California Instruments

**Revision C**
**October** 2000

**P/N 4601-960**

# 804BL Series
# Programmable Load
# User Manual

User Manual
Programmable Load
California Instruments
Models :

- 804LB with 1 – 4 load modules

# SAFETY SUMMARY

**This Programmable Load contains high voltage and current circuits which are potentially lethal. Because of its size and weight, mechanical stability must be ensured. The following safety guidelines must be followed when operating or servicing this equipment. These guidelines are not a substitute for vigilance and common sense. California Instruments assumes no liability for the customer's failure to comply with these requirements. If the power source is used in a manner not specified by California Instruments, the protection provided by the equipment may be impaired.**

**BEFORE APPLYING POWER**

1. Verify the correct voltage is applied to the unit (for example 240V).

2. The chassis and cabinet of this power source must be grounded to minimize shock hazard. A chassis ground is provided at the input terminal block. This is located at the back of the cabinet on the lower right hand side. The chassis ground must be connected to an electrical ground through an insulated wire of sufficient gauge.

**FUSES**

Use only fuses of the specified current, voltage, and protection speed (slow blow, normal blow, fast blow) rating. Do not short out the fuse holder or use a repaired fuse.

**DO NOT OPERATE IN A VOLATILE ATMOSPHERE**

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

**DO NOT TOUCH ENERGIZED CIRCUITS**

Disconnect the power cable before servicing this equipment. Even with the power cable disconnected, high voltage can still exist on some circuits. Discharge these voltages before servicing. Only qualified service personnel may remove covers, replace components or make adjustments.

**DO NOT SERVICE ALONE**

Do not remove covers, replace components, or make adjustments unless another person, who can administer first aid, is present.

**DO NOT EXCEED INPUT RATINGS OR OPERATE LOAD MODULES AT EXCESSIVE TEMPERATURES**

Do not exceed the rated input voltage or frequency. Additional hazards may be introduced because of component failure or improper operation.

**DO NOT MODIFY INSTRUMENT OR SUBSTITUTE PARTS**

Do not modify this instrument or substitute parts. Additional hazards may be introduced because of component failure or improper operation.

**MOVING THE PROGRAMMABLE LOAD**

When moving the programmable load, remove all AC power to the unit prior to moving it.

SAFETY SYMBOLS:


THIS SYMBOL INDICATES DIRECT CURRENT


THIS SYMBOL INDICATES ALTERNATING CURRENT


THIS SYMBOL INDICATES BOTH DIRECT AND ALTERNATING CURRENT


THIS SYMBOL INDICATES THREE—PHASE ALTERNATING CURRENT


THIS SYMBOL INDICATES EARTH (GROUND) TERMINAL


THIS SYMBOL INDICATES PROTECTIVE CONDUCTOR TERMINAL


THIS SYMBOL INDICATES FRAME OR CHASSIS TERMINAL


THIS SYMBOL INDICATES ON (SUPPLY)


THIS SYMBOL INDICATES OFF (SUPPLY)


THIS SYMBOL INDICATES CAUTION, RISK OF ELECTRIC SHOCK


THIS SYMBOL INDICATES CAUTION (REFER TO ACCOMPANYING DOCUMENTS)

# ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are fuses and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

# PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA number to shipping label. Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No. or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS 9689 Towne Centre Drive San Diego, CA 92121. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

# DAMAGE IN TRANSIT

The instrument should be tested when it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

# © 2000 COPYRIGHT

# Table of Contents

## List of Figures



## List of Tables

# 1. Introduction

This instruction manual contains information on the installation, operation, calibration and maintenance of the 804BL Programmable Load.

The Model 804BL Programmable Load is designed to provide a precisely controlled load, either via the front panel or computer interface, for lighting ballast parametric testing, ballast burn-in, and other evaluation and test applications. Using the 804BL, the user can simulate most fluorescent lamps, including 3 different filament types, and lamps nearing the end of their life. The 804BL also allows the ballast developer to simulate worst case conditions, similar to those encountered in the field. The Model 804BL offers more flexibility than the big assortment of resistive loads which is required to test the large variety of magnetic and electronic ballasts.

*Figure 1-1: Model 804BL Programmable Load*

## 1.1 General Description

The 804BL is a flexible Programmable Load permitting precise computer control of up to four load modules. Maximum dissipated power is 200 Watt per 804BL unit, (50 Watt per module). The user can program the load level for each module independently to simulate various lamp types, such as 32 W, 40 Watt, etc. Also, the user can program various filament resistor values, or short circuit these for instant start type lamp simulation. Multiple load modules therefore can be utilized for testing two and four lamp ballast units. An external trigger mode allows the unit to emulate lamp start-up behavior for programmed start ballasts.

Three different capacitor values, or no parallel capacitance may be selected by the user to simulate lamp capacitance. The user may control the 804BL via either the RS-232 serial port, or via the IEEE-488 port. The Programmable Load's internal calibration functions allow the user to verify system performance and accuracy with a NIST traceable DVM. This capability makes it easy for the user to maintain a ballast production test system per ISO-9000 requirements.

## 1.2 Available Functions

To test lighting ballasts under a variety of load conditions, the Model 804BL Programmable Load offers the following functions:

- Open circuit voltage test simulating “no lamp present”
- Filament resistance present, but lamp not conducting current
- Normal lamp operation, with filaments and lamp impedance within normal tolerance
- Filament values out of tolerance or open
- End-of-life lamp condition with unbalanced current flow through the lamp
- High parallel/parasitic wiring capacitance in the circuit

These capabilities combine to make the Model 804BL a flexible system, replacing actual lamps or the large assortment of resistive loads and control relays for ballast testing.

## 1.3 External Trigger

The 804BL can be pre-programmed from the front panel or by computer, to go to a predefined load and filament value upon an external trigger signal. This feature can be used to emulate the lamp start-up behavior as required in programmed start ballast testing.

## 1.4 High Resolution Accurate Load Settings

The Model 804BL Programmable Load supports high accuracy control of load resistance over a wide operating range. Resistance values can be set with a resolution of approximately 1.5 Ω in the range from 40 – 3200 Ω. Through its internal calibration data, the 804BL selects the value that is closest to the programmed value, and reads the resistance back to the user. This actual resistance is displayed via the front panel, and is also available via the computer interface. The actual load value is typically within 0.5 – 1.5 Ohms of the desired value, i.e. allows the user to control “lamp impedance” within a fraction of a percent.

## 1.5 Easy Front Panel Operation

A large back lit LCD display supports the menu driven front panel operation of the Model 804BL Programmable Load. A rotating knob permits the user to vary load values of individual modules, or all modules simultaneously. This allows load values to be set up quickly without the need for a computer or programming. For many ballast development tasks, front panel operation is all that is needed to test products in their design stage.

The large LCD display also supports display of all selected load, filament, and parallel capacitance parameters. The use of plain English menu's and a large rotary knob for setting parameters quickly, make the 804BL ideal for bench top use.

## 1.6 Easy Programming for Production Test

The use of industry standards such as IEEE-488.2, RS232C, and the SCPI command protocol greatly facilitate integration of the 804BL with new or existing ballast test systems. Programmers can be up and running in little time using familiar Standard Commands for Programmable Instruments (SCPI) syntax and/or instrument driver software panels.

# 2. Specifications

All specifications are for a single 804BL chassis and 23° ± 5° C.

## 2.1 System and Load Module Specifications

| | |
|---|---|
| **System** | |
| Modules | 1 through 4 |
| Inputs | Rear panel screw terminals |
| **Lamp Load** | |
| Range | 40 Ohms to 3200 Ohms |
| Resolution | < 1 Ohm typical, 2 Ohm max. |
| Accuracy | ± 0.5 % of setting ± 1 Ohm |
| Power Factor | 1.00 to 0.90, lagging in four discrete steps |
| Power dissipation (220 to 3200 ohms) | 100 Watt max. continuous per load, 150 Watt max short term (20 sec) peak load. 400 Watt max. continuous, 600 Watt max short term (20 sec) peak per chassis. |
| Maximum voltage | 1500 Vpeak, 1000 V rms into open circuit.<br>3500V rms, into programmed resistance. |
| Maximum Load Current | 0.8A rms (excludes Short Circuit mode) - 2 Amp slow-blow fuse protection |
| Frequency range | DC – 100 kHz |
| Output control | Relay controlled On/Off (open circuit), dual pole |
| Coupling | DC coupled |
| **Dimming Resistor** | |
| Purpose | Inserts a high resistance in series with the load to support dimming ballasts. |
| Fixed Resistor | Switchable fixed resistor 10K Ohm. |
| **Filament Load** | |
| Range | 2 sets of filament circuits, each having 3 fixed values. Nominal values set to popular lamp type filament resistors. Selectable via front panel and over the bus using relays.<br>Each set has bypass relays to allow switching between rapid start and instant start modes. |
| Power dissipation | 5 Watt Max. per resistor. |
| Maximum voltage | 20 V rms differential, 1500 V peak chassis to ground |
| Output control | Relay controlled Open or Closed |
| Coupling | Direct coupled |

| | |
|---|---|
| **End Of Life Detect** | |
| Purpose | Supports testing of lamp end-of-life detection by ballast. At the lamps end of life, one or the other phase current will be reduced. A diode / 20 K Ohm resistor network with a bypass relay is used to implement this function. |
| Modes | EOL or Bypass |
| Implementation | Half wave rectifier in series with load. |
| **Line Input** | |
| Voltage | 120 or 230 V, selectable |
| Current | Max. 1 amp, fused. |
| Line cord | Standard IEC connector |
| **Mechanical** | |
| Chassis Width | 17.75” / 450 mm |
| Chassis Height | 7.5" including feet; 7" w/o feet / 190 mm including feet; 178 w/o feet |
| Chassis Depth | 19.25” / 489 mm |
| Weight Net | 27.25 lbs / 12.4 kg |
| Weight Shipping | 40 lbs / 18 kg |

### 2.1.1 Included With Each 804BL Series System

- Instruction / Programming Manual.
- Sample control programs for use in conjunction with the BTS.
- RS232C Serial Cable, 9 pin to 9 pin.
- US line cord or "pig-tail" line cord.

### 2.1.2 Factory Installed Options:

-RMK Rack mount kit required to mount 804BL in an instrument rack.

## 2.2 Front Panel Controls

| | |
|---|---|
| **Controls:** | |
| Shuttle knob: | Allows continuous change of all values including load settings, filaments, lamp PF, and load On/Off. |
| Decimal keypad: | A conventional decimal keypad facilitates quick entry of numerical values such resistance values. The large blue enter key will make the value you enter effective. Using the SET key allows the user to preset all parameter values and update them all at once by pressing the Enter key. |
| Up/down arrow keys: | A set of up and down arrow keys is used to move the cursor position in all menus. This allows quick selection of the desired function or parameter. |
| Function keys: | Program key will show all program parameters. Input on/off key for load On/Off state control. Phase key will switch display to show settings for each of up to four load modules. Menu key will give access to instrument set-up and interface settings |
| **Displays:** | |
| LCD graphics display: | A large high contrast LCD display with back light provides easy to read guidance through all setup operations. An adjustable viewing angle makes it easy to read from all practical locations. |

## 2.3 Connectors

| | |
|---|---|
| Line input: | IEC fused Input |
| Load Power and Filament Input | Board mount compression type connectors |
| Interfaces: | 24 pin IEEE-488<br>9 pin RS232C<br>TTL trigger input |

## 2.4 Dimensions, Weight, Environmental

| | |
|---|---|
| Height: | 7.5" including feet; 7" w/o feet / 190 mm including feet; 178 w/o feet |
| Width: | 17.75" / 450 mm |
| Depth: | 19.25" / 489 mm |
| Weight: | Net: 27.25 lbs / 12.4 kg<br>Shipping: 40 lbs / 18 kg |
| Vibration and Shock: | Designed to meet NSTA project 1A transportation levels |
| Cooling: | Forced air cooling, front air intake, rear exhaust. |
| Operating Humidity: | 0 to 95 % RH, non condensing |
| Operating Temperature: | 0-39° Celsius, max 200 W<br>40-50° Celsius, max 160 W |
| Storage Temperature: | -20 to + 85 ° Celsius |

# 3. Unpacking and Installation

## 3.1 Unpacking

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. ***DO NOT*** return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment. See section 6.3 for information on service returns.

## 3.2 Power Requirements

The 804BL Programmable Load has been designed to operate from a single-phase 115 or 230 volt AC line. If 230 V AC line is present, the 230 setting must be selected on the rear panel.

***CAUTION: Verify that the 804BL Line Input selector is set for the appropriate voltage, either 115 or 230 V AC line. Operating the system from the wrong line voltage could result in a severely damaged unit.***

## 3.3 Mechanical Installation

The 804BL is a completely self contained programmable Load. It may be used free standing on a bench top or rack mounted. The 804BL programmable Load is fan cooled, drawing air in from the front and exhausting at the rear. The front of the unit must be kept clear of obstruction and a 6" clearance must be maintained to the rear. Special consideration of overall air flow characteristics and the resultant internal heat rise must be allowed for with systems installed inside enclosed cabinets to avoid self heating and over temperature problems, especially for higher power, multi-load module configurations.

For rack mount applications, the end-user must provide a means to support the unit in the instrument rack. The feet at the bottom of the unit may need to be removed for rack mount installation. They are intended for bench top use only.

## 3.4 AC Line Input Wiring

The AC line input IEC connector is located at the back of the unit. A standard equipment power cord must be used to connect the Programmable Load to line power. The mains connection must have a current rating equal to or greater than the input fuse and the input wiring must be sized to satisfy the applicable electrical codes. The AC line input fuse is located at the rear panel of the unit. A standard US line cord and a universal “pig-tail' line cord which can accept a country specific AC plug are included with each unit.

*Figure 3-1: Rear Panel View of the 804BL*

## 3.5 Load Module Input Connections

The pin designation below applies for each individual load module. The connectors are located at the rear side of the module, and the module needs to be partially removed from the chassis to make the connections. Each module is kept in place with two thumb screws. The module can be unplugged after the thumb screws are loosened. The pin designation is printed on the PC board.

| Pin | Signal | Description |
|---|---|---|
| 1 | Load 1 | Load input |
| 2 | Load 1 sense | Load sense line |
| 3 | N/C | No Connection |
| 4 | Fil-1A | Filament 1 input |
| 5 | Fil-1B | Filament 1 input |
| 6 | N/C | No connection |
| 7 | Fil-2A | Filament 2 input |
| 8 | Fil-2B | Filament 2 input |

| Pin | Signal | Description |
|---|---|---|
| 9 | N/C | No connection |
| 10 | Load-2 | Load power input |
| 11 | Load sense | Load sense line |
| 12 | N/C | No connection |
| 13 | I-sense Hi | Current sense output – HF only |
| 14 | I-sense Lo | Current sense output – HF only |
| 15 | Trig - Hi | Trigger input High |
| 16 | Trig - Lo | Trigger input common |

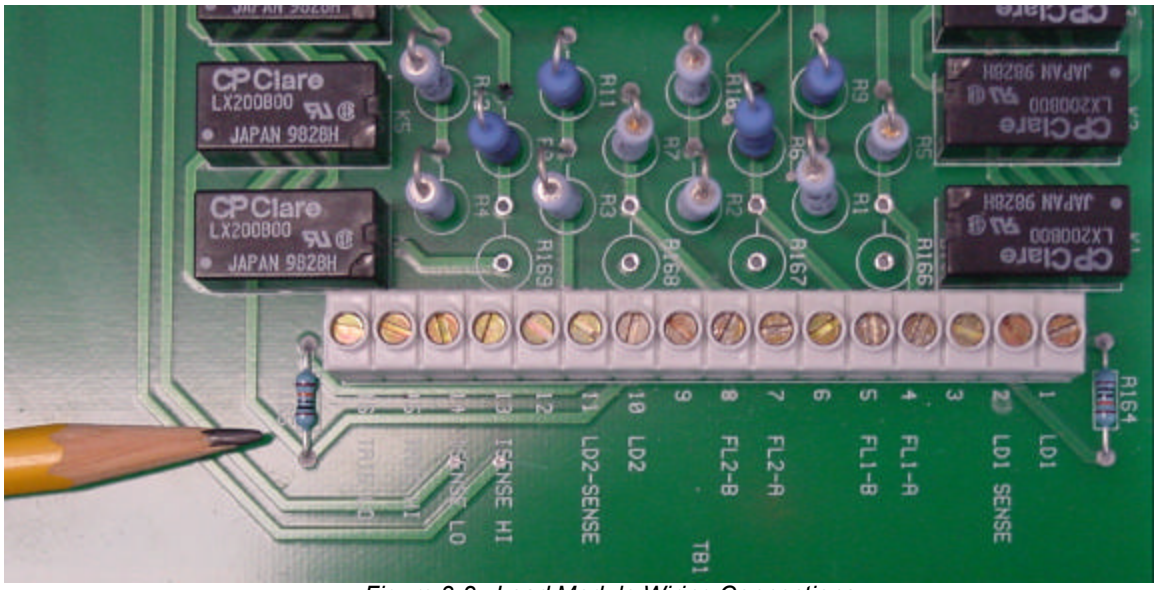
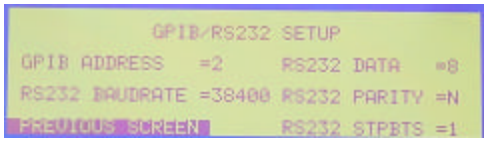



*Figure 3-2: Load Module Wiring Connections*

## 3.6 Unit Address Settings

The 804BL Programmable Load can be controlled via a computer using either the RS-232 interface or via the GPIB. The GPIB address can be selected via the front panel menu. Also, the RS-232 interface settings can be configured via the front panel.




### 3.6.1 External Trigger Input

Individual modules can be controlled/stepped to the next configuration via external trigger inputs. Each module has its own trigger lines, as shown in the connector configuration table in the

previous section - Load Module Input Connections. The trigger lines of multiple modules can be connected in parallel to one common trigger source.

# 4. Front Panel Operation

## 4.1 Tour of the Front Panel

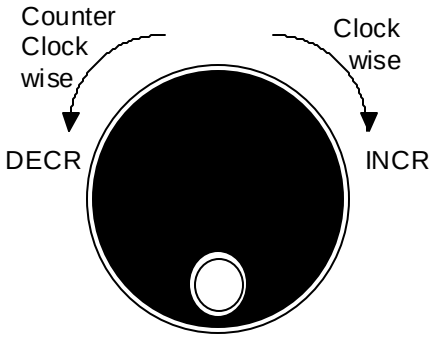
Before operating the Programmable Load using the front panel, it helps to understand the operation of the front panel controls. Specifically, the operation of the knob, keyboard and the menu layout are covered in the next few paragraphs.

### 4.1.1 Front Panel Controls and Indicators

The front panel can be divided in a small number of functional areas:

- Shuttle knob
- LCD display
- FUNCTION keypad
- DATA ENTRY keypad

### 4.1.2 The Shuttle Knob

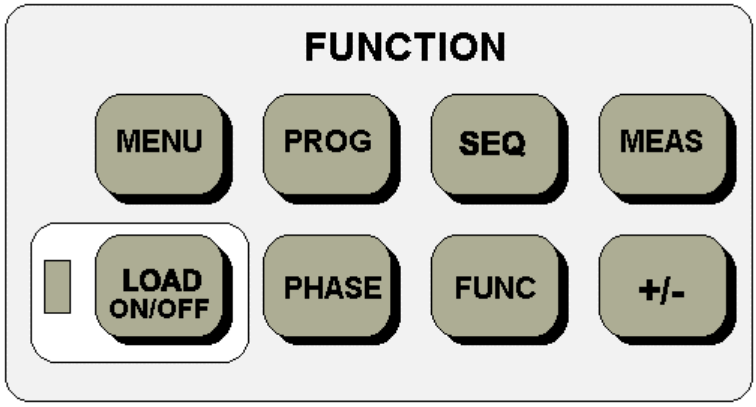



The shuttle knob is located to the right of the LCD screen and is used to change setup parameters. Note that it cannot be used to move the cursor position between menu fields. Use the UP and DOWN arrow keys in the FUNCTION keypad for this.

Changes made using the shuttle knob take effect immediately. There is no need to use the ENTER key when changing numeric value fields with the shuttle knob. When using the decimal keypad however, changes don't take effect until the ENTER key is pressed.

### 4.1.3 FUNCTION Keypad

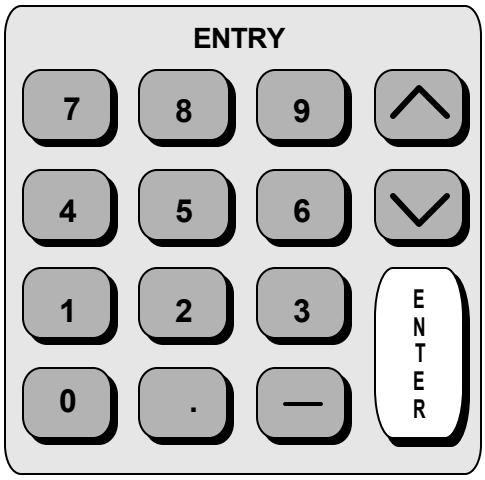
The function keypad provides access to all menus and measurement screens. The following keys are located in the FUNCTION keypad:




| KEY | DESCRIPTION |
|---|---|
| MENU | The top level menu is accessed by pressing the MENU key. Shortcut keys are used to provide direct access to the PROGRAM and load module setting screen as these are among the most frequently used screens. Thus, instead of going through the main menu to reach the PROGRAM, it can be accessed directly by pressing the PROG key respectively. A map of the Main menu is provided on the next few pages. There is only one top-level menu in the 804BL Programmable Load. |
| PROG | The PROG key is a shortcut to access the PROGRAM menu directly. The PROGRAM menu is the most frequently used menu. Thus, instead of going through the main menu to reach the PROGRAM menu, it can be accessed directly by pressing the PROG key. |
| LOAD ON/OFF | The LOAD ON/OFF key toggles the Programmable Load State for the selected modules on or off. The state of the Load is reflected by the green LED located directly to the left of the LOAD ON/OFF key. If the green LED is lit, the Load is enabled (closed) and the programmed value is active. If the green LED is off, the Programmable Load is open and presents a high impedance to the ballast. The ON/OFF button provides a convenient way to open the load without having to remove any wires. If the selected channel is ALL, the ON/OFF button applies to all modules. |
| PHASE | The PHASE key is used to select the load module (from 1 – 4) that is being controlled via the front panel. Pressing the PHASE key while “CHANNEL’ is highlighted will toggle from channel 1 – 2 – 3 – 4 - ALL. |
| +/- | The +/- key can be used to toggle the setting for those parameters that are controlled in steps, such as the filaments which can be toggled between Off-Low-Mid-High settings. |
| SEQ/MEAS/FUNC | The SEQ, MEAS and FUNC buttons are reserved for future use. |

### 4.1.4 DECIMAL KEYPAD

The decimal keypad may be used to enter any numeric parameter required in any of the menu fields. Several fields accept input from either the keypad or the knob. Data entered from the keypad is normally accepted once the ENTER key is pressed unless the front panel mode is in the SET mode. The following keys are available on the decimal keypad:




| | |
|---|---|
| CURSOR UP | The UP key moves the cursor position upwards one position to the previous available cursor position. If the present cursor position is at the top of the right hand column, the cursor is moved to the bottom position of the left hand column. If the present cursor is at the top of the left hand column, the cursor is moved to the bottom of the right hand column. |
| CURSOR DOWN | The DOWN key moves the cursor position downwards one position to the next available cursor position. If the present cursor position is at the bottom of the left hand column, the cursor is moved to the top position of the right hand column. If the present cursor is at the bottom of the right hand column, the cursor is moved to the top of the left hand column. |

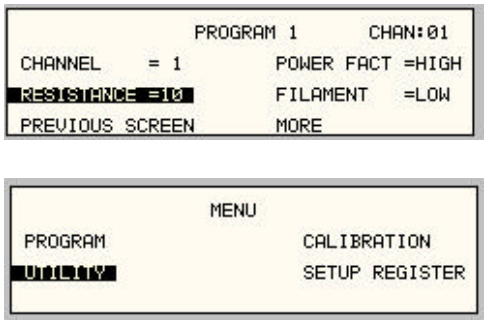
The decimal keypad can be used at any time in lieu of the shuttle knob to change output parameters. Direct data entry is often faster to effect large changes in values than using the shuttle knob.

| | |
|---|---|
| 0 through 9 | The numeric keys provide all decimal numbers for entry of parameters. |
| DECIMAL POINT | The decimal point key is used to enter fractional parts of values for fields that have a resolution less than 1. The amount of resolution for each menu field is normally visible on the LCD. If more digits are entered after the decimal point than can be accepted by a field, the value is automatically rounded to the available resolution when the ENTER key is pressed. |
| BACKSPACE | The BACKSPACE (←) key can be used to erase one digit at a time if you make a data entry error. |

### 4.1.5 LCD Display

The LCD display of the Programmable Load provides information on instrument settings and also guides the user through the various menus. To ease reading of the displayed information, most screens are widely spaced. A sample of the main menu screen that appears when the 804BL Programmable Load is powered up is shown below.

*Figure 4-1: Main System Menu and Main Load Module Menu*




Due to the amount of space available on each screen, some menus have been split into two screens. The MORE selection located at the bottom right hand side provides access to menu choices at the same level that did not fit on a single screen. Thus, to access PROGRAM 2, the cursor should be placed on the 'MORE' selection followed by pressing the 'ENTER' key. Alternatively, the PROGRAM key may be pressed to move to the PROGRAM 2 screen.

The present cursor position is always shown with an inverse bar. In the above example, the cursor is located on the UTILITY selection of the main menu screen. The cursor position can be moved by using the UP and DOWN keys located in the **DECIMAL** keypad.

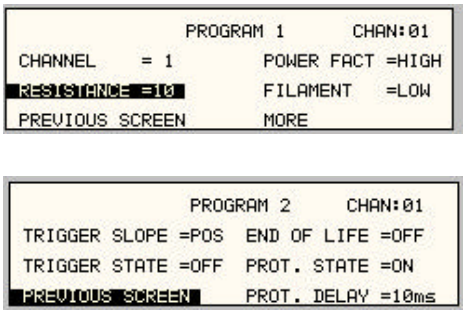
## 4.2 Menu Structure

The next few pages show a map of the available menus. There is one main menu (level 1) from which all other menus (level 2) can be reached. Frequently used (level 2) menus have a short cut key that provides direct access. An examples of this is the Program button. In any case, there are never more than three levels of menus, although some menus may be spread across more than one screen.

### 4.2.1 MAIN Menu

The top level menu gives access to the four (level 2) functional menus. Some of the menus are spread across two screens. The division of menu choices between the two screens is graphically illustrated in Figure 4-3 by the boxes in level 1. Each box represents one screen. The "Program 2" screens can be reached using the MORE entry of the "Program 1" screen. When in Program 2, the "Previous screen" choice allows the user to return to the previous screen.

*Figure 4-2: A Level 2 Menu That Requires Two Screens*




The following top level menu choices can be accessed from the MENU key:

| Entry | Description |
|---|---|
| | ***MENU 1*** |
| PROGRAM | The PROGRAM menu allows parameters for either ALL or any of the individual load modules to be changed. |
| UTILITY | The UTILITY menu provides access to GPIB and RS232 configuration as well as the initial set-up, overall system configuration and user defined limits. |
| SETUP REGISTERS | The SETUP REGISTERS menu allows complete instrument settings to be saved to nonvolatile memory. |
| CALIBRATION | The CALIBRATION selection provides access to a password protected calibration routine. Using an external DVM, the user can calibrate each of the load modules. |

### 4.2.2 Overview of Main Menu 1

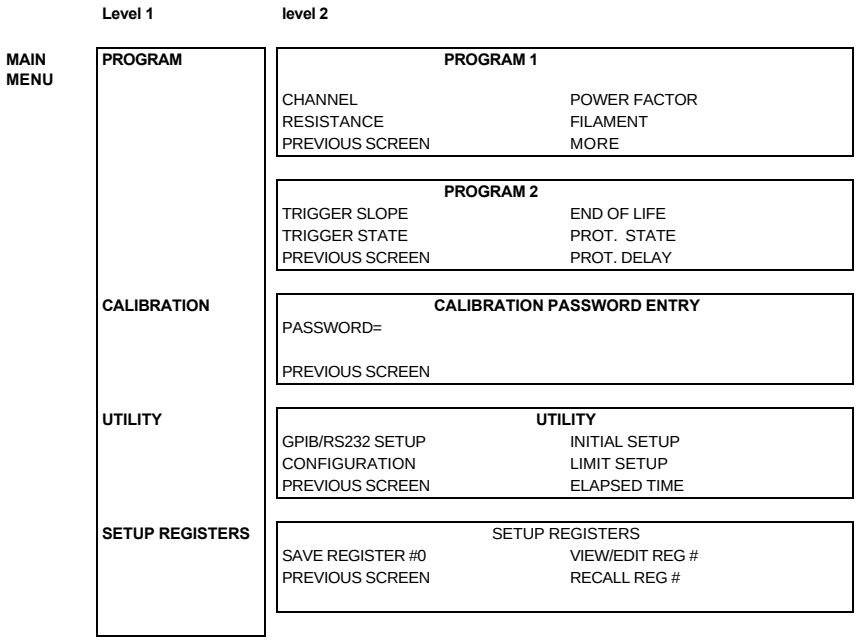


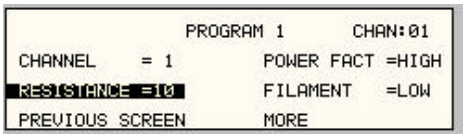

*Figure 4-3: Overview of Main Menu 1*

### 4.2.3 PROGRAM Menu

The PROGRAM 1 menu is shown in Figure 4-4. It can be reached in one of two ways:

1. By selecting the PROGRAM entry in the MENU screen and pressing the ENTER key
2. By pressing the PROG key in the FUNCTION keypad

*Figure 4-4: Program 1 Menu*



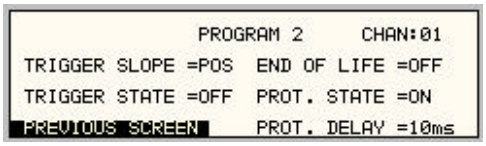

The PROGRAM menu is used to change load module parameters. The most commonly used setup parameters such as Channel, Resistance, and Filament are all located in screen 1 of the PROGRAM selection (PROGRAM 1 screen). Less frequently used parameters such as the TRIGGER and End-of-Life function are located in PROGRAM 2 which can be reached from the PROGRAM 1 screen using the MORE selection, or by pressing the PROGRAM key twice.

The PREVIOUS SCREEN entry, when selected, will return the user to the most recently selected menu. This is normally the MENU screen unless the PROGRAM menu was selected using the PROG key on the FUNCTION keypad. The following choices are available in the PROGRAM menus:

| Entry | Description |
|---|---|
| | ***PROGRAM 1*** |
| CHANNEL | Selects either ALL load modules or module 1,2,3, or 4. When the CHANNEL = ALL, the load resistor setting being entered applies to all modules. Also, the load On/Off button action applies either to ALL modules, or to the selected module. The selected module can be changed using the shuttle or the +/- key, or the PHASE key when the cursor is on this field. |
| RESISTANCE | The RESISTANCE setting determines the Load value in Ohms. The magnitude can be changed using the shuttle, or by entering the desired value via the keypad. The system will always set the actual load to the nearest available resistance, and read back the value in the display. When CHANNEL = ALL, the entered numerical value applies to all modules in the system. |
| PREVIOUS SCREEN | Moving the cursor to the PREVIOUS SCREEN field and pressing the Enter key reverts to the previous screen selected. |
| POWER FACT | Sets one of four power factor settings. These are, OFF i.e. the load is purely resistive, LOW (0.047 uF parallel to the resistance), MID (0.1 uF parallel to the resistance) or HI (0.147 uF parallel to the load resistance). The Power Factor setting can be changed with the shuttle, or the +/- key. |

| | |
|---|---|
| FILAMENT | Sets the Filament resistor value to one of four choices. These are OFF (Filaments open), LOW (filament resistor value of 3.2 Ohms) MID (Filament resistor value of 9.4 Ohms) or HI (filament resistor value of 11.2 Ohms). The value of this field can be changed with the shuttle or the +/- key. |
| MORE | Moving the cursor to the MORE field and pressing the Enter key selects the second PROGRAM 2 menu. The same can be accomplished by pressing the PROG key on the front panel. |

*Figure 4-5: Program 2 Menu*




***PROGRAM 2***

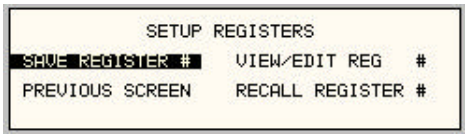
| Entry | Description |
|---|---|
| TRIGGER SLOPE | Toggles the trigger slope for either ALL or the selected module between POS(itive) and NEG(ative). After the user has defined the next state for one or all load modules, the module can be triggered by an external TTL compatible signal to go into this next state. This field determines whether the change will occur on the positive or negative transition of the trigger signal. The filed can be changed with the shuttle knob or the +/- key. |
| TRIGGER STATE | Toggles trigger mode capability for either ALL or the selected module ON or OFF. The mode must be ON in order for the module(s) to response to a trigger signal. This field can be changed with the shuttle knob or the +/- key. |
| PREVIOUS SCREEN | Moving the cursor to the PREVIOUS SCREEN field and pressing the Enter key reverts to the previous screen selected. |
| END OF LIFE | Toggles the End-of-Life circuitry in either ALL or the selected load module ON or OFF. When the End-of-Life circuitry is ON, a diode/resistor combination is inserted into the load circuit, causing asymmetrical current flow. This allows the system to verify EOL detection capability in the tested ballast. This field can be changed with the shuttle knob or the +/- key. |
| PROT. STATE | Toggles the protection mode ON/OFF. When ON, the controller is put into “sleep” mode before relays are switched. This is done to protect the controller from high level electrical pulses. This field can be changed with the shuttle knob or the +/- key. |
| PROT. DELAY | Sets the delay time between putting the controller into sleep mode, and activating relays . This field can be changed with the shuttle knob, or via numeric keypad entries. |

### 4.2.4 SETUP REGISTERS Menu

The SETUP REGISTERS menu allows the user to store and recall complete instrument setups. A total of 8 non volatile setup registers is available, numbered sequentially from 0 through 7.

The following entries can be found in the SETUP REGISTERS menu:

*Figure 4-6: Setup Register Menu*

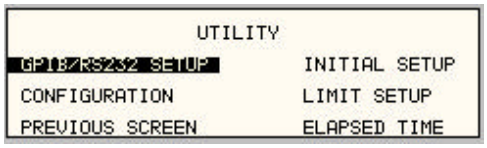



| Entry | Description |
|---|---|
| SAVE REGISTER | Save present instrument setup to a register number selected by the user. The numeric data entry keypad should be used to enter a number between 0 and 7. Once the ENTER key is pressed, all settings are saved. A message will appear at the bottom of the screen to confirm the save operation. |
| PREVIOUS SCREEN | Moving the cursor to the PREVIOUS SCREEN field and pressing the Enter key reverts to the previous screen selected. |
| VIEW/EDIT REGISTER | The View/Edit entry can be used to display the contents of a setup register before it is recalled. After the user enters a register number to view or edit and presses the ENTER key, the PROGRAM screen will appear. All parameters that will be changed by recalling the register will be blinking. If ENTER is pressed again, the register will be recalled and the new values take effect. To edit the register content, change all parameters that need to be changed. Pressing ENTER will save the new values and make them active. |
| RECALL REGISTER | Recall instrument setup from a register number selected by the user. The numeric data entry keypad should be used to enter a number between 0 and 7. Once the ENTER key is pressed, all settings are recalled. A message will appear at the bottom of the screen to confirm the recall operation. |

### 4.2.5 UTILITY Menus

The UTILITY menu provides access to less frequently used setup items. There is no connection between the various entries in the UTILITY menu other than there is no other logical place to put them. The following entries can be found in the UTILITY menu:

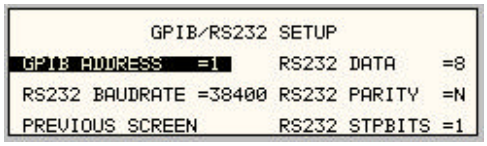
*Figure 4-7: Utility 1 Menu*




| Entry | Description |
|---|---|
| | ***UTILITY 1*** |
| GPIB/RS232 SETUP | This entry provides access to the setup parameters for either the IEEE-488 bus or the RS232C bus. All parameters are saved in non-volatile memory so their is rarely a need to change these values. |
| CONFIGURATION | This entry provides access to the overall configuration menu. For details, refer to paragraph 9.7. |
| PREVIOUS SCREEN | Moving the cursor to the PREVIOUS SCREEN field and pressing the Enter key reverts to the previous screen selected. |
| INITIAL SETUP | This entry provides access to the INITIAL SETUP menu, which determines the configuration that the 804BL assumes upon applying power to the unit. For details, refer to paragraph 4.2.5.2. |
| LIMIT SETUP | This entry provides access to the LIMIT SETUP menu, which allows thew user to set maximum values for a number of parameters. For details, refer to paragraph 4.2.5.3. |

| Entry | Description |
|---|---|

*Figure 4-8: GPIB/RS232 Menu*




***GPIB/RS232 menu***

### *4.2.5.1 GPIB/RS232 SETUP menu*

The GPIB/RS232 SETUP menu may be used to change the interface parameter settings for both the IEEE-488 interface and the RS232 serial interface. The following parameters can be set from this menu:

| Entry | Description |
|---|---|
| GPIB ADDRESS | Sets the IEEE-488 address used by the Programmable Load. The address value can be set from 0 through 31. Address 0 is often reserved for the IEEE-488 controller. The factory setting is address 1. Once changed, the IEEE-488 address is retained in nonvolatile memory. |
| RS232 BAUDRATE | This field can be used to set the RS232 baud rate to 9600, 19200 or 38400 baud. The baud rate set on the Programmable Load must match the one programmed for the communications port of the controller. |
| PREVIOUS SCREEN | Moving the cursor to the PREVIOUS SCREEN field and pressing the Enter key reverts to the previous screen selected. |
| RS232 DATA | This field is used to set the number of data bits to either 7 or 8. Factory setting is 8 bits. This value must match the number of data bits set on the communications port of the controller. |
| RS232 PARITY | This field is used to set the parity. Available options are Even (E), Odd (O) or no parity (N). Factory setting is No parity. This value must match the parity set on the communications port of the controller. |
| RS232 STPBITS | This field is used to set the number of stop bits used on the serial port. Available options are 1 or 2 bits. Factory setting is 1 stop bit. This value must match the parity set on the communications port of the controller.<br><br>The number of start bits is always fixed to 1 bit. |

### *4.2.5.2 INITIAL SETUP menu*

Any time the Programmable Load is powered up, the load settings will reflect the settings stored as the INITIAL setup values. This allows the unit to be powered up in a known state at all times.

*Figure 4-9: Initial Setup 1 Menu*

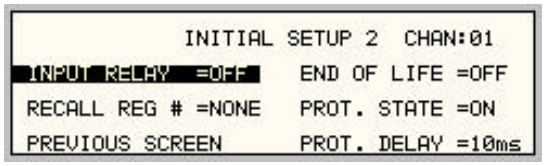

The INITIAL values can be set using the INITIAL SETUP menus. These menus can be reached from the UITILITY 1 menu.

The initial setup can be used to power up the Programmable Load with the Load state on, and a known load value setting such as 600 Ohm

The following fields are provided in the INITIAL SETUP menus:

| Entry | Description |
|---|---|
| | ***INITIAL SETUP 1*** |
| CHANNEL | Selects the channel for which the initial setting will apply. This can be CH 1-2-3-4, or ALL. |
| POWER FACT | Sets the power-on power factor value (OFF-LOW-MID-HIGH). |
| RESISTANCE | Sets the power-on load resistance value. |
| FILAMENT | Sets the power-on filament resistance value. This can be OFF-LOW-MID-HIGH |
| MORE | Moving the cursor to the MORE field and pressing the Enter key selects the INTIAL SETUP 2 screen. |

*Figure 4-10: Initial Setup 1 Menu*




| Entry | Description |
|---|---|
| | ***INITIAL SETUP 2*** |
| INPUT RELAY | Sets the power-on load state relay ( ON or OFF ) |
| RECALL REG # | This field can be set to OFF or to any of the available setup registers. See paragraph 4.2.4 for details on setting register content. If a valid setup register is set in the field, the settings contained in this register will be recalled on power up. In this case, any other settings in the INTIAL SETUP menus are overridden. |

| | |
|---|---|
| END OF LIFE | Toggles the End-of-Life circuitry in either ALL or the selected load module ON or OFF. When the End-of-Life circuitry is ON, a diode/resistor combination is inserted into the load circuit, causing asymmetrical current flow. This allows the system to verify EOL detection capability in the tested ballast. This field can be changed with the shuttle knob or the +/- key. |
| PROT. STATE | Toggles the protection mode ON/OFF. When ON, the controller is put into “sleep” mode before relays are switched. This is done to protect the controller from high level electrical pulses. This field can be changed with the shuttle knob or the +/- key. |
| PROT. DELAY | Sets the delay time between putting the controller into sleep mode, and activating relays . This field can be changed with the shuttle knob, or via numeric keypad entries. |

#### *4.2.5.3 LIMIT SETUP screen*

The limit setup screen is not a menu but only serves to inform the user of the hardware capabilities of the Programmable Load. The cursor can be moved to any of the fields in this screen but none of these fields can be changed. The following information is provided on this screen:

*Figure 4-11: Limit Setup 2 Screen*

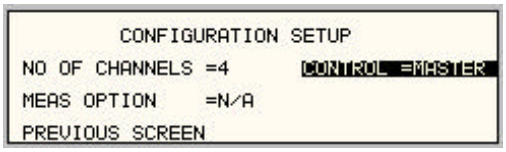

| Entry | Description |
|---|---|
| | ***LIMIT SETUP 1*** |
| RESIST HI | Maximum load resistance of a module. If the user enters a value that exceeds the limit, the load resistance remains at the value it already had. |
| RESIST LO | Minimum load resistance of a module. If the user enters a value that is less than the low limit, the load resistance remains at the value it already had.. |
| PFAC(HIGH) | The power factor settings for a load module are limited to 4 selections being, OFF-LOW-MID-HIGH. In the OFF state, the load is purely resistive with only parasitic capacitance and inductance of the resistors added to the circuit. In the LOW-MID-HIGH states, fixed capacitors are switched in parallel to the resistive load. |

| | |
|---|---|
| FILAMENT(LOW) | The filament settings are limited to 4 pre-set selections being OFF-LOW-MID-HIGH |
| PREVIOUS SCREEN | Moving the cursor to the PREVIOUS SCREEN field and pressing the Enter key reverts to the previous screen selected. |

#### *4.2.5.4 CONFIGURATION SETUP screen*

The configuration setup screen is not a menu but only serves to inform the user of the software features and options installed in the programmable Load. It also provides information on the number of 804BL load modules installed and any Auxiliary units connected to the master 804BL. The cursor can be moved to any of the fields in this screen but none of these fields can be changed. The following information is provided on this screen:

*Figure 4-12: Configuration Setup Screen*



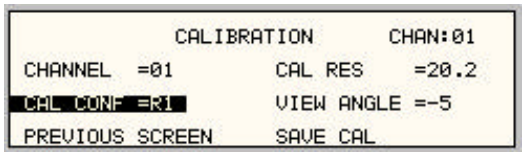

| Entry | Description |
|---|---|
| NO OF CHANNELS | Displays the number of Programmable Load modules (1 – 4) that are present in the 804BL chassis. A 804BL can also function as the master unit, and have a slave chassis connected to it. |
| MEAS OPTION | This selection is reserved for future use. |
| CONTROL | This field indicates if the controller is a master or auxiliary unit. Changing this field to an auxiliary unit with the shuttle will allow the load modules to be controlled from another 804BL. |

### 4.2.6 CALIBRATION Menu

The CALIBRATION menu provides access to the measurement calibration for all load modules.

To unlock the calibration mode, the correct password needs to be entered. For the 804BL Programmable Load, the calibration password is: "804". Enter "804" without the quotes while the cursor is on the PASSWORD = field using the decimal keypad and press the ENTER key. This will bring up the actual CALIBRATION menu.

*Figure 4-13: Calibration Password Entry screen*

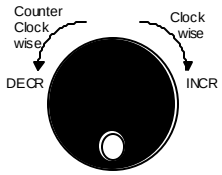


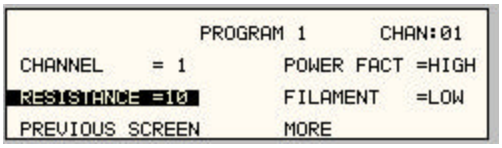

SAVE CAL. Selecting this field and pressing the ENTER key will cause the newly calculated calibration factors to be stored in Flash EPROM. If this step is skipped, the prior calibration scale factors will take effect the next time the Programmable Load is turned on.

***Note: Flash EPROM has a finite number of available write cycles. Do not save calibration scale factors unless the final adjustment has been made.***

## 4.3 Load Module Programming

This section covers basic mode programming operations performed through the front panel menus. Examples are provided for common applications.



### 4.3.1 Set the Resistance for a Load Module

Programmable Load mode parameters are all set from the PROGRAM 1 and PROGRAM 2 screens.

1. Use the MENU key and select the PROGRAM entry.
2. Press the ENTER key to bring up the PROGRAM 1 menu.

   or

2. Use the PROG key to directly bring up the PROGRAM 1 menu.

There are two methods for programming output parameters:

Slewing using the Shuttle

Keypad entry

### 4.3.2 Slewing Selections with the Shuttle

The default mode of operation is an immediate mode in which changes to settings made by the user with the shuttle or the keypad take immediate effect.

To change the channel number:

1. Place the cursor on the CHANNEL entry
2. Rotate the shuttle clockwise to scroll through the available load modules or select ALL

These changes take effect immediately.

To change the resistance value of a module

1. Place the cursor on the SET POINT entry
2. Rotate the shuttle clockwise to increase the value, counterclockwise to decrease the value

These changes take effect immediately.

### 4.3.3 Setting Power Factor and Filament Values

The power factor and filament values can be set to any of four pre-set values being: OFF-LOW-MID-HIGH. Their setting can be changed with the shuttle knob, or by pressing the +/-

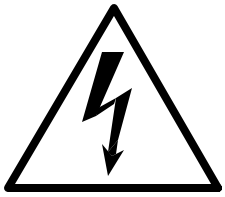
### 4.3.4 Accuracy Considerations

Any programmable load system has a finite accuracy and resolution specification. The error between programmed/desired load resistance and the actual resistance of the 804BL modules will typically be about 1 – 1.5 Ohms. If the user selects a value that falls very close to the values that can be reached with the various programmable “bits” the actual resistance value can be within 0.1 Ohms. Thus, the 804BL functions very much like a digital to analog (D/A ) converter, with a resolution that is determined by the number of available bits, which is 11 in the case of the 804BL. Furthermore, the accuracy of the individual bits is dependent on the accuracy of the external DVM that is used in the calibration process.

## 4.4 Module Loading and Thermal Considerations

Each load module is designed to simulate a fluorescent lamp, and therefore the system is normally configured for impedances in the range from approximately 400 – 800 Ù. Given the capabilities of the programmable load however, the user can set resistance values outside of these typical ranges. Even though each module is protected by a 2 Ampere fuse, it is possible to set certain load values so that the 2 Amp is not exceeded, but excessive power is dissipated in just a few resistors. This causes the module to overheat and even sustain damage if the overload situation is permitted to persist long enough. ***Excessive temperatures can be reached in a matter of 10 – 20 seconds if the load value is high enough !***

***It is the user's responsibility to control the 804BL in such a way that these excessive loading conditions do not occur for prolonged periods.***



# CAUTION

**HIGH VOLTAGES MAY BE PRESENT IN CERTAIN SECTIONS OF THIS PRODUCT. THIS EQUIPMENT GENERATES POTENTIALLY LETHAL VOLTAGES.**

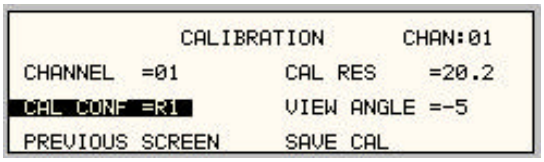
# DEATH

**ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED.**

# 5. Calibration

The Routine Calibration should be performed every 12 months. Non-routine Calibration is only required if a related assembly is replaced or if the periodic calibration is unsuccessful.

*Figure 5-1: Selecting the Calibration menu*




***WARNING: The calibration must be terminated properly or the unit will not function properly. Save the calibration or change the selected channel to terminate the calibration sequence.***

The table below lists the default resistor values for the 804BL:

| | |
|---|---|
| R1 | 2.4 |
| R2 | 4.3 |
| R3 | 7.8 |
| R4 | 13.0 |
| R5 | 24.0 |
| R6 | 45.5 |
| R7 | 90.0 |
| R8 | 146.7 |
| R9 | 220.0 |
| R10 | 430.0 |
| R11 | 880.0 |
| R12 | 1720.0 |
| R13 | 220 |
| R14 | 430 |

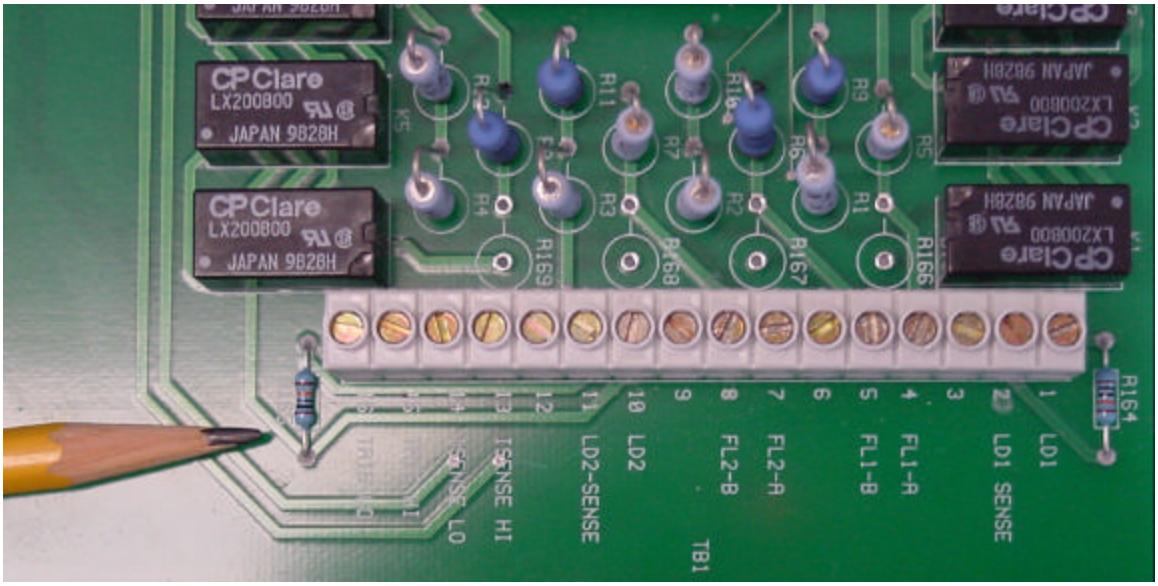
## 5.1 Calibration Equipment

Digital Multimeter: Fluke 45 or 8840 with GPIB interface and a PC with GPIB card.

## 5.2 Calibration Setup

The Programmable Load can be calibrated using a DMM and the California Instruments calibration software.

Connect the DMM for the resistance readings between the Load-1 and Load-2 terminals of the load module. The calibration software will step through all the “bits” of the load module, and read the exact value of each “bit”. These values will be stored, and then later used to approximate the load value that the user enters via the front panel or via the computer interface.




Contact California Instruments at support@calinst.com for the 804BL calibration software.

# 6. Service

## 6.1 Cleaning

The exterior of the Programmable Load may be cleaned with a cloth dampened with a mild detergent and wrung out. Disconnect mains power to the Programmable Load before cleaning. Do not spray water or other cleaning agents directly on the unit.

## 6.2 Fault Symptoms

### 6.2.1 No Current Flow Through the Module

Each module is protected by a 2 Amp slo-blow fuse. If the user attempts to use a module in conditions that exceed the allowed current level, this fuse will blow.

### 6.2.2 No Computer Communication

Verify the communication cable is connected from the computer to the load. Either RS232 or IEEE-488 may be used.

- If RS232 is used, verify the computer program software is set to the correct Comm port, baud rate, start bits and stop bits. These settings can be checked on the Programmable Load using the UTILITY menu. An RS232C serial cable is supplied with the Programmable Load. This is a straight through cable, which can be obtained from any local computer store as well if needed.
- If IEEE-488 is used, verify the correct IEEE address is selected on both the Programmable Load and the control program. An IEEE-488 cable is not supplied with the Programmable Load but any IEEE-488/GPIB cable can be used. Make sure the cable is properly seated and screwed down at both ends.
- Verify the status on the front panel display. It will show REMOTE on the top left hand corner, if communications are active.

## 6.3 Repair Procedure

In the unlikely event that the Programmable Load needs to be returned for repair or service, contact your local California Instruments representative from whom you purchased the instrument.

If no local service center is available, the unit may be shipped back to the factory using suitable packaging. Before returning a unit to the factory, you need to obtain a Return Material Authorization number. You can request an RMA number by fax or email using the following data:

Fax: + 1 858 677 0940

Email: support@calinst.com

Once you have received an RMA number, use the following shipping address to return the instrument for service:

**California Instruments Corporation.**
Attention: Customer Service
9689 Towne Centre Drive
San Diego, California 92121-1964
United States of America

## 6.4 Replaceable Parts

In order to ensure prompt, accurate service, please provide the following information, when applicable for each replacement part ordered.

a. Model number and serial number of the instrument.

b. California Instruments' part number for the sub-assembly where the component is located. (California Instruments PART #)

c. Component reference designator. (SEQ #)

d. Component description.

e. Component manufacturers' FSCM number. (VENDOR)

All replaceable part orders should be addressed to:

**California Instruments Corporation.**
Attention: Customer Service
9689 Towne Centre Drive
San Diego, California 92121-1964
United States of America

Orders may be placed by fax using the fax following fax number:

+1 858 677 0940

*Table 6-1: Replaceable Parts*

| CI PART # | DESCRIPTION |
|---|---|
| Contact Factory for replacement part numbers | |
| 7000-723-3 | Keyboard / LCD Display board |
| 4600-700-1 | CPU Board |
| 250727 | Internal CPU Board |
| 4601-700-1 | PC Assy, Resister Relay Module |
| 4601-701-1 | PC Assy, Power Supply Module |
| 4601-702-1 | Mother Board |
| 270215 | Fuse, 2 amp, 250 volt |
| 270188 | Fuse, Polyswitch |
| 241182 | Fan, 4", 24VDC |
| 270154 | Fuse, 1amp, 250 volt, SLO-BLO |

# 7. Remote Control

## 7.1 Introduction

The 804BL is comes standard equipped with a combination IEEE-488 and RS232C control interface.

As always, California Instruments appreciates your patronage and would welcome any comments and suggestions you might have regarding this product. Use the End-user feedback form located on page 36.

## 7.2 IEEE Interface

The 804BL Series is equipped with both RS232C and IEEE-488 interfaces. Both interfaces can be active at a time although this it is not recommended to do so. The IEEE address for the Programmable Load can be set from the GPIB/RS232 SETUP menu. See section 4.2.5.1 for details.

## 7.3 RS232C Interface

A suitable cable to connect the 804BL Programmable Load to a 9 pin PC-AT style serial port is supplied with the product. This is a straight through cable and can be replaced easily if lost.

***There are three 9 pin connectors on the rear panel of the 804BL. Only one of these is a RS232C connection (Female). The other two 9 pin connectors are RS485 (Male) connections and are used to interface to auxiliary load units.***

The 804BL Series expects a LF (Hex 10) terminator at the end of each string sent over the RS232C interface. If the programming environment you use to develop test programs does not append a LF terminator to each output string, the 804BL will not respond. This is true of some programs like LabView™ using VISA drivers.

**California Instruments Corporation**
Software End-user Registration Form

Complete and submit to:
***California Instruments Corporation***
*Attn: Customer Satisfaction Department*
*9689 Towne Centre Drive*
*San Diego CA 92121-1964*
*United States of America*

**End-user information**

Company _____ Division _____
Contact _____ Title _____
Department _____
Address _____ Mailstop _____
City _____ State _____ Zip _____
Phone ____-_____ Fax ____-_____
E-Mail _____@_____

*Note: Email is used to notify users of program updates that appear on the California Instruments' web site.*

**Software revision:**
ð BTS Sample programs
Program CI 804BL Programmable Load Graphical User Interface Version_____
Rel Date ___ / ___ / 19___

**Company use only:**
Date received : Receipt acknowledgment sent : yes / no
Updated version sent : ___ / ___ / 20___ Processed by :_____

CI-SWRF September- 2000

# 8. Introduction to SCPI

SCPI (Standard Commands for Programmable Instruments) is a programming language for controlling instrument functions over the RS232 or IEEE 488 bus. The same SCPI commands and parameters control the same functions in different classes of instruments..

## 8.1 Conventions Used in This Manual

| | |
|---|---|
| Angle brackets<> | Items within angle brackets are parameter abbreviations. For example, <NR1> indicates a specific form of numerical data. |
| Vertical bar | Vertical bars separate alternative parameters. For example, 0 \| 1 indicates that either "0" or "1" can be used as a parameter. |
| Square Brackets[] | Items within square brackets are optional. The representation [:LOAD]:RESistance means that :LOAD may be omitted. |
| Boldface font | Boldface font is used to emphasize syntax in command definitions. RES <NRf> shows a command definition. |
| Upper case font | Upper case font is used to show program lines in text. OUTP 1 shows a program line. |

## 8.2 The Commands and Messages

This paragraph explains the syntax difference between Dot2 Commands and SCPI messages.

**Types of Commands**

Instruments have two types of commands, common and subsystem.

- Common commands are generally not related to specific operations but to controlling overall Load functions such as reset, status and synchronization. All common commands consist of a three-letter mnemonic preceded by an asterisk:

  *RST *IDN? *SRE 255

- Subsystem commands perform specific Load functions. They are organized into an inverted tree structure with the "root" at the top. Some are single commands while others are grouped within specific subsystems. **You must include the root header in all commands sent to the Load.**

Refer to appendix A for the Load SCPI tree structure.

**Types of SCPI Messages**

There are two types of SCPI messages, program and response.

- A program message consists of one or more properly formatted SCPI commands sent from the controller to the Load. The message, which may be sent at any time, requests the Load to perform some action.
- A response message consists of data in a specific SCPI format sent from the Load to the controller. The Load sends the message only when commanded by program message that called a "query."

### The SCPI Command Tree

As previously explained the basic SCPI communication method involves sending one or more properly formatted commands from the SCPI command tree to the instrument as program messages. The following figure shows a portion of a subsystem command tree, from which you access the commands located along the various paths (you can see the complete tree in appendix A).

| **ROOT** | | |
|---|---|---|
| | | |
| [:LOAD] | :RESistance | [:IMMediate] |
| | | |
| | | :TRIGger |
| | | |
| | :PROTection | [:STATe] |
| | | |
| | | :DELay |

### The Root Level

Note the location of the ROOT node at the top of the tree. Commands at the root level are at the top level of the command tree. The SCPI interface is at this location when:

- The Load is powered on
- A device clear (DCL) is sent to the AC Load
- The SCPI interface encounters a message terminator
- The SCPI interface encounters a root specifier

### Active Header Path

In order to properly traverse the command tree, you must understand the concept of the active header path. When the Load is turned on (or under any of the other conditions listed above), the active path is at the root. That means the SCPI interface is ready to accept any command at the root level, such as LOAD.

If you enter LOAD the active header path moves one colon to the right. The interface is now ready to accept :RESistor or :PROTection as the next header. You must include the colon, because it is required between headers.

If you now enter :PROTection, the active path again moves one colon to the right. The interface is now ready to accept either :STATe or :DELay as the next header.

If you now enter :STATe you have reached the end of the command string. The active header path remains at :PROTection. If you wished, you could have entered
:PROTection ON;DELAY 10 and it would be accepted as a compound message consisting of:

1. LOAD:PROTection:STATe ON
2. LOAD:PROTection:DELay 10

The entire message would be:

LOAD:PROTection:STATe ON;DELay 10<newline>

The <newline> message terminator after DELay 10 returns the path to the root.

#### Moving Among Subsystems

In order to combine commands from different subsystems, you need to be able to restore the active path to the root. You do this with the root specifier (:). For example, you could set the Resistance to 20 ohms and set the Power factor to 0.8.

```
:RES 20
:PFAC 0.8
```

Because the root specifier resets the command parser to the root, you can use the root specifier and do the same thing in one message:

```
RES 20;:PFAC 0.8
```

#### Including Common Commands

You can combine common commands with system commands in the same message. Treat the common command as a message unit by separating it with a semicolon (the message unit separator). Common commands do not affect the active header path; you may insert them anywhere in the message.

```
RESistor 5;*ESE 255
OUTPut 0;*RCL 2
```

## 8.3 Using Queries

Observe the following precautions with queries:

- Set up the proper number of variables for the returned data.
- Read back all the results of a query before sending another command to the AC Load. Otherwise a Query Error will occur and the non-returned data will be lost.

## 8.4 Structure of a SCPI Message

SCPI messages consist of one or more message units ending in a message terminator. The terminator is not part of the syntax, but implicit in the way your programming language indicates the end of a line (such as a New Line or end-of-line character).

#### The Message Unit

The simplest SCPI command is a single message unit consisting of a command header (or keyword) followed by a message terminator.

```
RESistance?<newline>
PFACtor?<newline>
```

The message unit may include a parameter after the header. The parameter usually is numeric:

```
RESistance 20<newline>
```

### Combining Message Units

The following command message is briefly described here, with details in subsequent paragraphs.

LOAD:RES 10;:PFAC 0.9;:EOL? <NL>

The basic parts of the above message are:

| Message Component | Example |
|---|---|
| Headers | LOAD RES PFAC |
| Header Separator | The colon in LOAD:RES |
| Data | 10 0.9 |
| Data Separator | The space in RES 10 and PFAC 0.9 |
| Message Units | RES 10 PFAC 0.9 EOL? |
| Message Unit Separator | The semicolons in RES 10; and PFAC 0.9; |
| Root Specifier | The colon in :PFAC and :RES? |
| Query Indicator | The question mark in EOL? |
| Message Terminator | The <NL> (newline) indicator. Terminators are not part of the SCPI syntax |

### Headers

Headers are instructions recognized by the AC Load. Headers (which are sometimes known as "keywords") may be either in the long form or the short form.

| | |
|---|---|
| Long Form | The header is completely spelled out, such as RESistance, SYSTEM, and OUTPUT. |
| Short Form | The header has only the first three or four letters, such as RES, SYST, and OUTP. |

The SCPI interface is not sensitive to case. It will recognize any case mixture, such as RESISTANCE, RESistance or Resistance. Short form headers result in faster program execution.

### Header Convention

In the command descriptions used throughout this manual, the proper short form is shown in upper-case letters, such as RESistance.

Header Separator

If a command has more than one header, you must separate them with a colon SYSTem:ERRor TRIGger:SLOPe

### Optional Headers

The use of some headers is optional. Optional headers are shown in brackets, such as RESistancet[:IMMediate] 100.

### Query Indicator

Following a header with a question mark turns it into a query (SYSTem:ERR?, RESistance?).

### Message Unit Separator

When two or more message units are combined into a compound message, separate the units with a semicolon (RES 12.5;:PFAC 0.8).

### Root Specifier

When it precedes the first header of a message unit, the colon becomes the root specifier. It tells the command parser that this is the root or the top node of the command tree. Note the difference between root specifiers and header separators in the following examples:

| | |
|---|---|
| LOAD:RESistance:LEVel 100 | All colons are header separators |
| :LOAD:RESistance:LEVel 100 | Only the first colon is a root specifier |
| LOAD:RESistance:LEVel 100;:PFAC 0.9 | Only the third colon is a root specifier |

You do not have to precede root-level commands with a colon; there is an implied colon in front of every root-level command.

### Message Terminator

A terminator informs SCPI that it has reached the end of a message. The only permitted message terminator is:

- newline (<NL>), which is ASCII decimal 10 or hex 0A.

In the examples of this manual, there is an assumed message terminator at the end of each message. If the terminator needs to be shown, it is indicated as <NL> regardless of the actual terminator character.

## 8.5 SCPI Data Formats

All data programmed to or returned from the AC Load is in ASCII. The data type may be numerical or character string.

**Numerical Data Formats**

| Symbol | Data Form |
|---|---|
| **Talking Formats** | |
| <NR1> | Digits with an implied decimal point assumed at the right of the least-significant digit. Examples: 273 |
| <NR2> | Digits with an explicit decimal point. Example:.0273 |
| <NR3> | Digits with an explicit decimal point and an exponent. Example: 2.73E+2 |
| <Bool> | Boolean Data. Example: 0 \| 1 |
| **Listening Formats** | |
| <Nrf> | Extended format that includes <NR1>, <NR2> and <NR3>. Examples: 273.2 , 2.73E2 |
| <Bool> | Boolean Data. Example: 0 \| 1 |

**Character Data**

Character strings returned by query statements may take either of the following forms, depending on the length of the returned string:

| | |
|---|---|
| <CRD> | Character Response Data. Permits the return of character strings. |
| <AARD> | Arbitrary ASCII Response Data. Permits the return of un-delimited 7-bit ASCII. This data type has an implied message terminator. |
| <SRD> | String Response Data. Returns string parameters enclosed in double quotes. |

# 9. SCPI Command Reference

This chapter is organized as follows:

- Subsystem commands, arranged by subsystem
- IEEE 488.2 common commands

***Related Commands***

Where appropriate, related commands or queries are included. These are listed because they are either directly related by function, or because reading about them will clarify or enhance your understanding of the original command or query.

**Subsystem commands**

Subsystem commands are specific to Load functions. They can be a single command or a group of commands. The groups are comprised of commands that extend one or more levels below the root. The description of common commands follows the description of the subsystem commands.

The subsystem command groups are listed in alphabetical order and the commands within each subsystem are grouped alphabetically under the subsystem. Commands followed by a question mark (?) take only the query form. When commands take both the command and query form, this is noted in the syntax descriptions.

**IEEE 488.2 common commands**

Common commands are defined by the IEEE-488.2 standard and are described in chapter **Error! Reference source not found.** of this manual.

## 9.1 Subsystem Commands

Subsystem commands are specific to Load functions. They can be a single command or a group of commands. The groups are comprised of commands that extend one or more levels below the root. The description of common commands follows the description of the subsystem commands.

The subsystem command groups are listed in alphabetical order and the commands within each subsystem are grouped alphabetically under the subsystem. Commands followed by a question mark (?) take only the query form. When commands take both the command and query form, this is noted in the syntax descriptions.

## 9.2 Calibration Subsystem

The commands in this subsystem allow you to do the following:

- Enable and disable the calibration mode
- Calibrate the current and voltage gain of the AC load.
- Store the new calibration constants in nonvolatile memory.

**Subsystem Syntax**

CALibrate

| | |
|---|---|
| :PASSword | Allows entry of calibration password required to change calibration coefficients |
| :SAVe | Save Calibration values into nvram. |
| :RESistance | Calibrate Resistance value. |
| :CONFigurate | Isolate resistor for calibration purpose. |

### 9.2.1 Password

**CALibrate:PASSword**

This command allows the entry of the calibration password. The calibration password is required to use the data entry form of the calibration commands. Without the use of this password, a new calibration can not be performed. The calibration password is defined as the numeric portion of the AC load serial number spelled backwards. The password needs to be enclosed by single or double quotation marks. Thus, if the unit's serial number is 71234, the calibration password is “43217” and the command syntax would be:

CAL:PASS “43217”

Note that any non-numeric characters occurring in the serial number need to be discarded when sending the calibration password. Only the numeric portion is to be used.

| | |
|---|---|
| Command Syntax | CALibrate:PASSword<SRD> |
| Parameters | <numeric portion of serial number reversed> (default) |
| Examples | CAL:PASS '34593' CAL:PASS "35461" |
| Related Commands | *IDN? |

### 9.2.2 Save

**CALibration:SAVE**

This command saves the calibration coefficients into the flash memory. This command must be executed after the calibration is performed successfully. If not, the previous calibration coefficients will be user after the next power on cycle.

| | |
|---|---|
| Command Syntax | CALibrate:SAVe |
| Parameters | none |
| Examples | CAL:SAVE |
| Related Commands | *IDN? |

### 9.2.3 RESisatnce

**CALibrate:RESistance <NRf>**

***Channel selectable***

This command initiates the calibration of the Load resistance. The command will accept a single numeric entry or 15 numeric entry separated by commas. The 15 values represent the values of R0 through R14. A single data item represents the selected resistor for calibration with CAL:CONF

| | |
|---|---|
| Command Syntax | CALibrate:RESistance |
| Parameters | <NRf> (actual load resistance measured with external device) |
| Examples | CAL:RES 28.0 |
| Query Syntax | CALibrate:RESistance? 2 CALibrate:RESistance? |
| Returned Parameters | <NR2> or <NR2>,….,<NR2> |

### 9.2.4 CONFigurate

**CALibrate:CONFigurate <NRf>**

***Channel selectable***

This command is used to isolate each of the 15 Resistors for calibration purpose. The command accepts a single numeric value in the range of 0 to 14 which represents a Resistor to calibrate.

| | |
|---|---|
| Command Syntax | CALibrate:CONFigurate |
| Parameters | <NRf> (Resistor number 0 through 14) |
| Examples | CAL:CONF 2 |
| Query Syntax | CALibrate:CONF? |
| Returned Parameters | <NR2> (range 0 to 14) |

## 9.3 Instrument Subsystem

The Instrument subsystem controls the selected channel of the load.

**Subsystem Syntax**

INSTrument

| | |
|---|---|
| COUPle ALL \| NONE | Couples or uncouples commands |
| :NSELect 1 \| 2 \| 3 | Selects channel 1, 2 ,…or 16 using numeric references |
| :SELect A \| B \| C | Selects phase A, B or C using character references |

**INSTrument:COUPle**

This command may be used to couple all load channels in multi channel mode. When the channels are coupled, commands issued subsequently affect all channels in the system. This allows the load resistance to be programmed for all channels using a single command and without the need to select each channel individually. When uncoupled, commands issued must be preceded by the INST:NSEL command and will only affect the selected command.

Available parameters are ALL, to couple all channels and NONE, to uncouple all channels. If only a single channel is present, the INST:COUP commands are ignored.

| | |
|---|---|
| Command Syntax | INSTrument:COUPle |
| Parameters | ALL \| NONE |
| Examples | INST:COUP ALL |
| Query Syntax | INST:COUP? |
| Returned Parameters | <CRD> |
| Related Commands | INST:NSEL INST:SEL |

**INSTrument:NSELect**

This command may be used to select a specific load channel using a numeric reference. A "1" denotes channel 1, a "2" denotes channel 2 and a "5" denotes channel 5. As long as the instrument state is coupled, programming commands will affect all channels. As soon as the INST:COUP NONE command is issued, the last selected channel becomes selected. To immediately change the output of a single channel only, make sure the instrument state is uncoupled when issuing the INST:NSEL command.

Note that the all query subsystems are not affected by the INST:COUP command and always operate on the selected channel only. This means the instrument can remain in coupled mode while doing query commands using "`INST:NSEL <n>`. Note that when the instrument is subsequently put in the uncoupled state using "`INST:COUP NONE`", the last issued channel selection will be in effect. To make sure the desired channel is selected, follow the "`INST:COUP NONE`" command with an "`INST:NSEL <n>`" command.

| | |
|---|---|
| Command Syntax | INSTrument:NSEL |
| Parameters | 1 \| 2 \| 3\|…16 |
| Examples | INST:NSEL 1 |
| Query Syntax | INST:NSEL? |
| Returned Parameters | <CRD> |
| Related Commands | INST:COUP INST:SEL |

**INSTrument:SELect**

This command may be used by selecting a specific load channel using a character reference. “A” denotes channel A or module 1, “B” denotes channel B or module 2 and “C” denotes channel C or module 3, etc. As long as the instrument state is coupled however, programming commands will affect all channels. As soon as the INST:COUP NONE command is issued, the last selected channel becomes selected. To immediately change the output of a single channel only, make sure the instrument state is uncoupled when issuing the INST:SEL command.

| | | |
|---|---|---|
| Command Syntax | INSTrument:SEL | |
| Parameters | A \| B \| C | |
| Examples | INST:SEL A | |
| Query Syntax | INST:SEL? | |
| Returned Parameters | <CRD> | |
| Related Commands | INST:COUP | INST:NSEL |

## 9.4 Output Subsystem

This subsystem controls the external outputs of the Load.

**Subsystem Syntax**

OUTPut
    [:STATe] <bool>  Enable/disable trigger out drive
    :TRIGger

### 9.4.1 Load Output state

**OUTPut[:STATe]**

***channel selectable***

This command enables or disables the load. If the state is disabled, the load circuit is open. If the state is enabled, the load is connected to the UUT. The query form returns the load output state.

| | |
|---|---|
| Command Syntax | OUTPut[:STATe]<bool> |
| Parameters | 0 \| OFF \| 1 \| ON |
| *RST Value | define by PONSetup:OUTput |
| Examples | OUTP 1 |
| Query Syntax | OUTP[:STATe]? |
| Returned Parameters | 0 \| 1 |
| Related Commands | *RCL *SAV |

**OUTPut:TRIGger**

***channel selectable***

This command enables or disables the load output at the next trigger. The state of the output will not change until the trigger occurs. The trigger state of the channel must be enabled prior to issuing the command.

| | |
|---|---|
| Command Syntax | OUTPut:TRIGger <bool> |
| Parameters | 0 \| OFF \| 1 \| ON |
| *RST Value | define by PONSetup:OUTput |
| Examples | OUTP:TRIG ON |
| Query Syntax | OUTP:TRIG? |
| Returned Parameters | 0 \| 1 |
| Related Commands | *RCL *SAV TRIG:STAT |

## 9.5 Load Subsystem

This subsystem controls the load Resistance, End of life, Filament, Power factor, Protection, Protection delay and Power on setup.

### 9.5.1 Resistance Subsystem

This subsystem programs the load resistance and defines the range of acceptable data.

**Subsystem Syntax**

```
[LOAD:]
    :RESistance
        [:IMMediate]        Sets the Resistance value
        :TRIGger            Set the Resistance value at the trigger.
        :LIMit
            [:HIGH]         Query the upper resistance limit.
            :LOW            Query the lower resistance limit.
```

**RESistance[:IMMediate]**

***Channel selectable***

This command sets the load resistance in ohms.

| | |
|---|---|
| Command Syntax | [LOAD:]RESistance[:IMMedaite]<NRf+> |
| Parameters | <NRf> |
| Unit | Ohms |
| *RST | Defined by the PONSetup:RESistance |
| Examples | RES 10 RES:IMM .5 |
| Query Syntax | [LOAD:]RESistance[:IMM]? |
| Returned Parameters | <NR2> |
| Related Commands | RES:LIMit? RES:TRIG |

**RESistance:TRIGger**

***Channel selectable***

This command sets the load resistance in ohms. The change will not take effect until a valid trigger is issued. The trigger state must be enabled prior to the command.

| | |
|---|---|
| Command Syntax | [LOAD:]RESistance:TRIGger<NRf+> |
| Parameters | <NRf> |
| Unit | Ohms |
| *RST | Defined by the PONSetup:RESistance |
| Examples | RES:TRIG 20 |
| Query Syntax | [LOAD:]RESistance:TRIG? |
| Returned Parameters | <NR2> |
| Related Commands | RES:LIMit? TRIG:STAT |

**RESistance:LIMit[:HIGH]?**

***Channel selectable***

This command queries the maximum resistance value the load will accept. This limit value can be different after the calibration is performed.

| | |
|---|---|
| Command Syntax | [LOAD:]RESistance:LIMit[:HIGH]? |
| Examples | RES:LIM? |
| Returned Parameters | <NR2> |
| Related Commands | RES:LIMit:LOW? |

**RESistance:LIMit:LOW?**

***Channel selectable***

This command queries the minimum resistance value the load will accept. This limit value can be different after the calibration is performed.

| | |
|---|---|
| Command Syntax | [LOAD:]RESistance:LIMit:LOW? |
| Examples | RES:LIM:LOW? |
| Returned Parameters | <NR2> |
| Related Commands | RES:LIMit:HIGH? |

### 9.5.2 End of life Subsystem

This subsystem programs a load to simulate end of life.

**Subsystem Syntax**

```
[LOAD:]
    EOLife
        [:IMMedaite]        set end of life load
        :TRIGger            set end of life load at the trigger
```

**EOLife[:IMMediate]**

***Channel selectable***

This command sets the load to simulate end of life.

| | |
|---|---|
| Command Syntax | [LOAD:]EOLife[:IMMediate] <boolean> |
| Parameters | 1\|ON 0\|OFF |
| *RST | Defined by the PONSetup:EOLife |
| Examples | EOL ON |
| Query Syntax | [LOAD:]EOLife[:IMMediate]? |
| Returned Parameters | 1 or 0 |
| Related Commands | EOL:TRIG |

**EOLife[:TRIGger]**

***Channel selectable***

This command sets the load to simulate end of life. The change will not take effect until a valid trigger is issued. The Trigger State must be enabled prior to issuing the command.

| | |
|---|---|
| Command Syntax | [LOAD:]EOLife:TRIGger <boolean> |
| Parameters | 1\|ON 0\|OFF |
| *RST | Defined by the PONSetup:EOLife |
| Examples | EOL ON |
| Query Syntax | [LOAD:]EOLife[:IMMediate]? |
| Returned Parameters | 1 or 0 |
| Related Commands | EOL |

### 9.5.3 Power Factor Subsystem

This subsystem programs the power factor of the load.

**Subsystem Syntax**

```
[LOAD:]
    PFACtor
        [:IMMediate]    sets the power factor
        TRIGger <n>     sets the power factor at the trigger
        :LIMit          sets power factor limits
```

**PFACtor[:IMMeadite]**

***Channel selectable***

This command sets the power factor of the load. There are four valid settings for the power factor. OFF, LOW, MID and HIGH are the valid settings. The actual value for each setting can be obtained from the PFACtor:LIMit command.

| | |
|---|---|
| Command Syntax | [LOAD:]PFACtor[:IMMediate]<numerated> |
| Parameters | OFF\|LOW\|MID\|HIGH |
| Unit | (ratio) defined by the PFAC:LIM |
| *RST | Defined by the PONSetup:PFACtor |
| Examples | PFACtor LOW PFAC:HIGH |
| Query Syntax | [LOAD:]PFACtor[:IMMediate]? |
| Returned Parameters | OFF\|LOW\|MID\|HIGH |
| Related Commands | PFAC:LIMit PFAC:TRIG |

**PFACtor:TRIGger**

***Channel selectable***

This command sets the power factor of the load. There are four valid settings for the power factor. OFF, LOW, MID and HIGH are the valid settings. The change will not take effect until a valid trigger is issued. The trigger state must be enabled prior to the command. The actual value for each setting can be obtained from the PFACtor:LIMit command.

| | |
|---|---|
| Command Syntax | [LOAD:]PFACtor:TRIGger<numerated> |
| Parameters | OFF\|LOW\|MID\|HIGH |
| Unit | (ratio) defined by the PFAC:LIM |
| *RST | Defined by the PONSetup:PFACtor |
| Examples | PFACtor:TRIG LOW PFAC:TRIG HIGH |
| Query Syntax | [LOAD:]PFACtor:TRIG? |
| Returned Parameters | OFF\|LOW\|MID\|HIGH |
| Related Commands | PFAC:LIMit PFAC |

**PFACtor:LIMit**

***Channel selectable***

This command defines the load power factor values that correspond to the setting OFF, LOW, MID, and HIGH settings for the power factor.

| | |
|---|---|
| Query Syntax | [LOAD:]PFACtor:LIMit? |
| Parameters | MINimum\|MAXimum |
| Examples | PFAC:LIM? MAX PFAC:LIM? MIN PFAC:LIM? |
| Returned Parameters | <NR2> or <NR2>,<NR2>,<NR2>,<NR2> |

### 9.5.4 FILament Subsystem

This subsystem programs the Filament load.

**Subsystem Syntax**

[LOAD:]
FILament
[:IMMediate] sets the power factor
TRIGger <n> sets the power factor at the trigger
:LIMit sets power factor limits

**FILament[:IMMeadite]**

***Channel selectable***

This command sets the filament of the load. There are four valid settings for the filament. OFF, LOW, MID and HIGH are the valid settings. The actual value for each setting can be obtained from the FILament:LIMit command.

| | |
|---|---|
| Command Syntax | [LOAD:]FILament[:IMMediate]<numerated> |
| Parameters | OFF\|LOW\|MID\|HIGH |
| Unit | (ohms) defined by the FIL:LIM |
| *RST | Defined by the PONSetup:FILament |
| Examples | FILament LOW FIL:HIGH |
| Query Syntax | [LOAD:]FILament[:IMMediate]? |
| Returned Parameters | OFF\|LOW\|MID\|HIGH |
| Related Commands | FIL:LIMit FIL:TRIG |

**FILament:TRIGger**

***Channel selectable***

This command sets the power factor of the load. There are four valid settings for the power factor. OFF, LOW, MID and HIGH are the valid settings. The change will not take effect until a valid trigger is issued. The trigger state must be enabled prior to the command. The actual value for each setting can be obtained from the FILament:LIMit command.

| | |
|---|---|
| Command Syntax | [LOAD:]FILament:TRIGger<numerated> |
| Parameters | OFF\|LOW\|MID\|HIGH |
| Unit | (ohms) defined by the FIL:LIM |
| *RST | Defined by the PONSetup:FILament |
| Examples | FILament:TRIG LOW FIL:TRIG HIGH |
| Query Syntax | [LOAD:]FILament:TRIG? |
| Returned Parameters | OFF\|LOW\|MID\|HIGH |
| Related Commands | FIL:LIMit FIL |

**FILament:LIMit**

***Channel selectable***

This command defines the load filament values in ohms that correspond to the OFF, LOW, MID, and HIGH settings for the filament.

| | |
|---|---|
| Query Syntax | [LOAD:]FILament:LIMit? |
| Parameters | <NRF+> or <nrf1>,<nrf2>,<nrf3>,<nrf4> |
| Examples | PFAC:LIM? LOW PFAC:LIM? MID FIL:LIM? |
| Returned Parameters | <NR2> or <NR2>,<NR2>,<NR2>,<NR2> |

### 9.5.5 PROTction Subsystem

This subsystem enables or disables the system protection against EMP (Electro motive pulse). When enabled, it places all channels CPU into a sleep mode when commands are executed for a length defined by the PROT:DEL.

**Subsystem Syntax**

```
[LOAD:]
    PROTection
        [:ISTATe]      Turn protection on.
        :DELay         Set protection delay.
```

**PROTection[:STATe]**

This command enables or disables the loads' protection. This is a global command and will affect all channels.

| | |
|---|---|
| Command Syntax | [LOAD:]PROTection[:STATe] <boolean> |
| Parameters | 1\|ON 0\|OFF |
| *RST | Defined by the PONSetup:PROT:STAT |
| Examples | PROT ON |
| Query Syntax | [LOAD:]PROTection[:STATe] |
| Returned Parameters | 1 or 0 |
| Related Commands | PROT:DEL |

**PROTection:DELay**

This command sets the protection delay in milliseconds from 1 to 71msec. The default is 10msec. Protection state must be enabled. This is a global command that will affect all channels.

| | |
|---|---|
| Command Syntax | [LOAD:]PROTection:DELay <NRf+> |
| Parameters | 1 to 71 msec |
| *RST | Defined by the PONSetup:PROT:DELay |
| Examples | PROTDELay 20 |
| Query Syntax | [LOAD:]PROTection:DELay? |
| Returned Parameters | <NR2> |
| Related Commands | PROT[:STAT] |

## 9.6 Power On Setup Subsystem

This subsystem controls the initial condition of the load at the power on state.

**Subsystem syntax**

```
[LOAD:]
    PONSetup:
        STATe  <boolean>              Sets the load state
        RESistancer <n>               Sets the resistance value
        PFACtor <numerated>           Sets the power factor
        EOLife  <boolean>             Sets end of life
        FILament <numerated>
        REGister <n>                  Sets the power on register number
        PROTection
            [:STATe]   <boolean>      Sets protection state
            :DELay     <NRf>          Sets protection delay
```

**PONSetup:STATe**

***Channel selectable***

This command sets the initial load output state. The load will power up in a disabled state if the state is off.

| | |
|---|---|
| Command Syntax | [LOAD:]PONSetup:STATe |
| Parameters | 0\|OFF\|1\|ON |
| Examples | PONSetup:STAT OFF |
| Query Syntax | [LOAD:]PONSetup:STAT? |
| Returned Parameters | 0\|1 |

**PONSetup:RESistance**

***Channel selectable***

This command sets the initial resistance of the load.

| | |
|---|---|
| Command Syntax | [LOAD:]PONSetup:RESistance <NRf+> |
| Parameters | <NRf> |
| Unit | (ohms) |
| Examples | PONSetup:RES 100 |
| Query Syntax | [LOAD:]PONSetup:RES? |
| Returned Parameters | <NR2> |

**PONSetup:PFACtor**

***Channel selectable***

This command sets the initial power factor of the load.

| | |
|---|---|
| Command Syntax | [LOAD:]PONSetup:PFACtor <numerated> |
| Parameters | OFF\|LOW\|MID\|HIGH |
| Examples | PONSetup:PFAC MID |
| Query Syntax | [LOAD:]PONSetup:PFAC? |
| Returned Parameters | OFF\|LOW\|MID\|HIGH |

**PONSetup:EOLife**

***Channel selectable***

This command sets the initial end of life setting of the load.

| | |
|---|---|
| Command Syntax | [LOAD:]PONSetup:EOLife <boolean> |
| Parameters | OFF\|0 ON\|1 |
| Examples | PONSetup:EOLife OFF |
| Query Syntax | [LOAD:]PONSetup:EOL? |
| Returned Parameters | 0 \| 1 |

**PONSetup:FILament**

***Phase selectable***

This command sets the initial filament value of the load.

| | |
|---|---|
| Command Syntax | [LOAD:]PONSetup:FILament <numerated> |
| Parameters | OFF\|LOW\|MID\|HIGH |
| Examples | PONSetup:FIL MID |
| Query Syntax | [LOAD:]PONSetup:FIL? |
| Returned Parameters | OFF\|LOW\|MID\|HIGH |

**PONSetup:REGister**

This command will specify one of the 8- setup registers as the power on setup. If register 0 through 7 are specified and the register contains valid setup data, the load will use the data in this register as the power on initialization parameters and will override the parameters set by the PONSetup subsystem.

| | |
|---|---|
| Command Syntax | [LOAD:]PONSetup:REGister none\|0..7 |
| Parameters | none\|0…7 |
| Examples | PONSetup:REG NONE PONS:REG 1 |
| Query Syntax | [LOAD:]PONSetup:REG? |
| Returned Parameters | NONE\|0\|1 |

**PONSetup:PROT**

This command sets the initial protection state of all channels.

| | |
|---|---|
| Command Syntax | [LOAD:]PONSetup:PROTection <boolean> |
| Parameters | OFF\|0 ON\|1 |
| Examples | PONSetup:PROT OFF |
| Query Syntax | [LOAD:]PONSetup:PROT? |
| Returned Parameters | 0 \| 1 |

**PONSetup:PROTction:DELay**

This command sets the initial protection delay for all channels of the load.

| | |
|---|---|
| Command Syntax | [LOAD:]PONSetup:PROTectio:DELay <NRf+> |
| Parameters | <NRf> |
| Unit | (msec) |
| Examples | PONSetup:PROT:DELay 20 |
| Query Syntax | [LOAD:]PONSetup:PROT:DELay? |
| Returned Parameters | <NR2> |

## 9.7 System Commands

The system commands control the system-level functions of the AC Load.

**Subsystem Syntax**

SYSTem

| | |
|---|---|
| :ERRor? | Returns the error number and error string |
| :VERSion? | Returns the SCPI version number |
| :LOCal | Go to local mode (RS-232 only) |
| :REMote | Go to remote mode (RS-232 only) |
| :ETIMe? | Returns the elapse time |
| :CONFigure | Sets system configuration (Password required) |
| [:BYTE] | Reutrns the enabled options if any. |
| :NCHannel? | Returns the number of channels in the system |
| :COMMunicate | |
| :GPIB | |
| :ADDRess | Sets GPIB address |
| :SERial | |
| :BAUD | Sets the baud rate |
| :PARity | Sets the parity type |
| :BITS | Sets number of bits |
| :SBITs | Sets number of stop bits |
| :CONTROL | Configure the Load to a master or auxiliary unit |

**SYSTem:ERRor?**

This query returns the next error number followed by its corresponding error message string from the remote programming error queue. The queue is a FIFO (first-in, first-out) buffer that stores errors as they occur. As it is read, each error is removed from the queue. When all errors have been read, the query returns 0,No Error. If more errors are accumulated than the queue can hold, the last error in the queue is -350,Too Many Errors.

| | |
|---|---|
| Query Syntax | SYSTem:ERRor? |
| Parameters | None |
| Returned Parameters | <NR1>,<SRD> |
| Example | SYST:ERR? |

**SYSTem:VERSion?**

This query returns the SCPI version number to which the Load complies. The returned value is of the form YYYY.V, where YYYY represents the year and V is the revision number for that year.

| | |
|---|---|
| Query Syntax | SYSTem:VERSion? |
| Parameters | None |
| Returned Parameters | <NR2> |
| Example | SYST:VERS? |

**SYSTem:LOCal**

This command can only be used with the RS-232 interface. It sets the interface in Local state, which enables the front panel controls.

| | |
|---|---|
| Command Syntax | SYSTem:LOCal |
| Parameters | None |
| Example | SYST:LOC |
| Related Commands | SYST:REM |

**SYSTem:REMote**

This command can only be used with the RS-232 interface. It sets the interface in the Remote state, which disables all front panel controls.

| | |
|---|---|
| Command Syntax | SYSTem:REMote |
| Parameters | None |
| Example | SYST:REM |
| Related Commands | SYST:LOC |

**SYSTem:ETIMe?**

This command will return the elapsed time since turn-on (total number of accumulated hours, minutes and seconds).

| | |
|---|---|
| Command Syntax | SYSTem:ETIMe? |
| Parameters | none |
| Example | SYST:ETIM? |
| Returned Parameters | <NR1>,<NR1>,<NR1> |

**SYSTem:CONFigure[:BYTE]**

This command will set the system configuration. This is a protected command and requires a password. The query response is available however.

| | | |
|---|---|---|
| Command Syntax | SYSTem:CONFigure | |
| Parameters | FFT | |
| Example | SYST:CONF FFT | SYST:CONF? |
| Returned Parameters | <CRD> | |
| Related Commands | *OPT? | |

**SYSTem:CONFigure:NCHannel?**

***Channel selectable***

This is a query only command which returns the number of channels in the load system.

| | |
|---|---|
| Command Syntax | SYSTem:CONFigure:NCHannel? |
| Parameters | none |
| Example | SYST:CONF:NCH? |
| Returned Parameters | <NR2> |
| Related Commands | INST:NSEL |

**SYSTem:COMMunicate:GPIB:ADDRess**

This command sets the GPIB address.

| | |
|---|---|
| Command Syntax | SYSTem:COMMunicate:GPIB:ADDRess <NRF> |
| Parameters | 0 to 31 <listen address> |
| Example | SYST:COMM:GPIB:ADDR 2 |
| Returned Parameters | <NR1> |

**SYSTem:COMMunicate:SERial:BAUD**

This command sets the SERial port communication baud rate.

| | |
|---|---|
| Command Syntax | SYSTem:COMMunicate:SERial:BAUD <NRF> |
| Parameters | 9600 \| 19200 \| 38400 |
| Example | SYST:COMM:SER:BAUD 38400 |
| Returned Parameters | <NR1> |

**SYSTem:COMMunicate:SERial:PARity**

This command sets the SERial communication parity.

| | |
|---|---|
| Command Syntax | SYSTem:COMMunicate:SERial:PARity <parity> |
| Parameters | NONE\|EVEN\|ODD |
| Example | SYST:COMM:SER:PAR NONE |
| Returned Parameters | <CRD> |

**SYSTem:COMMunicate:SERial:BITS**

This command sets the number of data bits for the SERial communication port.

| | |
|---|---|
| Command Syntax | SYSTem:COMMunicate:SERial:BITS <NRF> |
| Parameters | 7\|8 |
| Example | SYST:COMM:SER:BITS 8 |
| Returned Parameters | <NR1> |

**SYSTem:COMMunicate:SERial:SBITs**

This command sets the number of stop bits for the SERial communication port.

| | |
|---|---|
| Command Syntax | SYSTem:COMMunicate:SERial:SBITs <NRF> |
| Parameters | 1\|2 |
| Example | SYST:COMM:SER:SBITs 1 |
| Returned Parameters | <NR1> |

**SYSTem:CONTrol**

This command will set the Load to a master or auxiliary unit mode. The setting will take place only at power up.

| | |
|---|---|
| Command Syntax | SYSTem:CONTrol MASTer \| AUXiliary |
| Parameters | MASTer \| AUXiliary |
| Example | SYST:CONT AUX |

## 9.8 Trigger Subsystem

This subsystem controls the triggering of the load. The TRIGger:INITiate command is a software trigger similar to the external trigger. The slope is ignored with the software trigger. The trigger subsystem must first be enabled using the STATe commands or no triggering action will occur.

**Subsystem Syntax**

| | |
|---|---|
| ABORt | Resets the trigger system to the Idle state |
| TRIGger | |
| [:INITate] | |
| :STATe | |
| :SLOPe | |

**ABORt**

This command will clear all parameters that are waiting for a trigger source.

| | |
|---|---|
| Command Syntax | ABORt |
| Parameters | none |
| Examples | ABOR |
| Related Commands | TRIG *RST |

**TRIG[:INITiate]**

The TRIGger[:INITiate] is software trigger. The trigger state for the channel must be enabled and the load functions must be with the trigger command set prior to the TRIG command.

| | |
|---|---|
| Command Syntax | TRIGger[:INITiate] |
| Parameters | None |
| Examples | TRIG |
| Related Commands | ABOR TRIG:STATe |

**TRIGger:STATe**

***Channel selectable***

This command enables the trigger for the selected channel.

| | |
|---|---|
| Command Syntax | TRIGger:STATe] <boolean> |
| Parameters | 1\|ON 0\|OFF |
| *RST | OFF |
| Examples | TRIG:STAT ON |
| Query Syntax | TRIGger:STATe? |
| Returned Parameters | 1 or 0 |
| Related Commands | TRIG |

**TRIGger:SLOPe**

This command sets the polarity for the external signal that the load will trigger at.

| | |
|---|---|
| Command Syntax | TRIGger:SLOPe <numrated> |
| Parameters | POS \| NEG |
| *RST | POS |
| Examples | TRIG:SLOP POS |
| Query Syntax | TRIGger:SLOPe? |
| Returned Parameters | POS \| NEG |
| Related Commands | TRIG TRIG:STAT |

# 10. Common Commands

Common commands begin with an * and consist of three letters (command) or three letters and a ? (query). Common commands are defined by the IEEE 488.2 standard to perform some common interface functions. The Load responds to the required common commands that control status reporting, synchronization, and internal operations. It also responds to optional common commands that control triggers, and stored operating parameters.

Common commands and queries are listed alphabetically. If a command has a corresponding query that simply returns the data or status specified by the command, then both command and query are included under the explanation for the command. If a query does not have a corresponding command or is functionally different from the command, then the query is listed separately. The description for each common command or query specifies any status registers affected. Refer to Chapter 11 for details on how to read specific register bits and use the information that they return.

Common Commands Syntax

| | |
|---|---|
| *CLS | Clear status |
| *ESE <n> | Standard event status enable |
| *ESE? | Return standard event status enable |
| *ESR? | Return event status register |
| *IDN? | Return instrument identification |
| *OPC | Enable "operation complete" bit in ESR |
| *OPC? | Return a "1" when operation complete |
| *OPT? | Return option number |
| *PSC <bool> | Power-on status clear state set/reset |
| *PSC? | Return power-on status clear state |
| *RCL <n> | Recall instrument state |
| *RST | Reset |
| *SAV <n> | Save instrument state |
| *SRE <n> | Set service request enable register |
| *SRE? | Return service request enable register |
| *STB? | Return status byte |
| *TRG | Trigger |
| *WAI | Hold off bus until all device commands done |

## 10.1 *CLS

This command clears the following registers (see Chapter 11 for descriptions of all status registers):

- Standard Event Status
- Status Byte
- Error Queue

| | |
|---|---|
| Command Syntax | *CLS |
| Parameters | None |

## 10.2 *ESE

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

The query reads the Standard Event Status Enable register.

**Bit Configuration of Standard Event Status Enable Register**

| Bit Position | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Bit Name | PON | not used | CME | EXE | DDE | QYE | not used | OPC |
| Bit Weight | 128 | | 32 | 16 | 8 | 4 | | 1 |

| | | | |
|---|---|---|---|
| CME | Command error | DDE | Device-dependent error |
| EXE | Execution error | OPC | Operation complete |
| PON | Power-on | QYE | Query error |

| | |
|---|---|
| Command Syntax | *ESE <NRf> |
| Parameters | 0 - 255 |
| Power-On Value | 0 (see *PSC command) |
| Example | *ESE 129 |
| Query Syntax | *ESE? |
| Returned Parameters | <NR1>(Register value) |
| Related Commands | *ESR? *STB? |

## 10.3 *ESR?

This query reads the Standard Event Status Event register. Reading the register clears it. The bit configuration of this register is the same as the Standard Event Status Enable register (see *ESE). See Chapter 11 for a detailed explanation of this register.

| | |
|---|---|
| Query Syntax | *ESR? |
| Parameters | None |
| Returned Parameters | <NR1>(Register value) |
| Related Commands | *CLS *ESE *ESE? *OPC |

## 10.4 *IDN?

This query requests the Load to identify itself. It returns the data in four fields separated by commas.

| | | |
|---|---|---|
| Query Syntax | *IDN? | |
| Returned Parameters | <AARD> | |
| | Field | Information |
| | California Instruments | Manufacturer |
| | xxxxxx | Model number and letter |
| | nnnnnn | Serial number or 0 |
| | Rev. n.n/n.n | Revision levels of firmware |
| Example | "CALIFORNIA INSTRUMENTS,804BL, 1234, Rev 2.1" | |

## 10.5 *OPC

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

Pending operations are complete when all commands sent before *OPC have been executed. This includes overlapped commands. Most commands are sequential and are completed before the next command is executed. Overlapped commands are executed in parallel with other commands.

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

The query causes the interface to place an ASCII "1" in the Output Queue when all pending operations are completed.

| | |
|---|---|
| Command Syntax | *OPC |
| Parameters | None |
| Query Syntax | *OPC? |
| Returned Parameters | <NR1> |
| Related Commands | *TRIG *WAI |

## 10.6 *OPT?

This query causes the Load to identify any options that are installed. Options are identified by a string keyword or a number. A 0 indicates no options are installed. If an option is installed, its corresponding keyword will be returned. Refer to the SYSTem:CONFigure[:BYTE] command on page 58 for more details.

| | |
|---|---|
| Query Syntax | *OPT? |
| Returned Parameters | <CRD>,[<CRD>] |

## 10.7 *PSC

This command controls the automatic clearing at power-on of the Service Request Enable and the Standard Event Status Enable registers (see Chapter 11 under 11.3 for register details):

| | |
|---|---|
| *PSC ON \| 1 | Prevents the register contents from being saved causing them to be cleared at power-on. This prevents a PON event from generating a SRQ at power-on. |
| PSC OFF \| 0 | Saves the contents of the Standard Event Enable and Service Request Enable registers in nonvolatile memory and recalls them at power-on. This allows a PON event to generate SRQ at power-on. Using the PCS command in this mode allows the control program to detect a power failure condition that caused the source to power down and back up again. |

| | |
|---|---|
| Command Syntax | *PSC<bool> |
| Parameters | 0 \| 1 \| OFF \| ON |
| Example | *PSC 0 *PSC 1 |
| Query Syntax | *PSC? |
| Returned Parameters | 0 \| 1 |
| Related Commands | *ESE *SRE |

## 10.8 *RCL

This command restores the Load to a state that was previously stored in memory with a *SAV command to the specified location. All states are recalled with the following exceptions:

| | |
|---|---|
| Command Syntax | *RCL <NRf> |
| Parameters | 0 through 7 |
| Example | *RCL 3 |
| Related Commands | *RST *SAV |

## 10.9 *RST

The reset (*RST) command has the same effect as an IEEE-488 Device Clear bus command but can be used over the RS232C interface as well. This command resets the load to the following factory-defined states:

| Item | Value | Item | Value |
|---|---|---|---|
| TRIG:STAT | OFF | OUTP:STATE | PONSetup |
| TRIG:SLOP | POS | | |

*Table 10-1: *RST default parameter values*

| | |
|---|---|
| Command Syntax | *RST |
| Parameters | None |
| Related Commands | *SAV |

A *RST command or a IEEE-488 Device Clear also clears all status registers but does not change the Event Enable registers for each status register group.

## 10.10 *SAV

This command stores the present state of the Load to a specified location in memory. Up to 8 states can be stored in nonvolatile memory.

| | |
|---|---|
| Command Syntax | *SAV |
| Parameters | 0 through 7 |
| Related Commands | PSC *RCL *RST |

## 10.11 *SRE

This command sets the condition of the Service Request Enable Register. This register determines which bits from the Status Byte Register (see *STB for its bit configuration) are allowed to set the Master Status Summary (MSS) bit and the Request for Service (RQS) summary bit. A 1 in any Service Request Enable Register bit position enables the corresponding Status Byte Register bit and all such enabled bits then are logically ORed to cause Bit 6 of the Status Byte Register to be set. See paragraph 11.3 for more details concerning this process.

When the IEEE-488 BUS controller conducts a serial poll in response to an SRQ, the RQS bit is cleared, but the MSS bit is not. When *SRE is cleared (by programming it with 0), the source cannot generate an SRQ to the controller.

| | |
|---|---|
| Command Syntax | *SRE <NRf> |
| Parameters | 0 to 255 |
| Default Value | 0 (see *PSC command) |
| Example | *SRE 255 |
| Query Syntax | *SRE? |
| Returned Paramters | <NR1>(Register binary value) |
| Related Commands | *ESE *ESR |

## 10.12 *STB?

This query reads the Status Byte register, which contains the status summary bits and the Output Queue MAV bit. Reading the Status Byte register does not clear it. The input summary bits are cleared when the appropriate event registers are read (see Chapter 11 for more information). A serial poll also returns the value of the Status Byte register, except that bit 6 returns Request for Service (RQS) instead of Master Status Summary (MSS). A serial poll clears RQS, but not MSS. When MSS is set, it indicates that the AC Load has one or more reasons for requesting service.

**Bit Configuration of Status Byte Register**

| Bit Position | 7 | 6 | 5 | 4 | 3 | 2 - 0 |
|---|---|---|---|---|---|---|
| Bit Name | OPER | MSS RQS | ESB | MAV | QUES | not used |
| Bit Weight | 128 | 64 | 32 | 16 | 8 | |

| | | | |
|---|---|---|---|
| OPER | Not used, will report 0 | MSS | master status summary |
| ESB | event status byte summary | RQS | request for service |
| QUES | Not used will report 0 | MAV | message available |

| | |
|---|---|
| Query Syntax | *STB? |
| Returned Paramters | <NR1> (Register binary value) |
| Related Commands | *SRE *ESE *ESR |

## 10.13 *TRG

This command is a software trigger that will cause all channels to update their program parameters to the values set by the trigger parameters if the trigger state is enabled.

| | |
|---|---|
| Command Syntax | *TRG |
| Parameters | None |

## 10.14 *WAI

This command has no function and will be ignored.

| | |
|---|---|
| Command Syntax | *WAI |
| Parameters | None |
| Related Commands | *OPC |

# 11. Status Registers

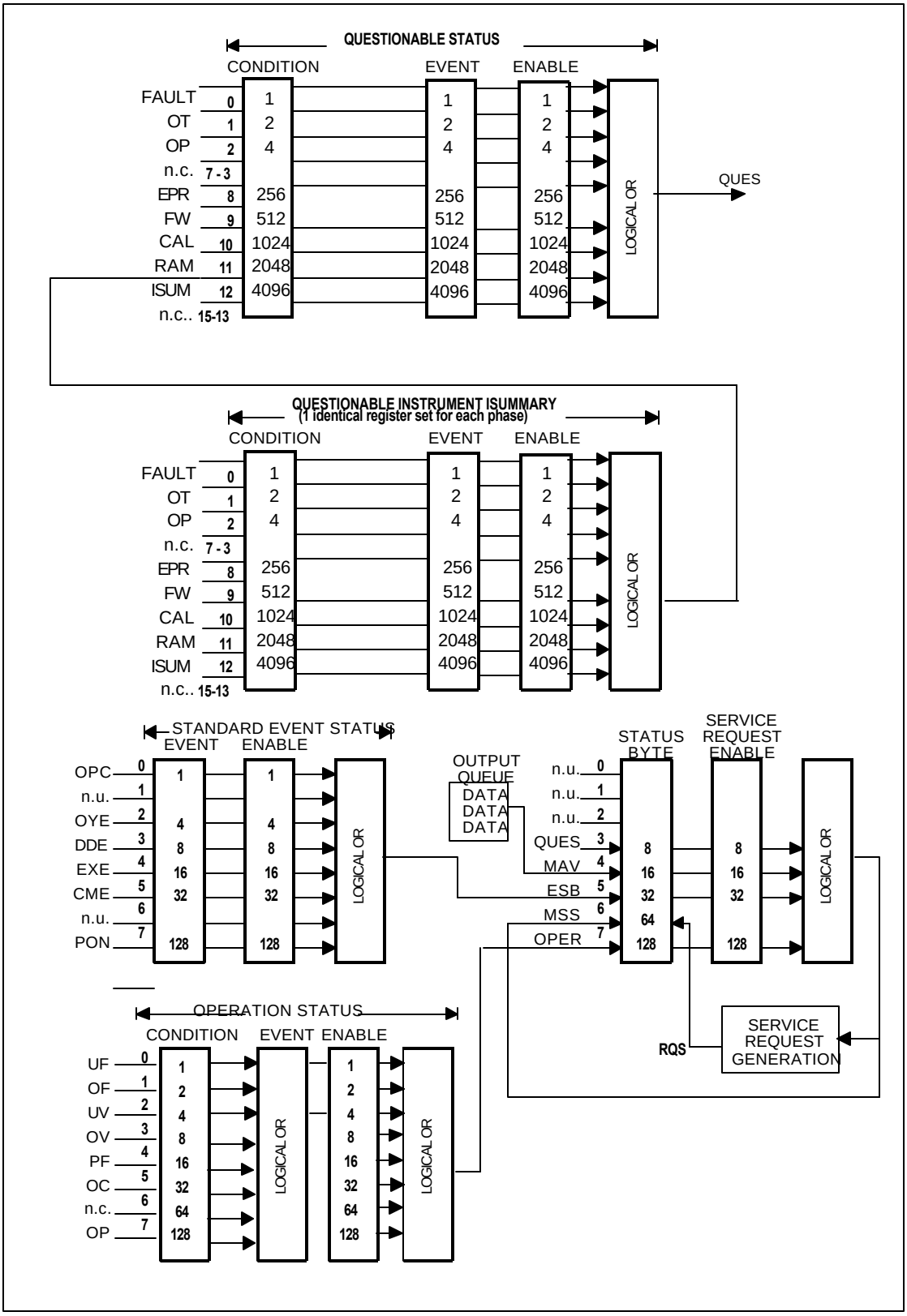
You can use status register programming to determine the operating condition of the Load at any time. For example, you may program the Load to generate an interrupt (assert SRQ) when a channel failed to communicate with the controller. When the interrupt occurs, your program can then act on the event in the appropriate fashion.

Figure 11-1 shows the status register structure of the Load. The Standard Event, Status Byte, and Service Request Enable registers as well as the Output Queue perform standard IEEE-488 functions as defined in the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation.

## 11.1 Power-On Conditions

All status register groups are cleared at power on. This means all data bits and all Event Enable register bits are cleared. It is possible however to set the PON mask in the Event enable register to cause a SRQ. This can be accomplished using the *PSC command. Once set, this condition is retained in non-volatile memory and will be recalled when power is applied to the Load. See paragraph 10.7 for details on the use of the *PSC command.

*Figure 11-1: Status System Model*



## 11.2 Standard Event Status Group

This group consists of an Event register and an Enable register that are programmed by Common commands. The Standard Event register latches events relating to the interface communication status (see Figure 11-1). It is a read-only register that is cleared when read. The Standard Event Enable register functions similarly to the enable registers of the Operation and Questionable status groups.

| Command | Action |
|---|---|
| *ESE | programs specific bits in the Standard Event Enable register. |
| *ESR? | reads and clears the Standard Event Event register. |

The PON bit in the Standard Event Event register is set whenever the Load is turned on. The most common use for PON is to generate an SRQ at power-on following an unexpected loss of power.

## 11.3 Status Byte Register

This register summarizes the information from all other status groups as defined in the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation.

| Command | Action |
|---|---|
| *STB? | Reads the data in the register but does not clear it (returns MSS in bit 6) |
| serial poll | Reads and clears the data in the register (returns RQS in bit 6) |

### The MSS Bit

This is a real-time (unlatched) summary of all Status Byte register bits that are enabled by the Service Request Enable register. MSS is set whenever the Load has one or more reasons for requesting service. *STB? reads the MSS in bit position 6 of the response but does not clear any of the bits in the Status Byte register.

### The RQS Bit

The RQS bit is a latched version of the MSS bit. Whenever the Load requests service, it sets the SRQ interrupt line true and latches RQS into bit 6 of the Status Byte register. When the controller does a serial poll, RQS is cleared inside the register and returned in bit position 6 of the response. The remaining bits of the Status Byte register are not disturbed.

### The MAV bit and Output Queue

The Output Queue is a first-in, first-out (FIFO) data register that stores Load-to-controller messages until the controller reads them. Whenever the queue holds one or more bytes, it sets the MAV bit (bit 4) of the Status byte register.

# 12. Options

| | |
|---|---|
| -RMK | Rack mount handle kit. Required to mount the 804BL in an instruments rack. |

# Appendix C: Error Messages

*Table 12-1: Error Messages*

| Error Number | Error Message String | Possible Cause |
|---|---|---|
| 0 | "No error" | |
| -100 | "Command error" | Command is not allowed in this context |
| -102 | "Syntax error" | Command mis-spelled |
| -103 | "Invalid separator" | Wrong separator used |
| -104 | "Data type error" | Different data type expected |
| -108 | "Parameter not allowed" | A parameter was send with the command but none was expected, |
| -109 | "Missing parameter" | A parameter was expected but none was send with the command. |
| -110 | "Command header error" | Wrong command header. Check command syntax. |
| -111 | "header separator error" | Invalid command separator. Use ";" |
| -112 | "Program mnemonic too long" | Command too long. Try breaking up into smaller commands. |
| -113 | "Undefined header" | Command not recognized. Check command syntax |
| -120 | "Numeric data error" | Error in number |
| -121 | "Invalid character in number" | Number send as part of command is not a valid number. |
| -123 | "Exponent too large" | Exponent out of range. |
| -128 | "Numeric data not allowed" | Command probably uses string parameters |
| -168 | "Block data not allowed" | Block data only supported for specific commands. |
| -200 | "Execution error" | Command execution failed. Unit could be in wrong mode or range |
| -201 | "Invalid while in local" | Unit only accepts IEEE bus commands while in REMOTE. Use ATN line to put unit in remoter before sending commands. |
| -203 | "Command protected" | Command requires password unlock first. |
| -210 | "Trigger error" | Trigger request failed |
| -211 | "Trigger ignored" | Trigger command could not be executed, possibly due to setup problem. Check program flow and syntax. |
| -213 | "Init ignored" | Subsystem could not be initialized. Check program flow and syntax. |
| -220 | "Parameter error" | Invalid parameter or parameter of wrong type. |
| -221 | "Setting conflict" | Requested setting conflicts with other setting. Check mode and operating restrictions. |
| -222 | "Data out of range" | Parameter data send with command is out of range. Check mode or range settings. |
| -223 | "Too much data" | More data send with command than expected. |
| -224 | "Illegal parameter value" | Parameter value not correct |
| -226 | "Lists not same length" | Sequence list for one or more sequence parameters has a different length |

| Error Number | Error Message String | Possible Cause |
|---|---|---|
| -241 | "Hardware missing" | Command requires hardware that is not present. |
| -254 | "Media full" | Not enough free memory or media available to save requested data or setup Delete one or more files or registers. |
| -255 | “Directory full” | No more directory entries available. Delete one or more files or registers. |
| -256 | “File name not found” | File or register requested for load or restore operation could not be found. Try changing media. |
| -257 | “File name error” | Error in file name. Check syntax and format. |
| -258 | “Illegal variable name” | Name of variable is not allowed. May conflict with other key words. |
| 3 | "Temperature fault" | Temperature too high. Check airflow, vents and fans. |
| 4 | "External sync. error" | Unable to sync to external unit. |
| 5 | "Initial memory lost" | Power on setup memory corrupted. |
| 6 | "Limit memory lost" | Configuration memory corrupted. |
| 7 | "System memory lost" | |
| 8 | "Calibration memory lost" | Calibration coefficients lost. Recalibrate unit. |
| 11 | "Duplicate sequence" | Error programming sequence. |
| 12 | "Too many sequence" | Number of steps in sequence is too high. |
| 13 | "Missing list parameter" | One or more parameters for list not specified or incorrect. |
| 16 | "Illegal during transient" | Requested operation can not occur while sequence or transient is in progress. |
| 20 | "Input buffer full" | Communication input buffer overrun. Try breaking up commands in smaller strings. |
| -300 | "Device specific error" | Hardware specific errror. |
| -311 | "Memory error" | |
| -314 | "Save/recall memory lost" | Registers may never have been saved to. |
| -315 | "Configuration memory lost" | Check limit settings |
| -330 | "Self-test failed" | Power on self test failure. Contact service. |
| -350 | "Queue overflow" | Too many errors without reading error queue |
| -400 | "Query error" | Unable to respond to query |
| -410 | "Query INTERRUPTED" | Another command came in before the response to a query was picked up. Check program flow. |
| -420 | "Query UNTERMINATED" | Response to a query never picked up. Check program flow. |
| -430 | "Query DEADLOCKED" | Two or more queries are interleaved. Check program flow. |
| -440 | "Query UNTERMINATED" | Response to a query never picked up. Check program flow. |

# 13. Index

***G***



***H***



***I***



***K***



***L***



***M***



***P***

***Q***



***R***



***S***



***T***



***U***



***W***