter: (25 ± 5°C) Refers to data read back to the controller over the GP-IB.	Accuracy	0.3% + 25 mA	0.2% + 11 mA
Front Panel Voltmeter: (25 ± 5°C)	Range	2 V, 20 V, 200 V	2 V, 20 V, 200 V
	Accuracy	0.07% +6 mV, 11 mV, 56 mV	0.07% + 50 mV, 55 mV, 100 mV)
Front Panel Ammeter: (25 ± 5°C)	Range	20 A, 200 A	20 A
	Accuracy	0.3% + (20 mA, 65 mA)	0.2% + 11 mA

Table 1-2. Supplemental Characteristics

Agilent Technologies Model			6033A	6038A
Programming: (25 ± 5°C) Given for control of the output over the GP-IB or with front panel controls		Voltage Resolution	5 mV	15 mV
		Current Resolution	7.5 mA	2.5 mA
Remote Voltmeter: (25 ± 5°C) Refers to data read back to the controller over the GP-IB		Resolution	5 mV	15 mV
Remote Ammeter: (25 ± 5°C) Refers to data read back to the controller over the GP-IB.		Resolution	7.5 mA	2.5 mA
Front Panel Voltmeter: (25 ± 5°C)		Resolution	5 mV, 10 mV, 100 mV	15 mV, 15 mV, 100 mV
Front Panel Ammeter: (25 ± 5°C)		Resolution	10 mA, 100 mA	10 mA
Maximum AC Input Current: +6% -13% (48-63) Hz		100 Vac (Opt.100)	6.0 A	6.0 A
		120 Vac (Std.)	6.5 A	6.5 A
		220 Vac (Opt.220)	3.8 A	3.8 A
		240 Vac (Opt.240)	3.6 A	3.6 A
Temperature Coefficient: Output change per degree Celsius change in ambient following 30 minute warm-up.		Voltage	50 ppm + 0.6 mV	50 ppm + 3 mV
		Current	100 ppm + 2 mA	90 ppm + 0.3 mA
Drift (Stability): Change in output (dc to 20 Hz) over 8-hour internal under constant line, load, and ambient following 30-minute warm-up		Voltage	0.02 % + 1 mV	0.02% + 2 mV
		Current	0.03% + 10 mA	0.03% + 3 mA
Programming Response Time: The maximum time required to change from zero volts to full scale voltage or from full scale voltage to 2 volts (5 volts for Agilent 6035A) and settle within the specified band. Full load is defined as the resistance equal to Vp1/Ip1. Light load is as specified		Settling Band	5 mV	15 mV
	Up	Full Load	100 ms	150 ms
		No Load	100 ms	120 ms
	Down	Full Load	200 ms	150 ms
		Light Load	500 ms (50 Ω)	750 ms (400 Ω)
Overvoltage Protection: Trip voltage adjustable via front panel control using the Display OVP function		Range	0-23 V	0-63 V
		Resolution	100 mV	100 mV
		Accuracy	0.3% + 200 mV	0.25% + 300 mV
Typical input power at rated output power: (see point P_2 on Figure 1-1)			340 W	325 W

6030A	6031A	6032A	6035A
0-200 V	**0-20 V**	**0-60 V**	**0-500 V**
0-17 A	**0-120 A**	**0-50 A**	**0-5 A**
1000-1200 W	**840-1072 W**	**1000-1200 W**	**1000-1050 W**
0.0l% + 5 mV	0.0l% + 3 mV	0.0l% + 5 mV	0.0l% + 40 mV
0.0l% + l0 mA	0.0l% + l5 mA	0.0l% + l0 mA	0.03%+34 mA
0.0l% + 5 mV	0.0l% + 2 mV	0.0l% + 3 mV	0.0l% + l3 mV
0.0l% + 5 mA	0.0l% + 25 mA	0.0l% + l0 mA	0.03%+l7 mA
22 mV/50 mV[2]	8 mV/50 mV	5 mV + 0.005% Vout/40 mV	50 mV/160 mV
l5 mA/[1]	l20 mA/[1]	25 mA/[1]	50 mA[1]
2 ms	2 ms	2 ms	5 ms
l50 mV	l00 mV	l00 mV	200 mV
0.035% + l45 mV	0.035% + l5 mV	0.035% + 40 mV	0.25%+400 mV
0.2% + 25 mA	0.25% + 250 mA[3]	0.2% + 85 mA	0.3%+85 mA
0.08% + 80 mV	0.08% + 7 mV	0.08% + 20 mV	0.5%+200 mV
0.36% + l5 mA	0.4% + 100 mA[3]	0.36% + 35 mA	0.5%+50 mA
20V, 200V, 2000V	2V,20V,200V	20V,200V	200V, 2000V
0.08%+(65mV,110mV,560mV)	0.08%+(7mV,12mV,57 mV)	0.08% + (20 mV, 70 mV)	0.5%±(300mV, 1.0V)
2 A, 20 A	20 A, 200 A	20 A, 200 A	10 A
0.36% + (l5 mA, 20 mA)	0.7% + 300 mA	0.36% + (40 mA, 90 mA)	0.5%+60 mA

NOTES.

1. Not specified
2. Initially, for each degree below 20°C the ripple increases 2.4 mV/°C. After loadis applied for 15 minutes, the increase becomes 1.4 mV/°C.
3 After a five-minute wait.

6030A	6031A	6032A	6035A
50 mV	5 mV	l5 mV	l25 mV
4.25 mA	30 mA	l2.5 mA	1.25 mA
50 mV	5 mV	l5 mV	l25 mV
4.25 mA	30 mA	l2.5 mA	l.25 mA
50 mV, 100 mV, 1 V	5 mV, l0 mV, l00 mV	l0 mV, l00 mV	l00 mV, l V
5 mA, l0 mA	l0 mA, l00 mA	l0 mA, l00 mA	20 mA
24A	24A	24A	24A
24 A	24 A	24 A	24A
l5 A	l5 A	l5 A	l5 A
l4 A	l4 A	l4 A	l4 A
50 ppm + 12mV	70 ppm + 2 mV	50 ppm + 4 mV	l00 ppm+30 mV
l00 ppm 3 mA	l80 ppm + l5 mA	l00 ppm + 8 mA	l00 ppm+7 mA
0.03% + l5 mV	0.03% + 3 mV	0.03% + 5 mV	0.03%+40 mV
0.03% + 5 mA	0.l% + 25 mA	0.03% + l0 mA	0.03%+l7 mA
300 mV	30 mV	90 mV	750 mV
300 ms (40 Ω)	300 ms	300 ms	350 ms (250Ω)
300 ms	300 ms	300 ms	250 ms
600 ms (40 Ω)	500 ms	2.0 sec	600 ms (250Ω)
3.5 sec (∞ Ω)	l.5 sec (50 Ω)	3.0 sec (100 Ω)	7.0 sec (∞ Ω)
0-2l4 V	02-22 V	0-64 V	0-535 V
600 mV	l00 mV	200 mV	1 V
0.3% + l.25 V	0.3% + 350 mV	0.3%+350 mA	l.0%+3.l3 V
l435 W	l375W	l450 W	l256 W

Table 1-2. Supplemental Characteristics (continued)

DC Floating Voltage: Either output terminal may be floated up to the following voltage (including the output voltage) from earth ground:
± 240 Vdc on Models 6031A, 6032A, 6033A, and 6038A
± 550 Vdc on Models 6030A and 6035A
Exceeding these voltage can result in damage to the equipment.

Remote Sensing: The power supply maintains specifications at the load with up to 0.5 volt drop per load lead. Operation with up to 2 volts per load lead is possible with some degradation of the load effect specification.

Absolute maximum ratings

- between FLT Terminals 1 and 2 is 17.5 Volts dc. (external resistor required to limit current to 1.25 mA max)
- between INH Terminals 3 and 4 is 5.5 Volts dc.
- between Terminals 1 or 2 to 4 or chassis to ground is 42 Volts dc.

Fault (FLT) levels (Terminals 1 and 2) (All models)

- Ioh (Low Level Output Current) is + 1.2 mA maximum
- Vol (Low Level Output Voltage) is 0.5 Volts Maximum

Inhibit (INH) Levels (Terminals 3 and 4) (All models)

- Vih (High Level Input Voltage) is 2 Volts
- Vil (Low Level Input Voltage) 0.5 Volts Maximum
- tw (Pulse Width) (minimum) = 50 ms (2 ms typ)
- td (Delay Time) = 2 ms typ
- Iil (Low Level Input Current) = -1.25 mA maximum

Multiple Operations: Up to two similar units may be connected in series or auto-parallel, to provide increased output capabilities. Mixing supplies with dissimilar output capabilities is not recommended because under certain conditions, the lower output supply may be stressed beyond its maximum voltage and or current capabilities by the higher output supply.

Temperature Rating (°C):

- Operating is 0-50 (Agilent 6030/6031/6032/6035); 0-55 (Agilent 6033/6038)
- Storage is - 40 + 75 (all models)

Weight kg. (Ibs)

Model	**Agilent 6030A**	**Agilent 6031A**	**Agilent6032A**	**Agilent 6033A**	**Agilent 6035A**	**Agilent 6038A**
Net	16.3 (36)	17.2 (38)	16.3 (36)	9.6 (21)	16.3 (36)	9.6 (21)
Shipping	21.7 (48)	22.7 (50)	21.8 (48)	11.4 (25)	21.7 (48)	11.4 (25)

Dimensions: See Figure 2-1.

Certification:
The unit is designed to comply with these requirements:

- ICE 348-Safety Requirements for Electronic Measuring Apparatus.
- CSA Electrical Bulletin 556B-Electronic Instruments and Scientific Apparatus for Special Use and Applications.
- VDE 0871.6.78 Level B-RFI Suppression of Radio Frequency Equipment for Industrial, Scientific, and Medical (ISM) and similar purposes.
- VDE 0411-Electronic Measuring Instruments and Automatic Controls.
- UL 1244-Electrical and Electronic Measuring & Testing Equipment.
- ANSI C39.5 Part 0 Draft 8-Electrical Testing, Measurement, and Control Equipment.

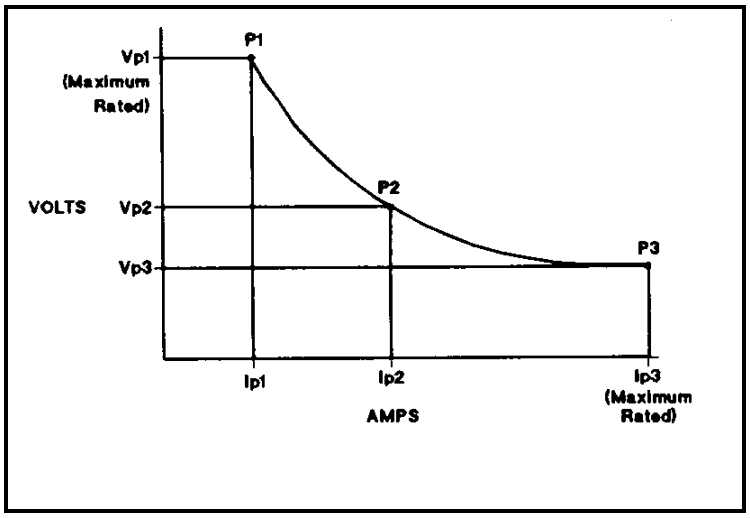
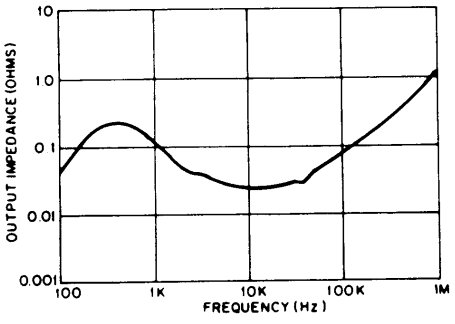


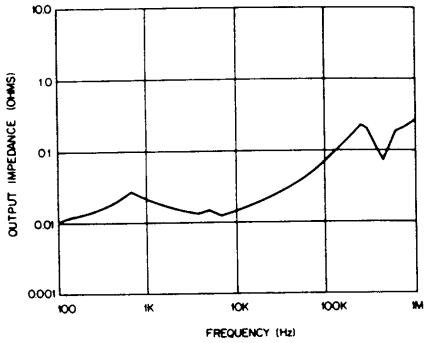
Figure 1-1. Output Characteristic Curve

Agilent Model	6030A	6031A	6032A	6033a	6035A	6038A
Vp1	200 V	20 V	60 V	20 V	500 V	60 V
Ip1	5 A	50 A	17.5 A	10 A	2 A	3.3 A
Vp2	120 V	14 V	40 V	14 V	350 V	40 V
Ip2	10 A	76 A	30 A	17.2 A	3 A	6 A
Vp3	60 V	7 V	20 V	6.7 V	200 V	20 V
Ip3	17 A	120 A	50 A	30 A	5 A	10 A

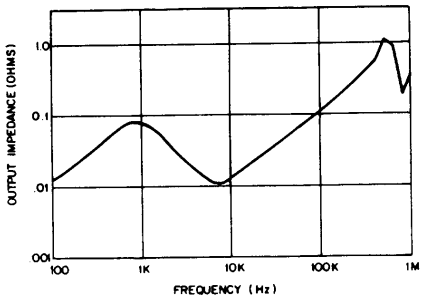
Output Impedance (typical)



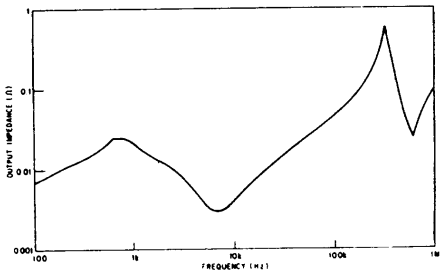
AGILENT 6030A



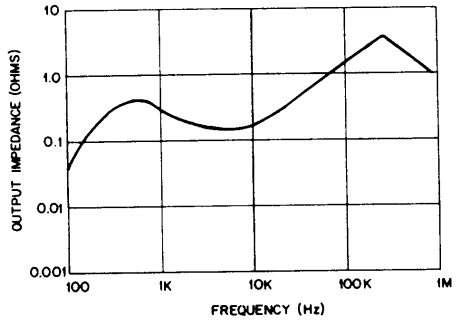
AGILENT 6031A



AGILENT 6032A



AGILENT 6033A and AGILENT 6038A



AGILENT 6035A

2

Installation

Introduction

This section contains instructions for checking and repacking the supply, bench or rack mounting, connecting the supply to ac input power, and converting the supply from one line voltage to another if required. Instructions for connecting load and GP-IB cables, and for setting the GP-IB address are given in Section III.

Note Agilent 603xA power supplies generate magnetic fields which may affect the operation of other instruments. If your instrument is susceptible to operating magnetic fields, do not locate it in the immediate vicinity of the Agilent 603xA power supply. Typically, at three inches from the supply, the electromagnetic field is less than 5 gauss.

Initial Inspection

Before shipment, this supply was inspected and found to be free of mechanical and electrical defects. As soon as the supply is unpacked, inspect for any damage that may have occurred in transit. Save all packing materials until the inspection is completed. If damage is found, file claim with carrier immediately. The Agilent Technologies Sales and Support office should be notified as soon as possible.

Mechanical Check

This check should confirm that there are no broken knobs or connectors, that the cabinet and panel surfaces are free of dents and scratches, and that the meter face and rear-panel plastic covers are not scratched or cracked.

Electrical Check

Section III contains an abbreviated check which can be used quickly to place the supply into operation. Refer to the inside front cover of the manual for Certification and Warranty statements.

Preparation For Use

In order to be put into service, the power supply must be connected to an appropriate ac input power source. Also, the line voltage for which the supply is set must be checked. Additional steps may include line voltage conversion and rack mounting. Do not apply power to the supply before reading Input Power Requirements paragraph on the following page.

Location and Cooling

The supply is fan cooled and must be installed with sufficient space in the rear and on sides for air flow. It should be used in an area where the ambient temperature does not exceed + 50 °C.

Outline Diagram

Figure 2-1 illustrates the outline shape and dimensions of the cabinet.

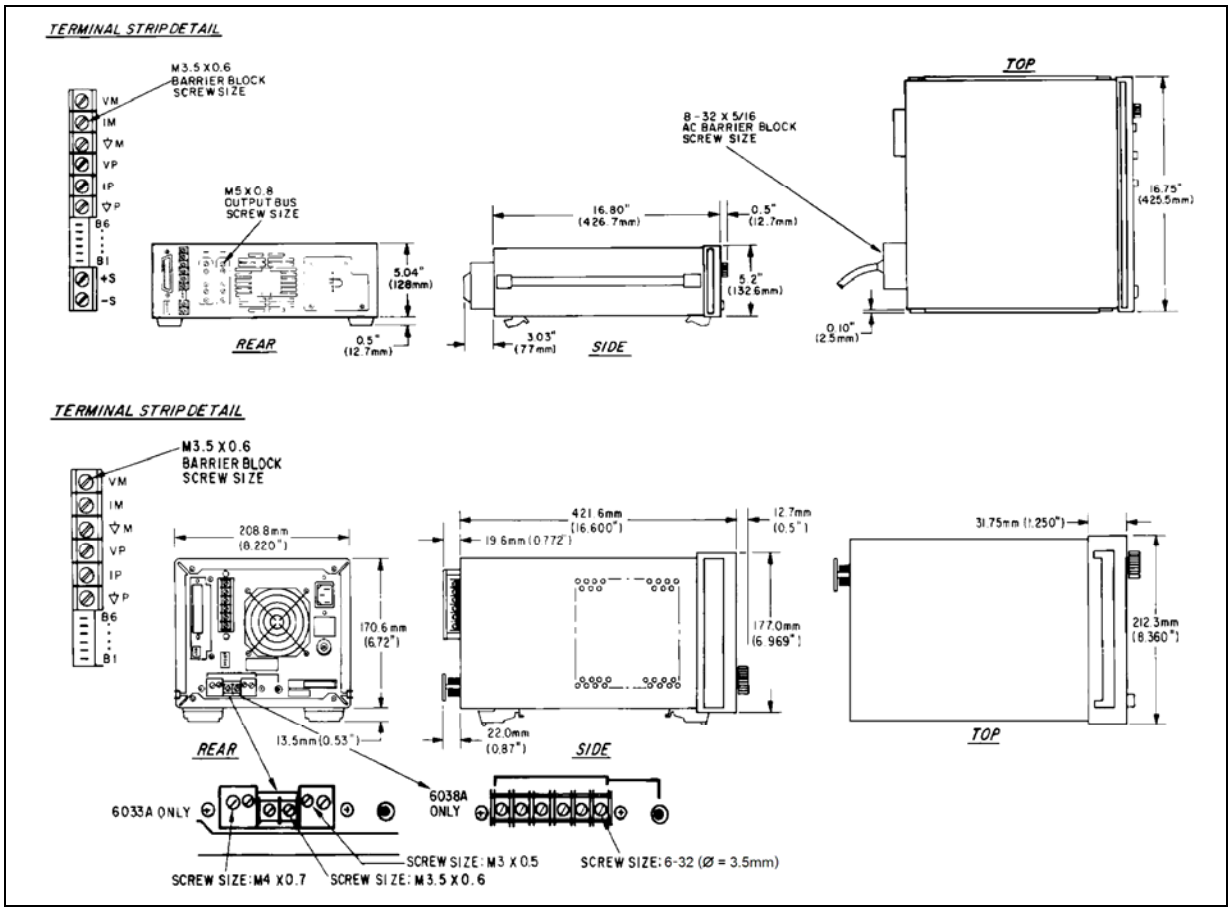


Figure 2-1. Outline Diagram

Bench Operation

The supply cabinet has plastic feet, which are shaped to ensure self aligning when stacked with other Agilent Technologies System II cabinets.

Rack Mounting

The supply can be mounted in a standard 19-inch rack enclosure. Rack mounting accessories for this unit are listed in the ACCESSORIES paragraph in Section I. Complete installation instructions are included with each rack mounting kit. Support rails are also required for rack mounting. These are usually supplied with the system cabinet.

Input Power Requirements

This supply may be operated from a nominal 120 V, 220 V or 240 V single-phase ac power source (48-63 Hz). The input voltage range and input current required for each of the nominal inputs are listed in Table 1-1. A label on the rear panel indicates the nominal line voltage for which the supply was set at the factory. If necessary, the user can convert the instrument from one line voltage option to another by following the instructions in the Line Voltage Option Conversion section of this chapter.

Power Connection

CAUTION	Connection of this supply to an ac power source should be done only by an electrician or other qualified personnel. Before connecting the supply to the ac power source, check the label on the rear panel to ensure that the supply is set for the ac voltage to be used. If necessary, convert the supply from one line voltage to another by following the instructions under “Line Voltage Conversion.”

Agilent Models 6033A, 6031A, 6032A, 6036A. Figure 2-2 illustrates the standard configuration of power-cord plugs used by Agilent Technologies. To connect input power, to the instrument proceed as follows:

a. Remove the AC filter assembly cover by unscrewing the four locating screws.

b. Insert the power cord through the strain relief clamp located on the cover.

c. Connect the wires to the terminal block in accordance with the prevailing color codes.

Green or green/yellow to the terminal labeled "⏚ "
White or blue wire to the terminal labeled "N"
Black or brown wire to the terminal labeled "L"

WARNING For proper protection by the instrument circuit breaker, the wire connected to the "L" terminal on the instrument must be connected to the "L" side of the line (hot); the wire connected to the "N" terminal must be connected to the "N" side of the line (neutral or common).

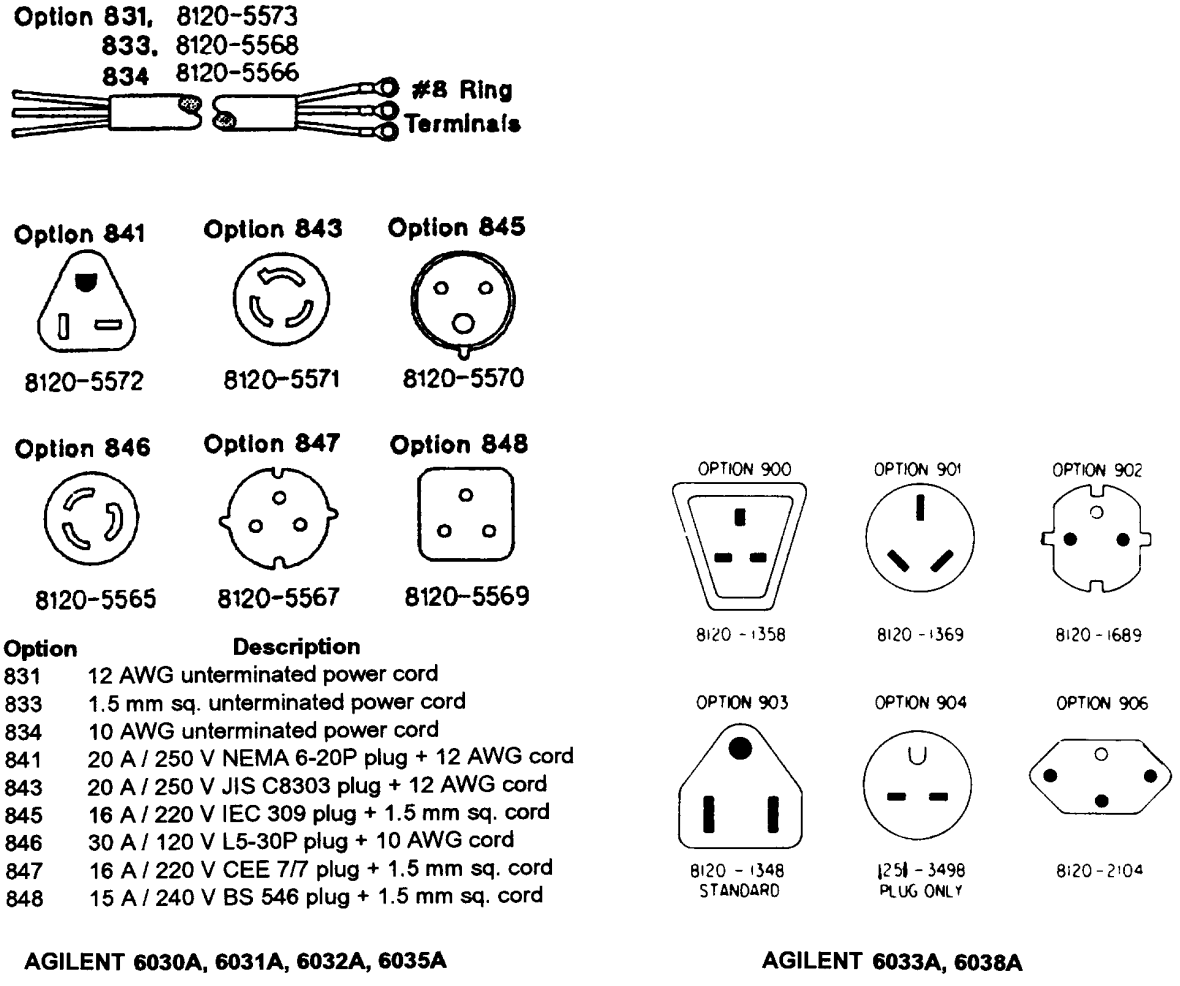


Figure 2-2. Power-Cord Plug Configurations

To protect operating personnel, the wire connected to the terminal must be connected to earth ground. In no event shall this instrument be operated without adequate ground connection.

d. Replace the cover, tighten all four screws and tighten the strain relief clamp. (All four screws must be tightened for unit to meet RFI specifications.)

e. Connect the other end of the power cord to an appropriate power source.

Note Connections to the ac power line must be made in accordance with applicable electrical codes. The international color code for identifying mains supply conductors is green/yellow, blue, and brown for earth, neutral, and line respectively. Corresponding USA/Canadian codes are green, white, and black.

CAUTION Before applying power to the instrument, check to see that the rear-panel circuit breaker CB1 is on (breaker may trip because of rough handling during transit). If the breaker trips while power is on, or if the breaker is found to be tripped at any time for unknown reasons, refer to troubleshooting procedures in the Service Manual.

Agilent Models 6033A, 6038A. The power supply is shipped from the factory with a power-cord plug appropriate for the user's location. Figure 2-2 illustrates the standard configuration of power-cord plugs used by Agilent Technologies. With each drawing is the Agilent Part Number for a replacement power cord equipped with a plug of that configuration. If a different power cord is required, contact the nearest Agilent Technologies Sales and Service office.

To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument panel and cabinet be grounded. This supply is equipped with a three-conductor power cable; the third conductor is the ground conductor. When the cable is plugged into an appropriate receptacle the supply is grounded. In no event shall this supply be operated without an adequate cabinet ground connection.

The offset pin on the standard power cable three-prong connector is the ground connection. If a two-contact receptacle is encountered, it must be replaced with a properly grounded three-contact receptacle in accordance with the National Electrical Code, local codes and ordinances. The work should be done by a qualified electrician.

Note Generally, it is good practice to keep the ac input lines separated from signal lines.

Line Voltage Option Conversion

CAUTION Conversion to or from 100 V operation requires recalibration and replacement of internal components in addition to the line voltage components, and is to be done only at the factory. Failure to reconfigure and recalibrate the power supply may result in damage to the unit.

Agilent Models 6030A, 6031A, 6032A, 6035A. Line voltage conversion is accomplished by adjusting three components: a two-section line select switch, and a line-voltage jumper. To convert the supply from one line voltage option to another, proceed as follows:

WARNING Some components and circuits are at ac line voltage even with the LINE switch off. To avoid electric shock hazard, disconnect line cord and load, and wait two minutes before removing cover.

a. Remove the outside cover by removing the four screws that hold the carrying straps, spread the bottom of the cover slightly and carefully slide the cover to the rear of the supply until it is clear. Next remove the top inside cover by removing the nine screws, four on top, three on right side, and two on left side, which connect the top inside cover to the supply chassis.

b. Use a small-blade screwdriver to set the two switch sections of S2 to match the pattern silk-screened on main board for nominal line voltage to be used. For example, to set switches for 120 V operation, move forward switch section so that its white slot is toward front of supply and move rearward switch section so that its white slot is toward rear of the instrument.

c. Set switch S1 to match the rearward section of S2, i.e., toward the rear for 100/120 V operation, toward the front for 220/240 V operation.

d. One end of W1 is soldered to the main board; the other end has a female quick-connect terminal that fits onto one of two terminals soldered to the main board. For 100 V or 120 V operation, W1 must be connected to terminal J9; for 220 V or 240 V operation, W1 must be connected to terminal J10. Be certain that jumper is firmly mated with connector on main board. Do not grip jumper insulation with pliers; either grip jumper wire by hand or grip jumper terminal with pliers.

e. Replace the inside top cover and the outside top cover. Mark the unit clearly with a tag or label indicating correct line voltage to be used.

f. Change line label.

Agilent Models 6033A, Agilent 6038A. Line voltage conversion is accomplished via three components; a two-section line select switch, line voltage jumper, and a rear panel fuse.

To convert the supply from one voltage to another, proceed as follows:

a. Remove the outside cover by removing the rear screw that holds the carrying strap, then carefully slide the cover to the rear of the supply until it is clear.

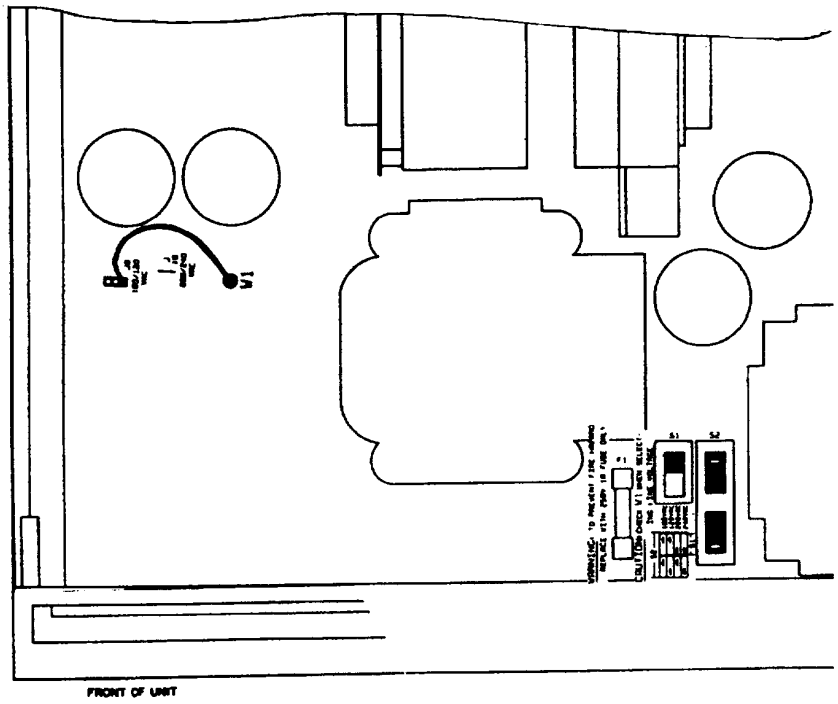
b. The line voltage select switch (S2) is located in the front left corner of the supply (see Figure 2-3). Use a small-blade screwdriver to set the two switch sections to match the pattern silk-screened on p.c. main board as shown in Figure 2-3. For example, to set switches for 120 V operation (as illustrated), move forward switch section so that its white slot is toward front of supply and move rearward switch section so its white slot is toward rear of supply.

c. One end of W5 is soldered to motherboard; the other end has a female right-angle quick-connect terminal that fits onto one of two terminals soldered to motherboard. For 100 V or 120 V operation, W5 must be connected to terminal closer to center of supply; for 220 V or 240 V operation, W5 must be connected to terminal closer to side of supply. Be certain that jumper is firmly mated with terminal on motherboard. Do not grip jumper insulation with pliers; either grip jumper wire by hand or grip jumper terminal with pliers.

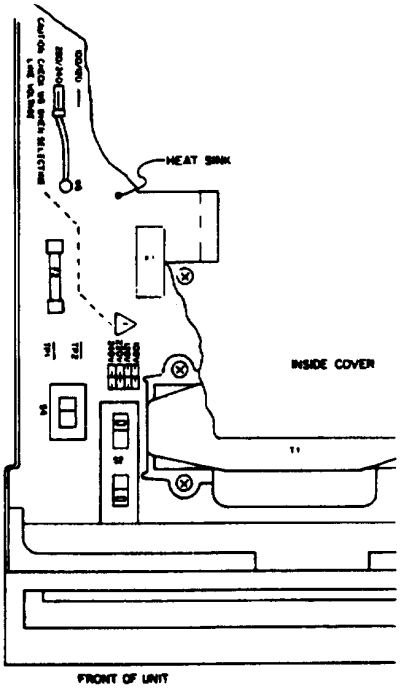
d. Check rating of fuse installed in rear-panel fuseholder. It should be 8 A for 100 or 120 Vac line voltages, or 4 A for 220 or 240 Vac line voltages. If necessary, replace the fuse with one of correct value. Do not use time-delay fuses.

    8 AM fuse, Agilent part number 2110-0383
    4 AM fuse, Agilent part number 2110-0055

e. Replace covers and mark the supply clearly with a tag or label indicated correct line voltage and fuse to be used.



AGILENT 6030A, 6031A, 6032A, 6035A



AGILENT 6033A, 6038A

Figure 2-3. Line Voltage Conversion Components

AC Line Impedance Check

The power supply is designed for proper operation with line impedance typically found in ac power lines. However, if the supply is connected to an ac power line having high impedance combined with line voltage near the minimum specified value, (e.g., 104 Vac for nominal 120 Vac), the unit will go out of regulation if it is asked to provide full rated output power. Such a situation might occur if the supply is connected to ac power an extended distance from the main ac distribution terminals and/or if the ac power wires from the main ac distribution terminals are of relatively small gauge.

Measurement of ac line voltage at the supply input terminals typically is not a reliable indication of the actual ac line voltage because of the peak clipping effect of the power supply and the averaging effect of the voltmeter. Symptoms of excessive line impedance may include erratic or no output from the supply and/or inability of the supply to provide full output power. If there is reason to suspect the ac power lines to the supply may have high impedance, perform the following check:

WARNING This check should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Turn power supply off before making or breaking connections to power supply. Hazardous voltages are present within the unit even when power switch is turned off.

a. Connect a variable load to the supply. Using the OUTPUT ADJUST controls and DISPLAY SETTINGS, set voltage and current (see Section III for detailed description) to maximum rating.

b. Set the load to the maximum rated output current for the power supply (see Table 1-1). The power supply output voltage should be greater than:

65 V for Agilent 6030A	6 V for Agilent 6033A
8 V for Agilent 6031A	220 V for Agilent 6035A
22 V for Agilent 6032A	20 V for Agilent 6038A

c. If the supply voltage is less than specified, perform the power limit calibration given in the Service Manual. If the power limit is calibrated correctly, but the unit still does not provide the required output, then the power supply is not receiving adequate ac line input.

Repackaging For Shipment

To insure safe shipment of the instrument, it is recommended that the package designed for the instrument be used. The original packaging material is reusable. If it is not available, contact your local Agilent Technologies Sales and Support office to obtain the materials. This office will also furnish the address of the nearest service office to which the instrument can be shipped. Be sure to attach a tag to the instrument specifying the owner, model number, full serial number, and service required or a brief description of the trouble.

Rear Panel Screw Sizes and Part Numbers

Refer to the following list if you need to replace any of the rear panel connection hardware. Figure 2-4 identifies the part number location.

Agilent Models 6030A, 6031A, 6032A, 6035A

Item	Description	Agilent Part number
ac input cover		5060-3237
ac input cover screws	M4 X 0.7 X 60 mm (qty 4)	0515-0156
ac input barrier block	3-terminal barrier block	0360-2217
ac input barrier block screws	8-32 X 5/16 (qty 3)	included with ac input barrier block
dc output cover		5040-1626
dc output cover screws	M4 X 0.7 X 10 mm (qty 3)	0515-0414 (washer 3050-1053)
control signal barrier block	6 - terminal barrier block	0360-2195

sense barrier block	2 - terminal barrier block	0360-2192
barrier block screws	M3.5 X 0.6 X 6 mm (qty 8)	0515-0212
FLT/INH connector	4 - terminal removable connector	1252-1488
output buss bar screws	M5 X 0.8 X 12 mm (qty 4)	0515-0155
output buss bar sense screws	M2 X 0.4 X 8 mm (qty 2)	0515-0212
red/black sense wires	wire kit	5060-2913

Agilent Model 6033A

Item	Description	Agilent Part number
barrier block cover		06023-00009
control signal barrier block	6 - terminal barrier block	0360-2195
sense barrier block	2 - terminal barrier block	0360-2192
barrier block screws	M3.5 X 0.6 X 6 mm (qty 8)	included with dc barrier blocks
FLT/INH connector	4 - terminal removable connector	1252-1488
dc output cover		0360-2191
dc output cover screws	M4 X 0.7 X 8 mm (qty 2)	0515-1085
output buss bar screws (large)	M4 X 0.7 X 8 mm (qty 2)	0515-0885
output buss bar screws (small)	M3 X 0.5 X 6 mm (qty 2)	0515-0886
sense jumpers		0360-2190

Agilent Model 6038A

Item	Description	Agilent Part number
barrier block cover		06023-00009
control signal barrier block	6 - terminal barrier block	0360-2195
barrier block screws	M3.5 X 0.6 X 6 mm (qty 6)	included with dc barrier block
FLT/INH connector	4 - terminal removable connector	1252-1488
dc output cover		0360-2191
output barrier block	6 - terminal barrier block	0360-1833
output cover screws	M5 X 0.7 X 8 mm (qty 2)	0515-1085
output barrier block screws	M3 X 0.6 X 6 mm (qty 8)	included with dc barrier blocks
sense jumpers		0360-2190

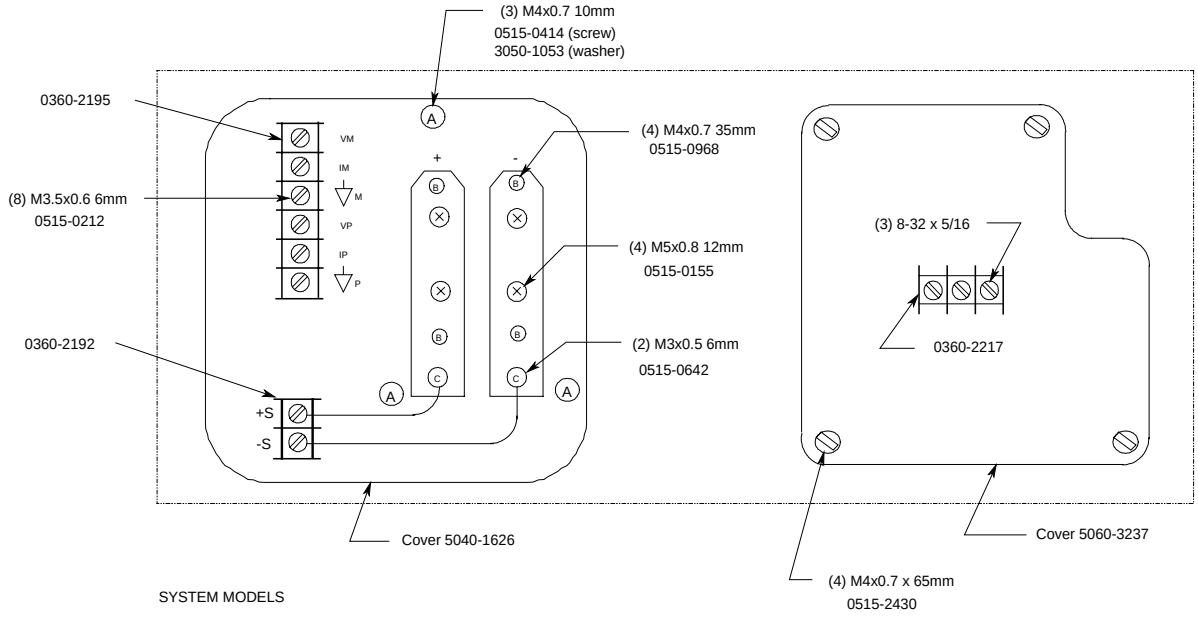


Figure 2-4. Part Number Location

3

OPERATING INSTRUCTIONS

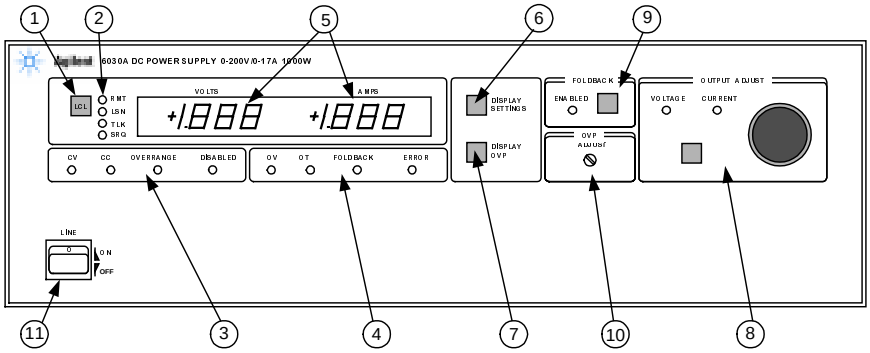
Introduction

This section describes the operating controls and indicators, turn-on checkout procedures, and operating procedures and considerations for the power supply. Local (front-panel) and remote (via GP-IB) operation are described separately, but the user should become familiar with both methods of operation. Information in pages 1-43 of this section applies to both local and remote operation.

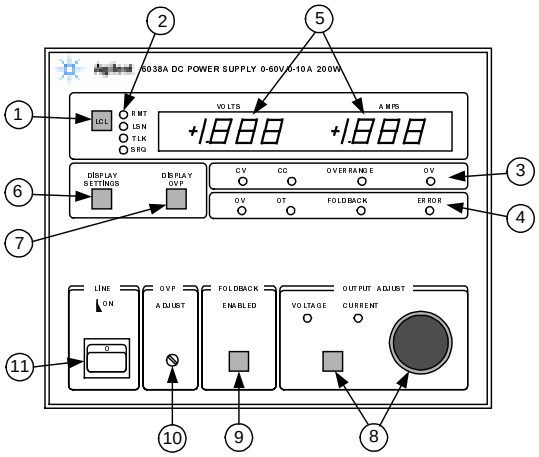
Standard Commands for Programming Instruments (SCPI) programming is described in Appendix C at the rear of this manual.

Programming examples for specific Agilent Technologies computers are given in Appendix D. More theoretical descriptions regarding the operational features of power supplies in general are given in the DC Power Supply Handbook, Application Note 90B (available at no charge from your local Agilent Technologies Sales Support Office).

Figure 3-1. Front-Panel Controls and Indicators



6030A, 6031A, 6032A, 6035A



6033A, 6038A

WARNING Before the instrument is turned on, all protective earth terminals, extension cords, and devices connected to the power supply should be connected to a protective earth ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

CAUTION This instrument can be damaged by electrostatic discharge into the GP-IB and control connectors, or the switches on the rear panel *while the unit is turned on*. Do not cause an electrostatic discharge into these connectors and switches (which may occur when they are touched) while the unit is turned on.
Also, consistent with good engineering practice, leads attached to customer accessible signal/monitoring ports should be twisted and shielded to maintain the instruments specified performance.

Controls and Indicators

The front-panel controls and indicators are shown in Figure 3-1 and described in Table 3-1. Table 3-1 also lists the paragraphs, in which, use of the controls and indicators is described.

Output Range For An Autoranging Power Supply

The power supply can operate as a constant voltage (CV) or constant current (CC) source over a wide range of output voltage and current combinations. The specifications table contains a graph showing the overall output range of the power supply. Figure 3-2 shows a rectangular operating locus that is defined by voltage and current settings of the power supply. The point on that locus at which the power supply actually operates is determined by the load resistance. Three load-resistance lines are shown on Figure 3-2. The line representing load resistance A, the highest load resistance shown on the graph, crosses the operating locus at point 1. Point 1 is on the part of the operating locus defined by the voltage setting, so the power supply operates in CV mode.

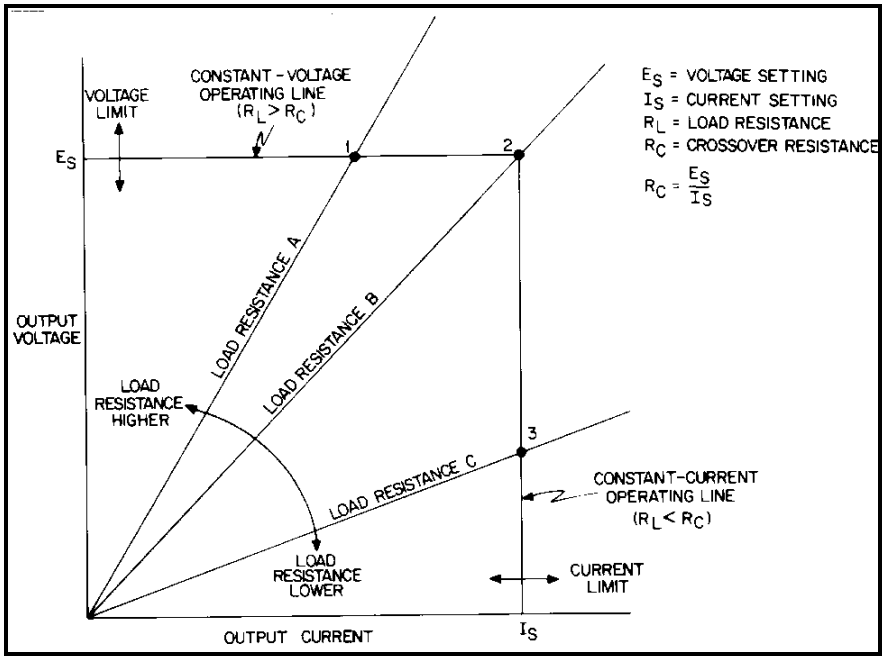


Figure 3-2. Determining Operating Point

Similarly, the line representing load resistance C, the lowest load resistance shown on the graph, crosses the operating locus at point 3. Point 3 is on the part of the operating locus defined by the current setting, so the power supply operates in CC mode.

Load Resistance B equals the crossover resistance for the particular combination of voltage and current settings shown on the graph. Either the CV or CC LED will light. If the load resistance increases, the voltage setting decreases, or the current setting increases, the power supply will operate in CV mode. Conversely, if the load resistance decreases, voltage setting increases, or current setting decreases, the power supply will operate in CC mode.

In Figure 3-2 the entire rectangular operating locus falls within the output range of the power supply. Figure 3-3 shows a situation in which the voltage and current settings are high enough that the rectangular operating locus is cut off by the maximum output power boundary of the power supply. For the load resistance A, the power supply operates in CV mode at the voltage and current values for point 1. Similarly, for load resistance D the power supply operates in CC mode at point 4.

For load resistances between B and C, the operating point will be on the maximum output-power boundary between points 2 and 3, and the OVERRANGE LED will be on. The VOLTS and AMPS displays will indicate the voltage and current being supplied to the output. (The product of the two readings will exceed rated output power of the supply.) Note that the actual boundary is beyond the specified minimum boundary. The OVERRANGE LED will light only if the actual boundary is exceeded.

The supply can operate in the overrange region for sustained periods without being damaged. However, the supply is not guaranteed to meet specifications in overrange. Output ripple increases substantially and regulation is seriously degraded.

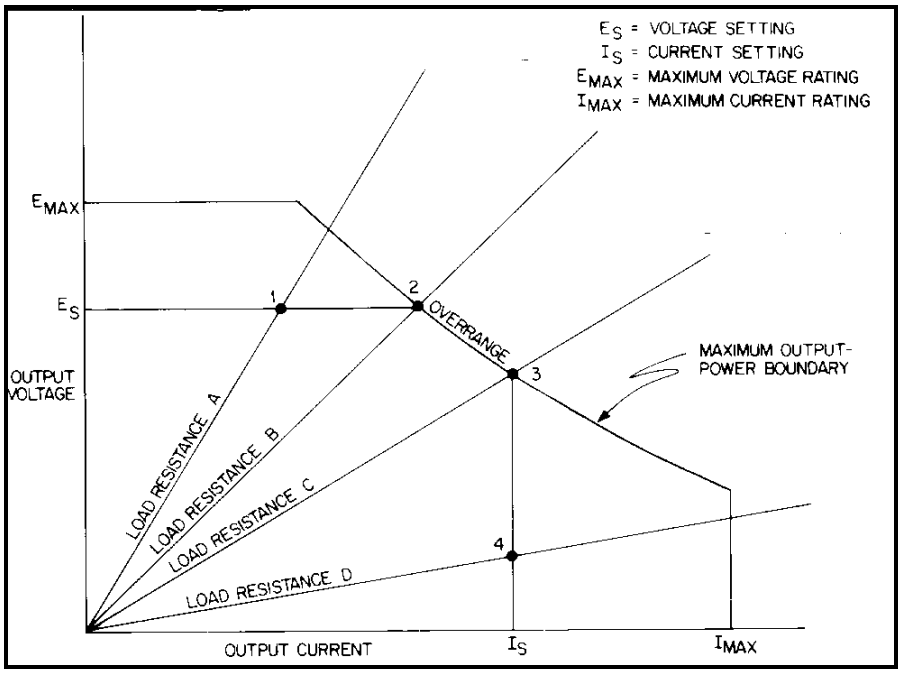


Figure 3-3. Overrange Operation

Table 3-1. Controls and Indicators

Number	Controls/Indicators	Description	Page
1	LCL Pushbutton	Returns unit to local control (unless local lockout has been received via GP-IB). In local, power supply remains subject to remotely programmed soft limits and delays. When held in for one second, LCL causes GP-IB address to be displayed for up to two seconds or until LCL switch is released.	44

Table 3-1. Controls and Indicators (continued)

Number	Controls/Indicators	Description	Page
2	GP-IB Status Indicators These four LEDs indicate the status of the power supply on the GP-IB.	RMT (green) indicates that power supply is under remote (GP-IB) control. LSN (green) indicates that power supply is addressed to listen. TLK (green) indicates that power supply is addressed to talk. SRQ (green) indicates that power supply is requesting service from controller.	43 45 45 45
3	Power Supply Status Indicators (Primary) These four LEDS indicate the operating state of the power supply. One and only one LED will be on at all times.	CV (green) indicates that the power supply is regulating its output at a constant voltage. CC (green) indicates that the power supply is regulating its output at a constant current. OVERRANGE (yellow) indicates that the power supply is operating beyond its maximum output power specification and that the output is not regulated. DISABLED (yellow) indicates that the power supply output has been turned off for one of these reasons: a. command from controller b. overvoltage protection c. overtemperature protection d. foldback protection e. low or high ac input voltage f. remote inhibit (INH)	35 35 31 42
4	Power Supply Status Indicators (Secondary) These four LEDs indicate the state of protective circuits within the power supply.	OV (yellow) indicates that the overvoltage protection circuit has disabled the output and is latched. OT (yellow) indicates that the overtemperature protection circuit has disabled the output. FOLDBACK (yellow) indicates that the foldback protection circuit has disabled the output and is latched. ERROR (yellow) indicates that the power supply has detected a programming error. If user attempts to exceed soft limits locally (using RPG), ERROR will light while RPG is being rotated and will remain on for approximately 1 second after rotation stops. For remote programming error, ERROR will turn off when error query is received.	35 42 39 35

Table 3-1. Controls and Indicators (continued)

Number	Controls/Indicators	Description	Page
5	Numeric Display	Two 3-1/2 digit alphanumeric displays with automatically positioned decimal point that ordinarily indicate output VOLTS and AMPS (see items 6 & 7). When power supply is turned on all segments light for approximately 1 second. During an error condition, power supply output may exceed display range; displays will indicate + OL or - OL.	33
6	DISPLAYS SETTINGS Pushbutton Switch	Causes numeric displays to indicate programmed voltage and current values, rather than actual output values; allows both settings to be made without the necessity of opening or shorting load.	35
7	DISPLAY OVP Pushbutton Switch	Causes VOLTS display to indicate OVP trip voltage, AMPS display is blanked; allows setting to be made without changing output settings or load connections.	38
8	OUTPUT ADJUST Controls - Rotary Pulse Generator (RPG) and pushbutton switch	OUTPUT ADJUST knob functions either as a voltage control or a current control, as determined by the pushbutton switch and indicated by whichever (green) indicator, VOLTAGE or CURRENT, is on. Knob functions as a two-speed device; faster rotation causes greater rate of change per revolution. OUTPUT ADJUST controls operate only when unit is under local control.	38
9	FOLDBACK Control	The pushbutton switch toggles foldback protection on and off in local operation; has no effect if power supply is not in CV or CC (ERROR LED flashes), or is in remote. Switch also resets foldback protection circuit if it has disabled power supply output. FOLDBACK ENABLED LED (green) operates in either local or remote.	39
10	OVP ADJUST	The recessed, single-turn screwdriver control sets the overvoltage protection trip voltage.	43
11	LINE Switch	Turns ac power on and off.	34

NOTE Under certain conditions of line and load, it is possible for the supply to provide more than rated output power and still maintain regulation. If this occurs, the unit will operate normally and the OVERRANGE indicator will be off. However, the slightest change in either line or load may cause the unit to go out of regulation. Operation of the unit beyond the rated-output-power boundary is not recommended under any circumstances.

Turn-On Checkout Procedure

The power supply performs a series of self tests each time power is turned on. All front-panel LEDs, including all meter segments, are also turned on. The tests take approximately one second to complete, and all indicators remain on while the tests are running. This alerts the operator that self tests are running, and allows the operator to note if any indicators are inoperative.

After the self tests are completed all front-panel indicators are turned off for one-half second, allowing the operator to note if any are stuck on. If the operator suspects that any indicator may be malfunctioning he should turn power off and back on again while observing that indicator.

Once the all-indicators-off period is over, the GP-IB address switch setting is displayed on the meter displays for one second. For example, if the address switches were set for address 5, the display would be: Adr 5

If the unit fails any of the self tests an error code is displayed on the meter displays. The unit will not respond to any commands, either from the front panel or GP-IB, and it should be removed for service. See the Service manual for a listing of the self test failure codes.

NOTE Because the power supply is testing itself, it is not possible to guarantee that the unit will provide an unambiguous indication of all possible failures. For example, a failure in the core of the microcomputer or in the hardware used to light the front-panel display may prevent the unit from indicating that it has failed a test.

The following procedure ensures that the supply is operational, and may be used as an incoming inspection check. Ensure that the rear-panel mode switches are set as shown in Figure 3-4, and that the sensing jumpers are tightened securely. Check that the rear-panel label indicates that the supply is set for the line voltage to be used. There should be no cables connected to the rear panel GP-IB connector. Check that the recessed OVP ADJUST control on the front panel is fully clockwise. The GP-IB address switches may be set to any address from 0 to 30 for this procedure.

NOTE +Sense lead is jumpered to + out and - sense lead is jumpered to - out lead at the factory.

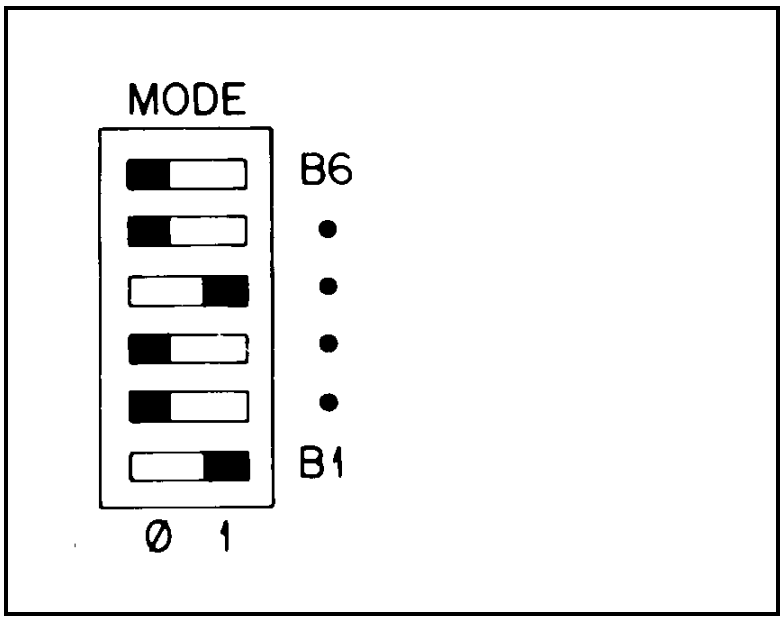


Figure 3-4. Factory Settings, Mode Switch

a. Press top of LINE rocker switch in to turn supply on. Fan should operate. Check that display shows GP-IB address set by rear-panel switches. After address display, CURRENT indicator should remain on and either CV or CC indicator should remain on. (SRQ indicator will remain on if rear-panel PON SRQ switch has been set to 1.)

b. Press momentary-contact DISPLAY SETTINGS pushbutton switch and check that VOLTS display indicates 0.00 and AMPS display indicates 0.00.

c. Press momentary-contact DISPLAY OVP pushbutton switch and check that VOLTS display indicates maximum OVP for the power supply.

d. Turn OUTPUT ADJUST knob clockwise, press DISPLAY SETTINGS switch, and check that AMPS setting has increased. CV indicator should be on and CC indicator should be off.

e. Press momentary-contact OUTPUT ADJUST pushbutton switch once; VOLTAGE indicator should turn on and CURRENT indicator should turn off.

f. Turn OUTPUT ADJUST knob clockwise and check that output voltage increases from zero to full output voltage as indicated on VOLTS display. Continued clockwise rotation may cause VOLTS display to indicate + OL, and ERROR indicator will light (turns off one second after clockwise rotation stops).

g. Check overvoltage protection circuit by turning OVP ADJUST control counterclockwise until OVP circuit trips. Output should drop to 0 V, CV indicator turns off, and DISABLED and OV indicators turn on (SRQ and VOLTAGE indicators remain on).

h. Reset OVP circuit by turning OVP ADJUST control fully clockwise and turning unit off and back on. Output voltage should come on at 0 volts.

i. To check constant current circuit, turn power supply off and short rear panel + and - output terminals with a wire of sufficient gauge to carry the supply's maximum current output (see Table 3-3).

j. Turn power supply on and press OUTPUT ADJUST switch once to turn on VOLTAGE indicator. Turn OUTPUT ADJUST knob clockwise, press DISPLAY SETTINGS switch, and check that VOLTS setting has increased. CC indicator should be on and CV indicator should be off.

k. Press OUTPUT ADJUST switch once; CURRENT indicator should turn on and VOLTAGE indicator should turn off.

1. Turn OUTPUT ADJUST knob clockwise and check that output current increases from zero to full output current as indicated on AMPS display. Continued clockwise rotation may cause AMPS display to indicate + OL, and ERROR indicator will light (turns off one second after clockwise rotation stops).

m. Turn off power supply, remove short from output, and read following instructions before connecting load to supply.

Initial Setup and Interconnections

WARNING Turn off input ac power before changing any rear-panel connection and make certain all wires and straps are properly connected and terminal block screws are securely tightened before reapplying power. Be certain to replace both terminal block covers before reapplying power to avoid exposing hazardous voltage.

Connecting the Load

Load connections to the power supply are made at the + and - terminals on the rear panel. Two factors must be considered when selecting wire size for load connections, conductor temperature and voltage drop.

To satisfy safety requirements, the wires to the load should be at least heavy enough not to overheat while carrying the power supply output current that would flow if the load were shorted. Use Tables 3-2 and 3-3 to determine the proper wire gauge for load connections to the power supply.

The wires must be properly terminated with connectors securely attached. Do not connect unterminated wires to the power supply.

The minimum wire size required to prevent overheating will not usually be large enough to provide good voltage regulation at the load. For proper regulation the load wires should be large enough to limit the voltage drop to no more than 0.5 volts

per lead. Table 3-2 lists resistivity for various wire sizes and the maximum lengths that may be used to limit voltage drop to 0.5 volts for various currents. Lengths listed are the sum of the lengths of the (+) and (-) load wires. Lengths are given in meters and (feet).

To determine maximum lengths (in meters or feet) for currents not listed, use the formula:

$$\text{maximum length} = \frac{500}{\text{current x resistivity}}$$

where current is expressed in amps and resistivity is expressed in ohms/kilometer or ohms/1000 feet. If load regulation is critical, read Remote Voltage Sensing in the following section.

Table 3-2. Maximum Wire Lengths To Limit Voltage Drops

Wire Size		Resistivity		Maximum Length In Meters (Feet)To Limit Voltage Drop To 0.5V Or Less		
AWG	Cross-Section Area In mm^2	Ω/kft	Ω/km	5 A	10A	17 A
22		16.15		(6.19)	(3.09	(1.82)
	0,5		40.1	2,5	1.2	.73
20		10.16		(9.8)	(5)	(2.8)
	0,75		26,7	3,7	1,8	1.1
18		6.388		(15.6)	(7.8)	(4.6)
	1		20,0	5,0	2,5	1.4
16		4.018		(24.8)	(12.4)	(7.3)
	1,5		13,7	7,3	3,64	2.1
14		2.526		(40)	(19.7)	(11.6)
	2,5		8,21	12,2	6,1	3.5
12		1.589		(62.9)	13.46)	(18.5)
	4		5,09	19.6	9,8	5.7
10		.9994		(100)	(50)	(29.4)
	6		3,39	29.5	14,7	8.6
8		0.6285		(160)	(79.5)	(46.7)
	10		1,95	51,2	25,6	15
6		0.3953		(252)	(126.5)	(74.4)
	16		1,24	80.6	40,3	23.7
4		0.2486		(402)	(201)	(118)
	25		0,795	125.7	62.8	37
2		0.1564		(639)	(319)	(188)
	35		0,565	176.9	88.5	52
	50		0,393	254.4	127	74.8
0		0.09832		(1017)	(508)	(299)
Wire sizes of AWG #14 ($2,5mm^2$) or smaller are normally used only for sense leads.						

WARNING Remember while calculating load wire size that the wire must be large enough not to overheat while carrying the current that would flow if the load were shorted.

Table 3-3 lists current-carrying capacity (ampacity) for various sizes of stranded copper wire.

The bus bars are covered by an impact-resistant plastic cover, which is secured to the unit with four M4 x 8 screws. Be certain to replace the cover after making connections.

If multiple loads are connected to one supply, each load should be connected to the supply's output terminals using separate pairs of connecting wires. This minimizes mutual coupling effects and takes full advantage of the supply's low output impedance. Each pair of connecting wires should be as short as possible and twisted or shielded to reduce noise pickup and radiation.

If load considerations require the use of output distribution terminals that are located remotely from the supply, then the power supply output terminals should be connected to the remote distribution terminals by a pair of twisted or shielded wires and each load should be separately connected to the remote distribution terminals. Remote voltage sensing is required under these circumstances (page 39). Sense either at the remote distribution terminals, or (if one load is more sensitive than the others) directly at the most critical load.

Table 3-3. Stranded Copper Wire Ampacity

Wire Size		Ampacity	NOTES:
AWG	**Cross Section Area in mm^2**		
22		5.0	1. Ratings for AWG-sized wires are derived from MIL-W-5088B. Ratings for metric-sized wires are derived from IEC Publication 335-1.
20		8.33	
	0,75	10	
18		15.4	
	1	13.5	2. Ampacity of aluminum wire is approximately 84% of that listed for copper wire.
16		19.4	
	1.5	16	
4		31.2	3. When two or more wires are bundled together, ampacity for each wire must be reduced to the following percentages:
	2.5	25	
12		40	
	4	32	2 conductors 94%
10		55	3 conductors 89%
6		40	4 conductors 83%
8		75	5 conductors 76%
	10	63	
6		100	4. Maximum temperatures: Ambient, 50°C; Conductor, 105°C
4		135	
2		180	
0		245	

Either positive or negative voltages can be obtained from the supply by grounding one of the output terminals. It is best to avoid grounding the output at any point other than the power supply output terminals to avoid noise problems caused by common-mode current flowing through the load leads to ground. Always use two wires to connect the load to the supply regardless of where or how the system is grounded. Never ground the system at more than one point. The maximum potential (including output voltage) that either output terminal is from ground must not exceed that specified on the output label on the rear chassis.

The PARD specifications in Table 1-1 apply at the power supply output terminals. However, noise spikes induced in the load leads at or near the load may affect the load although the spikes are inductively isolated from the power supply. To minimize voltage spikes at the load, connect a bypass capacitor as shown in Figure 3-5. With this setup, peak-to-peak noise at the load can actually be reduced to a level well below the value specified at the power supply output terminals.

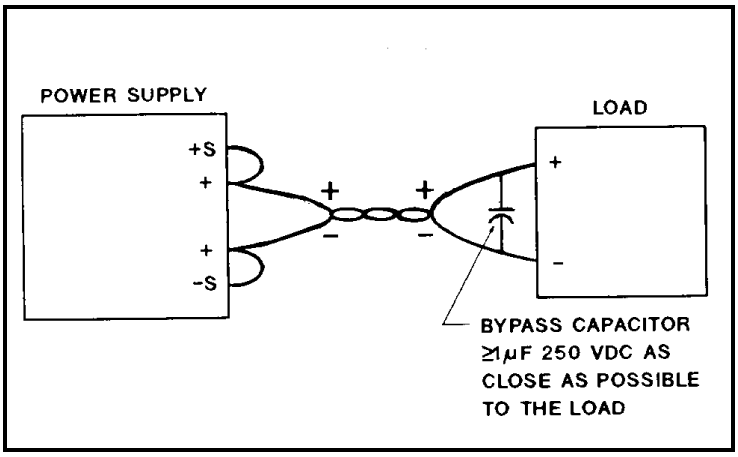


Figure 3-5. Connecting a Bypass Capacitor

Overvoltage Protection (OVP)

The overvoltage trip point is adjusted at the front panel. The approximate trip voltage range is from zero volts to approximately 107% of maximum rated voltage of the power supply. When the OVP circuit trips, the power supply output is disabled and delivers no output power, and the OVP and DISABLED indicators turn on.

Adjustment. OVP is set by the recessed single-turn OVP ADJUST potentiometer on the front panel. Rotating the control clockwise sets the trip voltage higher. (It is set to maximum at the factory.) When adjusting the OVP trip point, the possibility of false tripping must be considered. If the trip voltage is set too close to the supply's operating voltage, a transient in the output would falsely trip the OVP. For this reason it is recommended that the OVP trip voltage be set higher than the output voltage by at least 1 volt (see NOTE on the following page). To adjust the OVP trip voltage, proceed as follows:

a. Turn on supply and hold DISPLAY OVP pushbutton in.

b. Insert a small-blade screwdriver through hole in front panel and adjust OVP trip voltage to desired level.

OVP Reset. To reset OVP locally, turn the LINE switch off and then back on. OVP can also be reset via GP-IB by sending RST. The cause of the overvoltage must be removed before the OVP circuit is reset or the circuit will trip again immediately. If the OVP circuit trips continuously check the load and the trip voltage.

Foldback Protection

In some applications either CV or CC mode may be regarded as an error condition. The foldback protection feature protects sensitive loads by disabling the power supply output if the unit switches to the prohibited mode.

In local control, foldback protection is toggled on or off by the FOLDBACK pushbutton switch. The output will be disabled if the power supply switches from whichever mode (CV or CC) is in operation when foldback is enabled to the other mode. In addition to turning foldback protection on and off, the FOLDBACK pushbutton switch also resets the foldback protection circuit if it has tripped. The conditions which caused foldback should be corrected before the circuit is reset, or the foldback protection circuit will trip again after reset.

NOTE If the foldback protection circuit has tripped and you want both to reset the circuit and disable foldback protection, you must press the FOLDBACK switch twice in rapid succession, once to reset the foldback protection circuit and the second time to turn off foldback protection before it trips again.

The green FOLDBACK ENABLED LED lights to indicate that foldback protection is enabled; the yellow FOLDBACK LED lights to indicate that the foldback protection circuit has tripped. Note the ERROR LED will light if an attempt is made to turn on foldback protection while the power supply is not in CV or CC mode.

When enabled via GP-IB foldback protection can be enabled for either mode, regardless of the operating state of the power supply when the command is received.

Remote Voltage Sensing

Because of the unavoidable voltage drop developed in the load leads, the strapping pattern shown in Figure 3-4 will not provide the best possible voltage regulation at the load. The remote sensing connections shown in Figure 3-6 improve the voltage regulation at the load by monitoring the voltage there instead of at the supply's output terminals. Remote sensing allows the power supply to automatically increase the output voltage and compensate for the voltage drops in the load leads. This improves the voltage regulation at the load, and is especially useful for CV operation with loads that vary and have significant load-lead resistance. Note that with remote sensing, voltage readback is at the load. Remote sensing has no effect during CC operation. When using remote sensing, turn off the power supply before changing the rear-panel straps, sense leads, or load leads. Connect the unit for remote voltage sensing by connecting load leads from + OUT and - OUT terminals to the load, disconnecting straps between + Out and + S and between - Out and - S, and connecting sense leads from the + S and - S terminals to the load as shown in Figure 3-6.

NOTE Sensing is independent of other power supply functions; either local or remote sensing can be used regardless of how the power supply is programmed.

The load leads should be of the heaviest practical wire gauge, at least heavy enough to limit the voltage drop m each lead to 0.5 volts. The power supply has been designed to minimize the effects of long load-lead inductance, but best results will be obtained by using the shortest load leads practical.

NOTE Remote voltage sensing compensates for a voltage drop of up to 0.5 V in each lead, and there may be up to a 0.12 V drop between the -output terminal and the internal sensing resistor, at which point the OVP circuit is connected. Therefore, the voltage sensed by the OVP circuit could be as much as 1.12 V more than the voltage being regulated at the load. It may be necessary to readjust the OVP trip voltage when using remote sensing.

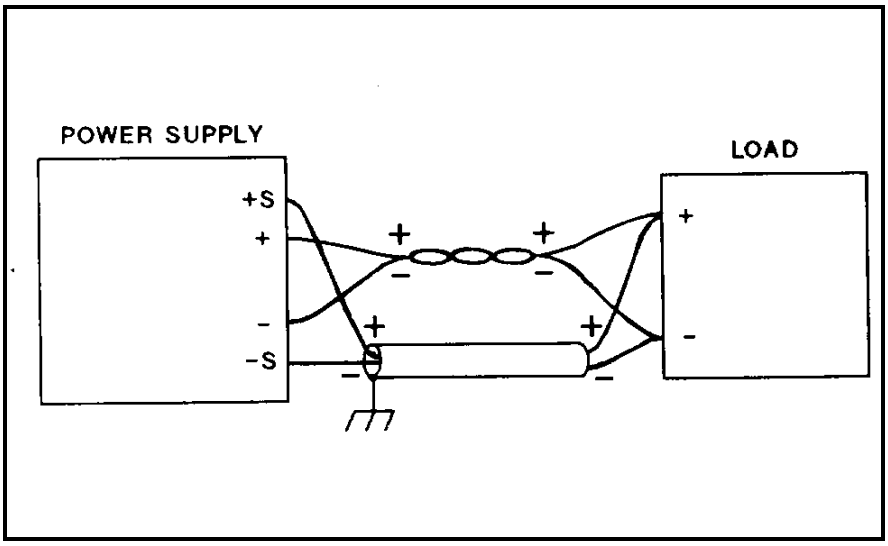


Figure 3-6. Remote Voltage Sensing

Because the sensing leads carry only a few milliamperes, the wires used for sensing can be much lighter than the load leads. Each sense lead should have no more than 0.2 ohms resistance. Use the resistivity columns in Table 3-2 to determine the minimum wire size for the length of sense leads being used. The sense leads should be a shielded, twisted pair to minimize the pickup of external noise. Any noise picked up on the sensing leads will appear at the supply's output, and CV load regulation may be adversely affected. The shield should be grounded at the power supply end only, and should not be used as one of the sensing conductors. The sensing leads should be connected as close to the load as possible.

If slightly degraded CV load regulation can be tolerated, the power supply will provide remote voltage sensing with up to 2 Vdc drop in each load lead and with more than 0.2 ohms resistance in each sense lead. As the voltage drop in the load leads increases, the load voltage error due to sense-lead resistance increases according to the formula:

$$\frac{(2Rs + .5)\ V1}{1000}$$

where Rs is the resistance in ohms of each sense lead and Vl is the voltage drop in each load lead. For example, if the resistance in each sense lead is 1 ohm and the voltage drop in each load lead is 2 Vdc, the load voltage might differ by [2(1) +.5]2/1000 = 5 mVdc from that with no sense-lead.

The sensing leads are part of the supply's programming circuits, so they should be connected in such a way as to make it unlikely that they might inadvertently become open circuited. If the sense leads open during operation, the voltage at the load will rise slightly above its programmed value.

NOTE The power supply includes protection resistors which reduce the effect of open sense leads during remote-sensing operation. If the + S lead opens, the output voltage is sensed between the + OUT terminal and the negative side of the load. If the - S lead opens the output voltage is sensed between the positive side of the load and - OUT. If both sense leads open, the output voltage is sensed locally.

Mode Switches

Figure 3-4 shows six switches on the rear panel that configure the power supply for digital programming (either GP-IB or front-panel RPG) or analog programming (resistance or voltage). (Note that front panel programming is digital; the rotary pulse generator (RPG) produces pulses that are monitored by the microprocessor, which then raises or lowers the digital input to the DACs that control the power supply output.) Table 3-4 shows the proper switch settings for each programming mode. When shipped from the factory the switches are set for GP-IB/front-panel-RPG programming, which is the normal operating mode for this power supply. The two analog programming modes are available for use in special circumstances.

Table 3-4. Mode Switches

Mode Switches		Programming Mode		
		GP-IB/RPG	Voltage	Resistance
	B6	0	0	1
CV	B5	0	0	0
Circuits	B4	1	0	0
	B3	0	0	1
CC	B2	0	0	0
Circuits	B1	1	0	0

Typically, only one programming mode is used for both output parameters (voltage and current). However, the mode switches allow voltage and current to be programmed independently. For example, voltage could be programmed digitally, either via GP-IB or front panel, while current is resistance programmed. Note that only one programming mode can be used for each parameter at one time. (For example, it is not permissible to superimpose an analog programming voltage on the digital programming signal. To do so will cause programming errors.)

GP-IB Connection

Connections between the power supply and the GP-IB are made via the GP-IB connector on the rear panel. Figure 3-7 shows the signals at each of the GP-IB connector pins. The GP-IB connectors table in Section 1 lists cables and cable accessories that are available from Agilent. The GP-IB connector uses metric threads.

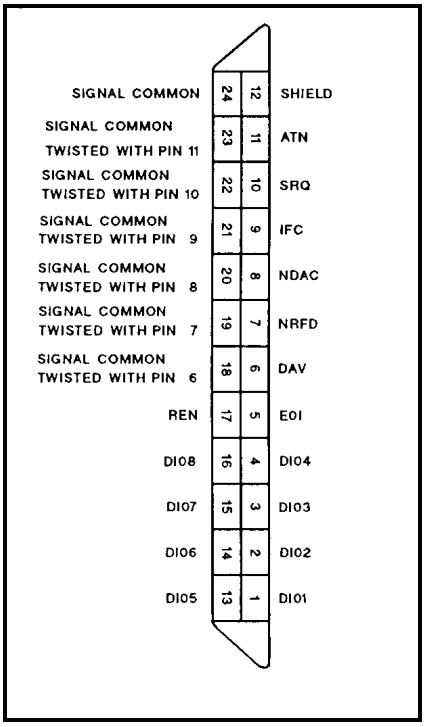


Figure 3-7. GP-IB Connector

An GP-IB system may be connected together in any configuration (star, linear or combination) as long as the following rules are followed:

1. The total number of devices is no more than 15.
2. The total length of all the cables used is no more than two meters times the number of devices connected together, up to an absolute maximum of 20 meters. (The length between adjacent devices is not critical as long as the total accumulated cable length is no more than the maximum allowed.)

NOTE IEEE Std 488.1-1987 states that caution should be taken if individual cable length exceeds 4m.

It is recommended that no more than three connector blocks be stacked together, as the resultant leverage can exert excessive force on the mounting panels. Be certain that all connectors are full seated and that the lock screws are firmly finger tightened. Do not use a screwdriver. The screwdriver slots in the lock screws are provided for removal only.

Page 44 provides information for operating the power supply in a GP-IB system. The Tutorial Description of the Agilent Technologies Interface Bus and other documents listed in Section 1 provide additional information that may be helpful when designing a GP-IB system.

Monitor Signals

Amplified and buffered voltage and current monitor output signals are available at the rear-panel terminal strip. These signals can be connected to remote meters to indicate output voltage and current. The signals vary from 0 to 5 volts to indicate a zero to full-scale output. Both monitor-output terminals are referenced to the monitor-common terminal. Output impedance of the monitor terminals is 10.2 k ± 5%; a load of 1 megohm will maintain 1% reading accuracy.

CAUTION The common terminal (M) is internally connected to the **minus** (-) output terminal.

Protective Circuits

Protective circuits within the power supply may limit or turn off the output in case of abnormal conditions. The cause of the protective action can be determined by observing the front panel indicators (lights and meters).

Overrange. If an overrange condition exists (load tries to draw more power than the supply can deliver), the OVERRANGE indicator turns on and both the CV and CC indicators are off. The product of the VOLTS and AMPS displays will exceed the maximum output power of the supply.

Disabled. If the power supply output is disabled, either by a command from GP-IB, by protective circuits within the supply, or by the INH input, the power supply output drops to zero and the DISABLED indicator turns on. The power supply can be disabled by overvoltage, overtemperature, or foldback (indicated by front-panel LEDs), by low or high ac line (mains) voltage, or externally via the remote inhibit (INH) input, by command from the controller (see Page 58).

Overvoltage. If the voltage across the power supply output terminals rises above a preset level, possibly because of a hardware malfunction, the overvoltage protection (OVP) circuit will trip. If this occurs, the power supply will be disabled and the OV indicator turned on. To reset the OVP circuit, first ensure that the condition that caused the overvoltage is corrected. Then turn the power supply off and back on. or reset OVP via the GP-IB.

Overtemperature. If the overtemperature protection circuit trips, the power supply will be disabled and the OT indicator turned on. The overtemperature circuit will reset automatically and the power supply output will be restored when the temperature drops sufficiently for safe operation.

AC Line Over/Under Voltage. If the ac line (mains) input voltage increases or decreases beyond the range for safe operation the power supply output may be disabled. The power supply output will be restored when the input voltage is within range.

Foldback. If foldback protection is enabled (FOLDBACK ENABLED LED on) and the power supply switches to the prohibited mode (CV or CC), the power supply output will be disabled and the FOLDBACK indicator turned on. Press the FOLDBACK pushbutton switch to reset the foldback protection circuit and restore the power supply output. Unless the conditions (voltage setting, current setting, load resistance) that caused foldback are changed, the circuit will trip again when the output is restored. Pressing the FOLDBACK switch a second time after resetting foldback will turn off foldback protection if desired.

Error. If the power supply receives an invalid command (syntax error, out of range), either locally or via GP-IB, the ERROR indicator turns on. The power supply ignores the invalid command and remains at previously set values. If the error was an attempt to exceed output limits using the front-panel OUTPUT ADJUST control (RPG), ERROR will turn off one second after RPG rotation stops.

Local Operation

The power supply is configured for local operation when the unit is turned on. Output voltage and current are both set to zero, and the OUTPUT ADJUST knob is configured to adjust output current (CURRENT indicator is on). Pressing the OUTPUT ADJUST pushbutton switch alternately configures the OUTPUT ADJUST knob to adjust output voltage and current, as indicated by the VOLTAGE and CURRENT indicators. Note that the OUTPUT ADJUST knob will vary whichever output parameter, voltage or current, is indicated by the VOLTAGE and CURRENT indicators, even when the other parameter is limiting the output.

By pressing the DISPLAY SETTINGS pushbutton switch the operator can observe the setting (limits) of both output parameters, rather than the actual output values. This allows the operator to set the current limit when the power supply is operating m CV mode, or set the voltage limit while in CC mode, without the necessity of disconnecting or adjusting the load.

When the power supply is under remote control (RMT indicator on), neither the VOLTAGE or CURRENT indicator is on and the OUTPUT ADJUST knob has no effect.

Constant Voltage Operation

To set up the power supply for constant voltage operation:

a. With power supply turned off, connect load to output terminals.

b. Turn on power supply. Hold in DISPLAY OVP pushbutton switch and set OVP ADJUST potentiometer for desired OVP trip voltage.

c. Ensure that CURRENT indicator is on, hold DISPLAY SETTINGS pushbutton switch in and rotate OUTPUT ADJUST knob to set desired current limit.

d. Press OUTPUT ADJUST switch once so that OUTPUT ADJUST knob controls voltage, and adjust output voltage to desired level.

e. If foldback protection is desired, press FOLDBACK pushbutton switch to enable this feature.

f. If a load change causes the current limit to be exceeded, the power supply automatically crosses over to constant current operation and the output voltage drops proportionately. If foldback protection is enabled, mode crossover causes the power supply output to be disabled. In setting the current limit, make adequate allowance for high current peaks that could cause unwanted mode crossover.

Constant Current Operation

To set up the power supply for constant current operation:

a. With power supply turned off, connect load to output terminals.

b. Turn on power supply. Hold in DISPLAY OVP pushbutton switch and set OVP ADJUST potentiometer for desired OVP trip voltage. In CC mode the voltage setting will limit output voltage under quiescent conditions, and the OVP circuit provides added protection against hardware faults.

c. Press OUTPUT ADJUST pushbutton switch once so that VOLTAGE indicator turns on, hold DISPLAY SETTINGS pushbutton switch in, and rotate OUTPUT ADJUST knob to set desired voltage limit.

d. Press OUTPUT ADJUST switch once so that OUTPUT ADJUST knob controls current, and adjust output current to desired level.

e. If foldback protection is desired, press FOLDBACK pushbutton switch to enable this feature.

f. If a load change causes the voltage limit to be exceeded, the power supply automatically crosses over to constant voltage operation and the output current drops proportionately. If foldback protection is enabled, mode crossover causes the power supply output to be disabled. In setting the voltage limit, make adequate allowance for voltage peaks that could cause unwanted mode crossover.

Return to Local

If the power supply is under remote control (RMT indicator on) and local lockout has not been sent (see Page 46), pressing the LCL pushbutton switch will return the unit to local (front panel) control. Holding the LCL switch in will prevent the power supply from returning to remote control for as long as the LCL switch is held in or until local lockout is sent.

If the power supply has been disabled via GP-IB, or remote inhibit (DISABLED indicator on), the LCL switch will not restore the output. The only way to re-enable locally is to turn the LINE switch off and then back on. The OUTPUT ADJUST controls continue to operate in local control even if the power supply is disabled.

NOTE Once the soft limits have been set by the controller via GP-IB, the OUTPUT ADJUST knob cannot be used to obtain a higher output beyond these limits. This condition is true for both local and GP-IB control.

GP-IB Operation

Interface Functions

The power supply implements the following GP-IB interface functions, which are defined by IEEE standard 488:

SH1 (Source Handshake)
AH1 (Acceptor Handshake)
T6 (Talker)
L4 (Listener)
SR1 (Service Request)
RL1 (Remote Local)
PP1 (Parallel Poll)
DC1 (Device Clear)
DT1 (Device Trigger)

Multiline Message Control Functions. The Acceptor Handshake, Source Handshake, Listener, and Talker functions are implemented by the interface circuits of the power supply and the controller and require no action by the user. The LSN or TLK indicators turn on when the power supply is addressed to listen or talk. (The talker function includes serial poll, see below).

Service Request. Service request is a uniline message that can be asserted by the power supply to interrupt the controller. Service request can be generated by a power supply fault condition. The operator defines which of eight power supply conditions are defined as faults. Enabling or disabling a condition from asserting service request does not affect the condition within the power supply, nor does it affect the front-panel status indicators. Page 62 provides instructions for unmasking service request capability.

A service request can also be generated at power on (PON), depending on the setting of the rear-panel PON SRQ switch. Therefore, with PON SRQ enabled, if a momentary power dropout causes the power supply memory to lose its programmed values, PON alerts the operator that the power supply has been initialized (see Page 47).

If the power supply fails self test at power on it will not respond to serial poll or any other commands on GP-IB. The user should include a time-out in his program after which the controller will not wait for the power supply to respond. If the time-out occurs, the power supply can be assumed to be malfunctioning and should be removed for service.

The SRQ indicator turns on whenever the power supply is requesting service from the controller, and remains on until the controller conducts a serial poll. Serial poll resets the SRQ bit and turns off the SRQ indicator, regardless of whether the fault that caused service request continues to exist.

Serial Poll. In a serial poll the controller can poll each device on the bus, one at a time. The power supply responds by placing the contents of the eight-bit serial poll register on the GP-IB data lines. Table 3-5 defines each of the bits in the serial poll register and defines what causes each bit to be set and reset. Bit positions 0 through 7 are placed on DIO lines 1 through 8. Note that the serial poll register represents only the power supply connected to the GP-IB, not other power supplies that may be slaved to the GP-IB connected unit.

Parallel Poll. Parallel poll allows the controller to receive one bit of data from each of many or all instruments on the bus at the same time. In Agilent Technologies power supplies this bit corresponds to bit 6, the RQS bit, of the serial poll register. Because the controller can receive this bit from at least eight instruments at one time, the controller can determine quickly which of a number of instruments on the bus requested service. The controller can then query that instrument to determine the cause of the service request. Parallel poll does not reset the service request bit in the power supply. The power supply's response to parallel poll can be configured remotely from the controller, or it can be configured locally.

Unless configured remotely, the power supply responds to a parallel poll with a "1" on one of the DIO lines (if requesting service), as determined by the setting of its address switches. Addresses 0 through 7 correspond to DIO lines 1 through 8 (decimal weight 2^0 through 2^7). If the address switches are set to 8 or higher, the power supply will not respond to a parallel poll unless the unit is configured remotely. The power supply can not return a "0" to indicate it was requesting service unless it has been configured remotely.

The power supply can be configured remotely to respond to a parallel poll with either a "1" or a "0" on one of the DIO lines if the unit is requesting service. Configuration statements with a decimal value of 0 through 7 will configure the unit to respond with a "0" on one of the DIO lines 1 through 8; decimal values of 8 through 15 configure the unit to respond with a "1" on one of DIO lines 1 through 8. By configuring the power supply remotely, the address switches may be set to any address from 0 through 30 without affecting the parallel poll response. The capability to configure either a "0" or "1" response allows the user to AND or OR two or more instruments on one DIO line.

Remote/Local. The remote/local function allows the power supply to operate in either local (front panel) or remote (via GP-IB) control. The user can send Local Lockout to the power supply via GP-IB to disable the front-panel LCL switch only. With Local Lockout, the controller determines if the unit operates in local or remote control; this enables the controller to prevent anyone else from returning the power supply to local control.

Device Clear. Device Clear is implemented in the power supply as Clear (see Page 63). The difference between Clear and Device Clear is that Device Clear can be an unaddressed or addressed command. Device Clear is typically used in systems to send all devices in the system to a known state with a single command (which could be generated by a "panic" button).

Table 3-5. Serial Poll Register

Bit Position	7	6	5	4	3	2	1	0
Bit Weight	128	64	32	16	8	4	2	1
Condition	-	RQS	ERR	RDY	-	-	PON	FAU

RQS Requesting Service
ERR Remote Programming Error
RDY Ready to Process Commands
PON Power On Reset
FAU Fault Condition

RQS is set when power supply generates a service request, and is reset immediately after a serial poll is conducted.

ERR follows ERR bit in Status Register, which is set whenever power supply detects a remote programming error. ERR is reset by ERR? query.

RDY is set whenever power supply finishes processing a command, and is reset when power supply starts to process a new command. Note that power supply input buffer can accept new commands via GP-IB even while unit is busy processing previously received commands.

PON is set when ac input power is turned on and is reset by CLR command or Device Clear interface message. PON is set in serial poll register regardless of whether PON SRQ is enabled by rear-panel switch.

FAU is set when any bit is set in Fault Register and is reset by FAULT? query.

Device Trigger. Device Trigger is implemented in the power supply as Trigger (see Page 59). Each device that is to respond to Device Trigger must be addressed. Device Trigger is typically used in systems to synchronize the operation of a number of addressed devices.

GP-IB Address Selection

The five GP-IB address switches are located on the rear panel. The GP-IB address is set in binary, with A1 the least significant bit and A5 the most significant bit. Figure 3-8 shows the factory-set address of "5" (binary 00101). The raised portion of the switch is shown in black. Any address from 00 to 30 decimal (00000 to 11110 binary) is a valid GP-IB address. The power supply will operate on whatever valid address is set on the address switches. Address 31 will cause a self-test error.

The operator should be aware that some other instruments on the GP-IB may initialize at a particular address although they can be programmed subsequently to respond to a different address. If the system includes instruments with this characteristic and they are programmed for addresses other than their initialized address, a momentary input power dropout may cause them to re-initialize their address. If another instrument, such as the power supply, is hardware set to that address, the system will not function properly. Therefore, the system program should be written to monitor any re-initialization. Any programmed data, such as addresses, that may have been lost will then have to be reset.

Holding the LCL switch in for one second causes the power supply's GP-IB address to be displayed on the front panel until the switch is released or two seconds elapse.

The address switches are also used during troubleshooting to select which self tests are run in test mode. If the power supply has been serviced be certain to check the GP-IB address switches. Note that the top two switches are not address switches. Be careful to use only the five bottom switches for setting the address.

Power-On Service Request

The power supply can request service from the controller when power is turned on. Power-on service request (PON SRQ) is enabled or disabled by the rear-panel PON SRQ switch, and cannot be controlled by commands via GP-IB. The service request bit is reset by a serial poll, regardless of whether set by power-on or some other cause. To enable power-on to request service, set the PON SRQ switch to "1", as shown in Figure 3-8. If enabled, PON SRQ will request service when the power supply is turned on or any time a momentary input power dropout causes the power supply to re-initialize.

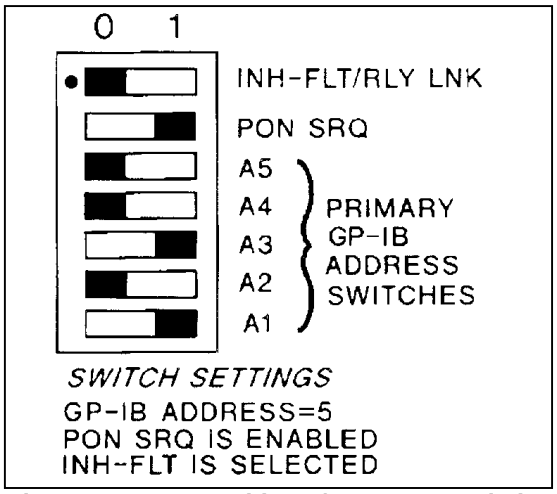


Figure 3-8. GP-IB Address/PON SRQ Switches

INH-FLT or RLY LNK Operation

The four-pin connector on the GP-IB board can be configured for either Fault Input (FLT) and Remote Inhibit (INH) operation or for operation with the Agilent 59510A or 59511A Relay Accessory. Setting the INH-FLT/RLY LNK switch to "0" (see Figure 3-8) selects INH-FLT operation as described on page 70. Setting the switch to "1" selects RLY LNK operation (see instructions supplied with the relay accessory and also Appendix C in this manual).

Initial Conditions

The power supply initializes at power on programmed with the values listed in Table 3-6.

Table 3-6. Initial Conditions

Voltage	0 Volts
Current	0 Amps
OUTPUT ADJUST Control	Enabled to adjust CURRENT
OVP	determined by setting of OVP ADJUST potentiometer on front panel
Soft Voltage Limit	Agilent 6030A - 204.750 volts Agilent 6031A - 20.475 volts Agilent 6032A - 61.425 volts Agilent 6033A - 20.475 volts Agilent 6035A - 511.875 Agilent 6038A - 61.425 volts
Soft Current Limit	Agilent 6030 A -17.403 amperes Agilent 6031A -122.85 amperes Agilent 6032A - 51.1875 amperes Agilent 6033A - 30.7125 amperes Agilent 6035A - 5.119 Agilent 6038A -10.2375 amperes
Delay	0.5 seconds
Foldback Protection	off
Output	on
Unmask	none
Hold	off
Store/Recall	all storage registers loaded with initial conditions of supply (output on/off is not stored)

Programming Syntax

The following paragraphs describe how to program the power supply via the GP-IB. These instructions concern device-dependent messages, such as setting output voltage. Interface management messages, such as serial poll, have been described previously on Page 44, Interface Functions.

Table 3-7 lists each of the device-dependent commands, the range of each parameter sent to the power supply or the response of the power supply to a query from the controller, and a brief description of each command. Also included is the number of the paragraph in which each command is described more fully. If no unit is specified where appropriate in data sent to the power supply, the power supply selects S.I. units (V,A,s).

NOTE Lower-case alpha characters sent to the power supply are treated as upper-case alpha characters.

Numbers Sent to Power Supply. Numbers can be sent to the power supply either with implicit or explicit decimal point notation, and with or without a scale factor (scientific notation), allowing use with controllers having a wide variety of output formats.

Numbers written in implicit point notation do not contain a decimal point; for example, 123 for one hundred twenty three. Numbers written in explicit point notation contain a decimal point, such as 1.23.

In scientific notation the letter "E" stands for "10 raised to". For example, 1.23E4 would be read as 1.23 times 10^4, which equals 12,300.

Plus and minus signs are considered numeric characters. All numeric data fields may contain an optional plus or minus sign on both the number itself and the scale factor, such as +1.23E-2.

All numeric data fields may contain leading spaces, and embedded spaces will be accepted between optional signs and digits, digits and E, decimal point and E, and E and optional sign. The following two examples contain one embedded space in each position in which they are allowed:

+ 1.23 E + 4 + 123. E + 4

Embedded spaces will not be accepted between digits or between digits and decimal point.

At least one digit must precede E. For example, 1E 4 is correct, E + 4 is incorrect. Lower case e is treated the same as upper case E.

Numbers Returned To Controller. The format of numbers returned to the controller depends upon the type of data requested, and is given in Table 3-8.

Leading zeroes are sent as spaces, except that the first digit to the left of a decimal point is never sent as a space.

All numeric data sent to the controller are preceded by a header consisting of alpha characters that identify the type of data, such as VOUT or ISET. The header consists of upper case characters only, with no embedded spaces. No suffixes are attached to numeric data.

Separators For Data Sent To Power Supply. Separators are used by the power supply to break up commands into pieces, called tokens, which it can interpret. Separation of commands into tokens is accomplished either explicitly by the insertion of separator characters or implicitly by noting a change from one class of input to another.

The explicit separators are commas and spaces. An explicit separator is required between tokens consisting of alpha characters. For example, SRQ ON is correct, SRQON is not correct. Commas are used only to separate parameters in the UNMASK command. Only one comma is allowed, and it may be preceded or followed by any number of spaces. For example, both these commands are correct.

UNMASK CC,OR,FOLD
UNMASK CC, OR, FOLD

but this command is incorrect

UNMASK CC OR FOLD

Spaces are used in all other cases requiring explicit separators. Any number of consecutive spaces is treated as one space.

Implicit separation occurs when the received characters change from upper or low case alpha (A...Z, a...z) to numeric (+, -,0...9). Spaces may also be used where implicit separation takes places. For example, both the following commands are correct:

VSET 5 V VSET5V

The question mark is implicitly separated from alpha characters, for example:

VMAX? VMAX ?

are both correct.

Table 3-7 GP-IB Commands

Command	*Range or **Response To Query	Description	Page
VSET x VSET xV	Agilent 6030A *0--204.75 V Agilent 6031A *0--20.475 V Agilent 6032A *0--61.425 V Agilent 6033A *0--20.475 V Agilent 6035A *0--511.88 V Agilent 6038A *0--61.425 V	Any of these commands is used to program output voltage. Initial Condition: 0 V	55
VSET xMV	Agilent 6030A *0--204750 mV Agilent 6031A *0--20475 mV Agilent 6032A *0--61425 mV Agilent 6033A *0--20475 mV Agilent 6035A *0--511880 mV Agilent 6038A *0--61425 mV		
ISET x ISET xA	Agilent 6030A *0--17.403 A Agilent 6031A *0--122.85 A Agilent 6032A *0--51.1875 A Agilent 6033A *0--30.7125 A Agilent 6035A *0--5.119 A Agilent 6038A *0--10.2375 A	Any of these commands is used to program output current. Initial Condition: 0 A	56
ISEFT xMA	Agilent 6030A *0--17403 mA Agilent 6031A *0--122850 mA Agilent 6032A *0--51187.5 mA Agilent 6033A *0--30712.5 mA Agilent 6035A *0--5119 mA Agilent 6038A *0--10237.5 mA		
VSET? ISET?	**VSET xx.xxx **ISET xx.xxx	Used to read voltage and current settings	56
VOUT? IOUT?	**VOUT xx.xxx **IOUT xx.xxx	Used to measure and read output voltage or current.	56
OVP?	**OVP xx.xx	Causes power supply to measure OVP setting (which is hardware set at front panel).	57
VMAX x VMAX xV VMAX xMV	(Same as VSET)	Any of these commands is used to program an upper limit (soft limit) on the voltage programming value that the power supply will accept.	57
IMAX x IMAX xA IMAX xMA	(Same as ISET)	Any of these commands is used to program an upper limit (soft limit) on the current programming value that the power supply will accept.	57
VMAX? IMAX?	**VMAX xx.xxx **IMAX xx.xxx	Used to read voltage and current limits (soft limits).	57

Table 3-7 GP-IB Commands (continued)

Command	*Range or **Response To Query	Description	Page
DLY x DLY xS DLY xMS	*0--31.999 s *0--31999 ms	Any of these commands is used to program the delay time after a new output voltage or current is implemented, or RST or OUT ON command is received. During delay power supply disables CV, CC, and OR conditions from being labeled as faults, and disables foldback protection.	57
DLY?	**DLY xx.xxx	Used to read delay time setting.	57
OUT OFF OUT 0 OUT ON OUT 1		.Enables or disables power supply output. Power supply remains able to implement commands even while output is disabled Initial Condition: OUT ON	58
OUT?	**OUT 0 or **OUT 1	Used to read OUTPUT ON/OFF setting	58
FOLD OFF, FOLD 0 FOLD CV FOLD 1 FOLD CC FOLD 2		Enables or disables foldback protection which will disable power supply output if power supply switches to whichever mode, CV or CC, is defined as the fold (error) condition. Foldback protection is inhibited during DELAY period. Initial Condition: FOLD OFF.	58
FOLD?	**FOLD 0 or **FOLD 1 or **FOLD 2	Used to read FOLDBACK setting.	58
RST		Used to reset power supply if output is disabled by overvoltage, remote inhibit, or foldback protection circuits. Power supply resets to present voltage and current settings (values can be changed while unit is disabled).	59
HOLD OFF HOLD 0 HOLD ON HOLD 1		Determine if certain newly received commands are implemented by power supply upon receipt or are held for later implementation while power supply continues to operate with previously received values. HOLD ON can be used to synchronize power supply changes with actions taken by other devices on the GP-IB. See TRG command. Initial Condition: HOLD OFF	59
HOLD?	**HOLD 0 or **HOLD 1	Used to read HOLD setting	59

Table 3-7 GP-IB Commands (continued)

Command	*Range or **Response To Query	Description	Page
T TRG		Used to implement commands that have been sent to and held by the power supply (power supply continues to operate with previous values until trigger command is received). See HOLD command. The device trigger interface message performs the same function.	59
STO x RCL x	*0-15	Cause power supply to store and recall up to 16 sets of the complete machine state except for output on/off. Machine state consists of: programmed voltage (first and second rank), programmed current (first and second rank), soft voltage limit, soft current limit, delay time, service request on/off, foldback (first and second rank), mask (first and second rank), and hold. Initial Condition: Each storage register is initialized to the turn-on values.	60
STS?	**STS xxx	Used to read the contents of the status register, which maintains the present status of the power supply. See Table 3-9 for a description of each bit in the status register, and the bit weight for each condition.	60
ASTS?	**ASTS xxx	Used to read the contents of the accumulated-status register, which stores any bit that was entered in the status register since the accumulated-status register was last read, regardless of whether the condition still exists. The bit descriptions and weights are the same as in the status register, see Table 3-9.	61
UNMASK mnemonics UNMASK xxx		Determines which conditions are capable of setting bits in the FAULT register; therefore, allows operator to define which conditions are fault conditions. Conditions can be enabled either by sending a string of mnemonics after the command UNMASK, or by sending the decimal equivalent of the total bit weight for all conditions to be enabled. The mnemonics and bit weights are the same as in the status register, see Table 3-9. Mnemonics are separated from each other by commas, and may be sent in any combination and in any order. The command UNMASK NONE disables all conditions from setting bits in fault register. Initial Condition: UNMASK NONE	62

Table 3-7 GP-IB Commands (continued)

Command	*Range or **Response To Query	Description	Page
UNMASK?	**UNMASK xxx	Used to read which bits in the status register have been enabled to set bits in the fault register (i.e.,which power supply conditions are defined as faults). xxx is decoded using bit weights in Table 3-9.	62
FAULT?	**FAULT xxx	Used to read which bits have been set in the fault register. A bit is set in the fault register when the corresponding bit in the status register changes from inactive to active AND the corresponding bit in the mask register is set. Bits in the fault register are reset only after the fault register is read. xxx is decoded using bit weights in Table 3-9.	62
SRQ OFF SRQ 0 SRQ ON SRQ 1		Enable or disable power supply's ability to request service from the controller for fault conditions. UNMASK command defines which power supply conditions are defined as faults. Initial Condition: SRQ OFF	62
SRQ?	**SRQ 0 or **SRQ 1	Used to read SRQ setting.	63
CLR		Used to initialize power supply to power-on state; also resets the PON bit in the serial poll register. The device clear interface message performs the same function.	63
ERR?	**ERR xx	Used to determine type of programming error detected by power supply. A remote programming error will set the ERR bit in the status register, which can be enabled by UNMASK to request service. See Table 3-10 for descriptions of error codes.	63

Table 3-7 GP-IB Commands (continued)

Command	*Range or **Response To Query	Description	Page
TEST?	**TEST xx	Causes power supply to run selftests and report any failures. Type of tests run depends on whether power supply output is on or off.	63
ID?	**Agilent 603xA or **Agilent 603xA, OPT 100	Causes power supply to report its model number and any options that affect the unit's output capability.	65

[Bracketed commands are equivalent.
x = any digit (within range)
MV = millivolt
MA = milliamp
MS = millisecond

** Query causes power supply to clear output buffer, gather requested data, and store it in output buffer. Data will be put on GP-IB when power supply is addressed to talk and ATN goes false. Only most recently requested data is stored, and it is not saved after being put on GP-IB.

Terminators For Data Sent To Power Supply. Terminators mark the end of a command string, and they instruct the power supply that the command it has just received should be executed. The terminator characters are the line feed and semicolon.

Line feed is sent by all Agilent controllers automatically after OUTPUT statements unless deliberately suppressed, so the user need not include a terminator when only one command is sent per line. If the user wishes to send more than one command per line the commands must be separated by semicolon.

Any number of consecutive terminators is treated as one. A terminator may be preceded or followed by any number of spaces, for example:

VOUT 15V;IOUT 5A
VOUT 15V ; IOUT 5A

are both correct

The carriage return character by itself is not sufficient to terminate a command, but it will be accepted without error in all cases where a terminator is expected.

Commands may also be terminated by asserting EOI on the GP-IB concurrently with the last character of the command. For example:

VSET 1.23
E
O
I

requires no semicolon or linefeed. Asserting EOI in conjunction with a terminator will have no adverse effect.

Table 3-8. Format of Numbers Sent from Power Supply

For these query commands: VSET? ISET? DLY? VOUT? IOUT? VMAX? IMAX? the response consists of a header followed by a space* followed by 5 decimal digits with an embedded decimal point, in this format: <header> <space>d.dddd to < header > < space > dddd. d The header consists of the query alpha characters without the question mark. Leading zeroes are sent as spaces, except that the first digit to the left of the decimal point is never sent as a space. *A minus sign can be sent instead of a space for VOUT, IOUT, and OVP.
For these query commands: STS? FAULT? ASTS? ERR? UNMASK? TEST? the response consists of a header followed by a space followed by three decimal digits with an implicit decimal point, in this format: < header > < space > ddd The header consists of the query alpha characters without the question mark. Leading zeroes are sent as spaces.
For these query commands: FOLD? HOLD? OUT? SRQ? the response consists of a header followed by a space followed by a single digit, in this format: < header > < space > d The header consists of the query alpha characters without the question mark.

Termination for Data Sent to Controller. All data returned to the controller are terminated by a carriage return character followed immediately by a linefeed character. EOI is asserted concurrently with linefeed.

Voltage Setting. Voltage is programmed in either volts or millivolts using any of the following codes (the value 20 is used as an example):

VSET 20

VSET 20 V

VSET 20 MV

The programmed voltage is the actual output if the power supply is in CV mode, or the voltage limit if the power supply is in CC mode.

The voltage setting may be read by sending:

VSET?

and addressing the power supply to talk.

The power supply can be instructed to measure its actual output voltage by sending:

VOUT?

The results are placed on the GP-IB when the power supply is addressed to talk, in this format (using 20 as an example):

VOUT 20.000

NOTE The programming resolution (LSB) for the VSET and ISET commands are specified in Table 1-1. The power supply will round off settings received to the nearest multiple of these values.

Current Setting. Current is programmed in either amps or milliamps using any of the following codes (the value 5 is used as an example):

ISET 5

ISET 5 A

ISET 5 MA

The programmed current is the actual output if the power supply is in CC mode, or the current limit if the power supply is in CV mode.

The current setting may be read by sending:

ISET?

and addressing the power supply to talk.

The power supply can be instructed to measure its actual output current by sending:

IOUT?

The results are placed on the GP-IB when the power supply is addressed to talk, in this format (using 5 as an example):

IOUT 5.000

OVP Measurement. OVP trip voltage is hardware set at the power supply front panel. The power supply can be instructed to measure the OVP trip voltage by sending:

OVP?

The results are placed on the GP-IB when the power supply is addressed to talk, in this format (using 20 as an example):

OVP 20.000

Soft Limits. The power supply can be sent soft limit values that place maximum limits on the voltage and current programming values that will be accepted. If the power supply receives a programming value that exceeds the soft limit, it will ignore the command, turn on the ERROR indicator, and set the ERR bits in the status register and in the serial poll register. The power supply will not accept soft limit values that are lower than present output values or values that are being held.

Soft limits are programmed using any of the following codes (the values 15 and 5 are used as examples):

VMAX 15 IMAX 5

VMAX 15 V IMAX 5 A

VMAX 15 MV IMAX 5 MA

The soft limits may be read by sending:

VMAX? IMAX?

and addressing the power supply to talk. The response from the power supply is in this format (using 15 and 5 as examples):

VMAX 15.000 IMAX 5.000

Delay. The power supply may switch modes or be unregulated momentarily after a new output value is programmed or the output is reset from zero. In most cases this temporary condition would not be considered a fault, and foldback or a service request would be a nuisance. Delay operates to mask CV, CC, and OR conditions from the fault register for a specific period after a new output value is implemented. The delay is initiated after the following commands:

OUT ON

RST

T, TRG, or Device Trigger

VSET OR ISET if hold is off

The power supply initializes with a delay of 0.5 seconds, which is appropriate in most cases. In some cases a longer or shorter delay may be required. For example, when up-programming output voltage with a very low current limit, CC mode may persist longer than 0.5 seconds.

Factors that influence how long the mode change or unregulated condition may last include: difference between old output value and new output value, current or voltage limit, and output (load) capacitance (for CV mode) or output inductance (for CC mode). The delay required must be determined empirically; the programming-response times in the specifications table, Section I, can be used as guidelines.

Delay can be programmed in 1 ms increments using either of the following codes (31999 used as an example):

DLY 31.999S

DLY 31999MS

Delay value may be read by sending:

DLY?

and addressing the power supply to talk. The response from the power supply is in this format (using 0.5 as an example):

DLY 0.500

Note that during the delay period CV and CC are masked from the foldback protection feature also. Delay does not affect the setting of the CV, CC, or OR bits in the status register or accumulated status register; delay affects only the setting of those bits in the fault register. Delay does not affect conditions other than CV, CC, or OR that may cause service request, nor will delay affect CV, CC, or OR if they occur at any time other than after a programmed output change.

Output On/Off. The power supply output can be turned on and off using these commands-

OUT OFF or OUT 0:

OUT ON or OUT 1

OUT OFF does not affect the voltage and current settings. OUT ON enables the power supply and returns the output to the present voltage and current settings, which can be changed while the output is off. OUT ON will not reset OVP, foldback protection, remote inhibit (INH), or fault indicator (FLT).

Output on/off is particularly useful when storing values for later recall. (Note that output on/off is the only programmable state that is not stored.) With the output off, the user can set up and store as many as 16 versions of the complete machine state without having the output change to a particular set of values until that setup is required.

The state of the output on/off function may be read by sending:

OUT ?

and addressing the power supply to talk. The response from the power supply is in this format:

OUT 0 or OUT 1

in which 0 indicates that the power supply output is off, and I indicates it is on.

Foldback Protection. As described on page 39, foldback protection can be enabled to turn off the power supply output if the power supply switches from the protected operating mode (either CV or CC) to the other mode. If the power supply changes to the specified mode, the output will be turned off and the DISABLED and FOLDBACK indicators will turn on. To prevent nuisance tripping while the output is being reprogrammed, foldback protection is inhibited during the delay period.

Foldback protection is programmed using these codes:

FOLD OFF or FOLD 0

FOLD CV or FOLD 1

FOLD CC or FOLD 2

FOLD CV means that the power supply should be operating in CC Mode, and foldback protection will turn off the output if the power supply switches to CV mode. FOLD CC means that foldback occurs if the power supply switches to CC mode.

The state of the foldback protection function may be read by sending:

FOLD?

and addressing the power supply to talk. The response from the power supply is in this format:

FOLD 0 or FOLD 1 or FOLD 2

in which 0 indicates that foldback protection is off, 1 indicates foldback protection will trip if the power supply switches to CV mode, and 2 indicates that foldback protection will trip if the power supply switches to CC mode.

Reset. Reset restores the power supply output if it has been disabled by OVP, foldback, or remote inhibit. The output returns to the present voltage and current settings; the values may be changed while the output is disabled. The power supply is reset with the command:

RST

Note that if the condition which caused OVP or foldback remains, the power supply output will be disabled again after reset. If a condition which tripped the INH input (set the RI bit true (1)) remains after a RST command is issued, the supply will not be re-enabled. The condition which tripped the INH input must be removed and the RI bit must become false before the supply can be returned to its previous settings. If the power supply output is disabled repeatedly, check that the OVP setting and delay time are appropriate for the application.

Hold and Trigger. The power supply contains first-rank and second-rank storage registers for values of voltage setting, current setting, foldback, and mask. The operating values are stored in the second rank, but the first rank can receive and hold different values for later implementation. With hold turned on, values in first rank are moved to second rank only upon receipt of a trigger or device trigger command.

This feature allows synchronization of multiple instruments on the GP-IB, and also ensures that new values are implemented at the same time within a single instrument. With hold turned off, values are loaded into both first and second rank when received.

Hold is turned on and off using these codes:

HOLD OFF or HOLD 0
HOLD ON or HOLD 1

The state of the hold on/off function may be read by sending:

HOLD?

and addressing the power supply to talk. The response from the power supply is in this format:

HOLD 0 or HOLD 1

in which 0 indicates that hold is turned off, and 1 indicates that hold is turned on.

Values that are held in first rank can be shifted to second rank (operating values) using either of these commands:

TRG or T

The device trigger interface command will also shift data from first rank to second rank.

Voltage and current values are compared to soft limits before being loaded into either first or second rank, and new soft limits are compared to values already programmed in both first and second rank. Any discrepancy between first and second rank voltage or current settings and voltage or current soft limits will result in an error condition.

The power supply has been designed to allow it to enforce sequential device command processing, which means that a second instrument on the GP-IB will not begin to receive commands until the power supply has finished processing its commands. The power supply can accept data much faster than it can process data. Therefore, if a second instrument had less data to process than the first had, the second instrument could start changing its output before the first instrument output started changing, even though the first instrument may have accepted all of its data before the second instrument began to receive its data. When using device trigger (a GP-IB interface function), the GP-IB interface circuit in the power supply will not finish the handshake of the GET message (group Execute Trigger) until all commands have been processed and the trigger action has been completed. The controller cannot send commands to a second instrument until the handshake is

completed with the first. Therefore, sending device trigger after sending a command assures that the second instrument cannot begin to receive commands until the first instrument has processed its commands.

For example, assume the following commands are sent to four power supplies assigned to addresses called PS1, PS2, PS3, and PS4:

```
OUTPUT PS1; "HOLD ON”5A”
OUTPUT PS2; "HOLD ON; lA"
TRIGGER PS1
TRIGGER PS2
OUTPUT PS3; "HOLD OFF; 10A"
TRIGGER PS3
OUTPUT PS4; "HOLD OFF. 2A"
```

Power supply 2 will start to change only after power supply 1 has started to change, and power supply 4 will start to change only after power supply 3 has started to change. Note that this feature concerns only the processing of the GP-IB command. The time required for the power supplies to settle at their new values depends on the load and on the direction and amount of change.

Store/Recall. The power supply can store up to 16 complete power supply states except for output on/off. This allows the operator to preset frequently used values, which can then be recalled when needed with a single command. Preset values are stored and recalled using these codes (3 and 1 used as examples):

```
STO 3
RCL 11
```

Sending a store command causes a "snapshot" of the present machine state to be stored. The power supply can then be programmed with new values. Note that only those values to be changed need be reprogrammed. For example, if the following command strings were sent in listed order to the power supply, the string stored in register 1 would include a current setting of 2 A and CC foldback in
addition to a voltage setting of 6 V. The string stored in register 2 would include a voltage setting of 8 V in addition to a current setting of 5 A and CV foldback. Note that the stored because the output was turned off. The store/recall designators need not be assigned in consecutive order, but they must be in the range of 0 to 15.

```
OUT OFF
VSET 5V; ISET 2A; FOLD CC; STO 0
VSET 8V; STO 1
ISET 5A; FOLD CV; STO 2
```

Status Register. The power supply maintains an 9-bit status register that reflects the present state of the unit. Each of the nine bits represents a separate condition; when the condition is true the corresponding bit is 1. Bits are assigned as shown in Table 3-9.

The status register can be read by sending:

```
STS?
```

and addressing the power supply to talk. The response from the power supply is in this format:

```
STS xxx
```

where xxx is a string of ASCII decimal digits. These digits specify an integer which is equal to the sum of the bit weights of the true conditions.

For example, if bits for both ERR (128) and CC (2) are set, the power supply would send ASCII digits 1 3 0 (128 +2 = 130).

Bits remain set in the status register as long as the corresponding conditions are true.

Table 3-9. Status Register

Bit Position	8	7	6	5	4	3	2	1	0
Bit Weight	256	128	64	32	16	8	4	2	1
Condition	RI	ERR	FOLD	AC	OT	OV	OR	CC	CV

CV Constant Voltage Mode
CC Constant Current Mode
OR Overrange
OV Overvoltage Protection Circuit Tripped
OT Overtemperature Protection Circuit Tripped
AC AC Line Dropout or Out of Range
FOLD Foldback Protection Circuit Tripped
ERR Remote Programming Error
RI Remote Inhibit (INH)

Accumulated Status Register. Reading the status register provides the controller only the state of the power supply at the time STS? was received. A condition that lasts only momentarily may not be observed even with frequent polling of the status register. To ensure that a temporary change can be noted by the controller, the power supply maintains an accumulated status (astatus) register. Table 3-9 describes the astatus register as well as the status register. A bit in the astatus register will be 1 if the corresponding bit in the status register has been 1 at any time since the astatus register was last read.

The astatus register can be read by sending:

ASTS?

and addressing the power supply to talk. The response from the power supply is in this format:

ASTS xxx

where xxx is decoded the same way as in the status register readback.

The astatus register is reset to the present value of the status register immediately after it is read by the ASTS? query.

Mask and Fault Registers. The power supply has two additional registers, the mask register and the fault register, both of which are arranged like the status register (Table 3-9). The mask register is maintained by the user, and is used to specify which bits in the status register are enabled (unmasked) to set bits in the fault register. A bit is set in the fault register when the corresponding bit in the status register changes from 0 to 1 and the corresponding bit in the mask register is 1. Whenever any bit is set in the fault register the FAU bit is set in the serial poll register.

Note that bits can be set in the fault register only when there is a change in either the status register or the mask register. Therefore, if a bit is set in the mask register (unmasked) after the corresponding condition becomes true in the status register, the associated bit will also be set in the fault register.

Bits may be set in the mask register (conditions unmasked) in either of two ways. The UNMASK command may be followed by mnemonics which specify which conditions are unmasked (enabled to set bits in the fault register), or the UNMASK command may be followed by a decimal number that is the sum of the weights of the bits to be set. The mnemonics and bit weights are the same as in Table 3-9. The mnemonic NONE or decimal number 0 will clear all bits in the mask register.

Bits are set in the mask register with either of the following codes (ERR/128, OR/4, and CC/2 used as examples):

UNMASK CC, OR, ERR
or
UNMASK 134

Mnemonics may be sent in any order, and they must be separated by commas. Note that the mask register does not affect the status register, it simply determines which bits in the status register can set bits in the fault register.

The mask register may be read by sending:

UNMASK?

and addressing the power supply to talk. The response from the power supply will be in this format (using 34 as an example):

UNMASK 134

The fault register may be read by sending:

FAULT?

and addressing the power supply to talk. The response from the power supply will be in this format (using 134 as an example):

FAULT 134

The fault register is cleared immediately after it is read by the FAULT? query.

Service Request. In some applications it may be desirable to interrupt the controller when a power supply fault condition occurs. The power supply interrupts the controller by asserting the service request (SRQ) line on the GP-IB. The ability to generate service requests for fault conditions can be turned on and off using the following commands:

SRQ OFF or SRQ 0

SRQ ON or SRQ 1

The service request function allows use of either polling or interrupt programming. With SRQ on, the SRQ line will be asserted true whenever the FAU bit in the serial poll register changes from 0 to 1. Therefore, the mask register, in addition to specifying which conditions set the FAU bit, also determines which conditions can generate service requests. Use of the FAULT? query will tell the user which condition caused the service request (except for PON, which is indicated by a separate bit in the serial poll register).

The state of the service request on/off function may be read by sending:

SRQ?

and addressing the power supply to talk. The response from the power supply is in this format:

SRQ 0 or SRQ 1

in which 0 indicates that service request capability is disabled, and 1 indicates it is enabled.

Note that service request capability for power on is controlled by the rear-panel PON SRQ switch, the setting of which will not be indicated in response to an SRQ? query.

Clear. The power supply can be returned to its power-on state with the command:

CLR

or by sending a device clear interface command. Clear is typically used to initialize the power supply to a known state at the beginning of a program. Clear also resets the PON bit in the serial poll register.

The clear command does not complete until the power supply control circuits have had time to settle. This prevents perturbations on the power supply output, regardless of the state before the clear command was sent. The clear command takes about 500 ms to execute.

Note that stored preset states (as many as 16) are not changed by the clear command.

Error. When the power supply detects a remote programming error it sets the ERR bit in the status register, which can be unmasked to request service, and it turns on the front-panel ERROR indicator. The ERR bit is also available in the serial poll response. Programming errors are usually the result of misspelled words or forgotten separators. When the power supply detects a programming error it dumps whatever portion of the command it has received and ignores all further characters until a terminator is received.

The type of error detected can be determined by sending:

ERR?

and addressing the power supply to talk. The response from the power supply is in this format:

ERR x

where x is a decimal digit from 0 to 8.

Table 3-10 lists the error codes with descriptions of each.

Test. The power supply runs a series of self tests when it is turned on, and selected tests can be run for troubleshooting. Either of two subsets of the self tests can be run by command from the controller. Self tests can be invoked via the GP-IB by sending the command:

TEST?

The type of self tests performed depends on whether the power supply output is turned on or off.

Table 3-10. Status Register Errors

Error #	Description
0	**No Errors**
1	**Unrecognized Character**—A character like ! " # was received
2	**Improper Number**—A numeric character (+ -. 0...9) was received but the following characters did not represent a proper number. For example, ± 5 V or .V or + V. Examples of errors that are not error 2 are: E + 04 is error 3 because E is not a numeric character and is not used in any command; 12. 34E~1 is error 4 because it is treated as 12 followed by 3.4, and no commands have two numbers separated by spaces.
3	**Unrecognized String**—A string of consecutive alpha characters that could not be found in the table of command words was received. Cause could be a spelling error or missing separator. For example, OUTON would be seen as one word, and would be an error.
4	**Syntax Error**—A word, number, terminator, or separator was incorrectly placed. For example, ON OUT, UNMASK,CC, or VOUT 5 V IOUT 5 A. A syntax error will also result if more than the maximum number of parameters are specified in the UNMASK mnemonic-form command.
5	**Number Out Of Range**—A number was received that is too large for the command with which it was received, for example, VOUT 5E + 5, RCL 200, or DLY 100S. Any negative number will also cause error 5. Note that soft limit errors are error 6.
6	**Attempt To Exceed Soft Limits**—An attempt was made to program a voltage or current greater than the soft limit. Note that if the programmed voltage or current is greater than the maximum rating of the supply, error 5 will result.
7	**Improper Soft Limit**—An attempt was made to program a soft limit less than the associated output value in either first or second rank. Note that if an attempt is made to program a soft limit greater than the maximum soft limit of the power supply, error 5 will result.
8	**Data Requested Without A Query Being Sent**—A query command, for example VOUT?, instructs the power supply to ready data for transmission to the controller. A query command must precede each request for data by the controller. If the controller requests data from the power supply (with ENTER statement) without first having sent a query, error 8 will result.
9	**Relay Error**—The relay accessory is not connected or is incorrectly configured, or the INH-FLT/RLY LNK switch is in the wrong position.

If the power supply output is disabled (OUT OFF command has been sent), the following tests are performed:

RAM Test #2
ROM Test
Real-Time Clock Test
Serializer Test
PSI Digital I/O Test
PSI DAC/ADC Test

If the power supply output is enabled (output is on), only these tests are performed:

RAM Test #2
ROM Test
Real-Time Clock Test
Serializer Test

When the power supply is addressed to talk after and addressing the power supply to talk. The response from TEST? has been received, it responds in this format: the power supply will be either:

TEST x

where x is a decimal number from 0 to 22. See the Service Manual for a listing of the selftest failure codes. TEST 0 indicates that all tests passed.

The test command does not complete until the power supply control circuits have had time to settle. This prevents perturbations on the power supply output. The test command takes about 500 ms to execute.

Note that the test command in no way changes the supply can be remotely programmed state or the output of the power supply

Model Identification. The power supply model number can be determined from the controller by sending the command:

ID?

and addressing the power supply to talk. The response from the power supply will be either:

ID Agilent 603xA or ID Agilent 603xA, OPT100

with the option 100 identification indicating that the power supply has a reduced output-power capability.

Analog Programming

The output voltage and/or current of the power supply can be remotely programmed by an external resistance or voltage. The power supply is configured for analog programming with rear-panel slide switches: the analog programming signals are connected to rear-panel screw-on terminals. Both voltage and current programming can be done at the same time.

CAUTION The common terminal (P) is internally connected to the **minus** (-) output terminal.

For resistance programming, internal CV and CC current sources supply 1.25 mA currents through the programming resistors to create programming voltages for the power supply. Resistances of 0 to 4 kilohms program the output from 0 to full scale. A variable resistor can control the output over its entire range. Or, a variable resistor connected in series and/or parallel with a fixed resistor can have its control restricted to a limited portion of the output range. Alternatively, a switch can be used to select fixed values of programming resistance to obtain a set of discrete voltages or currents.

NOTE The switching configuration used may require make before-break contacts to avoid producing the output voltage transients caused by momentarily opening the programming terminals.

To maintain the temperature and stability specifications of the power supply, any resistors used for programming must be stable, low-noise resistors with a temperature coefficient of less than 25ppm per °C and a power rating of at least 1/2 watt.

Both voltage and current outputs can also be controlled by a voltage source. A voltage of 0 to 5 volts programs the output from zero to full scale. Voltage sources of more than 5 volts can be scaled down to the proper range.

Setting the power supply for analog programming of voltage and/or current disables digital programming (front-panel or GP-IB) for that parameter.

The following paragraphs discuss in greater detail the methods of remotely programming the output voltage or current using either a resistance or voltage input. Whichever method is used, the wires connecting the programming device must be shielded to reduce noise pickup. The outer shield of the cable should not be used as a conductor, and should be connected to ground at one end only.

Refer to Table 3-4 for mode-switch settings for voltage or resistance programming.

Although the following setup drawings (Figure 3-9 through 3-13) show the supply strapped for local sensing, analog programming and remote voltage sensing do not interact and may be used simultaneously.

Constant Voltage Output, Resistance Control. The setup shown in Figure 3-9 allows the output voltage to be varied by using an external resistor to program the power supply. A programming resistor variable from 0 to 4000 ohms produces a proportional output voltage from zero to full scale. Note that fixed resistors may be connected in series and/or parallel with the variable programming resistor to set lower and/or upper output voltage limits. The resultant programming resistance is the sum of the series/parallel resistor combination, and must be between 0 and 4000 ohms. For example, a 2000 ohm resistor connected in series with the variable programming resistor will set the lower limit for output voltage at one-half full scale.

NOTE If the programming terminals (VP to ⏚P) become open circuited during resistance programming, the output voltage will tend to rise above rating. The supply will not be damaged if this occurs, but the overvoltage trip point should be properly adjusted to protect the user's load.

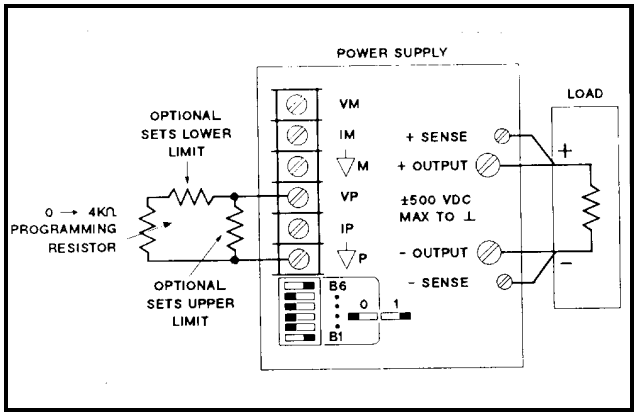


Figure 3-9. Resistance Programming of Output Voltage

Constant Voltage Output, Voltage Control. The setup shown in Figure 3-10 allows the output voltage to be varied by using an external voltage source to program the supply. A voltage source variable from 0 to + 5 volts produces a proportional output voltage from zero to full scale. The static load on the programming voltage source is less than 5 μA. A source resistance of less than 10 k is necessary to avoid degradation of offset and drift specifications.

NOTE If external resistors are used to limit the remote-programming voltage to 5 Vdc, the resulting high programming-source resistance can degrade the power supply's programming speed, offset and drift performance. Limit the equivalent source resistance to 10 k ohm maximum. Figure 3-11 shows a convenient way to calculate suitable voltage-divider resistance values for a 5 k ohm source resistance.

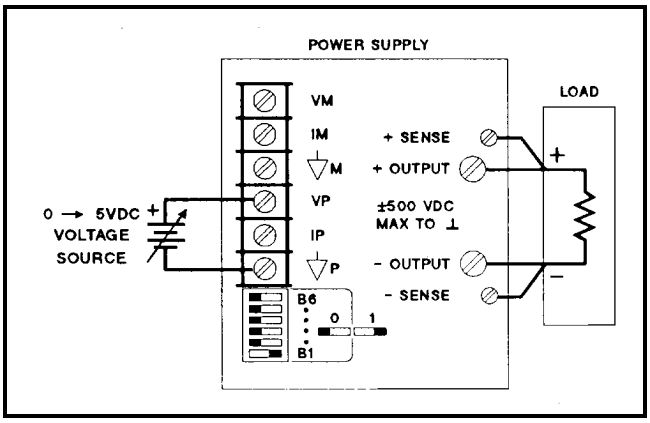


Figure 3-10. Voltage Programming of Output Voltage

Constant Current Output, Resistance Control. The setup shown in Figure 3-12 allows the output current to be varied by using an external resistor to program the supply. The discussion on Page 56 for constant voltage operation also applies for constant current operation.

CAUTION

If the programming terminals (IP to ⏚ P) become open circuited during resistance programming the output current will tend to rise above rating. The power supply will not be damaged if this occurs, but the user's load may be damaged. If there is a possibility that the programming leads may be opened, it is suggested that the optional resistor be connected directly across terminals IP and ⏚ P, as shown in Figure 3-12. The value of this resistor should be selected to limit the output current to the maximum that the load can handle without damage. For example, if the load can handle half the full current rating of the power supply, a 2000 ohm resistor should be connected from IP to ⏚ P. Of course, if this resistor is used, the resistance value actually programming the supply is the parallel combination of the programming resistor and the optional resistor.

Constant Current Output, Voltage Control. The setup shown in Figure 3-13 allows the output current to be varied by using an external voltage to program the supply. The discussions on the previous page also apply for constant current operation. The previous note also applies also to programming output current.

Multiple-Supply Operation

The power supply can be operated in combination with other power supplies to provide increased output capability. Auto-parallel operation of two power supplies can provide up to twice the output current. Other configurations are possible. Contact Agilent Technologies, Power Products Division for specific application assistance.

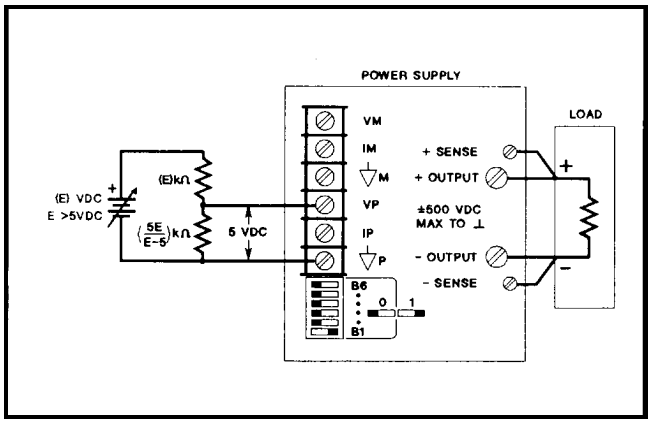


Figure 3-11. Optional Voltage Divide for Program Source

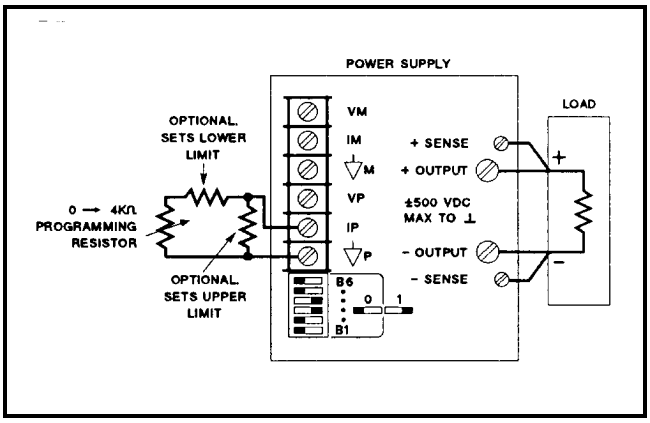


Figure 3-12. Resistance Programming of Output Current

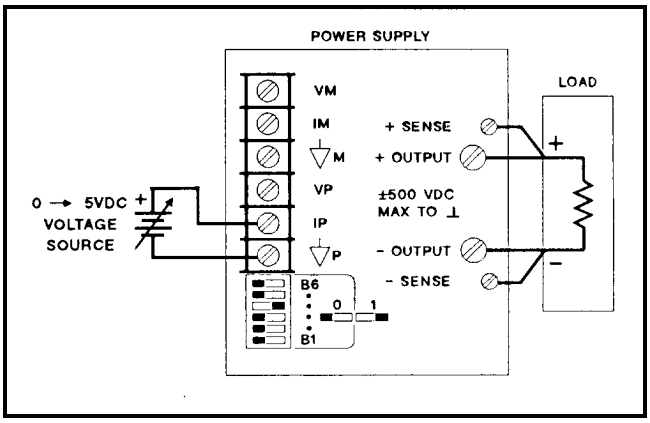


Figure 3-13. Voltage Programming of Output Current

Auto-Parallel Operation

Two units can be connected in an auto-parallel combination to provide twice the output current capability. One of the power supplies, the master, is programmed normally via the GP-IB. The other power supply, the slave, is analog programmed by the master. The slave may be connected to the GP-IB for readback, status, etc., but the mode switches of the slave must be set so that the slave is analog programmed by the master.

Foldback protection, if desired, may only be used with the master power supply.

Figure 3-14 shows the rear-panel mode switch settings and terminal connections for auto-parallel operation.

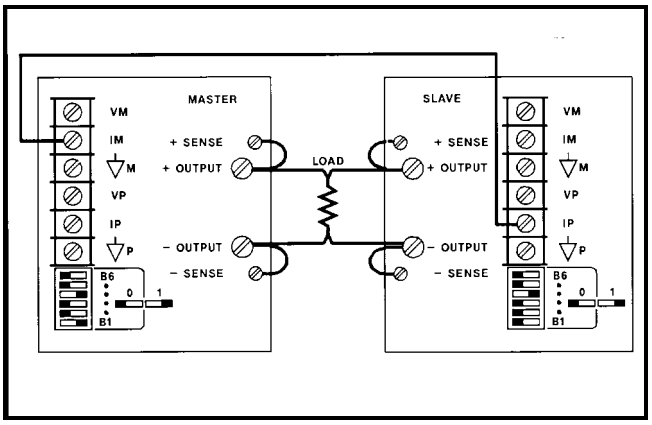


Figure 3-14. Auto-Parallel Operation

Setting Voltage and Current. Program the slave unit's output voltage above the master's to avoid interference with master-unit CV control. The slave unit's mode switches disable the slave unit's digital current setting from having any effect in auto-parallel operation. Program the master unit to the desired output voltage and 50% of total current. Verify that the slave is in CC operation.

When in CV operation, the master unit's voltage setting is the output voltage of the auto-parallel combination. The output current is the total current from all units. The fraction of total current that each unit provides is the same as the ratio of that unit's output current capability to the total output current capability of the auto-parallel combination.

In CC operation, the user must add up the current outputs from each unit and adjust the master until the total equals the desired load current.

Overvoltage Protection. Adjust the desired OVP shutdown limit using the master unit's OVP ADJUST control. Set the slave unit's OVP limit above the master's. When the master unit shuts down, the master programs the slave unit to zero voltage output. If a slave unit shuts down (because its OVP shutdown limit is set lower than the master's), it shuts down only itself, and the other unit supplies all the load current. The shut-down slave unit will draw some current through its down programming circuit. The extra current required from the master unit may cause the master to switch from CV to CC mode.

Remote Sensing. To remote sense with auto-parallel operation, connect remote-sense leads only to the master unit according to the remote-sensing instructions on Page 39.

NOTE Down-programming speed is slower with auto-parallel operation because only the master unit's down programmer operates.

Series Operation

Up to two supplies can have their outputs connected in series to provide increased output voltage. Each power supply is programmed via GP-IB with hold on, and then all units are triggered at once. Multiple loads may be connected in series, and the combination may be grounded at any one point to provide both positive and negative outputs. Regardless of whether or where the load is grounded, no point may be at a greater potential (+ or-) from ground than that specified on the output label on the rear chassis.

CAUTION It is not recommended that Agilent 6035A supplies be connected in series. if you do so, the common connection between the two supplies must be connected to earth ground (see Figure 3-15).

Add the voltage settings of each power supply together to determine the total output voltage. Set the current limits for each power supply to the maximum that the load can handle without damage.

CAUTION When two supplies are operated in series, they should be programmed to the same voltage to prevent possible damage to the lower voltage supply during short circuit conditions. Contact the factory if this is not possible.

Fault Input (FLT) and Remote Inhibit (INH) Connections

The connections for FLT and INH are made through a connector which is located on the rear of the power supply just below the GP-IB address/PON selection switches. The connector is supplied with its mating plug which provides a convenient way to access the FLT and INH circuitry (see Figure 3-16). To remove the plug grip it firmly, then pull it straight out of the connector. With a small screwdriver, loosen the terminal screws on the plug; connect the external FLT and/or INH circuitry, then install the plug back into the connector. Note that in order to prevent radio frequency interference (RFI), shielded or twisted pair wiring should be used for the FLT and INH connections. To prevent ground loops (if shielded wire is used) connect only one end of the shield to chassis ground. Several examples follow.

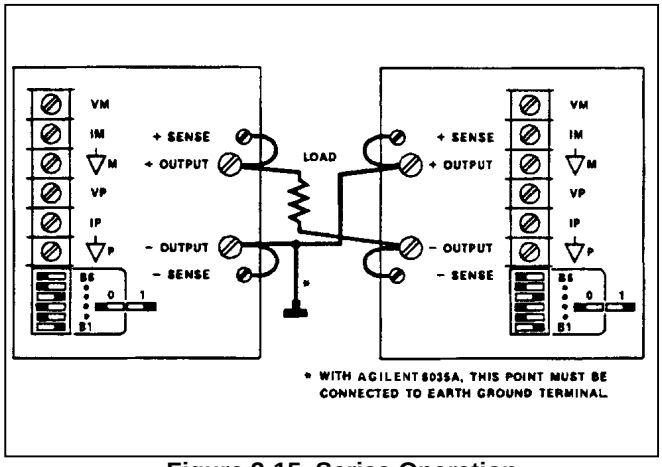


Figure 3-15. Series Operation

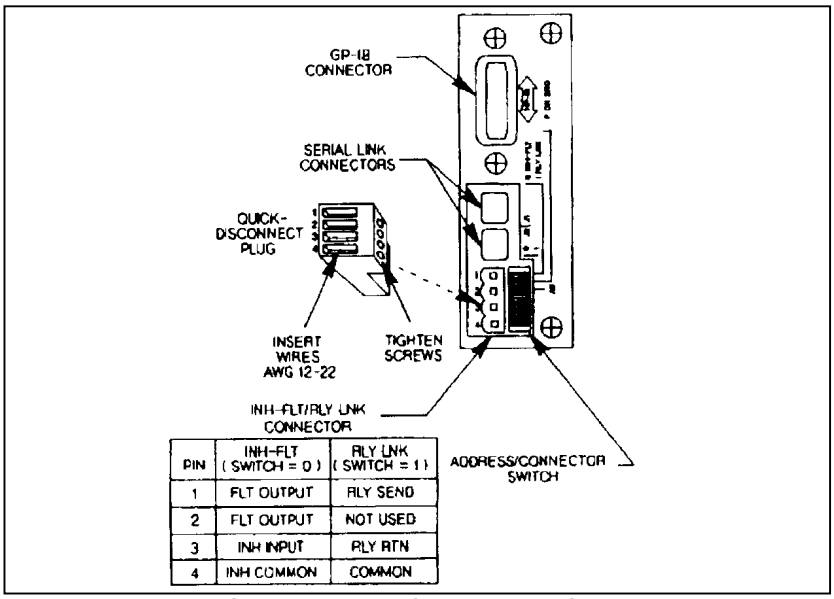
In Figure 3-17 shows a way to protect a load if the controller is halted during a debugging session. An externally, normally open switch (S1) is mounted on a hinged protection hood which covers the device under test. The terminals of the switch are connected to the INH input line. When the hood is lifted, the switch closes and the following simultaneous actions are taken by the power supply:

1. The power supply is disabled (as it is when an OUT OFF or OUT 0 is issued).

2. The RI bit in the status and astatus registers is set true (1).

3. The FLT line goes true (1) (provided the RI bit in the unmasked register has been set true (1)).

4. If the RI bit in the unmasked register has been set true (1) then the RI bit in the fault register will be set true (1) and the FAU bit in the serial poll register will be set true (1).



PIN	INH-FLT (SWITCH = 0)	RLY LNK (SWITCH = 1)
1	FLT OUTPUT	RLY SEND
2	FLT OUTPUT	NOT USED
3	INH INPUT	RLY RTN
4	INH COMMON	COMMON

Figure 3-16. FLT/INH Connections

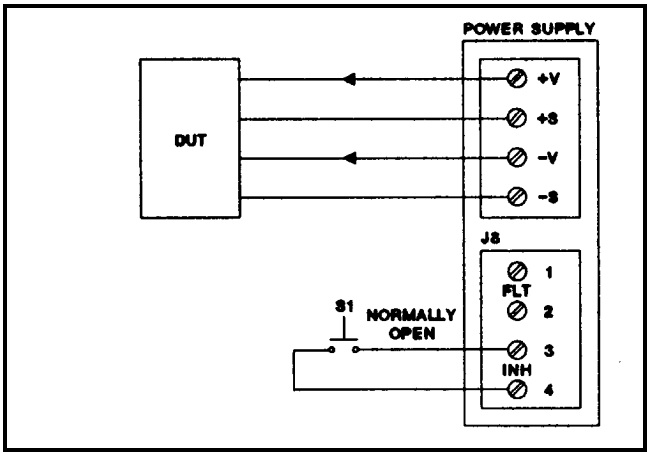


Figure 3-17. INH Example

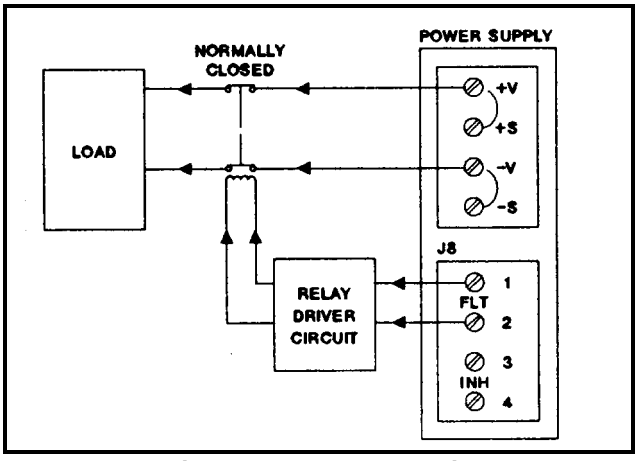


Figure 3-18. FLT Example

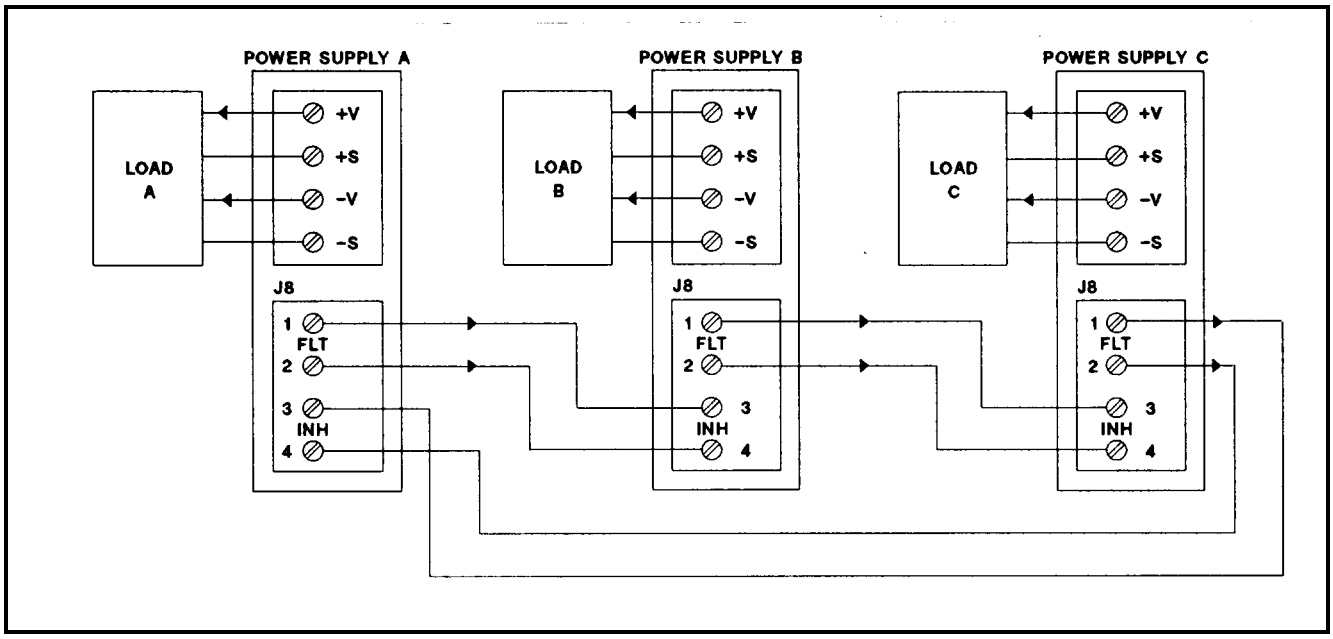


Figure 3-19a. FLT and INH with Multiple Supplies

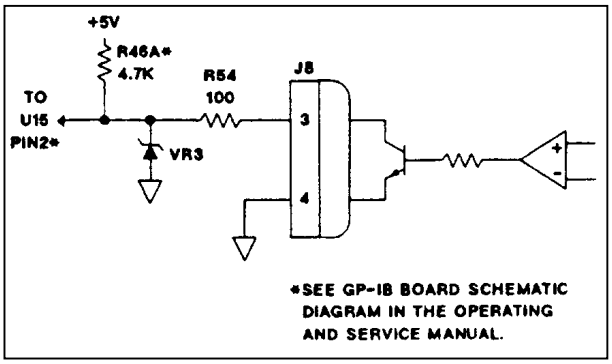


Figure 3-19b. Typical INH Setup

Closing the hood will not re-enable the supply, and during a serial poll the controller would be made aware that a fault exists via the FAU bit in the serial poll register. The fault register must now be read to reset the FLT and RI bit. Finally sending CLR will initialize the supply to its power on state (see Table 3-6).

Figure 3-18 shows an example of how to physically isolate the output of the supply from the load. The FLT output will go true for any unmasked fault condition (see Table 3-9), and it is used to trigger a relay driver circuit. When it is tripped, the relay driver circuit energizes the relay and the supply is then disconnected from the load. The fault line can be reset by reading the fault register and the power supply can be initialized to its power-on-state (see Table 3-6) by sending a CLR.

The setup in Figure 3-19a chains the FLT output of one supply to the INH input of the next. In this case a fault condition in any of the supplies would cause all of the supplies to be disabled simultaneously without controller involvement or external circuitry. The controller can be made aware of the fault via a service request (SRQ). Sending a FAULT? and then a RST will restore the outputs of the supplies to their programmed values before the INH circuit was tripped. Sending a CLR will initialize the supply to its power-on-state (see Table 3-6). To provide proper operation, correct polarity must be observed when connecting external circuitry to the INH input. A typical example is shown in Figure 3-19b.

In Figure 3-21 the FLT output drives not only the INH input, but also triggers a sequential down programmer circuit. This would allow any supply in the system to trigger the sequential down programmer (via their FLT outputs) and disable the supplies in a predetermined order (via their INH inputs). Timing relationships for FLT and INH are shown in Figure 3-20.

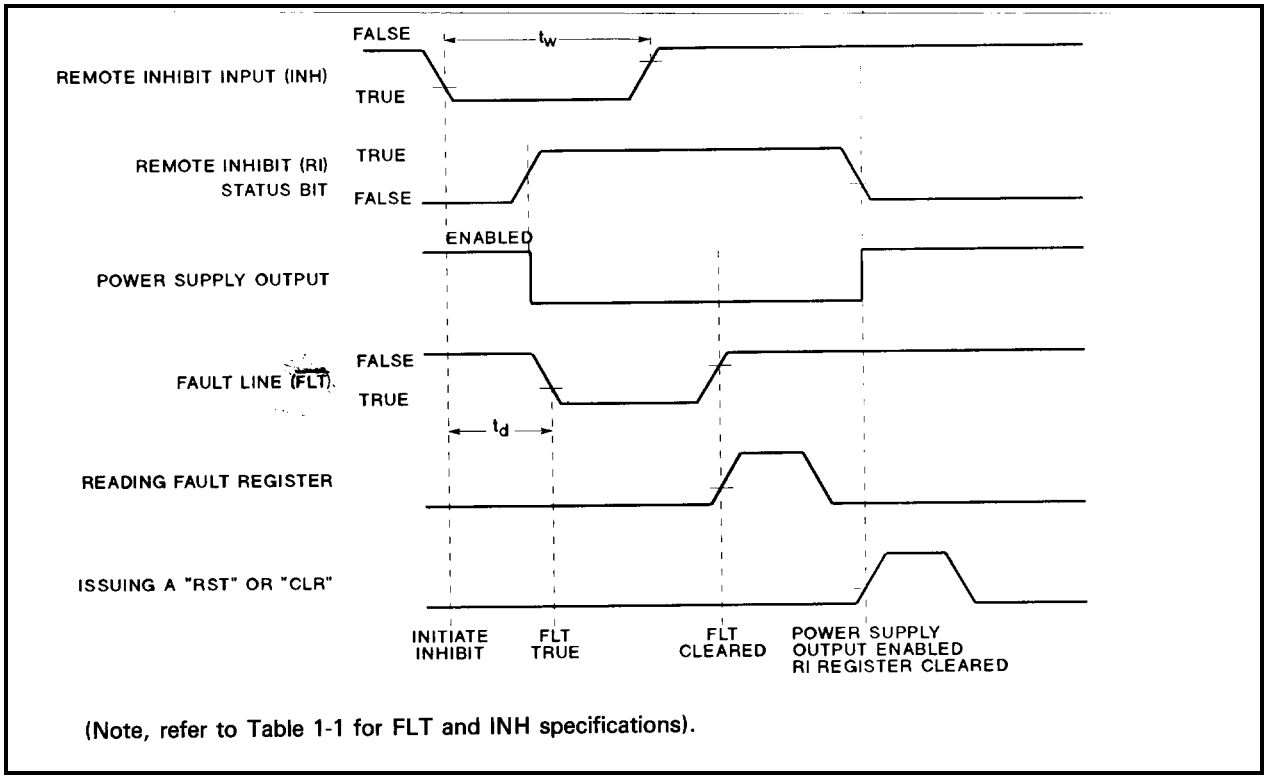


Figure 3-20. Timing Diagram

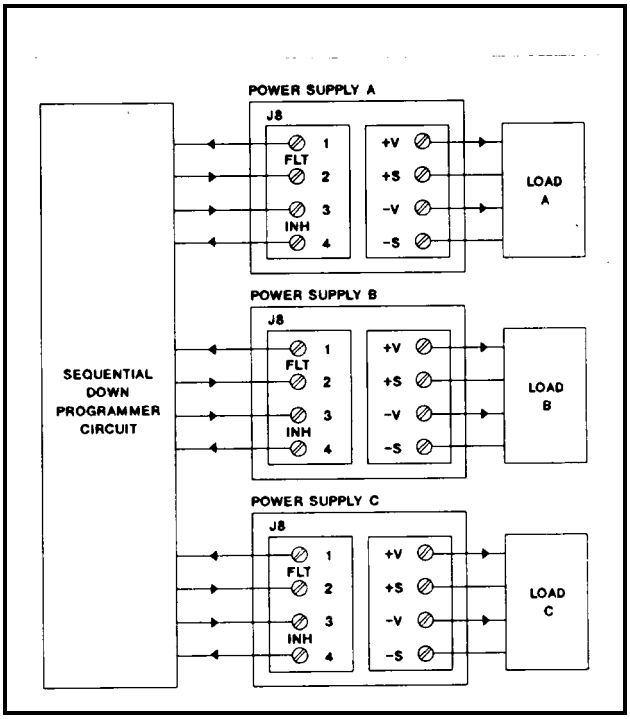


Figure 3-21. FLT & INH Example

A

100 VAC Input Power Option 100

General Information

Description

Option 100 is a modification of the power supply that involves changing the values of resistors located in the Overvoltage Protection and Power Limit Circuits. It also entails recalibrating the unit and changing the Front Panel These changes allow the unit to operate at a lower line voltage of 90-105 Vac, while operating on the same line frequency of 48-63 Hz. The reduced input voltage limits the output power, while retaining the standard unit's output current rating. Other parameters that change due to Option 100 include the Overvoltage Trip Range and the Remote Analog Programming Specification.

Scope of Appendix A

This appendix contains all the information necessary to support the power supply when it is equipped with Option 100. The appendix describes only the changes pertaining to Option 100 and how they affect the other portions of this manual. Unless otherwise specified in Appendix A, all other portions of the manual apply to both the standard supply and Option 100 supply.

Using Appendix A

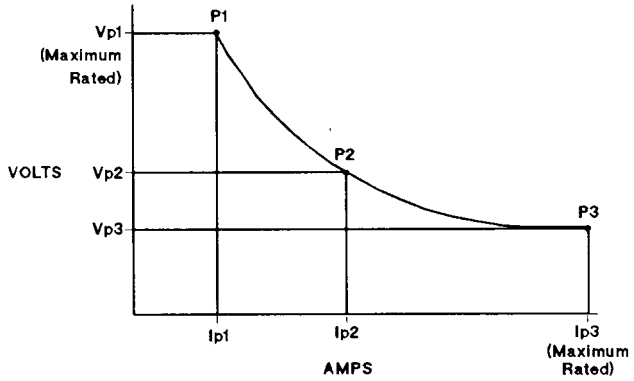
The Option 100 changes are listed sequentially, starting with Section I in the main body of the manual and working back through Section III. It is recommended that the user mark all the necessary changes directly into the manual using Appendix A as a guide. This will update the manual for Option 100 and eliminate the need for constant referrals back to Appendix A.

Manual Changes

Section I Manual Changes
In Table 1-1, change the following table Specifications.

Table A-1. Output Boundary Specifications

Agilent Model	6030A	6031A	6032A	6033A	6035A	6038A
VP_1	170	20	50	17	425	50
IP_1	4.7	35	16	10	1.38	3.7
VP_2	90	12	35	11.1	225	35
IP_2	10.8	73	26	18	3.20	5.7
VP_3	42	5.2	13.5	5	150	15
IP_3	17	120	50	30	5.0	10



Section II Manual Changes

For Agilent Models 6030A, 6031A, 6032A and 6035A: on page 2-7 (AC line Impedance Check, step b), where the maximum output voltages are tabulated, change the voltages as shown below:

6030A change 65 V to 50 V
6031A change 8 V to 6 V
6032A change 22 V to 13.5 V
6035A change 220 V to 150 V

Section III Manual Changes

On page 3-10 (Overvoltage Protection), change 107% to 90%.
On page 3-11 (Monitor Signals), change "0-5 Volts" to ''0-4.5 Volts' ' .
In Table 3-6, change the soft voltage limits as follows:

Model	from:	to:
6030A	204.75	174.03
6031A	20.475	17.40
6032A	61.425	52.21
6035A	511.875	435.10
6033A	20.475	17.40
6038A	61.425	52.21

In table 3-7, GP-IB Commands, change the boxes in the second column (*Range **Response) with voltages tabulated in tables a, b, c, or d as shown below.

Change the column for VSETx, VSETxV, VMAXx, and VMAXxV to set a.
Change the column for VSETxmV, and VMAXxmV to set b.
Change the column for ISETxA, ISETxA, IMAXx, and IMAXxA to set c.

Change the column for ISETxmA, and IMAXxmA to set d.

Agilent Model	Set a	Set b	Set c	Set d
6030A	0-175.00 V	0-175000 mV	0-17.403 A	0-17403 mA
6031A	020.45 V	0-20425 mV	0-122.85 A	0-122850 mA
6032A	0-51.495 V	0-51495 mV	0-51.1875 A	0-51187.5 mA
6033A	0-17.500 V	0-17500 mV	0-30.7125 A	0-30712.5 mA
6035A	0-437.50 V	0-437500 mV	0-5.119 A	0-5119 mA
6038A	0-51.495 V	0-51495 mV	0-10.2375 A	0-10237.5 mA

On page 65 (Analog Programming, 2nd paragraph), change the second sentence to read: “Resistance of 0 to 3.33 K ohms programs the output voltage from 0 to full scale. and a resistance of 0 to 4 K ohms programs the output current from 0 to full scale.”.

On page 65 (Analog Programming, 4th paragraph), change the second sentence to read, “A voltage of 0 to 4.25 V programs the output voltage from 0 to full scale and a voltage of 0 to 5 volts programs the output current from 0 to full scale.”.

On page 66 (Constant Voltage Output, Resistance Control), in the second sentence, change 4000 ohms to 3.33k ohms.

On page 66 (Constant Voltage Output, Voltage Control), change “0 to + 5 volts” to “0 to 4.25 volts”.

In Figures 3-10 and 3-11, where 5 Vdc, 5 E or 5 appear, change them to read +4.25 Vdc, 4.25E, or 4.25 respectfully.

B

Blank Front Panel Option 001

Introduction

This appendix describes the blank front panel option (Option 001) for the power supply. Option 001 is designed for applications in which front panel operation and monitoring are unnecessary. It has no front-panel controls and indicators except for the LINE switch and OVP ADJUST control found on the standard unit, and a pilot light to indicate when ac input power is turned on. All other characteristics of the standard power supply are retained.

Except for references to front-panel controls and indicators, most of the information in the manual applies to Option-001 units. No attempt has been made in this appendix to change every reference to the front-panel controls and indicators. In general, information in this appendix replaces only those procedures whose modification may not be obvious to the user. When reading the manual, the user can usually skip over references to front panel controls and indicators other than the LINE switch and OVP ADJUST control.

Description

The front panel printed-circuit assembly of the standard unit is not used in the Option-001 unit. Instead, the LINE switch, pilot light, and 10-turn OVP ADJUST potentiometer are mounted directly to the front chassis. Cables from the pilot light and the OVP ADJUST potentiometer plug onto the control board. Wires from the main board plug onto the back of the LINE switch.

Turn-On Check Out Procedure

The following procedure ensures that the unit is operational, and may be used as an incoming inspection check.

You should know how to operate the computer and send commands over the GP-IB. Read pages 44 through 65 to familiarize yourself with GP-IB control of the power supply; pay particular attention to the description of programming syntax (starting on page 48). Table 3-7 provides a summary of each of the GP-IB commands.

Refer to the Introductory Operating Guide specified in Section I for programming examples you can use to familiarize yourself with the power supply and its capabilities.

Before starting this procedure, ensure that the rear panel mode switches are set as shown in Figure 3-4, and that the sensing jumpers are tightened securely. Check that the rear-panel label indicates that the unit is set for the line voltage to be used. Check that the recessed OVP ADJUST control on the front panel is fully clockwise. Connect GP-IB cable from computer to rear-panel GP-IB connector.

The power supply performs a series of self tests each time power is turned On. The tests take approximately one second to complete. If the unit fails any of the self tests it will not respond to any commands from the GP-IB, and it should be removed for service.

NOTE Because the power supply is testing itself, it is not possible to guarantee that the unit will find every possible failure.

a. Press top of LINE rocker switch to turn unit on. Pilot light should turn on, and fan should operate.
b. Send string:

ID?

and address the power supply to talk. The response should be shown in Table B-1.

Table B-1. ID Query Response

Agilent Model	Response
Agilent 6030A	ID Agilent 6030A or ID Agilent 6030A, Opt 100
Agilent 6031A	ID Agilent 6031A or ID Agilent 6031A, Opt 100
Agilent 6032A	ID Agilent 6032A or ID Agilent 6032A, Opt 100
Agilent 6033A	ID Agilent 6033A or ID Agilent 6033A, Opt 100

If the power supply responds correctly, the microcomputer, associated circuits and software are almost certainly functioning properly.

The most common cause of failure of the power supply to respond to commands sent from the controller is typing errors. To determine if the power supply has detected an error, send string:

ERR?

and address the power supply to talk. The response should be:

ERR x

where x is a decimal digit from 0 to 8. See Table 3-10 for a description of error codes. If the power supply still fails to respond, check that you are using the appropriate format for sending GP-IB commands from your controller. Check that the GP-IB address switches on the rear panel of the power supply are set for the address being used. Substitute another GP-IB instrument for the suspect power supply to determine that a fault exists in the power supply and not in the controller, interface, or cables.

The following steps check the CV and CC loops and the OVP circuit. Remember that measured responses (VOUT,IOUT,OVP) may vary within specified tolerances from the expected response.

a. To check the CV loop, send string:

VSET 20; ISET 1

and wait one second for power supply to settle. Send string:

STS?

and address the power supply to talk. The response should be:

STS 1

indicating that the power supply is in the CV mode. Send string:

VOUT?

and address the power supply to talk. The response should be;

VOUT 20.000

b. To check the OVP circuit, send string:

VSET 10

To run the following program (Agilent-85 format is used here.

Use format appropriate for your computer.):

```
10 OUTPUT 705; “VOUT?”
20 ENTER 705; A$ 30 OUTPUT 705; “OVP?”
40 ENTER 705; B$
50 DISP A$,B$
60 GOTO 10
70 END
```

Turn OVP ADJUST potentiometer counterclockwise while observing VOUT and OVP readings on computer display. VOUT should drop to about 0 volts as OVP is adjusted below 10 volts. Stop program. Send string:

STS?

And address the power supply to talk. The response should be:

STS 8

indicating that the OVP circuit has tripped. Turn OVP ADJUST potentiometer fully clockwise. Send String:

RST

Restart program. VOUT should read 10 volts. Stop program.

c. To check constant current circuit, turn power supply off and connect a wire capable of handling the full current of the power supply across + and - terminals on rear panel.
d. Turn power supply on and send the appropriate string in Table B-2.

Table B-2. CC Check Command String

Agilent Model	String
Agilent 6030A	ISET 17 VSET 2
Agilent 6031A	ISET 120 VSET.2
Agilent 6032A	ISET 50 VSET.6
Agilent 6033A	ISET 30 VSET.2
Agilent 6035A	ISET 5 VSET 5
Agilent 6038A	ISET 10 VSET.6

Wait one second for power supply to settle. Send string:

STS?

and address the power supply to talk. The response should be:

STS 2

indicating that power supply is in the CC mode. Send string:

IOUT?

and address the power supply to talk. The response should be: the ISET value set in step d. above.

e. Turn off power supply, remove short from output, and read remainder of Section 3, except for LOCAL OPERATION, before connecting load to supply.

Overvoltage Protection Setting

For ease in setting the OVP trip voltage, use a looping program such as that listed in the check out procedure. This enables you to read the OVP trip voltage on the computer display while adjusting OVP at the power supply front panel.

C

Standard Commands for Programmable Instruments (SCPI)

ABOUT THIS APPENDIX

IF YOU WILL NOT BE PROGRAMMING USING SCPI COMMANDS, YOU DO NOT HAVE TO READ THIS APPENDIX.

This appendix documents the Standard Commands for Programmable Instruments (SCPI), formerly known as TMSL, and applies to Agilent Models 603xA Series Autoranging System DC Power Supplies with the serial numbers shown on the cover page of this manual.

READER PATH

All readers should read the "INTRODUCTION" of this appendix.

If you are unfamiliar with the Agilent 603xA power supplies, read through Section 3 of this Operating manual first, then return to this appendix.

If you are unfamiliar with SCPI, see "References", in this appendix.

NOTE TMSL (Test and Measurement Systems Language) and HPSL are earlier versions of SCPI. If you have used either of these languages, you probably will have no difficulty using SCPI.

If you are familiar with SCPI, but unfamiliar with programming this power supply, read the "Language Dictionary" and "Status Reporting" in this appendix.

REFERENCES

The following documents will assist you with programming in SCPI

- [1] *Beginner's Guide to SCPI* Agilent Part No. H2325-90001.
  Highly recommended for anyone who is not a programmer and who has not had previous SCPI (or TMSL) programming experience.
- [1] *Tutorial Description of the Agilent Technologies Interface Bus* Agilent Part No. 5952-0156.
  Highly recommended for those not experienced with the IEEE 488.1 and 488.2 standards.
- These are two formal documents concerning the GP-IB interface:

  [2] ANSI/IEEE Std 488.1-1987. IEEE Standard Digital Interface for Programmable Instrumentation.
  Defines the technical details of the GP-IB interface. While much of the information is beyond the need of most programmers, it can be used to clarify formal definitions of terms used in this and related documents.

[2]*ANSI/IEEE Std 488.2-1987. IEEE Standard Codes, Formats, Protocols, and Common Commands.* Recommended as a reference if you will do fairly sophisticated programming. Helpful for finding the precise definitions of certain types of SCPI message formats, data types, or common commands.

[1]To obtain a copy, contact your local Agilent Sales Office.
[2]Available from IEEE (Institute of Electrical and Electronics Engineers), 345 East 47th Street, New York, NY 10017, USA.

INTRODUCTION

The Agilent 603xA power supplies can now be programmed using either the original language commands (i.e. VSET, ISET, etc.) as documented in Section III of this manual, or the Standard Commands for Programming Instruments (SCPI) as documented in this appendix.

Local operation, analog remote programming, and all original language commands remain exactly the same except for the following:

- When using SCPI commands, the GP-IB parallel poll interface function (PP) is not implemented by the Agilent 603xA power supplies.

- When using the SCPI commands, the Foldback key on the front panel of the Agilent 603xA power supplies will toggle overcurrent protection on and off. Refer to CURR:PROT:STAT in the "Language Dictionary" for more details.

Note that all existing software written in the original language commands will still execute correctly with the new 603xA power supplies.

LANGUAGE SWITCHING

Both the original language commands (COMP for compatibility) and SCPI/TMSL commands are contained in ROM. Individually, either may be used to program the power supply. Two commands have been added to both languages to let you switch from one language to the other, and also query the power supply to determine the active language.

SYSTem:LANGuage < TMSL/COMP >
SYSTem:LANGuage?

For Agilent 603xA power supplies, the original language commands (ARPS) are described in Section III of this manual. For information about the SYST:LANG command as well as the other SCPI commands, refer to the "Language Dictionary" in this appendix.

When shipped from the factory, Agilent 603xA supplies are set to operate using the original ARPS language commands (COMP for compatibility).

STAND-ALONE CONNECTIONS

See Figure C-la. Each stand-alone power supply has its own primary GP-IB bus address. Stand-alone power supplies may be connected to the bus in series configuration, star configuration, or a combination of the two. You may connect from 1 to 15 stand-alone power supplies to a GP-IB interface.

LINKED CONNECTIONS

When programming with SCPI commands, it is possible to connect up to 15 additional power supplies per GP-IB address using linked connections, and still communicate with each supply individually.

Installation

As shown in Figure C-lb, the first power supply in a linked connection is connected directly to the controller via a GP-IB cable. It is the only power supply connected directly to the bus and has a unique primary bus address. You may connect from 1 to 15 direct power supplies to a GP-IB interface.

The remaining power supplies are connected to the "direct" power supply via a serial-link cable. Each "linked" supply has a unique secondary GP-IB address but derives its primary address from the direct power supply. You may connect from 1 to 15 linked power supplies to each direct power supply.

NOTE Either serial link connector on the rear of the GP-IB Board can be used for “input” or “output”'. In other words, either jack can be used to connect to the next linked supply.

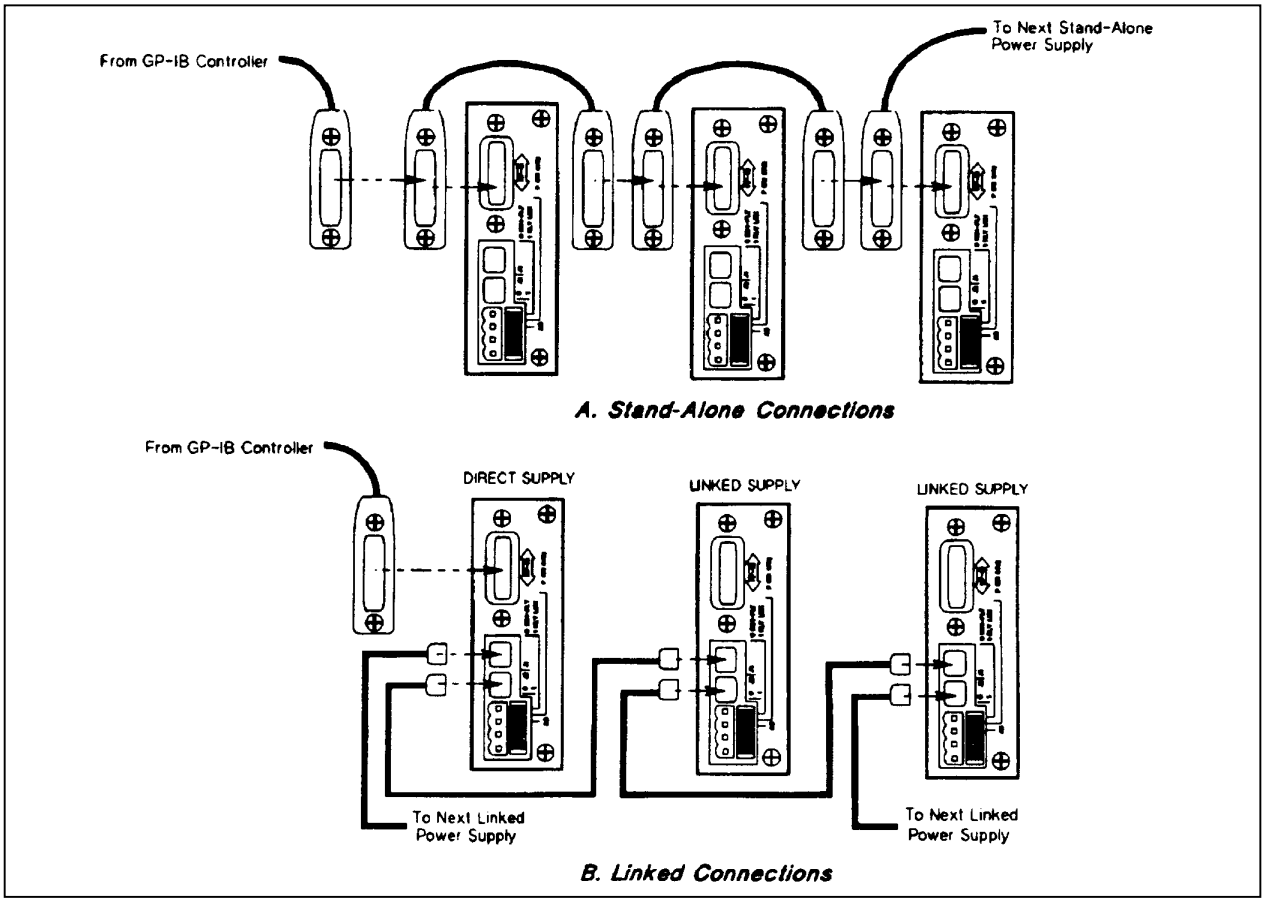


Figure C-1 Linked Connections

Setting the Address

NOTE The primary and secondary addresses cannot be selected over the GP-IB. However, there are important differences in addressing power supplies over the bus depending on if only primary or a combination of primary and secondary addresses are used. (See ”Addressing Over the Bus”).

Primary Address--is set using the switches A1 through A5 on the rear panel of the GP-IB Board as explained in Section III of this manual. All power supplies connected directly to the GP-IB interface must be set to a unique primary address. This applies whether they are "stand-alone" power supplies or "direct" supplies in a linked configuration.

Secondary Address--is only used when programming in SCPI using linked connections, and is set with the output adjust rotary pulse generator (RPG) in conjunction with the front panel LCL Key. To set the secondary address proceed as follows:

- Press and hold the LCL button until the secondary address is displayed. The primary address is displayed first, and after two seconds the secondary address is displayed until the key is released.
- Turn the RPG while the secondary address is being displayed to change the secondary address.

The secondary address can be set from 0 to 15 or null. A null is shown as a ”- - -" on the front panel LED. Secondary addresses are used as follows:

- - -	Select null "- - -” if you are using stand-alone connections only.
0	Select zero as the secondary address for the direct supply only.
1 thru 15	Select 1-15 as secondary addresses for linked supplies only. For linked supplies, the primary address is displayed as a null "- - -" when the LCL key is pressed. Note that the primary address switch settings are ignored on linked supplies.

Addressing Over the Bus

The following examples show how to address the power supply over the bus using stand-alone and linked connections. The examples assume that the GP-IB select code is 7 and the power supply primary address is 5. They also show the front panel display of the GP-IB Address.

GP-IB Address	Type of Connection	Front Panel Display	
		primary	secondary
705	STAND-ALONE	5	---
70500	DIRECT	5	0
70501	LINKED	---	1
↓	↓	↓	↓
70515	LINKED	---	15

LANGUAGE DICTIONARY

This section gives the syntax and parameters for all the IEEE 488.2 common commands and SCPI commands used by the Agilent Series 603xA power supplies. It is assumed that you are familiar with the introductory reference material (see "Related Documents" in Section I), which explains the terms, symbols, and syntactical structures used here and gives an introduction to programming. Original language (ARPS) commands are covered in Section III of this manual.

The programming examples are simple applications of the commands. A SCPI command functions the same way in all Agilent Series 603xA power supplies. Since SCPI syntax remains the same for all programming languages, the examples are generic.

Keywords

Syntax definitions use the long form, but both long and short form keywords appear in the examples. If you have any concern that the meaning of a keyword in your program listing will not be obvious at some later time, then use the long form to help make your program self-documenting.

Parameters

Most commands require a parameter and all queries will return a parameter. The range for a parameter may vary according to the model of power supply. For consistency, the examples use parameters for the Agilent 6033A. Parameters for all current models are listed in Table 3-7 of Section III.

Order of Presentation

The dictionary is organized as follows:

- IEEE 488.2 common commands, in alphabetical order
- Subsystem commands

COMMON Commands

Common commands are defined by the IEEE 488.2 standard to perform some common interface functions. Agilent Series 603xA power supplies respond to the 13 required common commands that control status reporting, synchronization, and internal operations. The supplies also respond to five optional common commands controlling triggers, power-on conditions, and stored operating parameters. The description for each common command or query specifies any status registers affected. In order to make use of this information, you must refer to "Status Reporting", which explains how to read specific register bits and use the information that they return.

Figure C-2 shows the common commands and queries, which are presented in alphabetical order. If a command has a corresponding query that simply returns the data or status specified by the command, then both command and query are included under the explanation for the command. If a query does not have a corresponding command or is functionally different from the command, then the query is listed separately.

Subsystem Commands

Subsystem commands are those that are specific to Agilent Series 603xA power supply functions. They consist of single commands and subsystems. Single commands and subsystems are listed together in alphabetical order. Individual commands within a subsystem are listed in alphabetical order under the subsystem.

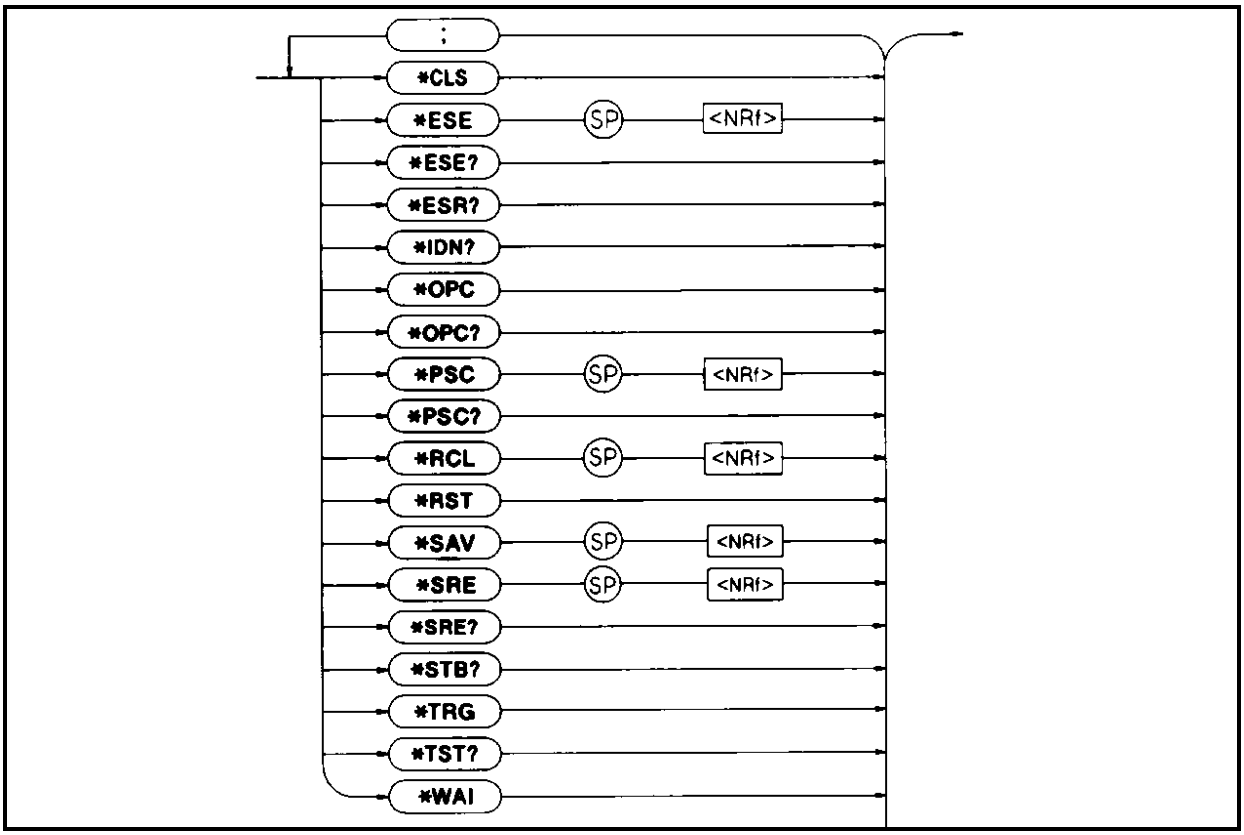


Figure C-2. Common Command Syntax Diagram

Figure C-3 is a tree diagram of the subsystem commands. Commands starting at the root direction are listed as either single commands or command subsystems. Command subsystems may consist of a single command, but usually are comprised of a set of commands that extend two or more levels below the root. Commands followed by a question mark (?) take only the query form. Except as noted in the syntax descriptions, all other commands take both command and the query form.

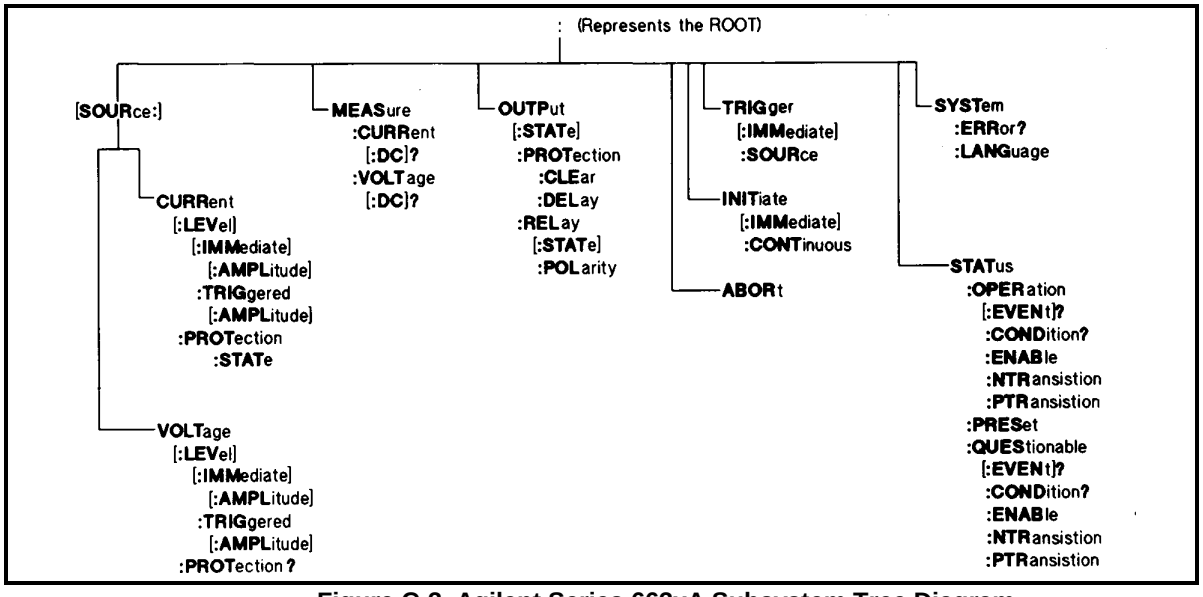


Figure C-3. Agilent Series 663xA Subsystem Tree Diagram

*CLS

Meaning and Type

Clear Status Device Status

Description

This command causes the following actions (see "Status Reporting" for descriptions of all registers):

- Clears the following registers without affecting any corresponding Enable Registers or Transition Filters:
  - Standard Event Status Event Register
  - Operation Status Event Register
  - Questionable Status Event Register
  - Status Byte Register
- Clears the Error Queue
- Forces a previously executed ***OPC** command to appear as if it had been completed. It does *not* do this with the ***OPC?** command (see ***OPC?** for more details).
- If ***CLS** immediately follows a program message terminator (<NL>), then the output queue and the MAV bit are also cleared.

Command Syntax ***CLS**

*ESE

Meaning and Type

Event Status Enable Device Status

Description

This command programs the Standard Event Status Enable register bits. The programming determines which events of the Standard Event Status Event register (see ***ESR?**) are allowed to set the ESB (Event Summary Bit) of the Status Byte register. A "1" in the bit position enables the corresponding event. All of the enabled events of the Standard Event Status Event Register are logically ORed to cause the ESB (bit 5) of the Status Byte Register to be set. See "Status Reporting" for descriptions of all three registers.

Bit Configuration of Standard Event Status Enable Register

Bit Position	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Condition	PON	0	CME	EXE	DDE	QYE	0	OPC
Bit Weight	128	64	32	16	8	4	2	1

CME = Command error; DDE = Device-dependent error; EXE = Execution error; OPC = Operation complete; PON = Power-on; QRY = Query error

Caution



If *PSC is programmed to zero, *ESE causes a write cycle to nonvolatile memory. Non volatile memory has a finite maximum number of write cycles. Programs that repeatedly cause write cycles to nonvolatile memory can eventually exceed the maximum number of write cycles and cause the memory to fail.

Command Syntax	***ESE <NRf>**
Parameters	*0 to 255*
Default Value	(See ***PSC**)
***RST Value**	*0*
Example	***ESE 129**
Query Syntax	***ESE?**
Returned Parameters	**<NRl> (Register value)**
Related Commands	***ESR? *PSC *STB?**

*ESR?

Meaning and Type

Event Status Register Device Status

Description

This query reads the Standard Event Status Event register. Reading the register clears it. The bit configuration of this register is the same as the Standard Event Status Enable register (***ESE**). See "TMSL - Status Reporting" for a detailed explanation of this register.

Query Syntax	***ESR?**
Returned Parameters	**<NRl>** (Register binary value)

*IDN?

Identification Query

Meaning and Type

Identification System Interface

Description

This query requests the power supply to identify itself.

Query Syntax	***IDN?**
Returned Parameters	**<AARD>**
	Information
	Manufacturer
	4-digit model number followed by a letter suffix
	10-character serial number or *0*
	Revision levels of firmware
Example	**Hewlett-Packard,6632A,0,sA.00.05,pA.01.01**

*OPC

Meaning and Type

Operation Complete Device Status

Description

This command causes the interface to set the OPC bit (bit 0) of the Standard Event Status register when the power supply has completed all pending operations. (See ***ESE** for the bit configuration of the Standard Event Status register.)

Pending operations are complete when:

- all previous commands have been executed
- any change in the output level caused by previous commands has been completed (completion of settling time, relay bounce, etc.)
- no pending trigger level operations are set

***OPC** does not prevent processing of subsequent commands but Bit 0 will not be set until all pending operations are completed.

Command Syntax ***OPC**

---

*OPC?

Meaning and Type

Operation Complete Device Status

Description

This query causes the interface to place an ASCII "1" in the Output Queue when all pending operations are completed. *Pending operations* are as defined for ***OPC**. Unlike ***OPC, *OPC?** prevents processing of all subsequent commands. ***OPC?** is intended to be used at the end of a command line so that the application program can then monitor the bus for data until it receives the "1" from the power supply Output Queue.

Caution



Do not follow ***OPC?** with ***TRG** or GP-IB bus triggers. Such triggers sent after ***OPC?** will be prevented from executing and will stop system operation. If this occurs, the only programmable way to restore operation is by sending the power supply a GP-IB DC1 (Device Clear) command.

Query Syntax ***OPC?**
Returned Parameters <**NR1**> ASCII 1 is placed in the Output Queue when the power supply has completed operations.

---

*PSC

Meaning and Type

Power-on Status Clear Device Initialization

Description

This command controls the automatic clearing at power turn on of:

- the Service Request Enable register
- the Standard Event Status Enable register

If the command parameter = *0*, then the above registers are not cleared at power turn on, but are programmed to their last previous state. This can enable the power supply to request service at turn on. Any non-zero parameter causes both registers to be cleared at turn on, preventing the power supply from being capable of requesting service at that time. See "Status Reporting" for details of these registers.

Caution



*PSC causes a write cycle to nonvolatile memory. Non volatile memory has a finite maximum number of write cycles. Programs that repeatedly cause write cycles to nonvolatile memory can eventually exceed the maximum number of write cycles and cause the memory to fail.

Command Syntax	***PSC** <bool>
Parameters	*0 or l*
Default Value	*0*
Example	***PSC 0 *PSC 1**
Query Syntax	***PSC?**
Returned Parameters	**<NR1>** *0 or 1*

---

*RCL

Meaning and Type

Recall Device State

Warning



Recalling a previously stored state may place a hazardous voltage at the power supply output.

Description

This command restores the power supply to a state that was previously stored in memory with the ***SAV** command to the specified location. The following parameters are affected by *RCL:

CURR[:LEV][:IMM]	**OUTP[:STAT]**	**OUTP:REL:POL**
CURR:PROT:STAT	**OUTP:PROT:DEL**	**VOLT[:LEV][:IMM]**
OUTP:RE~[:STAT]		

Sending ***RCL** also does the following:

- forces an **ABORt** command before resetting any parameters (this removes all pending trigger levels)
- forces an **OUT:PROT:CLE** command before resetting any parameters (this clears all status conditions)
- sets **INIT:CONT** to **OFF**
- sets **TRIG:SOUR** to **BUS**

Command Syntax	***RCL <NRf>**
Parameters	*0 through 4*
Example	***RCL 3**

*RST

Meaning and Type

Reset Device State

Description

This command reset the power supply to a factory-defined state as defined below. ***RST** also forces an **ABORt** and an **OUT:PROT:CLE** command.

CURR[:LEV] [:IMM] *	**OUTP *OFF***	**VOLT[:LEV][:IMM]***
CURR[:LEV]:TRIG*	**OUTP:PROT:DEL***	**VOLT[:LEV][:TRIG]***
CURR:PROT:STAT *OFF*	**OUTP:REL** *OFF*	
INIT:CONT *OFF*	**OUTP:REL:POL** *NORM*	

*Model-dependent value. See *ISET, DI,Y,* and *VSET* in Table 3-7 of Section III..

Command Syntax ***RST**

*SAV

Meaning and Type

SAVE Device State

Description

This command stores the present state of the power supply to the specified location in memory. Up to five states can be stored. Because the memory locations are volatile, all saved states are lost when the power supply is turned off. When the power supply is turned on, all memory locations are initialized to the factory defined state (see the ***RST** command).

The following power supply parameters are stored by ***SAV**:

CURR[:LEV][:IMM]	**OUTP[:STAT]**	**OUTP:REL:POL**
CURR:PROT:STAT	**OUTP:PROT:DEL**	**VOLT[:LEV][:IMM]**
OUTP:REL[:STAT]		

Caution



*SAV causes a write cycle to nonvolatile memory. Non volatile memory has a finite maximum number of write cycles. Programs that repeatedly cause write cycles to nonvolatile memory can eventually exceed the maximum number of write cycles and cause the memory to fail.

Command Syntax ***SAV <NRf>**
Parameters *0 to 4*
Example **SAV 3**

*SRE

Meaning and Type

Service Request Enable Device Interface

Description

This command sets the condition of the Service Request Enable Register. This register determines which events of the Status Byte Register (see ***STB** for its bit configuration) are summed into the MSS (Master Status Summary) and RQS (Request for Service) bits. RQS is the service request bit that is cleared by a serial poll; the MSS is not cleared when read.

A *1* in any Service Request Enable Register bit position enables the corresponding Status Byte bit to set the RQS and MSS bits. All the enabled Service Request Enable Register bits then are logically ORed to cause Bit 6 of the Status Byte Register to be set. See "Status Reporting" for more details concerning this process.

Caution



If *PSC is programmed to zero, *SRE causes a write cycle to nonvolatile memory. Non volatile memory has a finite maximum number of write cycles. Programs that repeatedly cause write cycles to nonvolatile memory can eventually exceed the maximum number of write cycles and cause the memory to fail.

Command Syntax ***SRE <NRf>**
Parameters *0 to 255*
Default Value **(See *PSC)**
Example ***SRE 20**
Query Syntax ***SRE?**
Returned Parameters **<NR1>** (Register binary value)

*STB?

Meaning and Type

Status Byte Device Status

Description

This query reads the Status Byte register without clearing it. The register is cleared only when subsequent action clears all its set bits. See "Status Reporting" for more information about the Status Byte register.

A serial poll also returns the value of the Status Byte register, except that bit 6 returns RQS instead of MSS. A serial poll clears RQS, but not MSS. When MSS is set, it indicates that the power supply has one or more reasons for requesting service.

Bit Configuration of Status Byte Register

Bit Position	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Condition	**OPER**	**[1]MSS**	**ESB**	**MAV**	**QUES**	**[2]**		
Bit Weight	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
ESB = Event status byte summary; MAV = Message available; MSS = Master status summary; OPER = Operation status summary; QUES = Questionable status summary								
[1]AIso represents RQS (Request for service). [2]These bits are always zero.								

Query Syntax ***STB?**
Returned Parameters **<NR1>** (Register binary value)

*TRG

Meaning and Type

Trigger Device Trigger

Description

This command, which is essentially the same as the Group Execute Trigger (<GET>) and the subsystem **TRIG[:IMM]** signals, generates a trigger to the power supply.

Command Syntax ***TRG**

*TST?

Meaning and Type

Test Device Test

Description

This query causes the power supply to do a self test and report any errors.

Query Syntax ***TST?**
Returned Paramters **<NR1>**
0 Indicates power supply passed self-test.
Nonzero Indicates a self-test failure.

*WAI

Meaning and Type

Wait to Continue Device Status

Description

This command instructs the power supply not to process any further commands until all pending operations are completed. "Pending operations" are as defined under the ***OPC** command. ***WAI** can be aborted only by sending the power supply a GP-IB **DCL** (Device Clear) command.

Command Syntax ***WAI**

ABOR

This command cancels any pending triggered levels stored by the **CURR:TRIG** or **VOLT:TRIG** commands. The pending level is set equal to the corresponding immediate value. **ABORt** also resets the WTG bit in the Operation Condition status register (see "Status Reporting"). If **INIT:CONT ON** has been programmed, the trigger system rearms itself immediately after **ABORt**, thereby setting WTG. ABORt is executed at power turn on.

Command Syntax **ABORt**
Examples **ABOR ABORT**

Current Subsystem

This subsystem programs the output current of the power supply.

CURR[:LEV]

Sets the immediate current level or the pending triggered current level of the power supply. The immediate level is the current programmed for the output terminals. The pending triggered current level is a stored value that will be transferred to the output when a trigger occurs. If no pending triggered level has been programmed, then the immediate command programs both levels to the same value. Once a trigger level is programmed, it is unaffected by subsequent changes to the immediate level.

Command Syntax	[**SOUR**ce]:**CURR**ent[:**LEV**el] [:**IMM**ediate][:**AMP**Litude] <**NRf+**> [**SOUR**ce][:**CURR**ent[:**LEV**el]:**TRIG**gered [:**AMPL**itude] <**NRf+**>
Parameters	See "ISET" in Table 3-7 of Section III.
Default Sufflx	A
Examples	**CURR 200 MA CURRENT:LEVEL 200 MA** **CURRENT:LEVEL:IMMEDIATE:AMPLITUDE2.5** **CURR:TRIG 20 CURRENT:LEVEL:TRIGGERED 20**
Query Syntax	[**SOUR**ce]:**CURR**ent[:**LEV**el] [:**IMM**ediate][:**AMP**Litude]? [**SOUR**ce]:**CURR**ent[:**LEV**el] [:**IMM**ediate][:**AMPL**itude]? **MAX** [**SOUR**ce]:**CURR**ent[:**LEV**el] [:**IMM**ediate][:**AMPL**itude]? **MIN** [**SOUR**ce]:**CURR**ent[**LEV**el]:**TRIG**ger [:**AMPL**itude]? [**SOUR**ce]:**CURR**ent[**LEV**el]:**TRIG**ger [:**AMPL**itude]? **MAX** [**SOUR**cel:**CURR**ent[:**LEV**ell:**TRIG**ger [:**AMPL**itude]? **MIN**

Returned Parameters **<NR3> CURR?** and **CURR:TRIG?** return presently programmed current levels. If the **TRIG** level is not programmed, both returned values are the same.
CURR? MAX and **CURR? MIN** return the maximum and minimum programmable immediate current levels.
CURR:TRIG? MAX and **CURR:TRIG?** MIN return the maximum and minimum programmable triggered current levels.

CURR:PROT:STAT

Enables or disables the power supply overcurrent protection function (OCP). If the OCP function is enabled and the output current exceeds the programmed immediate level then:

- the power supply output is disabled
- the Questionable Condition status register OC bit is set (see "Status Reporting").

An overcurrent condition can be cleared with the **OUTP:PROT:CLE** command after the condition that caused the OCP trip is removed.

Command Syntax	[**SOUR**ce][:**CURR**ent:**PROT**ection:**STATe <bool>**
Parameters	*0* or *OFF* *1* or *ON*
***RST Value**	*OFF*
Examples	**CURR: PROT: STAT 0 CURRENT: PROTECTION: STATE OFF** **CURR:PROT:STAT 1 CURRENT:PROTECTION:STATE ON**
Query Syntax	**[SOURce]:CURRent:PROTection:STATe?**
Returned Parameters	**<NRl>** *0 or 1*

Initiate Subsystem

This subsystem enables the trigger system. When a trigger is enabled, the triggering action will occur upon receipt of a <GET>, ***TRG**, or **TRIGg**er command. If a trigger circuit is not enabled, all trigger commands are ignored. The actions of the two initiate commands are:

- If **INIT:CONT** is **OFF**, then **INIT[:IMM**] arms the trigger system for a single trigger.
- If **INIT:CONT** is **ON**, then the trigger system is continuously armed and **INIT[:IMM**] is redundant.

Command Syntax	**INITiate[:IMMediate]** **INITiate:CONTinuous <bool>**
Parameters	For **INIT[:IMM]** (None) For **INIT:CONT** *0 or OFF 1 or ON*
***RST Value**	*OFF*
Examples	**INIT INITIATE: IMMEDIATE** **INIT:CONT 1 INITIATE:CONTINUOUS 1**
Query Syntax	For **INIT[:IMM]** (None) For **INIT:CONT INIT:CONT?**
Returned Parameters	**<NR1>** *0 or 1*

Measure Subsystem

This query subsystem returns the voltage and current measured at the power supply's sense

Query Syntax	**MEAS**ure**:CURRent[:DC?] MEAS**ure**:VOLT**age**[:DC?]**	**Default Suffix**
A for **MEAS:CURR**	V for **MEAS:VOLT**	
Examples	**MEAS: CURR? MEAS: VOLT?** **MEASURE: VOLTAGE: DC? MV**	
Returned Parameters	**<NR3>**	

Output Subsystem

This subsystem controls the power supply's voltage and current outputs and the optional Agilent 59510A/59511A Relay Accessory.

OUTP[:STAT]

Enables or disables the power supply's output. The exact state of a disabled output is model dependent, but it generally is in a condition of minimum output voltage and source current. If the power supply is configured with the Agilent 59510A/59511A Relay Accessory, the command will open the relay contacts when the output is disabled and close them when it is enabled. Use of the second (**NOR**elay) parameter prevents the command from having any effect on the relay; it remains in its existing state when **OUTP**ut is executed. The query form returns the output state, excluding that of the relay (see **OUTP:REL?).**

Command Syntax	**OUTP**ut[:**STATe] <NRf>[,NORelay]**
Parameters	*{O/OFF}[,NORelay] {I/ON}[,NORelay]*
***RST Value**	*0*
Examples	**OUTP 1 OUTPUT: STATE ON, NORELAY**
Query Syntax	**OUTP**ut**[:STAT**e**]?**
Returned Parameters	**<NRl>** *0 or 1*

OUTP:PROT

There are two output protection commands that do the following:

OUTP:PROT:CLE Clears any OV (overvoltage), OC (overcurrent, unless set via external voltage control),OT (overtemperature), or RI (remote inhibit) status conditions. If the power supply is configured with the Agilent 59510A/llA Relay Accessory, it will be restored to the state it was in before the protection circuit tripped.

OUTP:PROT:DEL Sets the time that a change in CV, CC, or UNREG condition must appear at the output before that change is recorded in the Status Operation Condition register. The delay prevents momentary output changes that can occur during reprogramming from being registered as events by the status subsystem.

Command Syntax **OUTP**ut:**PROT**ection:**CLE**ar
OUTPut:**PROT**ection:**DEL**lay <NRf+>
Parameters **OUTP:PROT:CLE** (None)
OUTP:PROT:DEL See "DI,Y" in Table 3-7 of Section III.
Default Sufflx *S*
Examples **OUTP: PROT: CLE OUTPUT: PROTECTION: CLEAR**
OUTPUT:PROTECTION:DELAY 75E-l
OUTP:PROT:DELMIN OUTPUT:PROT:DELAY MAX
Query Syntax **OUTP:PROT:CIE** (None**) OUTP:PROT:DEL?**
OUTP:PROT:DEL? MIN OUTP:PROT:DEL? MAX
Returned Parameters **<NR3> OUTP:PROT:DEL** returns value of programmed delay**.**
OUTP:PROT:DEL? MIN and **OUTP:PROT:DEL? MAX** return the minimum and maximum programmable delays.

OUTP:REL[:STAT]

This command is valid only if the power supply is configured for the optional Agilent 59510A and Agilent 59511A Relay Accessory. Programming **ON** closes the relay; programming **OFF** opens it. If the power supply is not configured for either device, the command generates an error.

Command Syntax **OUTP**ut**:REL**ay**[:STATe] <bool>**
Parameters *0 or OFF* *I or ON*
***RST Value** *0*
Examples **OUTP: REL 1 OUTPUT: RELAY OFF OUTPUT: RELAY: STATE OFF**
Query Syntax **OUTP:REL?**
Returned Parameters **<NR.1>** *0 or 1*

OUTP:REL:POL

This command is valid only if the power supply is configured for the Agilent 59511A Relay Accessory. The **NORM**al command causes the device output polarity to agree with that of the power supply. Programming **REV** causes the polarity of the device to be opposite to that of the power supply. If the power supply is not configured for the Agilent 59511A, either command generates an error.

Command Syntax **OUTP**ut**:REL**ay**:POL**arity **{NORMalREV**erse**}**
Parameters **<CRD>** *NORMal* or *REVerse*
***RST Value** *NORM*
Examples **OUTP: REL: POL NORM OUTPUT: RELAY: POLARITY REVERSE**
Query Syntax **OUTP:REL:POL?**
Returned Parameters **<CRD>** *NORM* or *REV*

Status Subsystem

This subsystem programs the power supply status registers. The power supply has two groups of status registers; **Operation** and **Questionable.** Each group consists of the following five registers:

Condition Enable Event NTR Filter PTR Filter

Status Operation Registers

The bit configuration of all Status Operation registers is shown in the following table:

Bit Configuration of Operation Registers

Bit Position	**15-12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Condition	**NU**	**NU**	**CC**	**NU**	**CV**	**NU**	**NU**	**WTG**	**NU**	**NU**	**NU**	**NU**	**NU**
Bit Weight		**2048**	**1024**	**512**	**256**	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**

CC = Power supply is sourcing current in CC mode; CV = Power supply is in constant voltage mode; NU = (Not used); WTG = Interface is waiting for a trigger.

See "Status Reporting" for more explanation of these registers.

STAT:OPER:COND?

Returns the value of the Operation Condition register. That is a read-only register which holds the real-time (unlatched) operational status of the power supply.

Query Syntax **STAT**us**:OPER**ation**:COND**ition**?**
Examples **STAT: OPER: COND? STATUS: OPERATION: CONDITION?**
Returned Parameters **<NRl>** (Register value)

STAT:OPER:ENAB

Sets or reads the value of the Operation Enable register. The Operation Enable register is a mask for enabling specific bits in the Operation Event register that can cause the operation summary bit of the Status Byte register to be set. The operation summary bit (bit 7) is the logical OR of all the enabled bits in the Operation Event register.

Command Syntax **STAT**us**:OPER**ation**:ENABL**e **<NRf>**
Parameters *0 to 32727*
Default Value *0*
Examples **STAT: OPER: ENAB 1312 STAT: OPER: ENAB 1 STATUS:OPERATION:ENABLE? Query Syntax** **STAT:OPER:ENAB?**
Returned Parameters **<NRl>** (Register value)

STAT:OPER:EVEN?

Returns the value of the Operation Event register. The Event register is a read-only register which holds (latches) all events that:

- are enabled by the Operation Enable register.
- are passed by the Operation NTR and/or PTR filter.

Reading the Operation Event register clears it.

Query Syntax **STAT**us**:OPER**tion**:EVEN**t?
Returned Parameters **<NR1>** (Register Value**)**
Examples **STAT: OPER: EVEN? STATUS: OPERATIONAL: EVENT?**

NTR/PTR Commands

These commands allow you to set or read the value of the Operation NTR (Negative-Transition) and PTR (Positive-Transistion) registers. These registers serve as polarity filters between the Operation Enable and Operation Event registers to cause the following actions:

- When a bit of the Operation NTR register is set to 1 then a 1-to-0 transition of a corresponding enabled bit of Operation Condition register will cause that bit to be set in the Operation Event register.
- When a bit of the Operation PTR register is set to 1 then a 0-to-1 transition of a corresponding enabled bit of Operation Condition register will cause that bit to be set in the Operation Event register.
- If the same bits in both NTR and PTR registers are set to 1, then *any transition* of that bit (if enabled) at the Operation Condition register will set the corresponding bit in the Operation Event register.
- If the same bits in both NTR and PTR registers are set to 0, then *no transition* of that bit (even if enabled) at the Operation Condition register can set the corresponding bit in the Operation Event register.

NOTE **I**f a Operation bit is in the proper state, then programming the corresponding1 PTR or NTR filter bit to *1* will set the associated Event Register bit.

Command Syntax STATus:**OPER**tion**:NTR**ansition **<NRf>**
STATus**:OPER**tion**:PTR**ansition **<NRf>**
Parameters *0 to 32727*
Default Value *0*
Examples **STAT:OPER:NTR32 STATUS:OPERATION:PTR 1312**
Query Syntax **STAT:OPER:NTR? STAT:OPER:PTR?**
Returned Parameters **<NR1>** (Register value**)**

STAT:PRES

This command sets all defined bits in the Status Subsystem PTR registers and clears all bits in the subsytem NTR and Enable registers. STAT:OPER:PTR is set to 1313 and STAT:QUES:PTR is set to 1555.

Command Syntax **STAT**us**:PRES**et
Examples ***STAT:*** **PRES** ***STATUS:*** **PRESET**

Status Questionable Registers

The bit configuration of all Status Questionable registers is as follows:

Bit Configuration of Questionable Registers

Bit Position	**15-11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Condition	**NU**	**UNR**	**RI**	**NU**	**NU**	**NU**	**NU**	**TO**	**NU**	**NU**	**OC**	**OV**
Bit Weight		**1024**	**512**	**256**	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**

NU = (Not used); OC = Overcurrent protection circuit has tripped; OT = Overtemperature status condition exists; OV = Overvoltage protection circuit has tripped; RI = Remote inhibit is active; UNR = Power supply output is unregulated.

See "Status Reporting" for more explanation of these registers.

STAT:QUES:COND?

Returns the value of the Questionable Condition register. That is a read-only register which holds the real-time (unlatched) questionable status of the power supply.

Query Syntax **STAT**us**:QUES**tionable**:COND**ition**?**
Examples **STAT: QUES: COND? STATUS: QUESTIONABLE: CONDITION?**
Returned Parameters **<NRl>** (Register value)

STAT:QUES:ENAB

Sets or reads the value of the Questionable Enable register. The Questionable Enable register is a mask for enabling specific bits in the Questionable Event register that can cause the questionable summary bit of the Status Byte register to be set. The questionable summary bit (bit 3) is the logical OR of all the enabled bits in the Questionable Event register.

Command Syntax STATus:**QUES**ionable**:ENABl**e **<NRf>**
Parameters *0 to 32727*
Default Value *0*
Examples **STAT: QUES: ENAB 20 STAT: QUES: ENAB 16**
Query Syntax **STAT:QUES:ENAB?**
Returned Parameters **<NRl>** (Register value)

STAT:QUES:EVEN?

Returns the value of the Questionable Event register. The Event register is a read-only register which holds (latches) all events that:

- are enabled by the Questionable Enable register.
- are passed by the Questionable NTR and/or PTR filter.

Reading the Questionable Event register clears it.

Query Syntax **STAT**us**:QUESi**onable**:EVEN**t**?**
Returned Parameters **<NR1>** (Register Value)
Examples **STAT: QUES: EVEN? STATUS: QUESTIONABLE: EVENT?**

NTR/PTR Commands

These commands allow you to set or read the value of the Questionable NTR (Negative-Transition) and PTR (Positive-Transistion) registers. These registers serve as polarity filters between the Questionable Enable and Questionable Event registers to cause the following actions:

- When a bit of the Questionable NTR register is set to 1 then a 1-to-0 transition of a corresponding enabled bit of Questionable Condition register will cause that bit to be set in the Questionable Event register.
- When a bit of the Questionable PTR register is set to 1 then a 0-to-1 transition of a corresponding enabled bit of Questionable Condition register will cause that bit to be set in the Questionable Event register.
- If the same bits in both NTR and PTR registers are set to 1, then *any transition* of that bit (if enabled) at the Questionable Condition register will set the corresponding bit in the Questionable Event register.
- If the same bits in both NTR and PTR registers are set to 0, then *no transition* of that bit (even if enabled) at the Questionable Condition register can set the corresponding bit in the Questionable Event register.

NOTE If a Questionable bit is in the proper state, then programming thecorresponding PTR or NTR filter bit to 1 will set the associated EventRegister bit.

Command Syntax	**STAT**us**:QUES**tionable**:NTR**ansition <**NRf**> **STAT**us**:QUES**tionable**:PTR**ansition <**NRf**>
Parameters	*0 to 32727*
Default Value	*0*
Examples	**STAT:QUES:NTR 16 STATUS:QUESTIONABLE:PTR 512**
Query Syntax	**STAT:QUES:NTR? STAT:QUES:PTR?**
Returned Parameters	<**NR1**> (Register value)

SYST:ERR?

Returns the next error number followed by its corresponding error message string from the remote programming error queue. The queue is a FIFO (first-in, first-out) buffer that stores errors as they occur. As it is read, each error is removed from the queue. When all errors have been read, the query returns 0,N0 ERROR. If more errors are accumulated than the queue can hold, the last error in the queue will be -350,T00 MANY ERRORS.

Query Syntax	**SYST**em**:ERR**or**?**
Returned Parameters	<**NRl**>,<**SRD**>
Examples	**SYST: ERR? SYSTEM: ERROR?**

SYST:LANG

Switches the interface between its SCPI (TMSL) command language and it compatibility language. Note that the earlier parameter "TMSL" must be used in place of "SCPI". Sending the command causes:

- The alternate language to become active and to be stored in nonvolatile memory.
- The power supply to reset and clear the storage and error registers.

NOTE After sending the SYST:LANG command, do not send another command or turn the supply off for at least five seconds.

If the power supply is shut off, it will resume operation in the last-selected language when power is restored.

Command Syntax	**SYST**em**:LANG**uage **{TMSL**|**COMP**atibility**}** ***Syntax is the same, regardless of the present language***
Parameters	<**CRD**> *TMSL* or *COMPatibility*
Default Value	*TMSL or last selected language*
Examples	**SYST:LANG TMSL SYSTEM:LANGUAGE COMPATIBILITY**
Query Syntax	**SYST**em**:LANG**uage**?**
Returned Paramters	<**CRD**> *TMSL* or *COMP*

Trigger Subsystem

This subsystem controls remote triggering of the power supply.

TRIG[:IMM]

When the trigger subsystem is armed, **TRIG** generates a trigger signal. The trigger will then:

1. Initiate the output change from the pending level to the immediate level (see **CURR[:LEV]:TRIG** and **VOLT[:LEV]:TRIG**).
2. Clear the WTG bit in the Status Operation Condition register.
3. If **INIT:CONT** has been sent, the trigger subsystem is immediately rearmed for subsequent triggers. This means that as soon as it is cleared, the WTG bit is again set to 1.

Command Syntax	**TRIG**er**[:IMM**ediate**]**
Examples	**TRIG TRIGGER:IMMEDIATE**

TRIG:SOUR

Sets the trigger source to bus commands. Since the power supply has no other trigger source than the GP-IB bus, this command need not be used. It is included in the command set to provide programming compatibility with other instruments (such as the Agilent Electronic Load family) that may have more than one trigger source.

Command Syntax	**TRIG**er:**SOUR**ce **BUS**
Parameters	<CRD> *BUS*
***RST Value**	*BUS*
Examples	**TRIG: SOUR BUS TRIGGER: SOURCE BUS**
Query Syntax	**TRIG:SOUR?**
Returned Parameters	**<CRD>** *BUS*

Voltage Subsystem

This subsystem programs the output voltage of the power supply.

VOLT[:LEV]

Sets the immediate voltage level or the pending triggered voltage level of the power supply. The immediate level is the voltage programmed for the output terminals. The pending triggered voltage level is a stored value that will be transferred to the output when a trigger occurs. If no pending triggered level has been programmed, then the immediate command programs both levels to the same value. Once a triggered level has been programmed, it is unaffected by subsequent changes to the immediate level.

Command Syntax	[SOURce]:VOLTage[:LEVel] [:IMMediate][:AMPLitude] <NRf+> [SOURce]:VOLTage[:lEVel]:TRIGgered[:AMPlitude] <Nrf+>
Parameters	See "VSET" in Table 3-7 of Section III.
Default Sufflx	*V*
Examples	**VOLT 200 MV VOLTAGE:LEVEL 200 MV** **VOLTAGE:LEVEL:IMMEDIATE:AMPLITUDE 2.5** **VOLT:TRIG 20 VOLTAGE:LEVEL:TRIGGERED 20** **VOLTAGE:LEVEL:TRIGGERED:AMPLITUDE 5.5**

Query Syntax	**[SOUR**ce**]:VOLT**age**[:LEV**el**] [:IMM**ediate**][:AMPL**itude**]?** **[SOUR**ce**]:VOLT**age**[:LEV**el**] [:IMM**ediate**][:AMPL**itude**]? MAX** **[SOUR**ce**] :VOLT**age**[:LEV**el**] [:IMM**ediate**] [:AMPL**itude**] ? MIN** **[SOUR**ce**]:VOLT**age**[LEV**el**]:TRIG**ger **[:AMPL**itude**]?** **[SOUR**ce**]:VOLT**age**[LEV**el**]:TRIG**ger **[:AMPL**itude**]? MAX** **[SOUR**ce**]:VOLT**age**[:LEV**el**]:TRIG**ger **[:AMPL**itude**]? MIN**
Returned Parameters	**<NR3> VOLT? and VOLT:TRIG?** return presently programmed voltage levels. If the **TRIG** level is not programmed, both returned values are the same. **VOLT MAX?** and **VOLT MIN?** return the maximum and minimum programmable immediate voltage levels. **VOLT:TRIG? MAX** and **VOLT:TRIG? MIN** return the maximum and minimum programmable triggered voltage levels.

VOLT:PROT[:AMPL]?

Queries the overvoltage protection level of the power supply. The overvoltage protection level can only be set from the front panel OVP potentiometer.

Query Syntax	**[SOUR**ce**]:VOLT**age**:PROT**ection **[:AMPL**itude**]?**
Returned Parameters	**<NR3> VOLT:PROT?** returns the presently set OVP level.
Examples	**VOLT: PROT? VOLTAGE: PROTECTION: AMPLITUDE?**

STATUS REPORTING

Figure C-4 shows the status structure of the power supply in SCPI mode. The Standard Event, Status Byte, Service Request Enable registers and the Output Queue perform standard GP-IB functions defined in the *IEEE 488.2 Standard Digital Interface for Programmable Instrumentation.* The Operation and Questionable Status registers implement the status reporting requirements of the power supply. Table C-5 shows the bit configuration of each status register.

Questionable Status Group

Register Functions. The Questionable Status registers record signals that indicate abnormal operation of the power supply. As shown in Figure C-4, the group consists of a Condition register, PTR/NTR Filter, Event register, and Enable register.

- The condition register holds real-time status transitions from the circuit being monitored. It is a read-only register.

- Each bit of the PTR filter, when programmed ON (1), allows a 0-to-1 transition of the corresponding Condition register bit to set the corresponding bit of the Event register.
- Each bit of the NTR filter, when programmed *On (1),* allows a 1-to-0 transition of the corresponding Condition register bit to set the corresponding bit of the Event register.
- The Event register latches any condition that is passed through by the PTR or NTR filter. It is a read-only register **(STAT:QUES:EVEN?)** that is cleared when read.
- The Enable register serves as a mask between the Event register and the Logical OR circuit that sets the QUES(tion) bit (3) of the Status Byte register. If a bit in the Enable register is programmed *On (1),* it allows the corresponding Event register bit to be summed into the QUES bit. The register is a readlwrite register programmed with the **STAT:QUES:ENAB** command.

Register Programming. Programming for this group is derived from the **STAT:QUES** commands (see Table C-2).

Table C-5. Bit Configuration of Status Reister Groups

Bit	Signal	Meaning
		Operation Status Group
5	WTG	The interface is waiting for a trigger
8	CV	The power supply is in the positive constant-voltage mode
10	CC	The power supply is sourcing current in the constant-current mode
		Questionable Status Group
0	OV	The power supply overvoltage protection circuit has tripped
1	OC	The power supply overcurrent protection circuit has tripped
4	OT	The power supply has an overtemperature condition
9	RI	The power supply remote inhibit status is active
10	UNR	The power supply output is unregulated
		Standard Event Status Group
0	OPC	Operation complete
2	QYE	Query error
3	DDE	Device-dependent error
4	EXE	Execution error
5	CME	Command error
7	PON	Power on
		Status Byte and Service Request Enable Registers
3	QUES	Questionable status byte summary
4	MAV	Message available
5	ESB	Event status byte summary
6	MSS	Master status summary
	RQS	Request for service
7	OPER	Operation status byte summary

Status Programming Examples. Table C-3 shows four examples that set the Questionable Status register group bits to enable specific conditions. Refer also to Figure C-4.

NOTE *PTR and NTR Filter programming is shown for consistency. In many cases, the default filter values make programming them unnecessary.*

Operation Status Group

Register Functions. The Operation Status registers record signals that are part of the power supply's normal operation. As shown in Figure C-4, the group consists of a set of registers similar to the Questionable Status group. The output of the Operation Status group is logically-ORed into the OPER(ation) summary bit (7) of the Status Byte register.

Register Programming. Programming for this group is derived from the **STAT:OPER** commands (Table C-4).

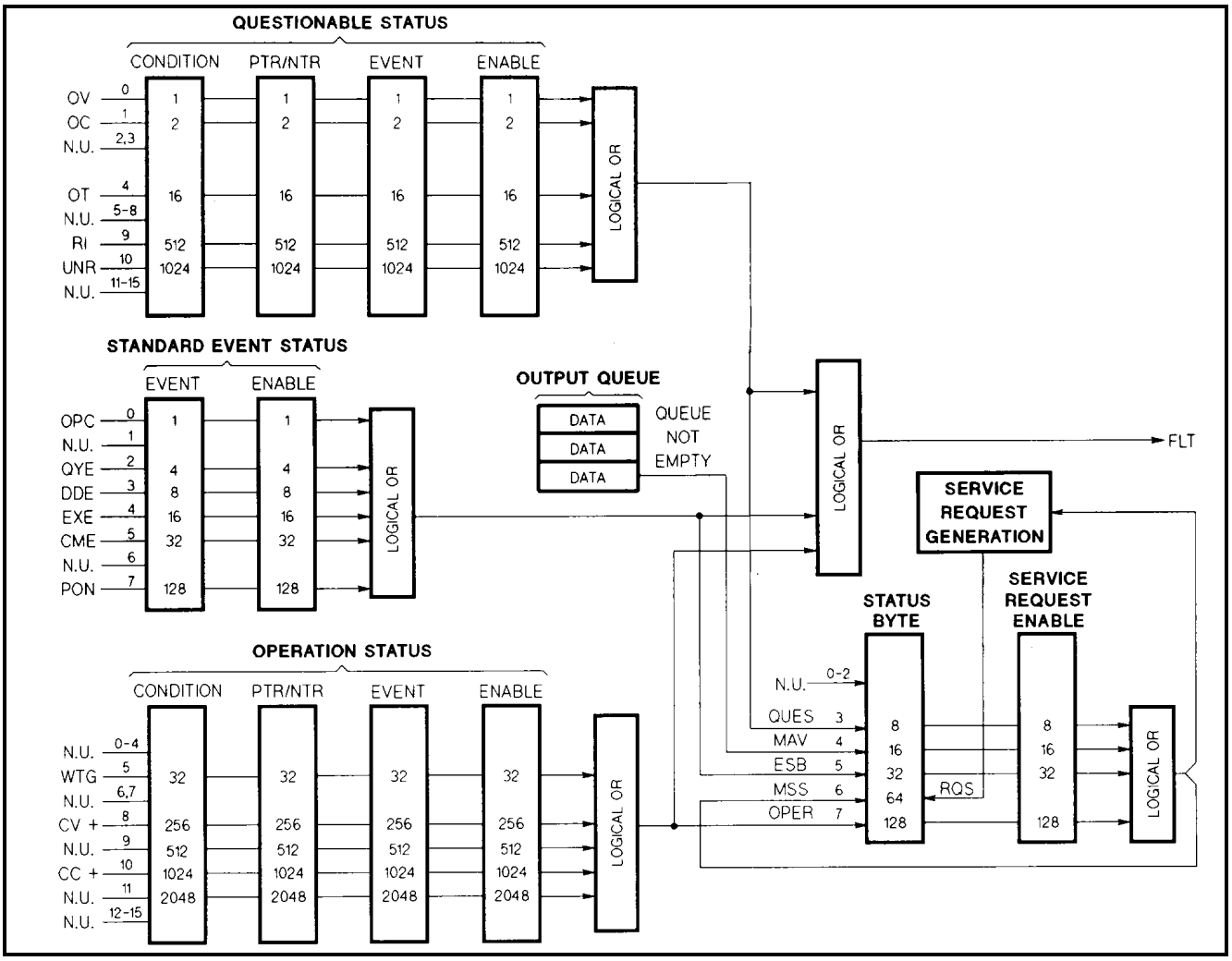


Figure C-4. Power Supply Status Structure

Table C-2. STAT:QUES Commands

Register	Command	Query	Cleared By
Condition	(None)	STAT:QUES:COND?	Cannot be cleared
PTR Filter	STAT:QUES:PTR <NRf>	STAT:QUES:PTR?	Programming 0
NTR Filter	STAT:QUES:NTR <NRf>	STAT:QUES:NTR?	Programming 0
Event	(None)	STAT:QUES:EVEN?	Reading or *CLS
Enable	STAT:QUES:ENAB <NRf>	STAT:QUES:ENAB?	Programming 0

Table C-3. Examples of Questionable Status Register Bit Programming

Example	Signal	Cond Reg Change	PTR Filter	NTR Filter	Event Reg	Enable Reg	Summary Bit
Example 1:	OT	*0* → *1*	1	0	1	1	1
Example 2:	UNR	*0=1* or	1	1	1	1	
Example 3:	RI		x	x	x	0	0
Example 4:	RI		*0*	1	0	1	1
Explanation of Examples							
Example 1:	Allow an overtemperature event to set the QUES summary bit. **STAT:QUES:ENAB 16;PTR 16**						
Example 2:	Allow both an unregulated event and the removal of that event to set the QUES summary bit **STAT:QUES:ENAB 1024;PTR 1024;NTR 1024**						
Example 3:	Prevent any remote inhibit event from setting the QUES summary bit. **STAT:QUES:ENAB 0** (or any value that does *not* set bit 9)						
Example 4:	Allow only the removal of an existing remote inhibit event to set the QUES summary bit **STAT:QUES:ENAB 512;NTR 512**						
Notes:	Boldface (1) indicates programmed state; italic (1) indicates signal state. "x" = "don't care' condition.						

Table C-4. STAT:OPER Commands

Register	Command	Query	Clear By
Condition	(None)	STAT:OPER:COND?	Cannot be cleared
PTR Filter	STAT:OPER:PTR <NRf>	STAT:OPER:PTR?	Programming 0
NTR Filter	STAT:OPER:NTR <NRf>	STAT:OPER:NTR?	Programming 0
Event	(None)	STAT:OPER:EVEN?	Reading or *CLS
Enable	STAT:OPER:ENAB <NRf>	STAT:OPER:ENAB?	Programming 0

Status Programming Example. Control over Conditional Status events is the same as for Questionable Status events. See Table C-1 for register configurations.

STAT:OPER:ENAN 32;NTR 32
Allow the OPER summary bit to be set whenever the power supply leaves CV mode

Standard Event Status Group

Register Functions. The Standard Event Status group consists of two registers (Event and Enable) that are progammed by common commands, not by STAT subsystem commands.

The Standard Event register latches events relating to interface communication status (see Table C-1). It is a readonly register that is cleared when read.

Read Query ***ESR?**
Clear Commands ***CLS *ESR?**

The Standard Event Enable register is a read/write register that functions similarly to the enable registers of the Operation and Questionable status groups.

Program Command ***ESE <NRf>**
Read Query ***ESE?**
Clear Command ***ESE 0**

NOTE *Since the power supply impliments ***PSC**, this register is cleared at power turn on if ***PSC = 1***

Status Programming Examples

ESE 60
Enables all error conditions into the ESB summary bit

ESE 129
Enables only the power-on and operation complete events into the ESB summary bit

Status Byte Register

The Status Byte register summarizes the information from all other status groups and is fully defined in the *IEEE 488.2 Standard Digital Interface for Programmable Instrumentation.* The bit configuration is shown in Table C-1. The Status Byte can be read either by a serial poll or by the common ***STB**? query. Both methods return the same data except for bit 6. Sending ***STB**? returns MSS in bit 6, while polling retums RQS in hit~

The RQS Bit. When the power supply requests service, it sets the SRQ interrupt line true and latches RQS into bit 6 of the Status Byte register. When the controller sends a serial poll to service the interrupt, the RQS bit is returned in bit position 6 of the register and also cleared inside the register. The remaining bits of the Status Byte register are not disturbed.

The MSS Bit. The MSS bit is real-time (unlatched) summary of all Status Byte register bits that are enabled by the Service Request Enable register. MSS goes true whenever the power supply has at least one reason (and possibly more) for requesting service. Sending the power supply an ***STB?** query reads the MSS bit in position 6 of the status byte. None of the bits are cleared during reading. To determine the service needs of the power supply without actually servicing any interrupts, send ***STB?.**

Clearing the Status Byte Register. Except for clearing RQS, both methods of reading the Status Byte register (serial polling and ***STB**?) do not alter the contents of the register. Normal application programs clear the register by performing the following actions:

1. Read the serial poll response to determine which summary bits are active.
2. Read the corresponding event register to determine which events have caused the summary bit to be set. This clears the register, removing the interrupt.
3. The interrupt will recur until the specific condition that generated each event is removed. If this is not possible, the event can be disabled by programming the corresponding bit of the group Enable register (or PTR/NTR filter).

Service Request Enable Register

Register Functions. This register is a mask that determines which bits from the Status Byte register will be ORed to generate a service request (SRQ). It is programmed with the ***SRE** common command. When this register is cleared, no service requests can be generated to the controller.

Register Programming

Program Command	***SRE <NRf~**
Read Query	***SRE?**
Clear Command	***SRE 0**

NOTE *Since the power supply implements ***PSC**, this register is cleared at power turn on if ***PSC = 1***

Status Programming Examples

SRE 255
Enables all bits to generate seruice requests

SRE 239
Excludes the MAV bit from gerlerating a service request

SRE 8
Enables only Questionable events to generate service requests

Output Queue

The Output Queue is a FIFO (first-in, first-out) data structure that stores power supply-to-controller messages until the controller reads them.

Whenever the queue holds one or more bytes, it sets the MAV bit (4) in the Status Byte register. The Output Queue is cleared by ***CLS** and at power turn on.

SCPI ERROR MESSAGES

Error messages are obtained remotely with the SYST:ERR? query. The error number is the value that is placed in the error queue. SYST:ERR? returns the error number into a variable and combines the error number and the error message into a string. There are two types of error messages stored in the power supply error queue, system errors and device-dependent errors.

System Errors

Table C-5 lists the system errors, which are associated with SCPI syntax errors and interface problems. Information inside the brackets is not part of the standard error message, but is included for clarification. When system errors occur, the Standard Event Status register (see "Status Reporting"') records them as follows:

Standard Event Status Register Error Bits

Bit Set	Error Code	Error Type
5	-100 thru -199	Command
4	- 200 thru - 299	Execution
3	- 300 thru - 399	Device-dependent
2	- 400 thru - 499	Query

Device-Dependent Errors

Hardware Errors During Turn-On Selftest. If a GP-IB failure occurs during selftest, the power supply may or may not be able to communicate with the controller. If possible, error - 330 (Self Test Error) is placed in the error queue. If a power supply output error occurs during selftest, error -330 and error -240 (Hardware Error) are placed in the queue. In addition, the error appears on the display (see the Operating manual). If output errors occur, the power supply will generate one or more - 240 errors for each command it cannot process. Use the **SYST:ERR?** query to read the error queue after power on to ensure that no - 330 or - 240 errors are present. Any power supply value returned by a query (such as **MEAS:CURR?)** should be assumed to be invalid.

Hardware Errors During Operation. If an error does not occur during selftest but after the power supply has been operating correctly for a time, error -240 is placed in the error queue. Most subsequent commands will not be executed and will also cause one or more - 240 errors to be placed in the queue after each command. If your application requires the controller to be signalled if the power supply fails, program the status registers to allow execution errors or device-dependent errors to generate an SRQ to the controller.

Table C-5. Summary of Error Messages

Error Number	Error String [Description/Explanation/Examples]
-100	Command error [generic]
-101	Invalid character
-102	Syntax error [unrecognized command or data type]
-103	Invalid separator
-104	Data type error [e.g., "numeric or string expected, got block data"]
-105	GET not allowed
-108	Parameter not allowed [too many parameters]
-109	Missing parameter [too few parameters]
-110	Command header error
-111	Header separator error
-112	Program mnemonic too long [maximum 12 characters]
-113	undefined header [operation not allowed]
-118	Query not allowed
-120	Numeric data error
-121	Invalid character in number [includes "9" in octal data "#q", etc.]
-123	Exponent too large [numeric overflow; exponent magnitude > 32 k]
-124	Too many digits [number too long; more than 255 digits received]
-128	Numeric data not allowed
-130	Suffix error
-131	Invalid suffix [unrecognized units, or units not appropriate]
-134	Suffix too long
-138	Suffix not allowed
-140	Character data error
-141	Invalid character data [bad character, or unrecognized]
-144	Character data too long [maximum length is 12 characters]
-148	Character data not allowed
-150	String data error
-151	Invalid string data [e.g., END received before close quote]
-158	String data not allowed
-160	Block data error
-161	Invalid block data [e.g., END received before length satisfied]
-168	Block data not allowed
-170	Expression error
-171	Invalid expression [e.g., illegal character in expression]

Table C-5. Summary of Error Messages (continued)

Error Number	Error String [Description/Explanation/Examples]
-178	Expression data not allowed
-180	Macro error
-181	Invalid outside macro definition [e.g., '$1' outside macro definition.]
-183	Invalid inside macro definition
-184	Macro parameter error
- 200	Execution error [generic]
- 220	Parameter error
- 221	Settings conflict [uncoupled parameters]
- 222	Data out of range [e.g., too large for this instrument]
- 223	Too much data [out of memory; block, string, or expression too long]
- 240	Hardware error
- 241	Hardware missing
- 270	Macro error
- 272	Macro execution error
- 273	Illegal macro label
- 276	Macro recursion error
- 277	Macro redefinition not allowed
- 310	System error
- 313	Calibration memory lost [out of cal due to memory failure]
-330	Self-test failed [more specific data after ";"]
- 350	Too many errors [error queue overflow]
- 400	Query error
- 410	Query INTERRUPTED [query followed by DAB or GET before response complete]
- 420	Query UNTERMINATED [addressed to talk, incomplete programming message received]
- 430	Query DEADLOCKED [too many queries in command string]
- 440	Query UNTERMINATED [after indefinite response]

SCPI COMMAND SUMMARY

This summary lists all power supply subsystem commands in alphabetical order, followed by all common commands in alphabetical order. See Table 3-7 in Section III for the numerical parameters for each model of the Agilent Series 603xA power supplies. Table C-6 is a cross reference to the corresponding ARPS commands in Table 3-7.

Command Summary

Subsystem Commands	
Command	*Parameters*
ABOR	(none)
[SOUR]:CURR[:LEV][:IMM][:AMPL]	<space> <NRf+ >[suffix]
[SOUR]:CURR?	(none) or <space>MlN or <space>MAX
[SOUR]:CURR[:LEV]:TRIG[:AMPL]	<space> <NRf+ >[suffix]
[SOUR]:CURR[:LEV]:TRIG?	(none) or <space>MlN or <space>MAX
[SOUR]:CURR:PROT:STAT	<space>0 or OFF <space>1 or ON
[SOURl:CURR:PROT:STAT?	(none)
INIT[:IMM]	(none)
INIT:CONT	< space > 0 or OFF or < space > ON
INIT:CONT?	(none)
MEAS:CURR[:DC]?	(none)
MEAS:VOLT[:DC]?	(none)

Command Summary (continued)

Subsystem Commands	
Command	*Parameters*
OUTP[:STAT]	<space>{0|OFF}[,NOR] <space>{l|ON}[,NOR]
OUTP?	(none)
OUTP:PROT:CLE	(none)
OUTP:PROT:DEL	< space > < NR1 > or < space > MIN or < space > MAX
ABOR	(none)
OUTP:PROT:DEL?	(none) or <space>MlN or <space>MAX
OUTP:REL:POL	<space>NORM or <space>REV
OUTP:REL:POL?	(none)
OUTP:REL[:STAT]	<space>0 or OFF <space>1 or ON
OUTP:REL:?	(none)
STAT:OPER:COND?	(none)
STAT:OPER:ENAB	<space> <NRf>
STAT:OPER:ENAB?	(none)
STAT:OPER[:EVEN]?	(none)
STAT:OPER:NTR	< space > < NRf >
STAT:OPER:NTR?	(none)
STAT:OPER:PTR	< space > < NRf >
STAT:OPER:PTR?	(none)
STAT:PRES	(none)
STAT:QUES:COND?	(none)
STAT:QUES:ENAB	< space > < NRf >
STAT:QUES:ENAB?	(none)
STAT:QUESL:EVEN]?	(none)
TRIG[:IMM]	(none)
TRIG:SOUR	< space > BUS
TRIG:SOUR?	(none)
[SOUR]:VOLT[:LEV][:IMM][:AMPL]	<space> <NRf+ >[suffix]
[SOUR]:VOLT?	(None) or <space>MlN or <space>MAX
[SOUR]:VOLT[:LEV]:TRIG[:AMPL]	<space> <NRf+ >[suffix]
[SOUR]:VOLT[:LEV]:TRIG?	(None) or <space>MlN or <space>MAX
[SOURl:VOLT:PROT[:AMPLl?	(None)

Common Commands			
Command	*Parameters*	*Command*	*Parameters*
*CLS	(None)	*RCL	< space > < NRf >
*ESE	<space> <NRf>	*RST	(None)
*ESE?	(None)	*SAV	< space > < NRf >
*ESR?	(None)	*SRE	< space > < NRf >
*IDN?	(None)	*SRE?	(None)
*OPC	(None)	*STB?	(None)
*OPC?	(None)	*TRG	(None)
*PSC	< space > < bool >	*TST?	(None)
*PSC?	(None)	*WAI	(None)

ARPS/SCPI Commands

Table C-6 lists the ARPS commands and compares them with the equivalent SCPI commands recognized by the Agilent series 603xA power supplies. Note that the Agilent Series 603xA power supplies use only a subset of SCPI commands. Use the **SYST:LANG** command to change between the two languages.

Note See Table 3-7 in Section III for command parameter ranges and Table 3-6 for the initial turn-on values.

Table C-6. Comparison of ARPS and SCPI Commands

ARPS Command	Equivalent SCPI Command	ARPS Command	Equivalent SCPI Command	ARPS Command	Equivalent SCPI Command
ASTS?	STAT:OPER? STAT:QUES? *ESE?	ID?	*IDN?	STO	*SAV
CLR	*RST	ISET x ISET xv ISET xMV	CURR	STS?	STAT:OPER:COND? STAT:QUES:COND? *ESE?
DLY x DLY xS DLY xMS DLY?	OUTP:PROT:DEL OUTP:PROT:DEL?	ISET? IOUT?	CURR? MEAS:CURR?	SYST:LANG SYST:LANG?	SYST:LANG SYST LANG ?
ERR?	SYST:ERR?	IMAX x IMAX xv IMAX xMV IMAX?	(none)	T TRG	INIT ON;TRIG INIT ON;*TRG
FAULT?	STAT:OPER:ENAB? STAT:QUES? *ESE?	OUT OFF OUT 0 OUT ON OUT 1 OUT?	OUTP:STAT OFF OUTP:STAT 0 OUTP:STAT ON OUTP:STAT 1 OUTP:STAT?	TEST?	*TST?
FOLD OFF FOLD 0 FOLD CV FOLD 1 FOLD CC FOLD 2 FOLD?	(none)	OVP’	VOLT:PROT?	UNMASK UNMASK?	STAT:OPER:ENAB STAT:QUES:ENAB *ESE STAT:OPER:ENAB? STAT:QUES:ENAB? *ESE?
HOLD OFF HOLD 0 HOLD CV HOLD 1 HOLD CC HOLD 2 HOLD?	(none)	RST	OUTP:PROT:CLE	VSET x VSET xv VSET xMV VSET? VOUT?	VOLT VOLT? MEAS:VOLT?
		RCL	*RCL	VMAX x	(none)
		SRQ OFF SRQ 0 SRQ ON SRQ 1 SRQ?	*SRE *SRE?	VMAX xv VMAX xMV VMAX?	

D

Programming the Agilent 603xA Power Supplies Using Basic

Introduction

The examples in this appendix are provided as an introduction to programming the Agilent 603xA power supplies with HPSeries 200/300 controllers using the BASIC programming language. The programming examples explain some of the more frequently used programmable functions of the power supplies.

NOTE: The examples in this appendix use the original language commands (ARPS) as described in section III of this manual.

The Agilent 603xA supplies can also be programmed using the SCPI commands as described in appendix C. In most cases, you can use the programming examples in this appendix with the SCPI commands. Simply replace the ARPS command string in the examples with the corresponding SCPI command string (see table C-6).

For more information about programming with BASIC, refer to the documentation provided with the HP Series 200 or 300 controller.

I/O Path Names

Throughout this appendix, I/O path names are used in place of interface and device select codes. In a large program, I/O path names simplify changing the address of an instrument if it becomes necessary. Reading and writing of the program are easier as well. The I/O path name can be carried in a common block and changed by a single assign statement.

In the following programming examples, the I/O path name @PS is used for the power supply. Note that the statement:

```
OUTPUT 705; "VSET 5"
```

is equivalent to:

```
OUTPUT @PS; "VSET 5”
```

as long as an assign statement defining the I/O path name @PS precedes any statements using the I/O path name.

Initialization

Sending the power supply the device command “CLR” will return the supply to its turn-on state. This function is useful for initialization to a known state within a program. Table 3-6 contains a list of the initial conditions.

Voltage and Current Programming

The power supply normally functions in one of two modes, either constant voltage with current limit or constant current with voltage limit. The operating mode is set by a combination of the set values and the load. For example, if the supply does not have a load connected, the following statements will put the supply in constant voltage mode at 5 volts out with a 10 amp current limit:

```
OUTPUT @PS;"VSET 5;ISET l0"
or OUTPUT @PS;"VSET";5;" ;ISET";l0
```

Note the use of a semicolon as a separator between the device command and the data in the second example program line above. The semicolon suppresses the carriage return and line feed which would be sent with a comma. The carriage return and line feed sent with a comma would cause an unrecognized statement.

A non-zero value of current should be programmed even without a load if constant voltage operation is desired. If current is not programmed, the supply may remain in constant current at zero volts

EXAMPLE 1: Programming voltage with a variable. This program ramps up output voltage in 200mV steps from 0 to 20 volts.

```
10        ASSIGN @Ps TO 705
20        OUTPUT @Ps: “CLR: ISET 1”
30        FOR Voltage=0 T0 20 STEP .2
40            OUTPUT @Ps : “VSET” :Voltage
50            WAIT .2
60        NEXT Voltage
70        END
```

Explanation:

10:	Assign I/O path name to power supply
20:	Initialize, program current limit to non zero value
30,60:	Increment voltage in 0.2 volt steps to 20 volts
50:	Wait 200mS between steps

Voltage and Current Readback

Reading back data from the power supply requires two statements. First, a device command must be sent which tells the power supply which data to obtain and send. Then the data can be entered into a variable. For example, the output voltage can be measured and read into the variable A with the following statements:

```
OUTPUT @PS;”VOUT?”
ENTER @ PS;A
```

Output current can be measured and read into A using the statements above by substituting "IOUT?" for “VOUT?”

The voltage and current settings can be read back as shown above using the queries “VSET?” and “ISET?”.

EXAMPLE 2: This example programs up the out-put of the supply, programs it down and prints out the time to settle to within 20mV of the programmed value. Because the down programming time varies with load and the change in programmed value, a function (Settled) is used here which waits for the output to settle to within 20mV of the set value before allowing the program to continue.

```
10        ASSIGN @Ps T0 705
20        COM /Ps/ @Ps
30        OUTPUT @Ps:”CLR:VSET 20:ISET 2”
40        WAIT 1
50        OUTPUT @Ps; “VSET .1”
60  Im:    IMAGE “SETTLED IN “,Z.DDD. “SECONDS”
70        IF FNSettled (.02,5) THEN
80           PRINT USING Im;FNElapsed_time
81           90       END IF
100       END
110       !
```

```
120       !
130       DEF FNSettled(OPTIONAL Band, Rdgs.Timelimit)
140 !       BAND=SETTLING BAND IN VOLTS
150 !       RDGS=READINGS WITHIN BAND
160 !       TIMELIMIT=SETTLING TIME ALLOWED, SECONDS
170       COM /Ps/ @Ps
180       OUTPUT @Ps:"VSET?"
190       ENTER @Ps;Vset
200       SET TIMEDATE 2.1E+11
210       !
220       Band_p=.01
230       Rdgs_p=2
240       Timelimit_p=5
250       Counter=0
260       !
270       IF NPAR>0 THEN Band_p=Band
280       IF NPAR>l THEN Rdgs_p=Rdgs
290       IF NPAR>2 THEN Timelimit_p=Timelimit
300       !
310       WHILE FNElapsed_time<Timelimit_p
320         IF ABS(FNVout-Vset)<Band_p THEN
330           Counter=Counter+l
340          IF Counter>=Rdgs p THEN RETURN l
350         ELSE
360           Counter=0
370         END IF
380       END WHILE
390       !
400       RETURN 0
410       FNEND
420       !
430       !
440       DEF FNVout
450       COM /Ps/ @Ps
460       OUTPUT @Ps; "VOUT?"
470       ENTER @Ps;Vout
480       RETURN Vout
490       FNEND
500       !
510       !
520       DEF FNElapsed_time
530       RETURN TIMEDATE-2.1E+11
540       FNEND
```

Explanation:

10:	Assign I/O path name for power supply
20:	Declare common block for I/O path name
30:	Clear power supply, set voltage to 20 Volts, current limit to 2 Amps
50:	Downprogram power supply to 100 mV
60:	Format statement for display
70,90:	If P.S. output has settled to within 20 mV of programmed value (for 5 consecutive readings) print message
130:	Define FN settled. (optional parameters described in lines 140-160)
170:	Bring in common block for I/O path name
180,190:	Read set value for voltage into VSET
200:	Initialize real time clock in computer
220-250:	Assign default values to variables corresponding to elements in parameter list. (Cannot reference optional parameters in context if not passed in parameter list.)
270-290:	If parameters are passed, assign values to corresponding subprogram variables
310-380:	Repeat 320-370 until time limit is reached
320-330:	If absolute value of output voltage (-Set voltage is within settling band) increment counter
340:	If counter=Desired number of readings within band, return 1
360:	If voltage left setting band, reset counter
400:	If time has elapsed, return 0
440-490:	Function reads and returns output voltage
520-540:	Function returns time elapsed since real time clock was initialized on line 200

Output Inhibit / Enable

The output of the supply can be inhibited without disturbing other programmed functions by sending the device command "OUT OFF" . While the supply is disabled in this manner, it can still accept new programming commands. The device command "OUT ON" will re-enable the output.

Power Supply Status

The power supply makes available several forms of status information. The present-status register contains continuously updated status information. The accumulated-status register provides a summary of the conditions which existed, even if only temporarily, since last reading the register.

The fault and mask registers, when used in conjunction with the service request and serial poll functions, allow the user to select which conditions can cause controller interrupts. The fault and mask registers can also be used independent of serial poll or service request in a manner similar to the accumulated-status register as shown in Example 5.

The structure of present-status, mask, fault and accumulated-status registers is as follows:

Condition	RI	ERR	FOLD	AC	OT	OV	OR	CC	CV
Bit position	8	7	6	5	4	3	2	1	0
Bit Weight	256	128	64	32	16	8	4	2	1

Where CV - Constant Voltage Mode
CC - Constant Current Mode
CR - Overrange Mode
OV - Overvoltage Tripped
OT - Overtemperature Tripped
AC - AC Line overage/Dropout
FOLD - Foldback Tripped
ERR - Programming Error
RI - Remote INH Tripped

Present Status

When a status condition is true, the appropriate bit in the present status register will be set.

The device query "STS?" will instruct the supply to output the present status. The query response will consist of the sum of the bit weights of the true conditions. For example, if the supply is operating in CV mode and a programming error was detected and not cleared, the status returned will be 128 + 1 = 129.

EXAMPLE 3: Function to check 'OR' bit in pre-sent status register. In the example, the calling program references the function as a Boolean variable in a conditional execution statement. In an application program a line such as line 30 could be used to branch in the event that the supply is in 'OR' mode.

```
10        ASSIGN @Ps T0 705
20        COM /Ps /@Ps
30        IF FNOr_mode THEN
40          PRINT "SUPPLY IS IN 0R MODE"
50        END IF
60        END
70        !
```

```
80      !
90      DEF FNOr_mode
100     COM /Ps/ @Ps
110     OUTPUT @Ps; “STS”
120     ENTER @Ps; Stat
130     RETURN BIT (Stat .2)
140     FNEND
```

Explanation:

10:	Assign I/O path name to power supply
20:	Declare common block for I/O path name
30:	If FNOR_MODE= true then print message
90:	Define function OR_MODE Bring in common block for I/O path name
110-120:	Read present status of power supply into the variable stat
130:	Return value of bit 2 of STAT

Accumulated Status

Accumulated status is structured the same as present status except the bits are latched. This allows the user to determine whether the supply entered an operating mode, even if only momentarily, since last reading the register. The device query "ASTS?" will instruct the supply to output the accumulated status. Reading the accumulated status also sets the accumulated status equal to the present status.

EXAMPLE 4: Function to check any one bit in the accumulated status register. The calling program treats the function as a Boolean variable in a conditional execution statement. This function can be used to determine whether the supply entered a given state since the function was last called. In this case, the ’OR’ bit (bit 2) is tested.

```
10      ASSIGN @Ps T0 705
20      COM /Ps /@Ps
30      IF FNAstat_bit(2) THEN
40        PRINT "SUPPLY ENTERED 0R MODE"‘
50      END IF
60      END
70      !
80      !
90      DEF FNAstat_bit(Abit)
100     COM /Ps/ @Ps
110     OUTPUT @Ps; “ASTS”
120     ENTER @Ps; Asts
130     RETURN BIT (Asts.Abit)
140     FNEND
```

Explanation:

10:	Assign I/O path name to power supply
20:	Declare common block for I/O path name
30-50:	If FNA stat bit= true then print message
90:	Define function ASTAT_BIT
100	Bring in common block for I/O path name
110-120:	Read accumulated status into variable ASTS
130:	Return value of bit 2 of ASTS

Fault and Mask Registers

Two additional registers provide the user with the ability to obtain selected subsets of the information available in the status register. The fault register can then be read to determine which condition caused the interrupt.

Bits in both registers are assigned as in the present-status register. The mask register allows the user to select which bits in the present status register can set bits in the fault register. A bit in the fault register is set on the rising edge of the corresponding status register bit.

Any subset of the nine status register conditions may be programmed in the mask register using the status bit mnemonics. For example, the following statement will set the CC, OR, OV and AC bits:

OUTPUT @PS;"UNMASK CC, OR, OV,AC"

The device query "FAULT?" instructs the power supply to output the contents of the fault register. This is the sum of the bit weights of true bits as with the other status registers. Reading the fault register clears the register.

EXAMPLE 5: Program to illustrate syntax of fault and mask register commands. These program statements would be similar in function to those in Example 4 with two differences: 1)OR mode could be detected only after enabling the OR bit in the mask register, and 2) the delay time to recognize the OR bit would be in effect. This would prevent fast transitions through OR mode from setting the OR bit by suitable adjustment of the delay time. Application programs which change the power supply output would avoid transient setting of this bit on up and down programming as long as delay time conditions are met.

```
10        ASSIGN @Ps TO 705
20        OUTPUT @Ps:"CLR:UNMASK OR"
30        !
40        !
50        !    D0 PROGRAM
60        !
70        !
80        OUTPUT @Ps:"FAULT?"
90        ENTER @Ps:Or_fault
100       IF Or_fault  THEN
110         PRINT "SUPPLY ENTERED OR MODE"
120       END IF
130       END
```

Explanation:

10:	Assign I/O path name to power supply
20:	Initialize power supply, set OR bit in mask register
80, 90:	Read fault register
100-110:	Print message if 'OR' bit was set in fault register

Serial Poll

Serial poll gives the programmer the capability of obtaining status information from the supply very quickly. The Agilent603XA serial poll register is set up as follows:

Condition	•	RQS	ERR	RDY	•	•	PON	FAU
Bit position	7	6	5	4	3	2	1	0
Bit Weight	128	64	32	16	8	4	2	1

Where • - Not Used
FAU - Fault Condition
PON - Power on Reset
RDY - Ready to Process Commands
ERR - Programming Error
RQS - Requesting Service

The ERR bit is set when a remote programming error is detected and is cleared when the "ERR?" device command is received. (See the section on detecting programming errors.)

The FAU bit is the logical OR of all the bits in the fault register. It is cleared when the "FAULT?" device command is received. (Provided the remote inhibit (INH) line is false).

The FAU bit can thus be used in conjunction with the fault and mask registers to give the programmer a rapid indication that a user-defined fault has occurred.

The RDY bit is cleared when the Agilent603XA is busy processing commands and set when the processing is completed.

The PON bit is set when power is first applied to the power supply and is cleared upon receipt of the "CLR" device command or the device clear interface management command.

RQS indicates that the supply has requested service. A serial poll will clear this bit.

The power supply can be serial polled by assigning the serial poll response to a variable:

SPOLL_RESP= SPOLL (@PS)

EXAMPLE 6: Use of serial poll to determine whether the supply passed through or into overrange mode. This program differs from the previous example only in the method of reading status. Serial poll is useful because it can be performed within a program line and is much faster than reading a status register. The greater speed is balanced by the level of status information available. If the user does not want to use interrupts from the power supply serial poll can provide the same information with periodic checking.

```
10        ASSIGN @Ps TO 705
20        OUTPUT @Ps;"CLR;UNMASK OR"
30        !
40        !
50        !    D0 PROGRAM
60        !
70        !
80        IF BIT (SPOLL(@Ps),0) THEN
90          PRINT "SUPPLY ENTERED OR MODE"
100       END IF
110       END
```

Explanation:

10: Assign I/O path name to power supply
20: Initialize power supply, set 'OR' bit in mask register
80-100: Conduct serial poll, compare to OR bit if both true, print message

Note: Fault register must be cleared with "FAULT?" query

Service Request

Service request provides the programmer with the means for interrupting the controller when a fault condition occurs. Service is requested when the FAU bit in the serial poll register, which is the logical OR of all bits in the fault register, becomes true with SRQ enabled.

The mask register is used to specify conditions which can cause an interrupt. The fault register can be read to determine which condition caused an interrupt.

The following commands enable and disable the service request function:

```
OUTPUT @PS;"SRQ ON"
OUTPUT @PS;~SRQ OFF"
```

EXAMPLE 7: Enable an interrupt upon a transition to overrange mode. This non-functional example is intended to show the syntax necessary for setting up an interrupt. A similar sequence of commands can be used to define an interrupt on any status condition(s) so as to get the controller's attention as quickly as possible upon transition to a fault condition.

```
10      ASSIGN @Ps TO 705
20      COM /Ps/ @Ps
30      OUTPUT @Ps; "CLR;UNMASK OR;SRQ ON"
40      ON INTR 7.1 CALL Err_trap
50      ENABLE INTR 7:2
60      !
70      !
80      !     DO PROGRAM
90      !
100     !
110       END
120     !
130     !
140     SUB Err_trap
150     OFF INTR"
160     COM /Ps/ @Ps
170     OUTPUT @Ps;FAULT?"
180     Spoll_resp=SPOLL (@Ps)
190     !
200     !
210     !     PROCESS INTERRUPT
220     !
230     !
240       SUBEND
```

Explanation:

```
10:     Assign I/O path name to power supply
20:     Declare common block for I/O path name
30:     Enable service request on transition to 'OR' mode
40:     Define interrupt at interface 7, (GP-IB) priority 1
50:     Enable interrupt at interface 7 on SRQ
140:    Define error handling routine
150:    Disable interrupt capability while processing
160:    Bring in common block for I/O path name
170:    Read fault register to clear FAU bit in serial poll register
180:    Conduct serial poll to clear RQS bit
```

Delay Time

When changing the output voltage or current level of the supply it may change state to overrange, CV, or CC mode during the transition. This may not be desirable if an interrupt is enabled upon a mode transition. To deal with such situation, a time delay is implemented, during which CC, CV and OR bits are masked to the fault register. In addition, to avoid nuisance tripping, the conditions are also masked to the foldback feature during the delay time.

The conditions are masked for the delay time following the execution of an "OUT ON", "RST", "TRG" or "RCL" command. "VSET" and "ISET" are masked only with "HOLD OFF".

Default value for the delay time is .5 seconds. Delay time is adjustable from 0 to 31.999 seconds in 1 mS increments. As an example, the following statement will set delay time to 4.23 seconds:

```
OUTPUT @PS; "DLY4.23S"
```

Programming Error Detection

The power supply can recognize all programming errors and inform the programmer when an error occurs. When an error is detected no attempt is made to execute the command. A bit in the serial poll register (ERR) is set. If the mask register and SRQ are set, an interrupt will be generated.

The error register contents can be entered into the variable ERR_CODE with the following sequence:

```
OUTPUT @PS; "ERR?"
ENTER @PS;ERR_CODE
```

The possible codes returned are:

0 NO ERROR DETECTED
1 UNRECOGNIZED CHARACTER
2 IMPROPER NUMBER
3 UNRECOGNIZED ALPHA CHARACTER
4 SYNTAX ERROR
5 NUMBER OUT OF RANGE
6 ATTEMPT TO EXCEED SOFT LIMITS
7 IMPROPER SOFT LIMIT
8 DATA REQUESTED WITHOUT QUERY

EXAMPLE 8: Program to check programming errors. This program can be entered and run as is. While the program is running, commands can be sent to the power supply from the computer keyboard. If a programming error is detected, evidenced by the 'ERROR' LED on the power supply front panel, depress the labeled softkey. The error will be displayed on the computer CRT.

```
10        COM /Ps/ @Ps
20        ASSIGN @Ps TO 705
30        ON KEY 0 LABEL "ERROR?" CALL Err_trap
40  Label: GOTO Label
50        END
60        !
70        !
```

```
80        SUB Err_trap
90        OFF KEY
100       COM /Ps/ @Ps
110       OUTPUT @Ps:"ERR?"
120       ENTER@Ps;Err
130       OUTPUT 2 USING "#.k":CHR$;(255)&CHR$(75)
140       IF Err THEN
150         PRINT "  POWER SUPPLY PROGRAMMING ERROR:"
160       END IF
170       SELECT Err
180         CASE 0
190             PRINT "NO ERROR HAS OCCURRED"
200             SUBEXIT
210         CASE 1
220             PRINT 'CHARACTER NOT RECOGNIZED"
230         CASE 2
240             PRINT "IMPROPER NUMBER"
250         CASE 3
260             PRINT "UNRECOGNIZED ALPHA CHARACTER"
270         CASE 4
280             PRINT "SYNTAX ERROR"
290         CASE 5
300             PRINT "NUMBER OUT OF RANGE"
310         CASE 6
320             PRINT "ATTEMPT TO PROGRAM ABOVE SOFT LIMIT"
330         CASE 7
340             PRINT "LIMIT CANNOT BE SET < OPERATING POINT"
350         CASE 8
360             PRINT "DATA REQUESTED W/O QUERY"
370         END SELECT
380       PRINT " RE-ENTER STATEMENT AND TRY AGAIN"
390       SUBEND
```

Explanation:

10:	Assign I/O path name to power supply
20:	Declare common block for I/O path name
30:	Define interrupt on softkey depression branch to error routine
40:	Idle on softkey definition
80:	Define subprogram ERR TRAP
100:	Bring in common block for I/O path name
110-120:	Enter error code from power supply
130:	Clear computer CRT
140-150:	If an error occurred, print message
170-420:	Print out message based on error code returned from power supply. If no error, print message saying no error occurred.

Protection Functions

Overvoltage

The trip level of the overvoltage protection circuit can be read by sending the device command "OVP?" and entering the result.

If the overvoltage protection circuit has tripped the supply can be reset by sending the "RST" device command .

Foldback

In certain applications, it may be desirable to have an overcurrent protection similar in function to the over-voltage protection.

An application of this feature might occur in the testing of P.C. board subassemblies. Using the power supply as a bias with current limit only could cause tracks to lift off the board in the event of a short circuit through a small track.

Using the CC foldback mode could prevent the supply from passing excessive currents through a shorted track by disabling the supply when constant current mode is entered .

To enable the CC foldback mode, send the power supply the device command "FOLD CC".

A reciprocal foldback function with CV operation as the trip condition can be enabled with the device command "FOLD CV". "FOLD OFF" disables either.

Soft Programming Limits

The supply can be directed to ignore commands to program voltage and current above predefined levels. Applications of the function might include programs which program the supply based on an unknown input and development and debugging of new test programs. Advantages of the programming limits include ease of programming and maintenance of a limit which remains when the program is no longer running.

Maximum programming values for voltage and current can be set with the "VMAX" and "IMAX" device commands if present output voltage or current does not exceed desired limits.

A subsequent attempt to program voltage or current above the soft limits will result in an error.

To set the maximum voltage allowable to 10 volts and maximum current to 1 amp, issue the following statement:

```
OUTPUT @PS;"VMAX l0;IMAX 1"
```

A subsequent attempt to program voltage above l0 volts or current above 1 amp will result in an error.

Fault Indicator (FLT) and Inhibit (INH)

FLT and INH provide additional shutdown protection features should the GP-IB or controller fail. Both FLT and INH are independent of the SRQ function available through the GP-IB, and are accessed through a rear panel jack.

FLT is an output circuit (TTL compatible) which provides the user with a means of knowing the status of any unmasked fault register bit.

INH is an input circuit (TTL compatible) which provides a way to disable the supply remotely.

Advanced Topics

Hold Mode

At times it may become necessary to program several power supplies synchronously. The hold mode provides advantages over other less precise means of synchronous programming. With hold mode, functions with first and second rank are all loaded into first rank buffers. When triggered with the "TRG" or "T" device commands or the group execute trigger interface management command, second rank is loaded. Voltage and current settings, foldback and mask register have dual rank storage.

EXAMPLE 9: Trigger three supplies synchronously. This program makes use of the trigger hold feature to load the buffers of three supplies then trigger them simultaneously. Note that while the supplies will be triggered at the same time, programming speed can vary from unit to unit so that supplies may not meet final output voltage simultaneously. Still, this method would offer the most precise synchronous trigger over the bus for multiple bias supply applications.

```
10      ASSIGN @Ps1 TO 701
20      ASSIGN @Ps2 TO 702
30      ASSIGN @Ps3 TO 703
40      ASSIGN @All_ps TO 701, 702, 703
50      OUTPUT @All_ps; “CLR;HOLD ON”
60      OUTPUT @Ps1; “VSET 12; ISET 3”
70      OUTPUT @Ps2; “ISET 4; VSET 2;FOLD CC”
80      OUTPUT @Ps3; “ISET .15:VSET 5"
90      OUTPUT @All_ps;"TRG; HOLD OFF"
```

Explanation:

10-40:	Assign I/O path names
50:	Set trigger holdoff on all three supplies
60-80:	Send programming information to the power supplies
90:	Trigger all three supplies simultaneously, release trigger holdoff mode

Note: TRG or T device command has same effect as trigger interface management command

Machines States

The power supply can store up to 16 complete states and recall them in arbitrary order. Storing a state involves taking a "snapshot" when the command is received. The following statement stores a state in register 10 and recalls register 4:

```
OUTPUT @PS;"STO 10;RCL 4"
```

EXAMPLE 10: Program using machine states to set up output. This method of setting up the output saves some time in processing the commands and facilitates repeating the same commands. A burn-in program would be and ideal use of this function.

```
10      ! PROGRAM T0 CYCLE 0N FIVE VOLTAGE SETTINGS
20      !
30      ASSIGN @Ps TO 705
40      OUTPUT @Ps:"CLR;OUT OFF"
50      !
60      !  NOTE: OUT OFF COMMAND NAT STORED IN
70      !  SNAPSHOT BUT DOES DISABLE SUPPLY
80      !
90      !  STORE THE FIVE STATES
100     !
110     OUTPUT @Ps:"VSET 1:ISET 20:STO1"
120     OUTPUT 2Ps:"VSET 2:ISET l0:F0LD CC:STO2"
```

```
130       OUTPUT @Ps:"VSET 3.ISET 6.7.STO3"
140       OUTPUT @Ps:"VSET 4,ISET 5.STO4"
150       OUTPUT @Ps:"VSET 5,ISET 4,STO5;CLR;OUT ON"
160       !
170       !  NOTE: CLR COMMAND DOES NOT CLEAR THE STATE REGISTERS. THE LAST
180       !              FOR STATES HAVE FOLDBACK ENABLED.
190       !
200       !
210       !  LOOP THROUGH THE STATES 10 TIMES
220       !
230         FOR Count=1 T0 10
240             FOR State=I T0 5
250                 OUTPUT @Ps; "RCL";State
260                 WAIT 2
270         NEXT State
280       NEXT Count
290       END
```

Explanation:

30:	Assign I/O path name to power supply
40:	Initialize power supply, inhibit output
110-150:	Store 5 states. Last 4 have foldback enabled. Line 150 reinitializes power supply after storing fifth state.
230-280:	Loop through the sequence of five states ten times

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Manual Updates

The following updates have been made to this manual since the print revision indicated on the title page.

2/24/99

Figure 2-4 has been added to page 28. Pages 23 to 28 have been reformatted to make room for this figure.

A Caution has been added to the *ESE, *PSC, *SAV, and *SRE, commands between pages 89 and 93.

2/01/00

All references to HP have been changed to Agilent.
All references to HP-IB have been changed to GPIB.

9/20/04

The Declaration of Conformity has been updated.

5/27/09

A URL has been added to the declaration page to obtain the latest declaration of conformity.

6/06/12

Figure 2-1 has been corrected for model 6038A.

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