USER’S GUIDE
Agilent Technologies
Series 661xxA
MPS POWER MODULES
& Model 66001A MPS KEYBOARD

SERIAL NUMBERS
Agilent Model 66101A; 3139A-00101 and Above*
Agilent Model 66102A; 3139A-00101 and Above*
Agilent Model 66103A; 3139A-00101 and Above*
Agilent Model 66104A; 3207A-00101 and Above*
Agilent Model 66105A; 3207A-00101 and Above*
Agilent Model 66106A; 3207A-00101 and Above*

* For instruments with higher Serial Numbers, a change page may be included.
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.

WARRANTY

This Agilent Technologies hardware product is warranted against defects in material and workmanship for a period of three years from date of delivery. Agilent Technologies software and firmware products, which are designated by Agilent Technologies for use with a hardware product and when properly installed on that hardware product, are warranted not to fail to execute their programming instructions due to defects in material and workmanship for a period of 90 days from date of delivery. During the warranty period Agilent Technologies, Inc will, at its option, either repair or replace products which prove to be defective. Agilent Technologies does not warrant that the operation of the software, firmware, or hardware shall be uninterrupted or error free.

For warranty service, with the exception of warranty options, this product must be returned to a service facility designated by Agilent Technologies. Customer shall prepay shipping charges by (and shall pay all duty and taxes) for products returned to Agilent Technologies for warranty service. Except for products returned to Customer from another country, Agilent Technologies shall pay for return of products to Customer.

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The above statements apply only to the standard product warranty. Warranty options, extended support contracts, product maintenance agreements and customer assistance agreements are also available. Contact your nearest Agilent Technologies Sales and Service office for further information on Agilent Technologies’ full line of Support Programs.
SAFETY SUMMARY

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

BEFORE APPLYING POWER.
Verify that the power module line voltage switch is set to match the available line voltage.

GROUND THE POWER MODULE.
When installed in a properly wired mainframe, this product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the power module must be connected to an electrical ground. The mainframe must be connected to the ac power mains through a three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. 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

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.
Do not operate the power module 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 power module is equipped with a power 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 line rating label may cause leakage currents in excess of 5.0 mA peak.

SAFETY SYMBOLS.

⚠️ Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).

حذر: Indicates hazardous voltages.

Ground (or security) symbol: Indicate earth (ground) terminal.

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.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.
Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification 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.

Power modules that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.
SAFETY SUMMARY (continued)

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

ENVIRONMENTAL CONDITIONS
All instruments are intended for indoor use in an installation category II, pollution degree 2 environment. They are 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.

SAFETY SYMBOL DEFINITIONS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct current</td>
<td>Terminal for Line conductor on permanently installed equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternating current</td>
<td>Caution, risk of electric shock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both direct and alternating current</td>
<td>Caution, hot surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three-phase alternating current</td>
<td>Caution (refer to accompanying documents)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth (ground) terminal</td>
<td>In position of a bi-stable push control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protective earth (ground) terminal</td>
<td>Out position of a bi-stable push control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame or chassis terminal</td>
<td>On (supply)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal for Neutral conductor on permanently installed equipment</td>
<td>Off (supply)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal is at earth potential (Used for measurement and control circuits designed to be operated with one terminal at earth potential.)</td>
<td>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.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Herstellerbescheinigung
* Schalldruckpegel Lp <70 dB(A) * Am Arbeitsplatz * Normaler Betrieb * Nach EN 27779 (Typprüfung).

Manufacturer’s Declaration
This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991.
*Sound Pressure Lp <70 dB(A) *At Operator Position * Normal Operation * According to EN 27779 (TypeTest).
DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014

Manufacturer’s Name: Agilent Technologies, Inc.

Manufacturer’s Address: 150 Green Pond Road
Rockaway, New Jersey 07866
U.S.A.

declares that the Product

Product Name: Modular Power System mainframe and modules
Model Number: Agilent 66000A Mainframe and modules
Agilent 66101A, 66102A, 66103A, 66104A, 66105A, 66106A

conforms to the following Product Specifications:


EMC: CISPR 11:1990 / EN 55011:1991 - Group 1 Class A
IEC 801-2:1991 / EN 50082-1:1992 - 4 kV CD, 8 kV AD
IEC 801-3:1984 / EN 50082-1:1992 - 3 V / m
IEC 801-4:1988 / EN 50082-1:1992 - 0.5 kV Signal Lines
1 kV Power Lines

Supplementary Information:


Note 1: The product family was introduced prior to 12/93.

New Jersey January 1997
Location Date
Bruce Krueger / Quality Manager

European Contact: Your local Agilent Technologies Sales and Service Office or Agilent Technologies GmbH,
Department TRE, Herrenberger Strasse 130, D-71034 Boeblingen (FAX:+49-7031-14-3143)

Printing History

The current edition of this guide is indicated below. Reprints of this guide containing minor corrections and updates may have the same printing date. New editions are identified by a new printing date and, in some cases, by a new part number. A new edition incorporates all new or corrected material since the previous edition. Changes to the guide occurring between editions are covered by change sheets shipped with the guide. Also, if the serial number prefix of your power module is higher than those listed on the title page of this guide, then it may or may not include a change sheet. That is because even though the higher serial prefix indicates a design change, that change may not affect the content of the guide.

Edition 1 ......Feb 1992
..........................Apr 1992
..........................Oct 1992
..........................July 1993
..........................June 1997
..........................April 2000

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Introduction

This guide describes how to install, check out, operate, and calibrate the Agilent Series 661xxA power modules used in the Agilent 66000 Modular Power System. Programming the power module from the optional Agilent 66001A Keyboard is described in Appendix B of this guide. Programming the power module over the GPIB bus is covered in the module Programming Guide (see "Related Documents", below). Setting the GPIB address is described in the mainframe Installation Guide. For complete verification procedures, see the module Service Guide (listed under "Related Documents", below). The Agilent 66000A Modular Power System Product Note has specific application programs in several DOS-compatible languages and GPIB interface drivers.

<table>
<thead>
<tr>
<th>Related Documents</th>
<th>Agilent Part No.</th>
</tr>
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<tbody>
<tr>
<td>Programming Guide for Agilent Series 661xxA MPS Power Modules</td>
<td>5959-3362</td>
</tr>
<tr>
<td>Installation Guide for DC Module Connectors</td>
<td>5959-3366</td>
</tr>
<tr>
<td>Service Guide for Agilent Series 661xxA Power Modules</td>
<td>5959-3364</td>
</tr>
<tr>
<td>Installation Guide for Agilent 66000A Modular Power System Mainframe</td>
<td>66000-90001</td>
</tr>
<tr>
<td>Service Guide for Agilent 66000A Modular Power System Mainframe</td>
<td>66000-90003</td>
</tr>
<tr>
<td>Quick Reference Card for Optional Agilent 66001A MPS Keyboard*</td>
<td>66001-90001</td>
</tr>
<tr>
<td>Agilent 66000A Modular Power System Product Note</td>
<td>5091-2497E</td>
</tr>
</tbody>
</table>

* A Quick Reference Card is shipped with each Agilent 66000 mainframe.

Safety Considerations

When properly installed in the mainframe, the power module is part of a subsystem that constitutes a Safety Class 1 instrument. The power module has a protective earth connection that is completed through a contact spring in the mainframe backplane. When the power module is moved in and out of the mainframe, the earth ground connection is made before ac power is connected and is removed after ac power is disconnected.

Instrument Identification

The power module is identified by a unique two-part serial number, such as 3139A 00177, visible on the module pull tab when it is in the fully extended position. The first part, or prefix, is a number-letter combination that provides the following information:

3130 The year and week of manufacture or last significant design change. Add 1960 to the first two digits to determine the year. For example, 31=1991, 32=1992, etc. The last two digits specify the week of the year (30 = the 30th week).

A The letter indicates the country of manufacture, where A = USA.

Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>760</td>
<td>Output Connector with Isolation/Polarity Reversal Relays</td>
</tr>
<tr>
<td>910</td>
<td>Series 661xxA Service Guide with extra Operating Guide</td>
</tr>
<tr>
<td>ABD</td>
<td>Series 661xxA German-language Quick Start Guide</td>
</tr>
<tr>
<td>ABE</td>
<td>Series 661xxA Spanish-language Quick Start Guide</td>
</tr>
</tbody>
</table>
The Agilent 66lxxA Series Power Modules are used in the Agilent 66000 Modular Power System (MPS) mainframe to provide a range of dc output voltages and currents. The modules are installed or removed from the front of the mainframe without the need for disconnecting any wires. Modules may be connected in series or parallel to provide increased output voltages or currents. The modules can be equipped with optional isolation and polarity reversal relays that are built into the module output connector.

The power module front panel has digital readouts of output voltage and current. It also has annunciators that indicate:

- constant voltage, constant current, or unregulated operation
- activation of a protection circuit
- disabling of the output
- remote operation (addressed by the controller)

Programming

The power module is programmed over the GPIB from a controller using SCPI (Standard Commands for Programmable Instruments). This makes power module programs compatible with those of all other instruments controlled with this language. Among the functions that can be programmed are output voltage and current, OVP (overvoltage protection), OCP (overcurrent protection), status registers, output relays, and output voltage and current calibration.

In addition, the power module has programmable trigger, list, and RI/DFI (remote inhibit/discrete fault indicator) subsystems. Triggers can occur from signals at the mainframe TRIG IN jack or from selected internal events. The list subsystem generates preprogrammed sequential outputs in response to triggers. The RI/DFI subsystem generates an output on the mainframe FLT line in response to selected internal events or turns off the output in response to an input on the mainframe INH line.

The power module also can be programmed locally from the optional Agilent 66001A MPS Keyboard. The keyboard has an alphabetical command menu for all power module SCPI commands. By scrolling through the menu and entering the appropriate parameters, commands may be created for development or debugging.

Output Characteristic

The power module can operate in either CV (constant voltage) or CC (constant current) mode over its voltage and current output range (see Table 1-1). The operating locus (see Output Characteristic Curve in Table 1-2) shows a single-range, limited two-quadrant capability. The operating point is determined by the voltage setting (V_S), the current setting (I_S) and the load impedance (R_L). Two operating points are shown. Point 1 is defined by the load line cutting the operating locus in the CV region, which defines the CV mode (curve A). In this mode, the power module will maintain the voltage at V_S for varying load currents (determined by V÷R_L) up to I_S. If the load demands a current greater than I_S, the power module switches to CC mode. CC mode (curve B) is defined by the load line cutting the operating locus in the CC region (see Point 2). Under this condition, the power module maintains the current at I_S at some voltage determined by I_S x R_L.
When the power module is operated beyond either rated output, the performance specifications are not guaranteed, although typical performance may be good. Operation in quadrant 2 is limited to about 10% of the maximum rated positive output current. This allows the power module to sink current for more rapid downprogramming in the CV mode.

**Specifications and Supplemental Characteristics**

Table 1-1 lists the specifications of the power modules. Specifications are warranted over the specified temperature range. Table 1-2 lists the supplemental characteristics, which are not warranted but are descriptions of performance determined either by design or type testing.

### Table 1-1. Performance Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>66101A</th>
<th>66102A</th>
<th>66103A</th>
<th>66104A</th>
<th>66105A</th>
<th>66106A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Ratings</td>
<td>0 - 8 V</td>
<td>0 - 20 V</td>
<td>0 - 35 V</td>
<td>0 - 60 V</td>
<td>0 - 120 V</td>
<td>0 - 200 V</td>
</tr>
<tr>
<td>Voltage:</td>
<td>0 - 16 A</td>
<td>0 - 7.5 A</td>
<td>0 - 4.5 A</td>
<td>0 - 2.5 A</td>
<td>0 - 1.25 A</td>
<td>0 - 0.75 A</td>
</tr>
<tr>
<td>Current:</td>
<td>128 W</td>
<td>150 W</td>
<td>157.5 W</td>
<td>150 W</td>
<td>150 W</td>
<td>150 W</td>
</tr>
<tr>
<td>Power:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Specifications are warranted over the temperature range 0 to 55°C with a resistive load and the output connected for local sensing. Derate the output current 1% per °C from 40°C to 55°C.

**Programming Accuracy @
calibration temperature ± 5 °C)**

| Voltage: | 0.03% + | 3 mV | 8 mV | 13 mV | 27 mV | 54 mV | 90 mV |
| Current: | 0.03% + | 6 mA | 3 mA | 2 mA | 1.2 mA | 0.6 mA | 0.4 mA |

*Factory calibration temperature = 25 °C

**Ripple & Noise (from 20 Hz to 20 MHz with outputs ungrounded, or with either output terminal grounded)**

| Constant Voltage: | rms | 2 mV | 3 mV | 5 mV | 9 mV | 18 mV | 30 mV |
| Constant Voltage: | p-p | 5 mV | 7 mV | 10 mV | 15 mV | 25 mV | 50 mV |
| Constant Current: | rms | 8 mA | 4 mA | 2 mA | 1 mA | 1 mA | 1 mA |

**Readback Accuracy**

With respect to actual output @ calibration temperature following self calibration.*

| Voltage: | 0.02% + | 2 mV | 5 mV | 8 mV | 16 mV | 32 mV | 54 mV |
| Current: | 0.02% + | 6 mA | 3 mA | 2 mA | 1 mA | 0.6 mA | 0.3 mA |

*Factory calibration temperature = 25 °C

**Load Regulation (change in output voltage or current for any load change within ratings)**

| Voltage: | 1 mV | 1 mV | 1 mV | 2 mV | 4 mV | 7 mV |
| Current: | 0.5 mA | 0.2 mA | 0.2 mA | 0.1 mA | 50 µA | 30 µA |
### Table 1-1. Performance Specifications (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter Description</th>
<th>Agilent Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Line Regulation</strong></td>
<td>(change in output voltage or current for any line change within ratings)</td>
<td>Agilent Model</td>
</tr>
<tr>
<td>Voltage:</td>
<td>0.5 mV</td>
<td>0.5 mV</td>
</tr>
<tr>
<td>Current:</td>
<td>0.75 mA</td>
<td>0.5 mA</td>
</tr>
<tr>
<td><strong>Transient Response Time</strong></td>
<td>(for output voltage to recover to within 100 mV of its previous level following a step change in load current that is up to 10% of the power module rated output current.)</td>
<td>&lt; 1 ms</td>
</tr>
<tr>
<td><strong>AC Input Ratings</strong></td>
<td>(selectable via module switch- see Chapter 2)</td>
<td>Nominal line voltage (Vac)</td>
</tr>
<tr>
<td>Frequency range:</td>
<td>47 - 63 Hz</td>
<td></td>
</tr>
<tr>
<td><strong>Output Terminal Isolation</strong></td>
<td>(maximum, from output to the mainframe chassis ground):</td>
<td>±240 Vdc</td>
</tr>
</tbody>
</table>

### Table 1-2. Supplemental Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter Description</th>
<th>Agilent Model</th>
</tr>
</thead>
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<td><strong>Output Programming Range</strong></td>
<td>(Maximum programmable values):</td>
<td>Agilent Model</td>
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<td>8.190 V</td>
<td>20.475 V</td>
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<td>Current:</td>
<td>16.380 A</td>
<td>7.678 A</td>
</tr>
<tr>
<td>OV Protection:</td>
<td>9.6 V</td>
<td>24.0 V</td>
</tr>
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<td><strong>Average Programming Resolution</strong></td>
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<td>Agilent Model</td>
</tr>
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<td>Voltage:</td>
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<td>5.9 mV</td>
</tr>
<tr>
<td>Current:</td>
<td>4.6 mA</td>
<td>2.3 mA</td>
</tr>
<tr>
<td>OV Protection:</td>
<td>50 mV</td>
<td>120 mV</td>
</tr>
<tr>
<td><strong>OVP Accuracy</strong></td>
<td>(@ calibration temperature ±5º C)*</td>
<td>Agilent Model</td>
</tr>
<tr>
<td>Voltage:</td>
<td>250 mV</td>
<td>500 mV</td>
</tr>
<tr>
<td><strong>Readback Resolution</strong></td>
<td>* Factory calibration temp = 25º C</td>
<td></td>
</tr>
<tr>
<td>Voltage:</td>
<td>0.305 mV</td>
<td>0.763 mV</td>
</tr>
<tr>
<td>Current:</td>
<td>0.587 mA</td>
<td>0.293 mA</td>
</tr>
<tr>
<td><strong>Drift (Temperature Stability)</strong></td>
<td>(following a 30-minute warmup, change in output over 8 hours under constant line, load, and ambient temperature)</td>
<td>Agilent Model</td>
</tr>
<tr>
<td>Voltage:</td>
<td>0.02% +</td>
<td>0.4 mV</td>
</tr>
<tr>
<td>Current:</td>
<td>0.02% +</td>
<td>8 mA</td>
</tr>
</tbody>
</table>
### Table 1-2. Supplemental Characteristics (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Agilent Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature Coefficients</strong></td>
<td></td>
</tr>
<tr>
<td>(change in output per °C after a 30-minute warmup)</td>
<td>66101A 66102A 66103A 66104A 66105A 66106A</td>
</tr>
<tr>
<td>Output Voltage:</td>
<td>30 ppm +</td>
</tr>
<tr>
<td>Output Current:</td>
<td>30 ppm +</td>
</tr>
<tr>
<td>Voltage Readback:</td>
<td>20 ppm +</td>
</tr>
<tr>
<td>± Current Readback:</td>
<td>20 ppm +</td>
</tr>
<tr>
<td>OV Protection:</td>
<td>1 mV 2 mV 4 mV 8 mV 16 mV 30 mV</td>
</tr>
</tbody>
</table>

| Maximum Reverse Current                        |               |
| (maximum current, without damage, that the power module will withstand while turned on and with the dc output reverse biased by an external dc source): | 16 A 7.5 A 4.5 A 2.5 A 1.25 A 0.75 A |

| Typical Output Common Mode Noise Current*      |               |
| (rms):                                        | 0.5 mA        |
| (peak-peak):                                  | 5 mA          |

* Referenced to mainframe chassis ground.

| Remote Sensing Capability                     |               |
| Voltage drop per lead:                        |               |
| Load voltage:                                 |               |
| Load Regulation:                              |               |
| Command Processing Time (average time for output to begin to change after receipt of digital data when the power module is connected directly to the GPIB): | 20 ms |

| Output Voltage Programming Response Time*     |               |
| Time for output to change from 10% to 90% of its total excursion: | < 20 ms |
| Time for output to change from 90% to 10% of its total excursion: | < 20 ms | < 50 ms |
| Time for output voltage to settle to within 0.1% of the final value: | 120 ms |

* Excluding command processing time
<table>
<thead>
<tr>
<th>Parameter</th>
<th>66101A</th>
<th>66102A</th>
<th>66103A</th>
<th>66104A</th>
<th>66105A</th>
<th>66106A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trigger Response Time</strong> (average time for the output voltage or current to begin to change upon receipt of an external trigger)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With GPIB activity:</td>
<td>5 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without GPIB activity:</td>
<td>3 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trigger Maximum Frequency</strong> (for repetitive external triggering, the maximum frequency for which the Trigger Response Time is valid)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With GPIB activity:</td>
<td>75 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without GPIB activity:</td>
<td>85 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dwell Time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programmable range:</td>
<td>10 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolution:</td>
<td>2 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With GPIB activity:</td>
<td>± 5 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without GPIB activity:</td>
<td>± 2.5 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Downprogramming:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active downprogrammer sinks approximately 10% of rated output current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Monotonicity:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output is monotonic over entire rated voltage, current, and temperature range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GPIB Interface Capabilities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface Signals (see IEEE 488.1):</td>
<td>AH1,C0,DC1, DT1,EL,LE4,PP0, RL1,SH1,SR1,TE6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programming Language:</td>
<td>SCPI (Standard Commands for Programmable Instruments)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Serial Link Capabilities</strong> (maximum power modules sharing one GPIB primary address)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td><strong>Savable States</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Nonvolatile memory locations:</td>
<td>5 (0 through 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatile memory locations:</td>
<td>5 (5 through 9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonvolatile memory write cycles:</td>
<td>40,000 (typical)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Recommended Calibration Interval:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 year</td>
</tr>
<tr>
<td><strong>Safety Compliance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complies with:</td>
<td>CSA 22.2 No.231 &amp; IEC 348</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designed to comply with:</td>
<td>UL 1244 &amp; VDE 0411</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RFI Suppression</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(designed to comply with):</td>
<td>FTZ 1046/84, Level B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width:</td>
<td>48.3 mm (1.9 in)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height:</td>
<td>141.2 mm (5.6 in)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull tab inserted:</td>
<td>571.4 mm (22.5 in)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull tab extended:</td>
<td>606.4 mm (23.8 in)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net:</td>
<td>2.7 kg (6 lb)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shipping:</td>
<td>4.1 kg (9 lb)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 1-2. Supplemental Characteristics (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Agilent Model Number and Parameter Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output Characteristic Curve:</strong></td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Graph" /></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>CV OPERATING CURVE</td>
</tr>
<tr>
<td>B</td>
<td>CC OPERATING CURVE</td>
</tr>
<tr>
<td>C</td>
<td>QUADRANT 2 OPERATION DURING DOWNNPROGRAMMING</td>
</tr>
</tbody>
</table>

MAXIMUM RATED OUTPUT

<table>
<thead>
<tr>
<th>HP Model</th>
<th>Vout</th>
<th>Iout</th>
<th>~Iout</th>
</tr>
</thead>
<tbody>
<tr>
<td>66101A</td>
<td>8 V</td>
<td>16 A</td>
<td>1.6 A</td>
</tr>
<tr>
<td>66102A</td>
<td>20 V</td>
<td>7.5 A</td>
<td>0.75 A</td>
</tr>
<tr>
<td>66103A</td>
<td>35 V</td>
<td>4.5 A</td>
<td>0.45 A</td>
</tr>
<tr>
<td>66104A</td>
<td>60 V</td>
<td>2.5 A</td>
<td>0.25 A</td>
</tr>
<tr>
<td>66105A</td>
<td>120 V</td>
<td>1.25 A</td>
<td>0.125 A</td>
</tr>
<tr>
<td>66106A</td>
<td>200 V</td>
<td>0.75 A</td>
<td>0.075 A</td>
</tr>
</tbody>
</table>

Table 1-3. Replaceable Parts List

<table>
<thead>
<tr>
<th>Description</th>
<th>Agilent Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable assembly, mainframe GPIB</td>
<td>10833D</td>
</tr>
<tr>
<td>0.5 meters (1.6 ft)</td>
<td></td>
</tr>
<tr>
<td>1 meter (3.3 ft)</td>
<td>10833A</td>
</tr>
<tr>
<td>2 meters (6.6 ft)</td>
<td>10833B</td>
</tr>
<tr>
<td>4 meters (13.2 ft)</td>
<td>10833C</td>
</tr>
<tr>
<td>Cable assembly, mainframe serial link</td>
<td>5080-2148</td>
</tr>
<tr>
<td>Fuse, ac-line, 6 A</td>
<td>2110-0056</td>
</tr>
<tr>
<td>Output connector, standard</td>
<td>5060-3386</td>
</tr>
<tr>
<td>Output connector, with relays</td>
<td>5060-3387</td>
</tr>
<tr>
<td>Output connector converter board (converts 5060-3386 to 5060-3387)</td>
<td>5060-3351</td>
</tr>
<tr>
<td>Plug, mainframe INH/RFI input</td>
<td>1252-1488</td>
</tr>
<tr>
<td>Resistor, calibration</td>
<td>(see Appendix A)</td>
</tr>
</tbody>
</table>
Installation

Inspection

Damage

When you receive your power module, inspect it for any obvious damage that may have occurred during shipment. If there is damage, notify the shipping carrier and the nearest Agilent Sales and Support Office immediately. Warranty information is printed in the front of this guide.

Items Supplied

In addition to this manual, check that the following items are included with each power module (see Table 1-3 for part numbers):

- One output connector
- One Series 66lxxA Programming Guide
- One or more Manual Change Sheets may be included with each guide. If there are change sheets, make the indicated corrections to the guides.

Switches

Before inserting the power module in the mainframe, read the following information to determine if you need to change any of the switch settings.

Line Voltage Switches

Figure 2-1 shows the location of the line voltage switches and the ac line fuse. The line voltage switches are shipped in the 230-volt position. If required, use a flat-bladed screwdriver or similar tool to move both switches to the proper position for your nominal line voltage.

<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>Switch Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>110, 120 Vac</td>
<td>115</td>
</tr>
<tr>
<td>200, 220, 230, 240 Vac</td>
<td>230</td>
</tr>
</tbody>
</table>

Note: If you change the line switch position, remember to also correct the line voltage label on the rear of the mainframe. The mainframe contains no line voltage switches.

Configuration Switch

Figure 2-2 shows the location of the power module configuration switch. Table 2-1 indicates the functions of the switch and the factory-default settings. If you need to change any of the settings, refer to the applicable function.
Table 2-1. Settings for Power Module Configuration Switch

<table>
<thead>
<tr>
<th>Desired Function</th>
<th>Required Switch Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI disabled</td>
<td>0 0 0 1 1 1</td>
</tr>
<tr>
<td>RI unlatched (live)</td>
<td>0 1 1 1 1 1</td>
</tr>
<tr>
<td>RI latching †</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Display disabled</td>
<td>0 1 1 1 1 1</td>
</tr>
<tr>
<td>Display enabled †</td>
<td>I 1 1 1 1 1</td>
</tr>
<tr>
<td>Inhibit calibration</td>
<td>0 0 1 1 1 1</td>
</tr>
<tr>
<td>Factory calibration</td>
<td>0 1 1 1 1 1</td>
</tr>
<tr>
<td>Normal calibration †</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Power on state is *RCL 0</td>
<td>0 1 1 1 1 1</td>
</tr>
<tr>
<td>Power on state is *RST†</td>
<td>1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

†= factory default setting  "0" Off or open  "1" On or closed.
*Positions 7 and 8 are for service functions. For normal operation, they must be set to 1.
Remote Inhibit (RI) Function Switches

This function allows the power module outputs to be shut down from a signal (low-true TTL level) applied to the mainframe INH input. The INH input is internally connected to the mainframe remote inhibit (RI) line. This line is normally high and is distributed to all power modules in the mainframe. An external switch closure that shorts the mainframe INH input is detected by the power module as an RI signal.

Note
See "Chapter 3 - Connections" in the mainframe Installation Guide for more information on external INH connections.

Within each power module, the RI signal is applied to the RI section of the configuration switch (see Figure 2-2). The RI switch allows you to select one of the following responses to the RI input signal:

<table>
<thead>
<tr>
<th>Switch Setting</th>
<th>RI Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI disabled</td>
<td>The module ignores the RI input signal</td>
</tr>
<tr>
<td>RI latched</td>
<td>The module shuts down and remains shut down when the RI signal goes true. A software command is required to restore the output (see &quot;Chapter 4 - Basic Power Module Commands&quot;).</td>
</tr>
<tr>
<td>RI nonlatched (real-time)</td>
<td>The module shuts down only as long as the RI signal is true (TTL low). The output is restored when the RI signal goes false (TTL high).</td>
</tr>
</tbody>
</table>

Display Function Switch

A single switch configures the display function. Use it to permanently turn the power module voltage and current display indicators off or on (the annunciators are unaffected by this switch). If the switch is left in the ON position, the display may be turned on or off by software commands (see the power module Programming Guide).

Calibration Function Switches

The calibration switches allow you to select one of the following modes of calibration:

<table>
<thead>
<tr>
<th>Switch Setting</th>
<th>Calibration Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal calibration</td>
<td>Permits normal calibration (requires entry of a password)</td>
</tr>
<tr>
<td>Factory calibration</td>
<td>Restores original factory calibration (no password is required)</td>
</tr>
<tr>
<td>Inhibit calibration</td>
<td>Prevents calibration</td>
</tr>
</tbody>
</table>

The factory position is useful if the power module has been miscalibrated or if the calibration password has been lost.

Power-On Function Switch

This switch allows you to determine the operating state of the power module when it is turned on. With the switch set to 1 (on), the power module will be in the factory-default reset state (see *RST in "Chapter 3 - Language Dictionary" of the power module Programming Guide). If you move the switch to 0, the power module will turn on to whatever state you save to memory location 0. See "Chapter 4 - Basic Power Module Commands" for more information.
Installing The Module In The Mainframe

1. Turn off the mainframe power switch.
2. Make certain the pull tab extends from the module (see Figure 2-3).
3. Slide the module into the mainframe slot. You may use any available slot.
4. Push the module into the backplane connector until you feel the module connector snap into the backplane connector.
5. Push the lock tab into the front of the module. If the module is not properly plugged into the backplane connector, the lock tab will not retract into the module.
6. If desired, mark or label the power module with its slot address.

Important: Marking or labeling the power module will prevent replacing it in the wrong slot if it is subsequently removed from the mainframe. Also, with two mainframes linked together, a slot can be either of two numbers, depending on whether it is in the main or the auxiliary mainframe (see "Connecting the Controller" in this chapter).

Connecting The Load

Output Connector

One output connector (see Table 1-3) is shipped with each power module. This can be either a standard or relay type. The Installation Guide supplied with the connector shows how to open the connector, connect the wires, and secure the connector to the mainframe.
Output Connections

Before making the actual connections, you must decide on the system configuration. The following factors are described in the rest of this chapter:

- using the correct wire size
- maintaining isolation guidelines
- selecting local or remote voltage sensing
- connecting modules in series or in parallel
- using output relays
- connecting to capacitive or inductive loads

Selecting the Proper Wire Size

**WARNING**  Fire Hazard. To satisfy safety requirements, load wires must be large enough not to overheat when carrying the short-circuit output current of the device connected to the power module. See Table 2-2 for the characteristics of AWG (American Wire Gage) copper wire.

<table>
<thead>
<tr>
<th>AWG No.</th>
<th>*Ampacity (Ω/m)</th>
<th>**Resistance (Ω/ft)</th>
<th>AWG No.</th>
<th>*Ampacity (Ω/m)</th>
<th>**Resistance (Ω/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>8.33</td>
<td>0.0345</td>
<td>12</td>
<td>40</td>
<td>0.0054</td>
</tr>
<tr>
<td>18</td>
<td>15.4</td>
<td>0.0217</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>19.4</td>
<td>0.0137</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>31.2</td>
<td>0.0086</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Output Isolation

**WARNING**  The output connector ground terminal is a low-noise ground provided for convenience, such as for grounding wire shields. This terminal is not designed to function as an equipment safety ground.

The power module output terminals are isolated from earth ground. If required, either output terminal may be grounded.

**CAUTION**  The potential between either output terminal and ground must not exceed ±240 Vdc. Failure to observe this restriction may damage the power module.

Local Voltage Sensing

Figure 2-4A shows the load connection for local sensing. There is a switch on the output connector that selects either local or remote sensing of the output voltage. The connector is shipped with the switch in the **LOCAL** position. In order to configure the output for local sensing, make certain this switch is set to **LOCAL**.

**Note**  The position of the Local/Remote switch also can be determined by software (see **VOLT:SENS:SOUR?** in "Chapter 3 - Language Dictionary" of the **Programming Guide**).

With local sensing, the power module voltage readback circuit senses the voltage at the output terminals. Since this does not compensate for voltage drops in the terminal screw connections and output leads, use Local sensing only in applications requiring low output currents or where the load regulation is not critical.
Remote Voltage Sensing

Figure 2-4B shows the wiring for remote sensing. There is a switch on the output connector that selects either local or remote sensing of the output voltage. To configure the output for remote sensing, do the following:

- Connect sense leads to the load
- Make certain that the connector switch is set to REMOTE

**Note** If you leave the connector switch in LOCAL, the power module will regulate the programmed voltage at the connector, not at the load.

Because they do not carry load current, you may use smaller gauge wire for the remote sense leads.

Be careful to avoid open circuits in the sense leads, such as leaving the output connector sense switch in the Local position. If this happens, the power module will regulate at its output terminals instead of at the load.

**Note** If the sense terminals are left open, the voltage at the output terminals will increase approximately 3 to 5% over the programmed value. The readback voltage will not indicate this increase because readback is measured at the sense terminals.

The dashed lines in the connection drawings illustrate remote sense connections. In this case, the remote sense terminals of the power module are connected to the load rather than the output terminals. This allows the power module to automatically compensate for the voltage drop in the load leads as well as to accurately read back the voltage at the load. In remote-sense applications, the voltage readback from across the load is not the output voltage of the power module. The actual output voltage is the sum of the load voltage and the voltage drop in the load lead. Keep this output voltage within the power module’s maximum voltage rating. Failure to do this may result in an unregulated condition, especially when the line voltage is low.

**Voltage Readback**

In remote sense applications, the voltage readback occurs directly at the load. This allows the power module to automatically compensate for the voltage drop in the load leads and to provide an accurate voltage readback directly across the load.
Output Rating

The rated output voltage and current specified in Table 1-1 applies at the output terminals of the power module. With remote sensing, the power module must increase its output to compensate for voltage dropped in the load leads. If you attempt to provide full rated output voltage at the sense terminals (load), the power module’s output voltage may exceed its maximum rating. This may trip the OV protection circuit, which senses the voltage at the output terminals, or cause an unregulated output condition, particularly when the ac line voltage is low.

Output Noise

Noise picked up by the sense leads may appear at the output of the power module and can adversely affect the load regulation. To minimize noise pickup, twist the sense leads and route them parallel and close to the load leads. It may be necessary to use shielded sense leads in noisy environments. If you do, ground the shield only at the output connector ground screw. Do not use the shield as one of the sense leads.

Parallel Operation

Power modules may be connected in parallel to obtain increased output current. The power modules must be individually programmed; they do not function in the autoparallel mode that is commonly used by many Agilent power supplies.

Figure 2-5 shows two power modules connected in parallel. You must keep the same impedance to the load by using leads of equal length and wire size from each module to the load. Select one module (usually the one with the lesser current capacity) to operate in the "CV Mode". The other module then must operate in the "CC Mode" module. If you are using remote sensing, connect the sense leads to the module operating in the CV mode.

Since you must program one module to operate in CV mode and the other to operate in CC mode, refer to the output characteristic curve shown at the end of Chapter 1 to see what this means. Curve † shows a module operating in CV mode; its output voltage remains constant over the range of its operating current. Curve ‡ shows a module operating in CC mode; its output current remains constant over the range of its operating voltage.

For proper parallel operation, observe the following rules:

1. Program both module outputs OFF.
2. Program the CV mode module for the desired output voltage.
3. Program the CV mode module’s OVP voltage to the desired value; always higher than the output voltage.
4. Program the output and OVP voltages of the CC module slightly higher (about 1 volt) than those of the CV module. This is to ensure that the CC module stays in CC mode.
5. In order to maintain proper regulation, the load must always draw at least as much current as is programmed for the module that is in CC mode. You can maintain regulation over a range of current only as long as this condition remains true.

6. As near as is permitted by condition 5, program the current levels of both modules for a balanced distribution of the total output current. Do not program the CV module near its maximum output current level.

7. Program the outputs of both modules ON.

8. When the system is operating, observe that the CV annunciator of the CV module stays on and the CC annunciator on the CC module stays on. If not, repeat steps 1 through 7.

9. Once the modules are properly set up, do all subsequent voltage programming from the CV module; the CC module will track that module.

**CAUTION** Remember that although the CV module is controlling the output voltage, the CC module is programmed to a slightly higher voltage. Do not allow the CC module to go into CV mode. Do not program the CV module to 0 volts without first disabling the outputs of both power modules. Otherwise, the CV module could sink up to 10% of its rated output current from the CC module.

As an example, assume that an Agilent 66102A (20 V @ 7.5 A) and an Agilent 66103A (35 V @ 4.5 A) are connected in parallel to supply a load of 10 amperes at 18 volts. The Agilent 66102A is selected as CC mode module and will supply approximately 7.6 A, maximum. The Agilent 66103A will be the CV module and will supply the remaining current (2.4 A). When the two modules are operated in parallel, you may expect the system to regulate at 18 Volts and 10 amperes as long as the load current remains above 7.6 amperes (see rule 5, above).

The following program shows how to program the two power modules. Generic code (SCPI commands) are shown; they may be sent either from the keyboard or from a GPIB controller.

```
OUTP OFF
VOLT:LEV 18
VOLT:PROT 18.5
CURR:LEV 2.4

VOLT:LEV 19
VOLT:PROT 19.5
CURR:LEV MAX

OUTP ON
```

**Send to both modules**

**Program the CV mode module**

**Program the CC mode module**

**Restore the outputs of both modules**

**Series Operation**

**CAUTION** To prevent damage to the equipment, floating voltages must not exceed 240 Vdc. No output terminal may be more than 240 V from chassis ground.

Figure 2-6 shows how the outputs of two power modules may be connected in series to increase the output voltage. **Connect only power modules that have the same maximum output current ratings.** It is recommended that you set up both modules to operate in CV mode with their current outputs equal to the full load current. If the external load is a storage device, such as a battery or large capacitance, be careful how you shut down the system. For example, turning off just one module could damage the remaining module by subjecting it to double its maximum output voltage from the storage device.
Each power module has a reverse voltage protection diode across its output. If a reverse voltage is applied, the power module has no control over the current through this diode. To avoid damaging the power module, never connect it to a reverse voltage that can force it to conduct current in excess of the power module’s maximum reverse current (see Table 1-2).

Multiple Loads

When connecting multiple loads to the power module with local sensing, use a separate pair of wires for each load (see Figure 2-7). Each pair of wires should be as short as possible and twisted or bundled to reduce lead inductance and noise pickup. If cabling or terminal considerations require the use of distribution terminals located outside the output connector, then remote voltage sensing is recommended. Connect the sense leads either at the distribution terminals or directly at one of the loads if it is more critical than the others.

Optional Relay Connector

If you are using the Option 760 output connector with isolation or polarity reversal relays, the output and sense lead terminal connections are the same as those of the standard output connector. When the output connector Remote/Local switch is in Remote, both the output leads and the sense leads are under relay control. An existing standard connector can be converted into a relay connector. The Installation Guide provided with the connector (see "Related Documents" in Chapter 1) includes instructions for doing this.

Capacitive Loads
The power module is designed to be stable for load capacitances up to the following values:

<table>
<thead>
<tr>
<th>Module</th>
<th>Capacitance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agilent 66101A</td>
<td>50,000 µF</td>
</tr>
<tr>
<td>Agilent 66102A</td>
<td>20,000 µF</td>
</tr>
<tr>
<td>Agilent 66103A</td>
<td>10,000 µF</td>
</tr>
<tr>
<td>Agilent 66104A</td>
<td>4,500 µF</td>
</tr>
<tr>
<td>Agilent 66105A</td>
<td>2,750 µF</td>
</tr>
<tr>
<td>Agilent 66106A</td>
<td>1,650 µF</td>
</tr>
</tbody>
</table>

**Inductive Loads**

You may safely connect the power module output to inductive loads up to 100 mH. (Higher inductances are possible with a modified module. Consult the factory for details.)

**OVP Considerations**

The OVP circuit senses the voltage at the output terminals, not at the sense terminals. Therefore the voltage sensed by the OVP circuit can be significantly higher than the voltage being regulated at the load. You must program the OVP trip voltage high enough to compensate for the expected drop from the power module output to the load.

**Battery Charging**

The power module OVP trip circuit has a downprogrammer that discharges the output whenever OVP trips. If the output is connected to a battery and the OVP is tripped (or the power module voltage is programmed below the battery voltage), the power module will sink current from the battery. The down programmer limits the value of this current to no more than 10% of the power module’s maximum rated output current.

**Connecting The Controller**

The Agilent 66000A Mainframe has a GPIB port for connection to the controller. Each power module has a GPIB primary address determined by a switch on the mainframe, and a GPIB subaddress determined by the mainframe slot in which the module is installed. If the mainframe GPIB address is set to 705, this becomes the power module’s primary address.

The Agilent 66000A Mainframe mode switch determines the IEEE 488 secondary addresses (also referred to as subaddresses) of the modules that are installed in the mainframe. With the mainframe mode switch set to **MAIN**, modules are assigned secondary addresses of 00 to 07, which correspond to the slot locations indicated on the mainframe. The mainframe mode switch must be set to **MAIN** when the mainframe is connected directly to the GPIB. For example, if a module is installed in slot 3 of a mainframe that is set to GPIB address 705, the complete address of the module is 70503.

The mainframe mode switch must be set to **AUX** (auxiliary) when the mainframe is serially-linked to another mainframe that is directly connected to the GPIB. In mainframes that have the mode switch set to **AUX**, modules are assigned secondary addresses of 08 to 15. Secondary address 08 corresponds to slot location 0 on the mainframe and secondary address 15 corresponds to slot location 7 on the mainframe. For example, if a module is installed in slot 3 of a mainframe that is serially linked to another mainframe at GPIB address 705, the complete address of the module is 70511.

<table>
<thead>
<tr>
<th>Module Slot Locations/Addresses</th>
<th>Mainframe Mode Switch = <strong>MAIN</strong></th>
<th>Mainframe Mode Switch = <strong>AUX</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Slot Location</td>
<td>0 1 2 3 4 5 6 7</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Secondary Address</td>
<td>00 01 02 03 04 05 06 07</td>
<td>08 09 10 11 12 13 14 15</td>
</tr>
</tbody>
</table>

For details concerning GPIB cabling and addressing, see "Chapter 2 - Installation" in the Agilent 66000A Mainframe *Users Guide*. 
Turn-On Checkout

Introduction

This chapter provides a quick test of the power module functions. See "Chapter 4 - Basic Power Module Commands" for more details of power module operation.

Note

These procedures assume you have checked and, if required, correctly set the following switches for each module:

- the line voltage switch (see Figure 2-1)
- the configuration switch (see Table 2-2)
- the output connector Local/Remote switch

The procedures for doing this are given in Chapter 2.

Module Panel Display

The power module display provides the information shown in Table 3-1. There are no operating controls on the power module.

Table 3-1. Power Module Front Panel Display

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLTS</td>
<td>Digital readout of output voltage</td>
</tr>
<tr>
<td>AMPS</td>
<td>Digital readout of output current</td>
</tr>
<tr>
<td>CV</td>
<td>Lights when power module is in constant voltage mode</td>
</tr>
<tr>
<td>CC</td>
<td>Lights when power module is in constant current mode</td>
</tr>
<tr>
<td>Addr</td>
<td>Lights when power module is addressed over GPIB</td>
</tr>
<tr>
<td>Unr</td>
<td>Lights when power module output is unregulated</td>
</tr>
<tr>
<td>Dis</td>
<td>Lights when power module output is disabled</td>
</tr>
<tr>
<td>Prot</td>
<td>Lights when power module protection circuit is activated (overvoltage, overcurrent, overtemperature, or remote inhibit)</td>
</tr>
</tbody>
</table>
When you turn on the mainframe, the power module goes through a self-test. All front panel readout digits and annunciators turn on briefly. The panel then remains in the state shown in Table 3-1A.

**Note** The figure assumes the power module still retains its factory default turn-on state. You can change this state if desired (see "Chapter 4 - Basic Power Module Commands").

### Checking Basic Module Functions

The power module is designed for remote programming over the GPIB. It also can be locally programmed from the optional Agilent 66001A MPS Keyboard. Table 3-2 gives the SCPI commands for the remotely programmed tests. You can send these same commands from the keyboard (see "Appendix B").

<table>
<thead>
<tr>
<th>Command</th>
<th>Action</th>
<th>Display Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VOLT 5.1</strong></td>
<td>Set output voltage to 5.1 V</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>OUTP ON</strong></td>
<td>Enable the output</td>
<td>5.10</td>
</tr>
<tr>
<td><strong>VOLT:PROT 4.9</strong></td>
<td>Activate OVP circuit (by setting protection voltage below output voltage)</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>VOLT:PROT MAX</strong></td>
<td>Clear OVP circuit</td>
<td>5.10</td>
</tr>
<tr>
<td><strong>OUTP:PROT:CLE</strong></td>
<td>Clear OVP circuit</td>
<td>5.10</td>
</tr>
</tbody>
</table>

**Save and Recall Functions**

<table>
<thead>
<tr>
<th>Command</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SAV 5</strong></td>
<td>Save present state to location 5</td>
</tr>
<tr>
<td><strong>VOLT 3.55</strong></td>
<td>Set output voltage to 3.55 V</td>
</tr>
<tr>
<td><strong>OUTP OFF</strong></td>
<td>Turn off the output</td>
</tr>
<tr>
<td><strong>SAV 6</strong></td>
<td>Save present state to location 6</td>
</tr>
<tr>
<td><strong>RCL 5</strong></td>
<td>Restore state 5</td>
</tr>
<tr>
<td><strong>RCL 6</strong></td>
<td>Restore state 6</td>
</tr>
</tbody>
</table>

**Output Current (With output disabled, short the output terminals with a wire size sufficient to carry the maximum current of the module.)**

<table>
<thead>
<tr>
<th>Command</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CURR 3.1</strong></td>
<td>Set output current to 3.1 amps</td>
</tr>
<tr>
<td><strong>OUTP ON</strong></td>
<td>Enable the output</td>
</tr>
</tbody>
</table>

**Overcurrent Protection**

<table>
<thead>
<tr>
<th>Command</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CURR:PROT:STAT ON</strong></td>
<td>Activate OCP circuit (by enabling OCP when the output is shorted)</td>
</tr>
<tr>
<td><strong>CURR:PROT:STAT OFF</strong></td>
<td>Clear OCP circuit</td>
</tr>
<tr>
<td><strong>OUTP:PROT:CLE</strong></td>
<td>Clear OCP circuit</td>
</tr>
</tbody>
</table>

*Addr will not light if the module is controlled from the keyboard.
In Case Of Trouble

Mainframe Failure

You can assume there is a problem with the mainframe if there is more than one module in the mainframe and none of the module fans are on. The trouble also is probably in the mainframe if the module fans are on and the their displays are enabled (see "Configuration Switch" in "Chapter 2 - Installation") but their VOLTS and AMPS displays do not light. If a module does not appear to be operating but its VOLTS and AMPS display light, move the module to another address slot. If the above condition still occurs, then the problem probably is in the module.

Module Line Fuse

If a power module’s fan is on but its front panel does not light, the module line fuse may be blown. Proceed as follows:

1. Remove the power module from the mainframe.

Note
You can remove and insert the power module without turning off the mainframe power provided the module output is either disabled or is programmed to zero and there is no GPIB bus, trigger bus, or RI/DFI activity. If you are in doubt, turn off the mainframe power.

2. Check the line fuse (see Figure 2-1). If it is defective, replace it with one of the same type and rating (for the Agilent part number, see Table 1-3).

CAUTION
Do not use a slow-blow fuse as a replacement.

3. Replace the power module in the mainframe.

Module Output Connector

If the module panel indicates a normal voltage but there is no output at the load, the problem may be in the output connector. This is even more probable if the connector has relays. The following tests may isolate the problem:

- If another module is working normally, use its mainframe slot for the suspected module (be careful to guard against any difference in module output voltage). If there is still no output, the problem is in the module. If the module has an output in the new slot, the problem is with its original output connector.
- To check a suspected connector with a good module, proceed as follows (see DC Module Connectors Installation Guide for details of the connector and its jumpers):
  1. Disable the power module output (Dis annunciator on).
  2. Remove the output connector from mainframe.
  3. Examine the connector plug for bent pins.
  4. Remove the cover from the output connector.
  5. If there is no relay board, go to step 6. Otherwise, proceed as follows:
    a. Remove the relay board by pulling it straight up.
    b. Examine relay board connector for bent pins.
    c. Examine the connector board to ensure that the required jumpers have been cut to enable relay operation.
  6. Examine the jumpers on the connector board. If any jumpers have been cut, they must be replaced.

Error Messages

A power module may fail either during selftest or while operating (runtime). In either case, the module display may show an error message indicating the reason for the failure.
Selftest Error Messages

Table 3-3 lists the displayed selftest error messages. All these errors are hardware failures that require service.

Note
If you are using the optional Agilent 66001A MPS Keyboard, it will also display selftest error messages.

Table 3-3. Selftest Error Messages

<table>
<thead>
<tr>
<th>Display</th>
<th>Failed Test</th>
<th>Display</th>
<th>Failed Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>U 1</td>
<td>Internal RAM</td>
<td>U 8</td>
<td>Ambient temperature reading</td>
</tr>
<tr>
<td>U 2</td>
<td>External RAM</td>
<td>U 9</td>
<td>(Not used)</td>
</tr>
<tr>
<td>U 3</td>
<td>ROM checksum</td>
<td>U 10</td>
<td>Voltage programming, low range</td>
</tr>
<tr>
<td>U 4</td>
<td>(Not used)</td>
<td>U 11</td>
<td>Current programming, low range</td>
</tr>
<tr>
<td>U 5</td>
<td>(Not used)</td>
<td>U 12</td>
<td>Voltage programming, high range</td>
</tr>
<tr>
<td>U 6</td>
<td>12 V supply</td>
<td>U 13</td>
<td>Current programming, high range</td>
</tr>
<tr>
<td>U 7</td>
<td>5 V supply</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The power module also can detect an EEPROM checksum error. This error is not identified by number, but causes the following symptoms:

- The power module starts up with both the VOLTS and AMPS full-scale programming and metering ranges accepting values up to 1000.
- Self-test error code 330 is stored in the SCPI error queue where it can be read by software (see “Chapter 5 - Error Messages” in the Programming Guide).
- The software identify query (*IDN?) returns 0A in the model field.
- The calibration password is set to 0.

An EEPROM checksum error can occur due to the following operating conditions:

- Excessive number of write cycles to an EEPROM (see Table 1-2). This condition is not recoverable and requires service.
- Loss of ac input power during a checksum calculation. This condition, which is very unlikely, is recoverable.
  You may be able to recover by performing the following steps from the controller or keyboard:
  1. Enable the calibration mode (CAL:STAT ON,0)
  2. Save an operating state to EEPROM. (e.g., *SAV 2)
- This forces the power module to write to EEPROM and establishes a new checksum.

Runtime Error Messages

Table 3-4 lists the runtime error messages. Runtime errors cease normal power module operation, disable the output, and display a code on the front panel. The error code is preceded by "U" and is displayed on both the VOLTS and AMPS displays. Runtime errors are hardware malfunctions that require service.

Table 3-4. Runtime Error Messages

<table>
<thead>
<tr>
<th>Display</th>
<th>Meaning</th>
<th>Display</th>
<th>Meaning</th>
<th>Display</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>U 101</td>
<td>EEPROM write error</td>
<td>U 102</td>
<td>Internal software error</td>
<td>U 103</td>
<td>Unexpected interrupt</td>
</tr>
</tbody>
</table>
Basic Power Module Commands

Introduction

"Chapter 3 - Language Dictionary" of the Programming Guide describes all the power module commands. This chapter introduces you to the commands that control the following basic functions:

- output state
- protection circuits
- fixed-mode output
- list-mode output
- triggers
- the RFI function
- the DFI function

The power module can be programmed from a controller over the GPIB or from an optional Agilent 66001A MPS Keyboard plugged into the mainframe. In order to apply the information in this chapter, you must have a working knowledge of either method. Information concerning programming is presented as follows:

<table>
<thead>
<tr>
<th>Method of Control</th>
<th>Consult</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPIB Controller</td>
<td>Programming Guide for Agilent Series 66lxxA MPS Power Modules</td>
</tr>
<tr>
<td>MPS Keyboard</td>
<td>Appendix B of this guide</td>
</tr>
</tbody>
</table>

GPIB Controller

The power module is programmed by SCPI (Standard Commands for Programmable Instruments) commands sent as strings within your language statements. "Chapter 2 Introduction to Programming" of the Programming Guide explains how to do this. The syntax of each command in given in Chapter 3 of that guide.

MPS Keyboard

If you have installed the optional MPS keyboard, you can execute the commands given here. You do not have to understand the details of SCPI programming, because the keyboard menu allows you to step through all commands. If you have a keyboard, it is highly recommended that you use it until you are familiar with the general concepts of power module operation.

Note

The keyboard menu omits optional SCPI headers. That is why some commands displayed on the keyboard will not look exactly like the syntax given in Chapter 3 of the Programming Guide.

Synopsis Of Commands

The following tables summarize the SCPI commands by function. The short form without optional headers is used in this chapter. For example, the full command for turning on the output as given in the Programming Guide is OUTPut [:STATe] ON. Here the optional [STATe] (in brackets) is omitted and only the short form (in capital letters) OUTP ON is used.

The query form of a command (OUTP?) is omitted unless the command is only of the query form (such as MEAS:VOLT?).
Controlling the Output State

The following commands control the power module output state:

**Table 4-1. Power Module Output Commands**

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTP ON</td>
<td>Enables the output.</td>
</tr>
<tr>
<td>OUTP OFF</td>
<td>Disables the output.</td>
</tr>
<tr>
<td>OUTP / NOR</td>
<td>Enables the output without affecting the output relay.</td>
</tr>
<tr>
<td>OUTP 0, NOR</td>
<td>Disables the output without affecting the output relay.</td>
</tr>
<tr>
<td>OUTP: REL 1</td>
<td>Closes the (optional) output relay contacts.</td>
</tr>
<tr>
<td>OUTP: REL 0</td>
<td>Opens the (optional) output relay contacts.</td>
</tr>
<tr>
<td>OUTP: REL: POL NORM</td>
<td>Makes the (optional) output relay polarity the same as the module output.</td>
</tr>
<tr>
<td>OUTP: REL: POL REV</td>
<td>Makes the (optional) output relay polarity opposite to the module output. The output is disabled while the relay polarity is being reversed.)</td>
</tr>
</tbody>
</table>

Controlling Protection Functions

The following commands control the power module protection circuits:

**Table 4-2. Power Module Protection Commands**

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURR: PROT: STAT ON</td>
<td>Turns on the OCP (overcurrent protection), which disables the output if the output current exceeds the programmed current.</td>
</tr>
<tr>
<td>CURR: PROT: STAT OFF</td>
<td>Turns off the current protection.</td>
</tr>
<tr>
<td>VOLT: PROT &lt;value&gt;</td>
<td>Programs the OVP (overvoltage protection) level. The protection circuit will trip if the output voltage exceeds the OVP level.</td>
</tr>
<tr>
<td>OUTP: PROT: CLE</td>
<td>Clears any active protection conditions (panel Prot annunciator goes off). Before the command can comply, you must remove the condition that caused the protection circuit to trip.</td>
</tr>
<tr>
<td>OUTP: PROT: DEL .05</td>
<td>Specifies a delay (in seconds) between the time a protection condition is detected and the actual activation of the protection circuit. (Does not apply to OVP.)</td>
</tr>
</tbody>
</table>

Controlling Fixed-Mode Output

The following commands control the power module fixed-mode voltage and current output:

**Table 4-3. Power Module Fixed-Mode Output Commands**

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURR: MODE FIX</td>
<td>Sets the current mode to fixed (as opposed to list). FIX is the factory default power on state.</td>
</tr>
<tr>
<td>CURR &lt;value&gt;</td>
<td>Programs the immediate output current level (in amperes).</td>
</tr>
<tr>
<td>CURR: TRIG &lt;value&gt;</td>
<td>Programs the triggered output current level (in amperes). See &quot;Trigger Commands&quot;.</td>
</tr>
<tr>
<td>MEAS: CURR?</td>
<td>Returns the present value of the output current.</td>
</tr>
<tr>
<td>VOLT: MODE FIX</td>
<td>Sets the voltage mode to fixed (as opposed to list). FIX is the factory default power on state.</td>
</tr>
<tr>
<td>VOLT &lt;value&gt;</td>
<td>Programs the immediate output voltage level (in amperes).</td>
</tr>
<tr>
<td>VOLT: TRIG &lt;value&gt;</td>
<td>Programs the triggered output voltage level (in amperes). See &quot;Trigger Commands&quot;.</td>
</tr>
<tr>
<td>MEAS: VOLT?</td>
<td>Returns the present value of the output voltage.</td>
</tr>
<tr>
<td>VOLT: SENS?</td>
<td>Returns the position of the output connector sense switch (INT is local; EXT is remote).</td>
</tr>
</tbody>
</table>
Controlling List-Mode Output

The following commands control the power module list-mode voltage and current output. Lists require a trigger to begin execution. For an explanation of lists and triggers, see "Chapter 5 - Synchronizing Power Module Output Changes": in the Programming Guide.

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURR:MODE LIST</td>
<td>Sets the current mode to list (as opposed to fixed).</td>
</tr>
<tr>
<td>LIST:CURR &lt;value&gt;,&lt;value&gt;</td>
<td>Programs the output current values (or points) in the list. When you execute the list, the output will sequentially step through the list values.</td>
</tr>
<tr>
<td>LIST:CURR:POIN?</td>
<td>Returns the number of points programmed in the current list.</td>
</tr>
<tr>
<td>VOLT:MODE LIST</td>
<td>Sets the voltage mode to list (as opposed to fixed).</td>
</tr>
<tr>
<td>LIST:VOLT &lt;value&gt;,&lt;value&gt;</td>
<td>Programs the output voltage values (or points) in the list. When you execute the list, the output will sequentially step through the list values.</td>
</tr>
<tr>
<td>LIST:VOLT:POIN?</td>
<td>Returns the number of points programmed in the voltage list.</td>
</tr>
<tr>
<td>LIST:DWEL &lt;value&gt;,&lt;value&gt;</td>
<td>Programs the dwell value, in seconds, for each value in a voltage or current list. There must be one dwell value for each value in the voltage or current list.</td>
</tr>
<tr>
<td>LIST:DWEL:POIN?</td>
<td>Returns the number of points programmed in the dwell list.</td>
</tr>
<tr>
<td>LIST: STEP ONCE</td>
<td>Commands the list to execute only one value (point) when a trigger is received. This specifies a trigger-paced list.</td>
</tr>
<tr>
<td>LIST: STEP AUTO</td>
<td>Commands the list to execute all values (points) when a trigger is received. This specifies a dwell-paced list.</td>
</tr>
</tbody>
</table>

Controlling Triggers

The following commands control the power module trigger subsystem. For a detailed description of this subsystem, see "Chapter 5 - Synchronizing Power Module Output Changes": in the Programming Guide.

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>INIT</td>
<td>Initiates the trigger subsystem to detect one trigger. No triggers will be processed unless the subsystem is initiated.</td>
</tr>
<tr>
<td>INIT:CONT</td>
<td>Keeps the trigger subsystem continuously initiated so it will process each incoming trigger.</td>
</tr>
<tr>
<td>TRIG:SOUR BUS</td>
<td>EXT</td>
</tr>
<tr>
<td>TRIG:DEL &lt;value&gt;</td>
<td>Programs the delay time (in seconds) between the detection of a trigger and its execution.</td>
</tr>
<tr>
<td>TRIG:TRG</td>
<td>Either command sends a trigger signal to the power module over the GPIB bus. When TRIG:SOUR LINK is programmed, this command specifies the link parameter for the trigger (see Programming Guide).</td>
</tr>
<tr>
<td>TRIG:LINK &lt;parameter&gt;</td>
<td>Enables the power module Trigger Out signal, which is a 20-µs negative-true TTL pulse available at the mainframe TRIGGER OUT jack. To use this output, you must program a TTLT trigger source (OUTP:TTLT:SOUR).</td>
</tr>
<tr>
<td>OUTP: TILT ON</td>
<td>Enables the power module Trigger Out signal.</td>
</tr>
<tr>
<td>OUTP: TTLT OFF</td>
<td>Disables the power module Trigger Out signal.</td>
</tr>
<tr>
<td>OUTP:TTLT:SOUR BUS</td>
<td>EXT</td>
</tr>
<tr>
<td>OUTP:TTLT:LINK</td>
<td>When OUTP: SOUR LINK is programmed, this command specifies the link parameter for the trigger (see Programming Guide).</td>
</tr>
</tbody>
</table>
Using the RI/DFI Functions

RI (Remote Inhibit) Input

The signal applied to the mainframe digital connector INH input (see "Chapter 3 Connections" of the mainframe Installation Guide) is the RI (remote inhibit). The module function switch described in "Chapter 2 - Installation" allows you to enable or disable the RI input and, when enabled, to specify RI as either latching or nonlatching. If the module function switch is set to enable RI, then the input signal will disable the power module output. If the function switch is also set to RI nonlatching, then removing the signal from the INH input restores the power module output. If the function switch is set to RI latching, an RI status bit is latched and the power module remains disabled after the input signal is removed. The RI status bit is removed either by reading the Status Questionable Event register (STAT: QUES?) or by clearing it (*CLS). See the Programming Guide for specifics.

The detected RI bit can be used to generate a DFI signal that appears at the mainframe FLT output. This signal, in turn, can be wired to the RI inputs of other power modules to also disable their outputs (see the wiring diagram in Chapter 3 of the mainframe Installation Guide).

DFI (Discrete Fault Indicator) Output

When the DFI function is enabled (OUTP:DFI ON), you can program the Status Subsystem to cause any status condition (including RI) to generate a DFI output, which appears as a TTL low-true signal at the mainframe digital connector FLT output. See "Chapter 4 - Status Reporting" in the Programming Guide for details of programming the Status Subsystem.

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTP:DFI ON</td>
<td>Enables the DFI function.</td>
</tr>
<tr>
<td>OUTP:DFI OFF</td>
<td>Disables the DFI function.</td>
</tr>
<tr>
<td>OUTP: DFI: SOUR LINK</td>
<td>Specifies the source for DFI events. The only source is LINK.</td>
</tr>
<tr>
<td>OUTP: DFI: LINK &lt;parameter&gt;</td>
<td>Specifies what power module status events are linked to the DFI function. Table 3-1 in the Programming Guide identifies all the DFI link parameters.</td>
</tr>
</tbody>
</table>

Table 4-6. DFI Output Commands

Only one parameter may be specified for OUTP: DFI: LINK, such as OUTP: DFI: LINK CC. However, you can specify entire status groups by specifying a summary bit. For example, OUTP: DFI: LINK QUES specifies the Questionable Status summary bit, which is the logical OR of OV, OC, OT, RI, and UNR. The default link parameter SUM3 is the logical OR of the QUES, OPER, and ESB summary bits. This gives DFI access to all three status register groups (see "Chapter 4 - Status Reporting" in the Programming Guide for more information).

Changing The Power On State

Switch 6 of the module function switches (see "Chapter 2 - Installation") determines the state of the power module when you turn it on. With the switch in the factory-default position (1), the module turns on in the reset (*RST) state. You will find the parameters for this state listed under the *RST command in "Chapter 3 - Language Dictionary" of the Programming Guide. If you store your own parameters in location 0 (*SAV 0), and set the switch to 0, then the module will assume that state when you turn it on.

Note: The *RST state is a safe turn-on state that should not be replaced without careful consideration.
Calibration

Introduction

The power module may be calibrated either over the GPIB from a controller or from an Agilent 66001A Modular Power System keyboard. Instructions are included for either method. The procedures given here apply to all Series 66l0xA Power Modules.

Enabling Or Disabling The Calibration Function

There are two ways of controlling access to the calibration function. One is by hardware and the other is with software.

Hardware Control

The CAL positions of the power module function switch (see Table 2-1 in "Chapter 2 Installation") allows hardware control over the calibration function. The factory-default setting is for normal calibration. Setting the switches to the Inhibit calibration position prevents any calibration from being performed.

Software Control

The password parameter of the CAL: STAT command allows software control over the calibration function. The standard factory password is the module model number (for example, 66102 for the Agilent 66102A). By changing the password, you can either restrict or allow unlimited access to the calibration function (see "Changing the Calibration Password").

Changing The Calibration Password

You can change the password only when the module is in the calibration mode (which requires you to know the present password). To change the password from 66101 to 81591, send the following commands:

CAL:STAT ON, 66102
CAL:PASS 81591

If you change the password to 0, then all password protection is removed. The Calibration Subsystem then will accept the CAL: STAT ON command without a password.

Performing a Calibration

Perform the procedures in the order given. The assumed password is 66102; use your actual password in the procedures.

Important These instructions do not include verification procedures. If you need to perform verification as part of your calibration procedure, refer to the Series Agilent 66l0xA Service Manual.
Equipment Required

The equipment listed in Table A-1, or equivalent, is required for calibration.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Characteristics</th>
<th>Recommended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltmeter</td>
<td>D-c accuracy 0.005%, 6 digits; resolution 1 µV</td>
<td>Agilent 3458A</td>
</tr>
<tr>
<td>Shunt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agilent 66101A, 66102A</td>
<td>0.01Ω, 100 A, 100 W, 0.04% @ 100 W, 0.01% @ 1W, power coeff. 0.0004%/watt in air</td>
<td>Guildline 9230/100</td>
</tr>
<tr>
<td>Agilent 66103A, 66104A, 66105A, 66106A</td>
<td>0.1 Ω, 15 A, 25 W, 0.04% @ 25 W, 0.01% @ 1W, power coeff. 0.002%/watt in air</td>
<td>Guildline 9230/15</td>
</tr>
<tr>
<td>GPIB Controller or Keyboard</td>
<td>HP Vectra (or IBM compatible) with GPIB Interface or Agilent BASIC series Agilent 66001A MPS</td>
<td></td>
</tr>
</tbody>
</table>

Calibrating Voltage

**WARNING** Calibration may cause dangerous voltages to be present at the power module output.

The following procedure calibrates the output voltage and the overvoltage protection (OVP). During voltage calibration, you will enter two readings from the external DVM. You must calibrate the voltage before calibrating the OVP. You do not have to enter any external readings when calibrating the OVP.

Table A-2. Voltage Calibration Procedure

<table>
<thead>
<tr>
<th>Keyboard Entry</th>
<th>Controller Entry †</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage Calibration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>† R Enter</td>
<td>*RST</td>
<td>Reset the power module</td>
</tr>
<tr>
<td>OR Enter</td>
<td>OUTP ON</td>
<td>Enable the output</td>
</tr>
<tr>
<td>GS 66102 Enter</td>
<td>CAL:STAT 1,66102</td>
<td>Using your password, enable the calibration mode</td>
</tr>
<tr>
<td>G V M Enter</td>
<td>CAL:VOLT:LEV MIN</td>
<td>Select the lower calibration point</td>
</tr>
<tr>
<td>G V M Enter</td>
<td>CAL: VOLT: DATA &lt;NRf&gt;</td>
<td>Enter the digital voltmeter reading</td>
</tr>
<tr>
<td>G V M Enter</td>
<td>CAL:VOLT:LEV MAX</td>
<td>Select the upper calibration point</td>
</tr>
<tr>
<td>G V M Enter</td>
<td>CAL:VOLT:DATA &lt;NRf&gt;</td>
<td>Enter the digital voltmeter reading</td>
</tr>
</tbody>
</table>

Note: The following step overwrites the existing voltage calibration constants stored in nonvolatile memory.

<table>
<thead>
<tr>
<th>Controller Entry</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS Enter</td>
<td>CAL:SAV</td>
</tr>
</tbody>
</table>

Overvoltage Protection Calibration

If the optional output relay is installed, either disconnect it or set it to the OFF (open) state.

<table>
<thead>
<tr>
<th>Controller Entry</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>G V P Enter</td>
<td>CAL:VOLT:PROT</td>
</tr>
</tbody>
</table>

Note: It takes a few seconds for the power module to make the measurement. When completed, the new constant is automatically stored in nonvolatile memory.

† See Figure A-2 for program listing.
‡ Enter the voltage measured by the external digital multimeter.
Calibrating Current

The following procedure calibrates the output current. During the calibration, you will make two voltage measurements across the output shunt and enter the computed current.

**Table A-3. Current Calibration Procedure**

<table>
<thead>
<tr>
<th>Keyboard Entry</th>
<th>Controller Entry †</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q 0</strong> Enter</td>
<td>OUTP OFF</td>
<td>Disable the output</td>
</tr>
<tr>
<td></td>
<td>Connect the equipment as shown in Figure A-1b. (Before proceeding, set the module output, via the keyboard or the GPIB, for 1.0 V at 0.5 A.)</td>
<td></td>
</tr>
<tr>
<td><strong>Q 1</strong> Enter</td>
<td>OUTP ON</td>
<td>Enable the output</td>
</tr>
<tr>
<td><strong>G S H H 66102</strong> Enter</td>
<td>CAL:STAT 1,66102</td>
<td>Using your password, enable the calibration mode</td>
</tr>
<tr>
<td><strong>G G L M</strong> Enter</td>
<td>CAL:CURR:LEV MIN</td>
<td>Select the lower calibration point</td>
</tr>
</tbody>
</table>

Wait for the meter reading to stabilize. Then read the meter and enter the calculated current value.‡

| **G G H H H H** Enter | CAL: CURR:DATA < NRf> | Enter lower current value                      |
| **G G L M** Enter    | CAL:CURR:LEV MAX     | Select the upper calibration point             |

Wait for the meter reading to stabilize. Then read the meter and enter the calculated current value.‡

| **G G H H H H** Enter | CAL: CURR: DATA < NRf> | Enter the upper current value                  |

Note: The following step overwrites the existing current calibration constants stored in nonvolatile memory.

| **G S** Enter       | CAL:SAV             | Save the new calibration constants             |

† See Figure A-2 for program listing.
‡ Calculate the current value as follows:

\[ I = \frac{V_R}{R} \]
Using The CAL:AUTO Command

Normal calibration procedures also calibrate the readback circuits that respond to the MEAS: CURR? and MEAS: VOLT? commands. During normal operation, the readback accuracy is affected by temperature changes within the power module. Use of the CAL:AUTO command reduces the temperature error component of the readback accuracy specification. See "Chapter 3 - Language Dictionary" of the Programming Guide for information about this command.

Recovering The Factory Calibration Constants

The original factory calibration constants are stored in EPROM and can be recovered. This may prove helpful in situations where miscalibration is suspected and it is not possible to recalibrate. To restore factory calibration, proceed as follows:

1. Remove the power module from the mainframe and set the calibration switches to the factory position (see Table 2-1 in "Chapter 2 - Installation").
2. Replace the power module and cycle the power (on and then off).
3. Remove the power module from the mainframe and restore the calibration switches to the normal position.
4. Replace the module in the mainframe.

The module now has its original factory calibration constants. However, password protection has been removed from the CAL:STAT ON command.

Recovering From A Lost Calibration Password

The standard factory password is the module model number (for example, 66102). If no one has changed the password, entering the model number will enable the calibration mode (for example, CAL:STAT ON,66102).

If the password is unknown, then the only alternative is to perform the procedure given under "Recovering the Factory Calibration Constants". This removes the password protection from the CAL: STAT ON command. However, it also changes the calibration constants to their original factory values.

Calibration Error Messages

If you enter calibration commands from the keyboard, it will display the error messages listed in Table A-4.

<table>
<thead>
<tr>
<th>Table A-4. Keyboard Calibration Error Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAL ERROR</td>
</tr>
<tr>
<td>DOES NOT CAL</td>
</tr>
<tr>
<td>PASSWD ERROR</td>
</tr>
<tr>
<td>WRONG MODE</td>
</tr>
</tbody>
</table>

Agilent Basic Calibration Program

The following program can be run on any controller operating under Agilent BASIC. The assumed slot address is 0 and calibration password is 66101. If required, change these parameters in the appropriate statements.
! VOLTAGE CALIBRATION PROGRAM

CONNECT INSTRUMENTS AS SHOWN IN FIGURE A-la

DIM Resp$[255], Err_msg$[255]

VOLT_cal:

Err_found=0

INPUT "CONNECT INSTRUMENTS AS SHOWN IN FIGURE A-la ... Press any key to continue." , Resp$

Resp$=""

ASSIGN @Ps TO 70500

OUTPUT @Ps;"*RST;OUTPUT ON" ! INITIALIZE POWER SUPPLY

OUTPUT @Ps;"VOLT MAX"

OUTPUT @Ps;"CURR MAX"

OUTPUT @Ps;"CAL:STATE ON, 66101" ! PASSWORD IS OPTIONAL - ONLY

INPUT "ENTER VOLTAGE MEASUREMENT FROM EXTERNAL VOLTMETER", Volt_read

OUTPUT @Ps;"CAL:VOLTAGE "; Volt_read

INPUT "ENTER VOLTAGE MEASUREMENT FROM EXTERNAL VOLTMETER", Volt_read

OUTPUT @Ps;"CAL:VOLTAGE:PROT" ! CALIBRATE OVERVOLTAGE PROTECTION

GOSUB Save_cal

IF Err_found THEN

INPUT "ERRORS have occurred, REPEAT VOLTAGE CALIBRATION (Y OR N)?", Resp$

IF TRIM$(UPC$(Resp$[l,l]))="Y" THEN GOTO Volt_cal

END IF

IF Err_found THEN

PRINT "VOLTAGE CALIBRATION NOT SAVED"

ELSE

PRINT "VOLTAGE CALIBRATION COMPLETE"

END

CURRENT CALIBRATION PROGRAM

CONNECT INSTRUMENTS AS SHOWN IN FIGURE A-lb

Current_cal:

Err_found=0

INPUT "CONNECT INSTRUMENTS AS SHOWN IN FIGURE A-lb ... Press any key to continue." , Resp$

Resp$=""

OUTPUT @Ps;"CAL:STATE ON, 66101" ! PASSWORD IS OPTIONAL - ONLY

OUTPUT @Ps;"CAL:STATE ON, 66101" ! REQUIRED IF SET TO NON-ZERO

! NOTE: DEFAULT = MODEL NUMBER

! REFER TO TABLE A-1 FOR CORRECT SHUNT VALUE FOR MODEL BEING CALIBRATED

Figure A-2. Agilent BASIC Calibration Program
40    Calibration

INPUT "ENTER VALUE OF CURRENT SHUNT BEING USED",Shunt_val
OUTPUT @Ps;"CAL:CURRENT:LEVEL MIN"
INPUT "ENTER VOLTAGE MEASUREMENT FROM EXTERNAL VOLTMETER",Volt_read
Current=Volt_read/Shunt_val
OUTPUT @Ps;"CAL:CURRENT ";Current
OUTPUT @Ps;"CAL:CURRENT:LEVEL MAX"
INPUT "ENTER VOLTAGE MEASUREMENT FROM EXTERNAL VOLTMETER",Volt_read
Current=Volt_read/Shunt_val
OUTPUT @Ps;"CAL:CURRENT ";Current
GOSUB Save_cal
IF Err_found THEN
    INPUT "ERRORS have occurred, REPEAT CURRENT CALIBRATION (Y OR N)?",Resp$
    IF TRIMS(UPC$(Resp$[1,1]))="Y" THEN GOTO Current_cal
    END IF
    IF Err_found THEN
        PRINT "CURRENT CALIBRATION NOT SAVED"
    ELSE
        PRINT "CURRENT CALIBRATION COMPLETE"
    END IF
    STOP
END
SAVE_CAL: ! SAVE CALIBRATION CONSTANTS
    REPEAT
        OUTPUT @Ps;"SYSTEM:ERROR?"
        ENTER @Ps;Err_num,Err_msg$
        IF Err_num<>0 THEN
            PRINT "ERROR: ";Err_msg$
            Err_found=1
        END IF
    UNTIL Err_num=0
    IF NOT Err_found THEN
        INPUT "SAVE CALIBRATION CONSTANTS (Y OR N)?",Resp$
        IF TRIMS(UPC$(Resp$[1,1]))="Y" THEN
            OUTPUT @Ps;"CAL:SAVE"
        END IF
    END IF
    END IF
    OUTPUT @Ps;"CAL:STATE 0"
RETURN
END

Figure A-2. Agilent BASIC Calibration Program (continued)
Using The Agilent 66001A MPS Keyboard

Introduction

This appendix describes the Agilent 66001A Modular Power System (MPS) Keyboard, which is available as an option for the Agilent 66000A Modular Power System.

The Agilent 66001A MPS Keyboard lets you program the Agilent 66000A Modular Power System without having to connect it to a computer. With the keyboard, you can:

- Access any module in the mainframe that the keyboard is plugged into.
- Display operating and status information from the selected module.
- Control the module from the fields that appear on the display.
- Program the module using SCPI commands and queries.
- Read error messages.

Connecting The Keyboard

The keyboard plugs into a jack on the front of the mainframe as indicated in the following figure. A keyboard jack is also available on the rear panel. The keyboard can be plugged in or out while the mainframe is on.

Note

Do not connect more than one keyboard to a mainframe.
Keyboard Description

This section briefly explains the various areas on the keyboard as indicated in the following figure:

<table>
<thead>
<tr>
<th>DISPLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Subaddress and Instrument**

The subaddress of the presently selected module appears on the left side of the display. The instrument field displays an instrument number when the module contains more than one instrument. Power supply modules do not use this field.

**Meter Area**

The predominant area of the display presents operating and status information about the selected module. This is referred to as the meter area of the display. Power supply modules display the output voltage and current as well as the operating mode in the meter area of the display. Refer to "Using the Display" for more information.

The meter area is also used to display the SCPI commands when the Command function is active. Use the meter area to construct the SCPI command and then send the command to the module.

**Annunciators**

Annunciators on the bottom of the display provide additional information on the operation of the presently selected module. Active annunciators can indicate:

- **Shift**
  - The Shift Lock key has been pressed.
- **Unr**
  - The module is unregulated.
- **Dis**
  - The module’s output is disabled.
- **Prot**
  - One of the protection features has been activated.
- **Err**
  - There is an error message in the SCPI error queue.
- **Cal**
  - Calibration mode is enabled.
- **Rmt**
  - The module is in remote mode (keyboard disabled).
- **Lsn**
  - The module is addressed to listen over the GPIB.
- **Tlk**
  - The module is addressed to talk over the GPIB.
- **SRQ**
  - The module has generated a service request.
## ② SYSTEM KEYS

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>This key switches from remote operation (over the GPIB) to local operation using the keyboard. Press Local when the Rmt annunciator is on to enable the keyboard.</td>
</tr>
<tr>
<td>Subaddr</td>
<td>This key moves the cursor to the subaddress field so you can select another module. Use the Entry or Select keys to enter another subaddress.</td>
</tr>
</tbody>
</table>

## ③ FUNCTION KEYS

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter</td>
<td>This function continuously displays operating information about the selected module. The Meter function is the turn-on default function, and is also in effect whenever the mainframe is in remote mode.</td>
</tr>
<tr>
<td>Command</td>
<td>This function lets you send a SCPI command or query to the selected module. Use the letter keys or the Select keys to select the SCPI command. Refer to the power module Programming Guide for a complete description of the SCPI commands. Refer to the end of this appendix for the SCPI command tree used by the keyboard.</td>
</tr>
<tr>
<td>Status</td>
<td>This function displays status information about the following QUEStionable and CONDition status register bits: CV, CC, OV, OC, RT, WTG, and DWE. Refer to the power module Programming Guide for a complete description of the QUEStionable and CONDition status registers.</td>
</tr>
<tr>
<td>Error</td>
<td>This function displays the error messages whenever the Err annunciator on the display indicates that an error has occurred.</td>
</tr>
<tr>
<td>Meter Config</td>
<td>This function lets you format the meter area of the display. Power supply modules do not use additional meter formats.</td>
</tr>
<tr>
<td>Command All</td>
<td>This function lets you send the next command entered from the keypad to all the modules in the mainframe. The subaddress field on the display indicates &quot;ALL&quot; when this function is active. You must press Command All each time you want to send a command to all modules.</td>
</tr>
<tr>
<td>Prot Clear</td>
<td>This function clears any latched protection features that have tripped.</td>
</tr>
</tbody>
</table>

## ④ SELECT KEYS

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>When the Meter function is active, these keys let you move across the display so that you can enter or change values in the selected fields. When the Command function is active, these keys let you move across the various levels of the command tree structure. Numeric command parameters default either to zero or the last programmed value.</td>
</tr>
<tr>
<td>Up/Down</td>
<td>When the Meter function is active, these keys let you increment and decrement the numeric values in the selected field. When the Command function is active, these keys let you scroll up and down through the choices at each level of the command tree.</td>
</tr>
<tr>
<td>Recall Command</td>
<td>This key lets you recall up to five previous commands that were sent. You can edit any recalled command. Press Enter to send the command.</td>
</tr>
<tr>
<td>ESC</td>
<td>This key exits any action and returns the display to the Meter function. If the Command function is active, the displayed command is not executed (same as Meter ).</td>
</tr>
</tbody>
</table>
### ENTRY KEYS

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 through 9</td>
<td>These keys let you enter numeric values. Values can be entered directly. If the Meter function is active, the display automatically switches to the Command function with the appropriate command for programming the metered mode on the display.</td>
</tr>
<tr>
<td>.</td>
<td>This key enters the decimal point.</td>
</tr>
<tr>
<td>,</td>
<td>This key is used to separate multiple command arguments such as those used with a List command.</td>
</tr>
<tr>
<td>▲ Value ▼ Value</td>
<td>These keys let you increment and decrement the numeric values in the selected field when the Meter function is active. Note that numeric values change in larger steps the longer these keys are held down. When the Command function is active, these keys let you increment and decrement numeric command parameters.</td>
</tr>
<tr>
<td>+ –</td>
<td>These keys let you assign a polarity to a value that is entered with the numeric Entry keys. You must enter the polarity before you enter the number.</td>
</tr>
<tr>
<td>E</td>
<td>This key lets you enter the exponent of a value that is entered with the numeric Entry keys. Enter the exponent after you enter the number.</td>
</tr>
<tr>
<td>–</td>
<td>This key backspaces over and deletes individual digits in a numeric entry field (same as Back Space).</td>
</tr>
<tr>
<td>Clear Entry Enter</td>
<td>This key clears the entire numeric entry field. This key executes a command.</td>
</tr>
</tbody>
</table>

### LETTER KEYS

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A through Z</td>
<td>These keys let you select SCPI commands when the Command function is active. Letter keys select the choices that begin with the letter that is pressed and move across the command tree when additional selections are available. Shift ed letters make selections by scrolling through the choices at the present command level that start with the shifted letter.</td>
</tr>
<tr>
<td>8</td>
<td>This key is the prompt for the SCPI instrument commands.</td>
</tr>
<tr>
<td>9</td>
<td>This key is the prompt for the GPIB commands (IEEE-488.2).</td>
</tr>
<tr>
<td>?</td>
<td>This key is the prompt for SCPI queries. Append the prompt to the query. The result of the query appears on the display after it is entered.</td>
</tr>
<tr>
<td>Shift</td>
<td>This key accesses the shifted key functions. The Shift annunciator on the display indicates that the key was depressed. The annunciator turns off when the next key is pressed.</td>
</tr>
<tr>
<td>Shift Lock</td>
<td>This key locks the shift key functions. The Shift annunciator on the display indicates when the shift functions are locked.</td>
</tr>
<tr>
<td>Back Space</td>
<td>This key backspaces over and deletes individual digits in a numeric entry field (same as ).</td>
</tr>
<tr>
<td>Enter</td>
<td>This key executes a command.</td>
</tr>
</tbody>
</table>
Using The Display

Changing or Entering Values

The following figure is an example of the keyboard display when a power module is addressed and the Meter function is active:

![Keyboard Display Example]

The keyboard continuously displays measured voltage and current. The blinking cursor initially highlights the voltage field, which indicates that the value in that field can be changed using the numeric Entry keys. You can also use the ← and → keys to move the cursor across the display to select other fields that you want to change.

Press ▲ Value repeatedly to increment the voltage value.

![Value Increment]

You can also use the numeric Entry keys to enter a new value directly into the field. The display will switch to the Command function when the numeric Entry keys are used. Enter the new value next to the SCPI command, and execute the command with the Enter key.

![Display Command]

Displaying Status

Use the Status key to view the present state of the following status bits of the addressed module: CV, CC, OV, OC, OT, RT, WTG, and DWE. A Status mnemonic appears on the display only if the corresponding bit has been set in the status registers. In the following example, the display indicates that the module is in constant voltage (CV) mode and is waiting (WTG) for a trigger input.

![Status Display]

The status response remains on the display until you press another key to do something else, or until the module goes into remote mode. Press ESC or Meter to return to the meter function.
Sending SCPI Commands

As described in the power module *Programming Guide*, SCPI commands are organized into message units. The keyboard can only send one message unit at a time; you cannot combine message units. Also, optional headers within a command do not appear on the display. There are two ways to construct message units using the keyboard:

- locate and append each SCPI header to the message unit with the Select keys, or
- directly construct the message using only the first letter of each header with the letter keys.

The figure at the end of this appendix shows the SCPI command tree structure that is used by the keyboard. When the command function is selected with the (Command) key, the VOLTage command appears on the display for power supply modules.

The Select keys let you move up and down as well as across the various levels of the command tree. When numeric parameters are accessed with the Select keys, the value either defaults to zero or the last programmed value.

Letter keys let you directly access headers by typing the first letter of the header. Letter keys select headers by moving across the levels of the command tree. If more than one header starts with the same letter at a specific level in the command tree, the first choice in that level is selected. Use the (or ) key to select the command you want to use. You can also use the (Shift) ed letters to scroll through the available choices at the present command level that start with the shifted letter.

Command Example

The following examples show how to use the Select keys or the letter keys to construct and send commands to the addressed module. In this example, the voltage protection level of a power supply module is being set to 7 volts.

```
Command
02 -- :

Subaddr Instr
02 -- :VOLTage

Subaddr Instr
02 -- :VOLT 0.0E+0

Subaddr Instr
02 -- :VOLT MAX

Subaddr Instr
02 -- :VOLT MIN
```
Using the letter keys to directly access and send commands is much faster than using the Select keys to find and then send commands. Of course, this method is faster only if you know which commands you are going to program. The following sequence shows the same example using the letter keys:

**Query Example**

Queries return data from the addressed module. Use the Select keys or the letter keys to construct and send queries to the addressed module in the same way that you send commands. When you enter the query, the display returns a value. In the following example, the power module is queried as to its actual voltage output:
The query response remains on the display until you press another key to do something else, or until the module goes into remote mode. Press \texttt{ESC} or \texttt{Meter} to return to the meter function.

To query the programmed setting of any command parameter, use the cursor control keys to access the parameter field of the command. The value that appears is the last programmed value. In the following example, the module is queried as to its voltage protection setting:

![Subaddr Instr](image)

You can now change the voltage protection level or press \texttt{ESC} or \texttt{Meter} to return to the meter function.

\textbf{Note} If a SCPI command has a corresponding query, you can also add the \texttt{?} after the command to turn the command into a query. If a command does not have a corresponding query, the \texttt{?} key is ignored.

\textbf{Error Example}

If you make an error when you are constructing a command, the display will inform you that an error has occurred when you enter the command. The following message is an example of an error that has occurred because the data entered for a parameter was out of the range of the power module.

![Subaddr Instr](image)

Either press \texttt{Recall Command} to recall and edit the command that caused the error or press \texttt{ESC} or \texttt{Meter} to clear the message and return to the meter function.

With the keyboard, you can also read back any system error that has occurred when the module is operating in remote mode. The \texttt{Err} annunciator on the display indicates that there is an error in the SCPI error queue. If the module is in remote mode, you must first press \texttt{Local} to get out of remote mode. The following example shows how to read error messages when the module is in remote mode:
If the **Err** annunciator is still on after the error message is displayed, it means there are additional error messages in the SCPI error queue. Press **Error** to display the other messages. Each time you press the **Error** key it removes one error from the error queue.

### SCPI Command Tree

The following figure illustrates the SCPI command tree used by the keyboard.
**GPB COMMANDS**

- *CLS*  
- *OPC*  
- *RST*  
- *TRG*  
- *ESE (NRF)*  
- *OFT*  
- *SAV (NRF)*  
- *TST?*  
- *ESE (NRF)*  
- *PSC 01*  
- *SRE (NRF)*  
- *WAI*  
- *IDN?*  
- *RCL (NRF)*  
- *STB?*

**SCPI COMMAND TREE**

FOR Agilent SERIES 661xxx A MODULES

**:ABOR**

- **:CALibrate**
  - **:AUTO 0 || ONCE | OFF | ON**
  - **:CURRent <NRF>**
  - **:PASScode <NRF>**
  - **:SAVE**
  - **:STATe OFF | ON, [<NRF>]**
  - **:VOLTage <NRF>**
    - **:LEVel [MIN | MAX]**
    - **:PROtection**
  - **:CURRent <NRF> [MIN | MAX]**
    - **:MODE FIX | LIST**
    - **:STATe OFF | ON**
    - **:TRIGgered <NRF> [MIN | MAX]**

- **:DISPlay**
  - **:STATe OFF | ON**

- **:INITiate**
  - **:CONTinuous OFF | ON**

- **:LIST**
  - **:COUNt <NRF> [MIN | MIN | MAX]**
  - **:CURRent <NRF> [MIN | MAX | MIN]**
  - **:POInts?**
  - **:DWEEl <NRF> [MIN | MAX]**
  - **:STEP AUTO | ONCE**
  - **:VOLTage <NRF> [MAX | MIN]**
    - **:POInts?**

- **:MEASure**
  - **:CURRent <NRF> [MAX | MIN]**
  - **:VOLTage <NRF> [MAX | MIN]**

**:SYSTem**

- **:ERRor?**
  - **:VERSion?**

- **:TRIGger**
  - **:DLay <NRF> [MAX | MIN]**
  - **:LINK [‘link parameter’]**
  - **:SOURCE [LINK]**
  - **:PROTection**
    - **:CLEAR**
    - **:RElay OFF | ON**
    - **:POLarity NORM | REV**
    - **:TTLTrig OFF | ON**
  - **:STATus**
    - **:OPeration?**
    - **:CONDITION?**
    - **:ENABLE <NRF>**
    - **:NTRanion <NRF>**
    - **:PTRanion <NRF>**
  - **:PRESet**
    - **:QUESTIONable?**
    - **:CONDITION?**
    - **:ENABLE <NRF>**
    - **:NTRanion <NRF>**
    - **:PTRanion <NRF>**
  - **:TRIGgered <NRF> [MIN | MAX]**

NRF = permissible number format (see Modules Programming Guide)
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Technical data is subject to change.
Manual Updates

The following updates have been made to this manual since the print revision indicated on the title page.

4/15/00

All references to HP have been changed to Agilent.
All references to HP-IB have been changed to GPIB.