# XBL Series
# Electronic Loads
## Operation & Programming Manual

**TDI-Dynaload® Division**

Document Number 404078 — Revision P4

## Disclaimer

The contents of this document, including all specifications, are subject to change without notice.

## Mandatory Customer Information
## Federal Communications Commission (FCC) Statement

**NOTE:** This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy; and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. Operation of this equipment in a residential area may cause harmful interference in which case the user will be required to correct the interference at their expense.

## Trademarks

**Dynaload** is a registered trademark of Transistor Devices, Inc.

## Ordering Information

The ordering number for this document is 402825. To order this document, contact:

TDI-Dynaload Division
36 Newburgh Road
Hackettstown, NJ 07840
Telephone: (908) 850-5088
Facsimile: (908) 850-0679

## Online Availability

To find out more about TDI and our products, visit us on the web at: **http://www.tdipower.com/** or visit TDI-Dynaload directly at: **http://www.dynaload.com**.

## Customer Services

For technical assistance regarding our products, contact the following:

## Sales Inquires, Customer Service and Repairs

Dynaload Sales
sales@tdipower.com
Customer Service
Kelly Bray: bray_k@tdipower.com
Telephone: (908) 850-5088
Facsimile: (908) 850-0679

# Attention:

**Addendum to**
**XBL Series Electronic Load**
**Operations and Programming Manual**
Document # 404078-Revision P2

The query "**ERR**?" (*Error Register)* (page 67 of the manual) is currently not supported by the code in the unit. If an incorrect command is sent to the unit, the command will be ignored.

The query "**CON**?" (*Condition Register)*(page 58 of the manual) is currently not supported by the code in the unit.

The query "**STATUS?**" replaces "**CON**?" (*XBL Alarm Status)*(page 125 of the manual) is supported by the code in the unit. This query gives the same response messages as "CON?" above only the Bit and Weight are different.

The query "**IST?**" (*Internal Self Test*) will only return "Self Test Passed" if sent with the following two conditions.

1. The input stud voltage to the load **must** be at zero volts.
2. The unit must be in the "**Load On**" condition.

# Contents

Chapter 1. — Overview ........ 10
Introduction ........ 10
Model Number ........ 11
Modes of Operation ........ 11
Constant Current Mode ........ 11
Constant Resistance Mode ........ 12
Constant Voltage Mode ........ 12
Constant Power Mode ........ 12
Pulse Mode ........ 12
Front Panel Features and Controls ........ 13
Table A Continued. Front Panel Features and Controls ........ 14

Chapter 2. — Operating Instructions ........ 16
Operator Safety Instructions and Symbols ........ 16
Rear Panel Description and Electrical Connections ........ 17
E– and E+ Power Input Connections ........ 18
The Master /Slave connectors: ........ 18
The “IEEE-488” Connector ........ 18
Ethernet Communications Connector: ........ 18
AC Input ........ 18
Input Voltage Selector ........ 18
AC Input Wiring Tips ........ 19
Fuse Replacement ........ 19
Current Interrupt Circuit (Option) ........ 19
The Master/Slave Connectors ........ 20
Master/Slave Connector Wiring ........ 20
The Terminal Block and Terminal Block Connections ........ 20
*External Instruments connected to the terminal block (TB) should be isolated not earth grounded. All input or output TB connections should be references to S-.* ........ 21
CS (Current Sample) ........ 21
REM (Remote or External Programming) ........ 21
EN (Remote Enable) ........ 21
*Remove local sense jumpers before connecting the remote sense wires to your power source or damage will occur to the load.* ........ 22
S– and S+ (Voltage Sense) ........ 22
S– and S+ (Voltage Sense) Wiring Tips ........ 22
Terminal Block Connections Optional Equipment Wiring ........ 24
Effects Of Cable Length ........ 25
Current Oscillation ........ 25
Line Loss ........ 25
Recommended Operating Procedure ........ 27
Operating Mode Guidelines ........ 28
CI — Constant Current Mode (Basic Mode) ........ 28
CR — Constant Resistance Mode (Basic Mode) ........ 28
CV — Constant Voltage Mode (Basic Mode) ........ 29
CP — Constant Power Mode (Basic Mode) ........ 29

Full Scale Range Switching ........................................................................................29
Master/Slave Parallel Operation ..................................................................................29
Short Circuit Feature...................................................................................................30
MEM — Memory Recall Locations ............................................................................30
Manual Adjust.............................................................................................................31
Remote Programming .................................................................................................31
Local Control .............................................................................................................31
Fault Indicators ...........................................................................................................31
Programmable Under Voltage ....................................................................................32
Menu Commands........................................................................................................32
#1 MODEL ............................................................................................................33
Pulse Mode ............................................................................................................36
Manual Operation .......................................................................................................37
Operation using IEEE-488 Programming...................................................................37
Effects of Cable Inductance On Pulse Loading ..........................................................37
Transconductance .......................................................................................................39
Location, Airflow, Maintenance..................................................................................39
Troubleshooting Guide...............................................................................................41

Chapter 3. — PC Control using IEEE-488 Commands and Programming... 47
Control of a Dynaload through a Personal Computer .................................................47
Introduction .................................................................................................................47
IEEE-488 Bus Subsets.................................................................................................47
Data Separators............................................................................................................48
Program Line Terminators ..........................................................................................48
Numerical Data Formats..............................................................................................48
Numerical Data Units ..................................................................................................48
Power-on Defaults........................................................................................................51
Queries ........................................................................................................................52
XBL Command and Queries Listed Alphabetically.....................................................52
*IDN? _Identification_ ............................................................................................57
*RST Reset ............................................................................................................57
*TST? Alternate form of IST? query......................................................................58
AV1 _Amps/Volt Pulsing Base Level_ ....................................................................58
AV2 Amps/Volt Pulsing Peak Level ......................................................................58
AV?........................................................................................................................59
APV Amps/Volt High alternate command .............................................................59
AVH Amps/Volt High.............................................................................................59
VL _Amps/Volt Low_ ...............................................................................................59
DDTE?...................................................................................................................61
BLDLOC? .............................................................................................................62
CI _Constant Current_ ..............................................................................................63
CLRBB ..................................................................................................................64
CON? _Condition register_......................................................................................64
CP _Constant Power_...............................................................................................66
CR? ........................................................................................................................67
CR _Constant Resistance Low alternate command_ ................................................68

CRH *Constant Resistance High*.....69
CRL *Constant Resistance Low*.....70
CV *Constant Voltage*.....71
DU *Duty Cycle*.....72
ERR? *Error Register*.....72
ET RST *Elapsed Timer Reset*.....74
ET? *Elapsed Timer*.....75
FQ Frequency.....75
GPRCLS Close General Purpose Relay.....75
GPROPN Open General Purpose Relay.....75
GWY *Set Ethernet Gateway*.....77
I? *Read Current*.....78
I1 *Constant Current Pulsing Base Level*.....79
I2 *Constant Current Pulsing Peak Level*.....80
ID? *Identification*.....81
INDEP *Independent Mode*.....85
IL *Current Limit*.....86
IP *Set Ethernet Address*.....87
IST? *Internal Self Test*.....88
IWV *Constant Current Mode After Compliance Voltage Reached*.....89
LAT *Latch register*.....92
LOAD *Load On/Off Control*.....93
LOCK *Front Panel Lock*.....94
MAC? *Ethernet MAC Address*.....95
MASTER *Master Mode*.....96
MAXCUR? *Maximum Current Measured*.....97
MAXPWR? *Maximum Power Measured*.....98
MAXVOL? *Maximum Voltage Measured*.....99
MDL?.....100
MODE? *Operating Mode*.....101
MR *Memory Recall*.....102
MS *Memory Save*.....103
NM *Set Ethernet Net Mask*.....105
P? *Read Power*.....106
P1 *Constant Power Pulsing Base Level*.....107
P2 *Constant Power Pulsing Peak Level*.....108
PL *Power Limit*.....109
PORT *Set Ethernet TCP Port*.....110
R1 *Constant Resistance Pulsing Base Level*.....111
R2 *Constant Resistance Pulsing Peak Level*.....112
RNG *Range*.....113
RNGS?.....114
RS232 *RS232 Settings*.....115
RST *Reset*.....117
S1 *Rising Slew Rate*.....118
S2 *Falling Slew Rate*.....119
SBE *Summary Bit Enable register*.....120
SDN *Shutdown register*.....121

SERNO? *XBL Serial Number* ..... 122
SF *Slew Fast* ..... 123
SHORT *Short Circuit* ..... 124
SLAVE *Slave Mode* ..... 125
SN? ..... 126
SR *Slew Rate* ..... 127
SRQ *Service Request Register* ..... 128
SS *Slew Slow* ..... 129
STA? *Status Register* ..... 130
STATUS? *XBL Alarm Status (HEX)* ..... 131
STATXT Status Text ..... 132
SW *Square Wave Pulsing* ..... 133
T1 *Pulsing Base Time* ..... 134
T2 *Pulsing Peak Time* ..... 135
TEXT *Text Mode* ..... 136
UV *Under Voltage* ..... 137
V? *Read Voltage* ..... 138
V1 *Constant Voltage Pulsing Base Level* ..... 139
V2 *Constant Voltage Pulsing Peak Level* ..... 140
VER? *Version* ..... 141
VL *Voltage Limit* ..... 142
WARRDTE? ..... 143
WF *Waveform* ..... 144
XM *External Modulation* ..... 145
Status and Event Registers —Status Structure ..... 146

Glossary ..... 149

Setting Up Ethernet Communications ..... 163

Chapter 4. — Appendix A — List of Commands ..... 166

Appendix B — List of Queries ..... 166

Appendix C — Outline Drawings by Model ..... 167

# Figures

Figure 1. Constant Current Mode ....................11

Figure 2. Constant Resistance Mode ....................12

Figure 3. Constant Voltage Mode ....................12

Figure 4. Constant Power Mode ....................12

Figure 5. Front Panel Features and Controls ....................13

Figure 6. Typical Rear Panel Connections ....................17

Figure 7. "Canbus" RJ 12 Master - Slave connection ....................20

Figure 8. Terminal Block Connections ....................21

Figure 9. Remote Voltage Sense ....................23

Figure 10. Terminal Block Connections Optional Equipment Wiring....................24

Figure 11. Load Status Structure ....................147

# Tables

Table A. Front Panel Features and Controls ....................13

Table B. Equipment Safety Symbols....................16

Table C. Voltage Selector Tab Setting Guide ....................19

Table D. Wire Gauge/Ampere Rating Reference Table....................26

Table E. Major and Minor Fault Indicators....................31

Table F. Menu Commands ....................32

Table G. Troubleshooting Fault Conditions and Indicators ....................41

Table H. Troubleshooting (Symptoms/Possible Causes/Explanations and Corrective Actions) ...41

Table I. Bus Subset Capabilities........................................................................................47

Table J. Numerical Data Formats......................................................................................48

Table K. Numerical Data Units..........................................................................................49

Table L. Power on Defaults................................................................................................51

# Equations

Equation 1. Establishing Maximum Cable Length........................................................37

Equation 2. Formula to Establish Capacitor Requirements ..........................................38

# Chapter 1. — Overview

## Introduction

The XBL Series single channel loads are ideal for testing power supplies, fuel cells, large batteries, and other related DC power equipment.

The high range current capability and constant power feature facilitate battery testing and analysis. The ultra-fast slew rate provides unmatched power supply transient testing capabilities.

The ultra-low voltage, high current capability makes the XBL Series an ideal solution for most fuel cell requirements.

Standard Features for the XBL Series include the following:

- Ratings from 0-1000 Volts (XBL 1000V only), 0-1000 Amps, up to 6000 watts in a single unit
- Units available include:
- 800 Watt (8 inches W x 5.25 inches H x 22 inches D)
- 2000 Watt (19 inches W x 5.25 inches H x 22 inches D)
- 4000 Watt (19 inches W x 8.75 inches H x 22 inches D)
- 6000 Watt (19 inches W x 10.5 inches H x 22 inches D)
- Variable speed fans minimize fan noise (standard on 2000W , 4000 and 6000W only)
- Operation below 0.5 volts at 1000 Amps (On 50V, 1000A units only.)
- Five modes of operation: Constant Current, Constant Resistance, Constant Power, Constant Voltage, Pulse Mode
- Full Scale Range Switching: for increased resolution and accuracy
- Synchronized paralleling to create larger systems that are controlled simultaneously
- Internal pulse generator for transient testing (Slew is not adjustable in pulse mode)
- Lab View drivers are available for IEEE-488 computer control.
- Ethernet control
- XBLs have a remote user interface are available.

## Model Number

| | | | | | |
|---|---|---|---|---|---|
| **Understanding Your Model Number** | | | | | |
| Dynaloads Model Numbering System | | | | | |
| Each part of the model number describes the capabilities of the unit | | | | | |
| Example | | | | | |
| XBL/RBL | 488 | 400 | 600 | 4000 | D |
| Family Type | Communication Interface | Max Volts | Max Amps | Max Watts | Letter |
| RBL= Air Cooled | IEEE488 unless SDL | 50-1000 | Various | 400-6000 | Current Interrupt |
| WCL=Water Cooled Master | RS232 special order | 50-1000 | Various | 400-6000 | |
| WCS=Water Cooled Slave | No control functions | 50-1000 | Various | 400-6000 | |
| XBL=Digital Processing | Ethernet models after( 2006) | 50-1000 | Various | 400-6000 | |
| SDL=Special Dynaload | Various configurations | 50-1000 | Various | 400-6000 | Modified |
| DLP= Dyna Load Pulse | Original Pulsed loads | | | | |
| DLVP=Variable Pulse | 2nd Generation Pulsed Load | | | | |
| MCL=Multi Channel Load | Various Modules | 50-600 | Various | 175 & 350 | |
| Rack Systems Designators | | | | | |
| System Numbering Method Example | | | | | |
| SYS | 52 | 400 | 00120 | | P |
| SYSTEM | Rack Height in inches | Max Voltage | Total Watts(all units) | | Coolant Purge |

The Dynaload modes of operation are described in the sections that follow and are thoroughly detailed in *Chapter 2.* — Operating Instructions.

## Modes of Operation

The Dynaload is a precision instrument that simulates DC loads to test power supplies, generators, servo systems, batteries and similar DC sources.

The XBL Series provides five basic modes of operation: Constant Current, Constant Resistance, Constant Voltage, Constant Power and Pulse Mode. Complete control is available through the full feature front panel, IEEE-488 bus, RS232, or Ethernet interface. A 0-10V analog programming input is standard in constant current mode. The connections for RS 232, Ethernet, or IEEE-488 and analog programming are located at the rear of the unit. Refer to **Error! Reference source not found.** Through **Error! Reference source not found.** and the five modes of operation explanations that follow.

## Constant Current Mode

Referring to **Error! Reference source not found.**, the Dynaload will sink the set current regardless of the input voltage.

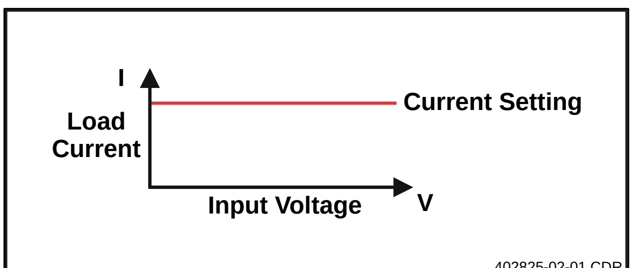



***Figure 1. Constant Current Mode***

### Constant Resistance Mode

Referring to **Error! Reference source not found.**, the Dynaload will sink current linearly proportional to the input voltage. This is set in Amps/Volt, (1/R), or ohms.

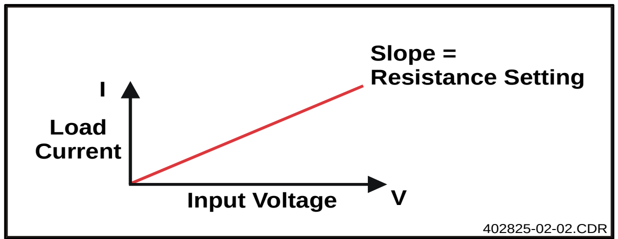



***Figure 2 Constant Resistance Mode***

### Constant Voltage Mode

Referring to **Error! Reference source not found.**, the Dynaload will sink the current required to maintain the voltage of the source connected to it.

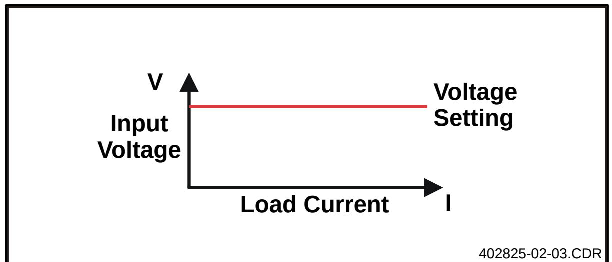



***Figure 3. Constant Voltage Mode***

### Constant Power Mode

Referring to **Error! Reference source not found.**, the Dynaload will sink the current required at its present input voltage to maintain the desired power level.

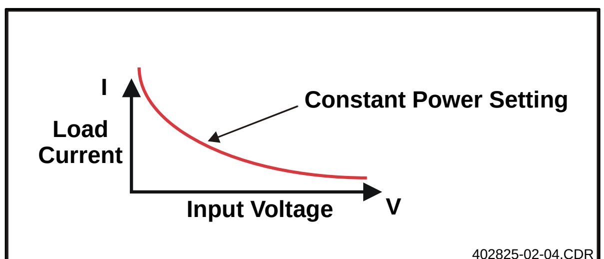



***Figure 4. Constant Power Mode***

### Pulse Mode

This mode can be used with any of the three preceding modes. Pulse mode is an enhancement that allows for operation between two predefined levels of current, resistance, voltage or power.

# Front Panel Features and Controls

To better understand the features and controls of the front panel, refer to Figure and Table . The item numbers in the figure directly correspond to the item numbers in the table.

**“Note” Pulse mode cannot be used in CV Mode**

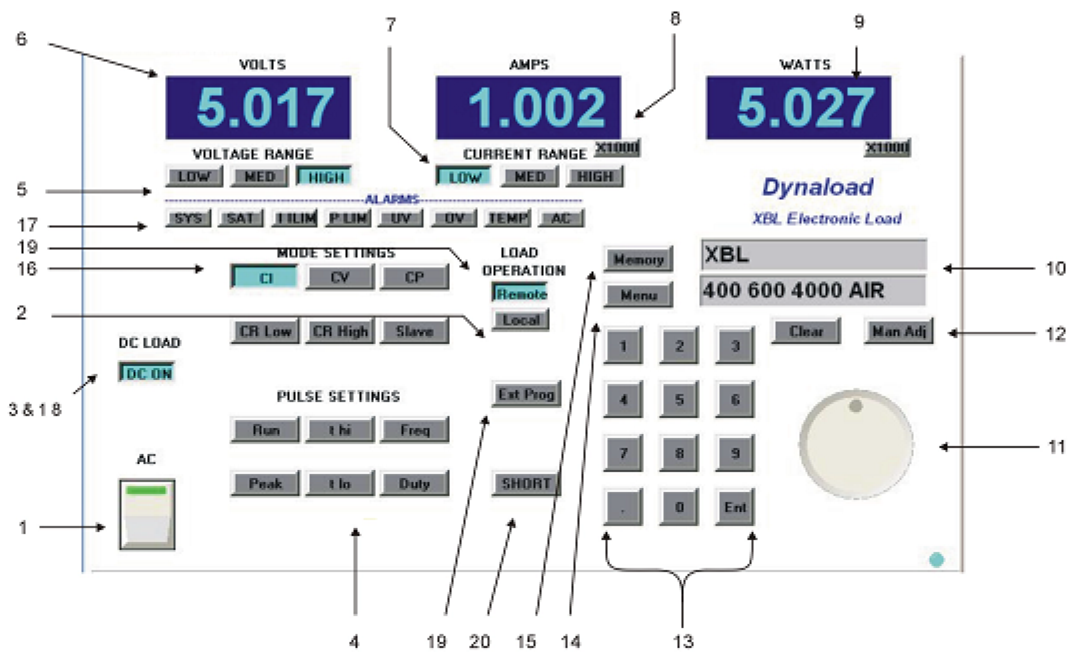



*Figure 5. Front Panel Features and Controls*

| *Table A. Front Panel Features and Controls* | |
|---|---|
| **Item Number** | **Description** |
| 1 | AC Power (Power On, Power Off) |
| 2 | Remote / Local Select |
| 3 | DC Load (On, Off) |

***Table A Continued. Front Panel Features and Controls***

| | |
|---|---|
| 4 | Pulse Mode Controls<br>RUN: Pulse Mode On/Off<br>PEAK: Sets peak amplitude of pulse<br>FREQ: Sets frequency of pulse<br>DUTY CYCLE: Sets duty cycle of pulse<br>TLO (Time LOW): Sets duration of the low portion of pulse<br>THI (Time HIGH): Sets duration of the high portion of pulse |
| **Item Number** | **Description** |
| 5 | Voltmeter/Voltage Full Scale Range Selection* |
| 6 | Voltmeter - 4 digit |
| 7 | Ammeter/Current Full Scale Range Selection* |
| 8 | Ammeter - 4 digit |
| 9 | Watt meter - 4 digit |
| 10 | Backlit Alpha-Numeric Display. This display indicates data input from the front panel controls. This will also display other data as selected through the menu selector. |
| 11 | Manual Adjust Knob |
| 12 | Manual Adjust Enable |
| 13 | Keypad (for numerical entry) |
| 14 | Menu Select |
| 15 | MEMORY Presets (up to 6 configurations) |
| 16 | Mode Select<br>CI: Constant Current Mode Select<br>CV: Constant Voltage Mode Select<br>CP: Constant Power Mode Select<br>CR LOW: Constant Resistance (Low Ohm) Mode Select<br>CR HIGH: Constant Resistance (High Ohm) Mode Select<br>EXT PROG: Remote Programming Mode Select<br>SLAVE: Slave Mode Selection<br>SHORT: Short Circuit toggle (Latching action use with caution) |
| 17 | Fault And Warning Status Indicators<br>SYS: System Fault Indicator<br>UV: Undervoltage Fault Indicator<br>OV: Overvoltage Fault Indicator<br>TEMP: Over Temperature Fault Indicator<br>I LIM: Current Limit Warning Indicator<br>P LIM: Power Limit Warning Indicator<br>SAT: Saturation Warning Indicator<br>AC: Line Voltage Fault Warning Indicator |
| 18 | Load on Indicator ( Item 18 on figure 5) |

| | |
|---|---|
| 19 | Remote Program Enable (Toggle) |
| 20 | Short Circuit Test Enable (Toggle) |

* The XBL Series offers selectable full-scale ranges for current and voltage. When a full scale is selected it changes the full scale of the meter, the current sample, the front panel adjustments, IEEE controlled adjustments and the analog programming input. This provides an increase in accuracy and resolution. There are three standard full-scale current ranges and three standard full-scale voltage ranges.

# *Chapter 2. — Operating Instructions*

## Operator Safety Instructions and Symbols

It is very important that these safety instructions and operation instructions are read and understood prior to the installation and use of this electronic load. Failure to follow these basic guidelines could result in serious injury, death or damage to the load.

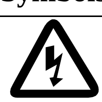
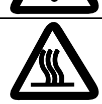
This electronic load is inherently safe by design. It cannot produce any hazardous voltages or currents; however, when in use it may expose the operator to the hazards of the DC source to which the load is connected. This equipment is intended for use by trained personnel. There are no operator serviceable parts inside. All service and calibration must be performed by authorized personnel only. Table B describes the safety symbols and their definitions. Safety symbols are placed to ensure the safety of Dynaload operators and should never be covered or removed from the equipment.

**WARNING:**

***Ensure that all AC and DC power for the load, the test source, and any peripheral equipment is OFF prior to making any connections to the load. Also ensure that the proper AC input range is selected before attaching the line cord; and that the load selected is properly rated for the voltage and current generated by the DC source; and that all connections are correct and secure, and that all safety covers are in place before applying power.***

***If the unit is to be mounted, please consider the weight and position of the equipment to prevent the rack from becoming top heavy. A top-heavy rack can create a tip over hazard. All air intake and exhaust ports should be kept clear of obstructions.***

***Table B. Equipment Safety Symbols***

| **Symbols** | **Definitions** | **Publication Numbers** |
|---|---|---|
|  | **CAUTION, RISK OF ELECTRIC SHOCK** | ISO 3864, No. B.3.6 |
|  | **CAUTION, REFER TO INSTRUCTION MANUAL, DAMAGE CAN RESULT** | ISO 3864, No. B.3.1 |
|  | **CAUTION BURN DANGER EASILY TOUCHED HIGHER TEMPERATURE PARTS** | ISO 3864 |

# Rear Panel Description and Electrical Connections

Electrical connections are made on the rear panel of the unit. Typical rear panel connections are detailed in Figure 6. The rear panel also has terminal block connections that are detailed later in this section as is an optional equipment wiring diagram, using the terminal block connections.

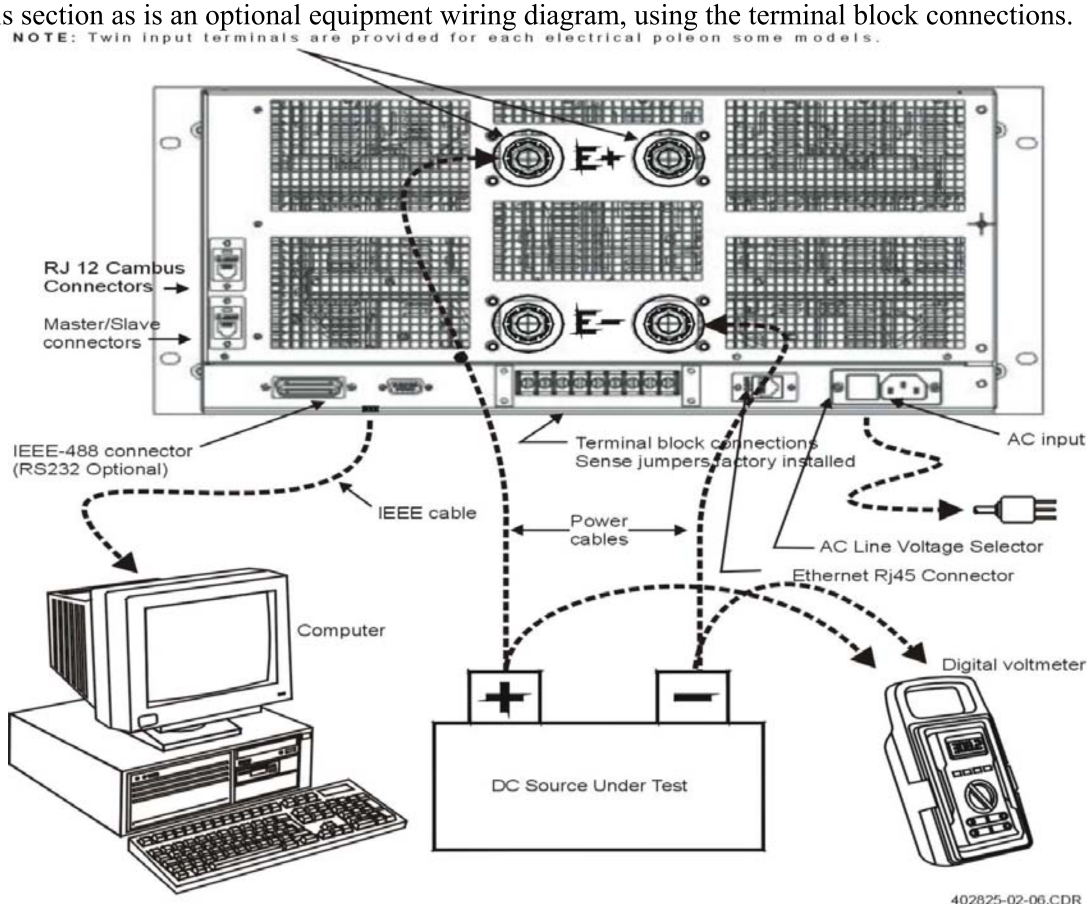



***Figure 6. Typical Rear Panel Connections***

## E– and E+ Power Input Connections

Referring to, E– and E+ are the power inputs for connecting the power source to be monitored or tested. **The E– and E+ power inputs are the large threaded bolts (studs) on the rear of the unit.** Use the shortest cables that are large enough in cross-sectional area to handle the power source's current output. Twist and bundle the E+, E– cable(s) as a means of reducing self-inductance. Also, use heavy-duty lugs and nuts to secure the E+, E– cables to the studs. Connect only the power source load cables to these studs; all other connections must be made via the terminal strip located below the studs.

**CAUTION:**
***Only the power source-to-load connections are to be made to these studs.***

## The Master /Slave connectors:

These two connectors are CAM bus RJ 12, 6X6, Type located on the left rear of the unit

## The "IEEE-488" Connector:

This is used for computer control and uses a standard IEEE-488 cable (refer to).

## Ethernet Communications Connector:

RJ45 connector located on all XBL models.

## AC Input

This connection provides the Dynaload with its operating power and its safety ground. Power requirements are user selectable as follows: Note on 800W units only 120 VAC and 240 VAC are available.

100V, 1.8A / 120V, 1.5A
200V, 0.9A / 240V, 0.8A
47Hz – 63Hz

## Input Voltage Selector

**WARNING:**
***Ensure that the power cord is removed before making changes to the voltage selector tab.***

The AC input module on the rear of the Dynaload will have one of two possible selectors. Only the labeling on the selector is different, the applicable ranges are identical. The selector will be labeled as follows: *[100,120,200,240]*...or...*[115,125,230,250] ..or [100,120,220,240]*. Use Table C to set the voltage selector position for your input voltage. The selected voltage should be positioned adjacent to the molded arrow on the top of the input module.

| AC Input Voltage | Selector Marked 100, 120, 200, 240 | Selector Marked 115, 125, 230, 250 | Selector Marked 100, 120, 220, 240 |
|---|---|---|---|
| 90V – 110V | 100 | 115 | 100 |
| 108V – 132V | 120 | 125 | 120 |
| 180V – 220V | 200 | 230 | 220 |
| 216V – 264V | 240 | 250 | 240 |

***Table C. Voltage Selector Tab Setting Guide***

## AC Input Wiring Tips

A standard U.S. three-prong cord is provided with your Dynaload. The voltage selector tab is mounted to the left of the three-prong AC connector (see figure 6)

**WARNING:**

***The power cord provides a chassis ground through a third conductor. Make sure that your power outlet is of the 3-conductor type with the correct pin connected to earth ground. Always Connect the AC cord first to your Dynaload and THEN to the utility outlet.***

## Fuse Replacement

The AC input fuse is located inside the voltage selector tab. The fuse replacement part numbers for the Dynaload are:

| | | | |
|---|---|---|---|
| **US,** | (3 Amp, 250 Volt, slow blow) | 1.5 inch American version, or equivalent | MDA-3 |
| **UK,** | 250V (3.15 Amp, 250 Volt, slow blow) | 20 mm European version) or equivalent. | GDC-3.15A-250V |

## Current Interrupt Circuit (Option)

When the Current Interrupt circuit is activated all current flow and the current drive control to each module is shut down in approximately 5 microseconds.

The loads power section consists of power modules with F.E.T.s (Field Effect Transistors). The number of FETs and modules vary from model to model depending on the unit's maximum power rating. These FETs equally share the loads current.

On the back of each load with the current interrupt option is a BNC connector. The Current Interrupt is activated by a closed contact shorting the BNC connector. For a smooth transition of current from Set Point Amps to zero Amps a method of closure with no contact bounce should be used. An NPN type transistor (open collector) can be used. The positive (center pin) of the BNC connector is 15 VDC or less and shorting the BNC connector will draw less than 10 milli amps.

When the Current Interrupt circuit is activated two things happen, all the FET gates are pulled down to a negative voltage thus shutting down all current flow in approximately 5 micro seconds and the current drive control to each module is shut down.

Care should be taken with regard to the cable length between the load and the power source. Since the longer the cables the higher the cable inductance, when current flows an electro-magnetic field charges about the cables. When the current is abruptly cut off (as in actuation of the current interrupt) the field collapses and a high voltage spike will occur, depending on the amount of current and the inductance. For this reason the cable length should be as short as possible and the positive and negative cables should be twisted around each other. This will minimize the inductance and voltage spike.

The loads operation manual has two sections, “Effects of Cable Inductance on Pulse Loading” and “Effects of Cable Length.” This will give additional information.

## The Master/Slave Connectors

These two RJ 12 connectors are used for synchronized parallel Dynaload operation. The two connectors are labeled “Parallel Master Out” and “Parallel Slave In” ).

## Master/Slave Connector Wiring

The two RJ 12 connectors are used to link the master unit to slave units. This is not a standard telephone type cable that is necessary in master/slave systems. This is a six wire cable. Install this cable starting with the master unit (“Master Out”) connected to “Slave In” on the slave unit. Additional slave units would be connected from “Master Out” of the first slave to “Slave In” on the next unit. This configuration can be extended to multiple units. Refer to the Master/Slave Parallel Operation section later in this chapter.

## The Terminal Block and Terminal Block Connections

The sections that follow are to better understand the wiring connections that can be made to the terminal block.

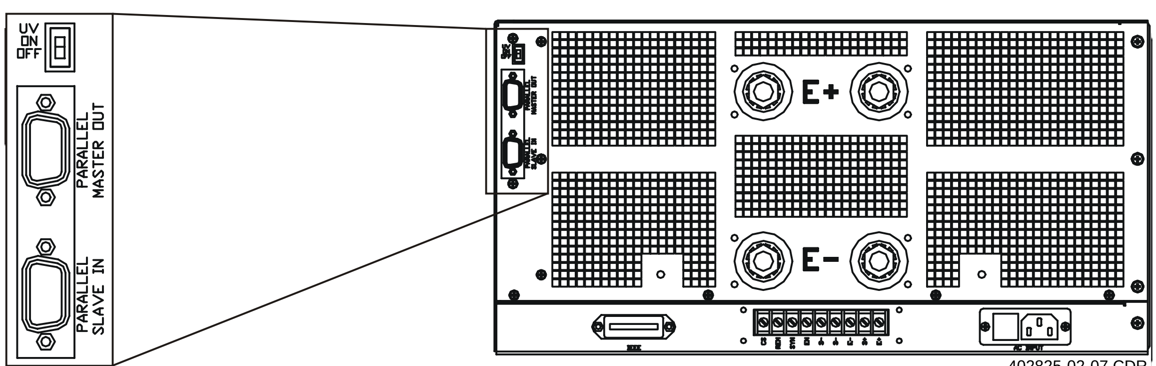



***Figure 7. “Canbus” RJ 12 Master - Slave Connectors***

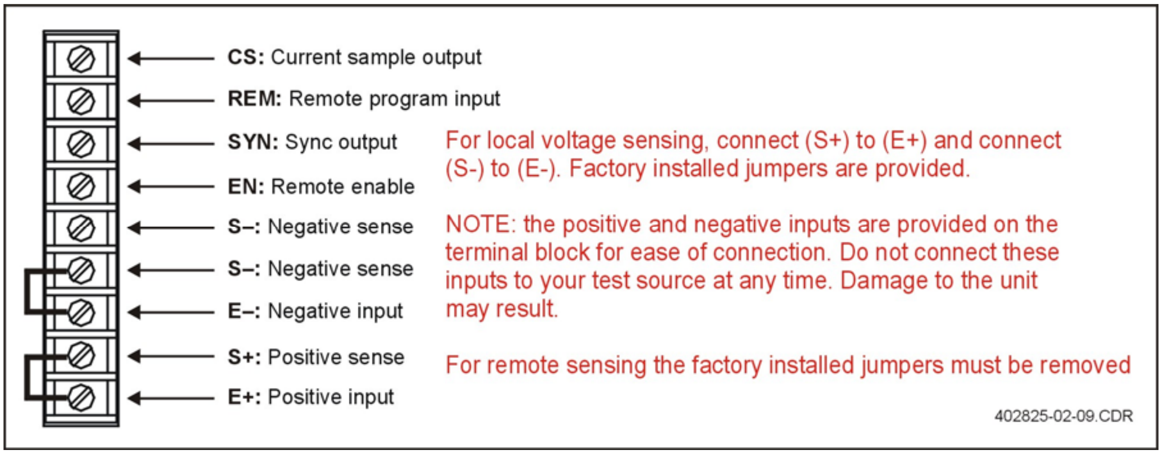



***Figure 8. Terminal Block Connections***

## CAUTION:

***External Instruments connected to the terminal block (TB) should be isolated not earth grounded. All input or output TB connections should be references to S-.***

### CS (Current Sample)

The CS (Current Sample Output) terminal is provided for the current sample output signal. The current sample output should be referenced to the (S–) terminal.

A 0-10V signal representing 0-full scale current in each of the selected current ranges is generated. This signal is a true representation of the current level and waveform being generated by the load. Connect an oscilloscope or other external instruments to this terminal as monitoring devices. The instruments should be referenced to terminal S–. Shielded wire is recommended.

The scope or instrument used should be isolated, not earth grounded.

### REM (Remote or External Programming)

The REM (Remote Program Input [External Modulation]) terminal is the connecting point for remote programming from an external programming source. This input is referenced to (S–).

This is the remote control input signal. 0 to 10 volts input yields a 0 to full scale loading in the constant current mode and range. When a signal or waveform is presented at this input it will be translated directly into your current level and waveform. The signal source should be referenced to S–.

### EN (Remote Enable)

The E- terminal is the remote DC enable. Connection between E- and S- must be connected in order to turn the DC on. This input is typically used for remote Emergency Power Off (EPO) operation of the DC on/ off function.

Note: The enable pin has a 1.5 K Ohm resistor (Pull Up) to an internal 15V DC source.

This input is used for remote operation of the DC on/off function. This input operates in series with the front panel control. If the front panel is in the ON position the enable can toggle the DC on and off.

**CAUTION:**

***Remove local sense jumpers before connecting the remote sense wires to your power source or damage will occur to the load.***

### S– and S+ (Voltage Sense)

There are two S– terminals and one S+ terminal. The S– and S+ (Sense Negative and Sense Positive) terminals are used to sense the load voltage. The connection of a remote voltage sense device to the S– and S+ terminals is illustrated in Figure .

**CAUTION:** ***Do not attempt to connect these inputs as the load inputs, internal damage may occur.***

### S– and S+ (Voltage Sense) Wiring Tips

The S– and S+ terminals may be connected at the back of the Dynaload, or remotely at the source. In any single or multiple load system, S– should be connected to E– (or the negative of the source) ***at one and ONLY one point***.

**CAUTION:**
***Damaging current loops could result from multiple connections to E–.***

The Dynaload is supplied with two (2) metal straps between the S–, E– terminals and between the S+, E+ terminals on the terminal strip. These are to facilitate voltage sense wiring when sensing locally.

The S– and S+ external sense leads can be connected anywhere between the power source and the Dynaload. It is recommended that the voltage sense wires are connected to the power source terminals. This will eliminate potential errors due to voltage drop in the cable. It is also recommended to use shielded wire for remote voltage sense leads to prevent external noise from being introduced into the system.

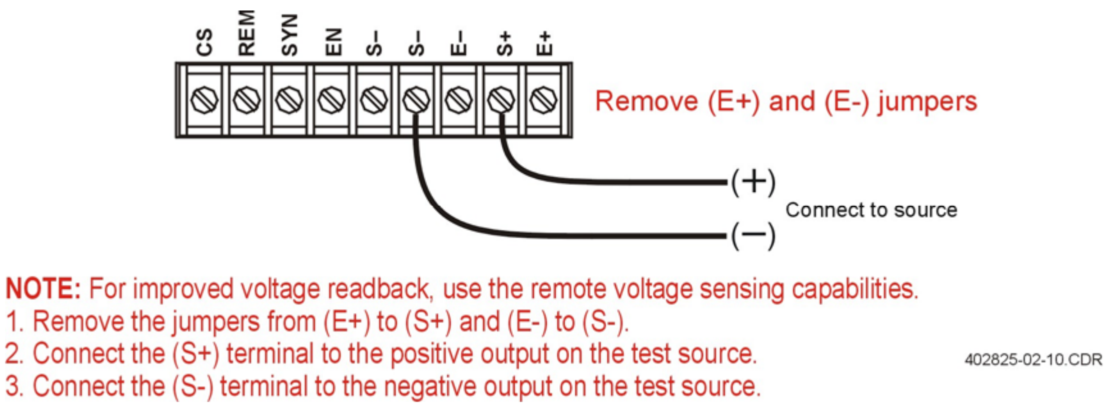



***Figure 9. Remote Voltage Sense***

## E– and E+ (Input)

E– and E+ are connected internally to the power input terminals. They are to be used only as a convenient connection point for the sense terminals when sensing the voltage locally.

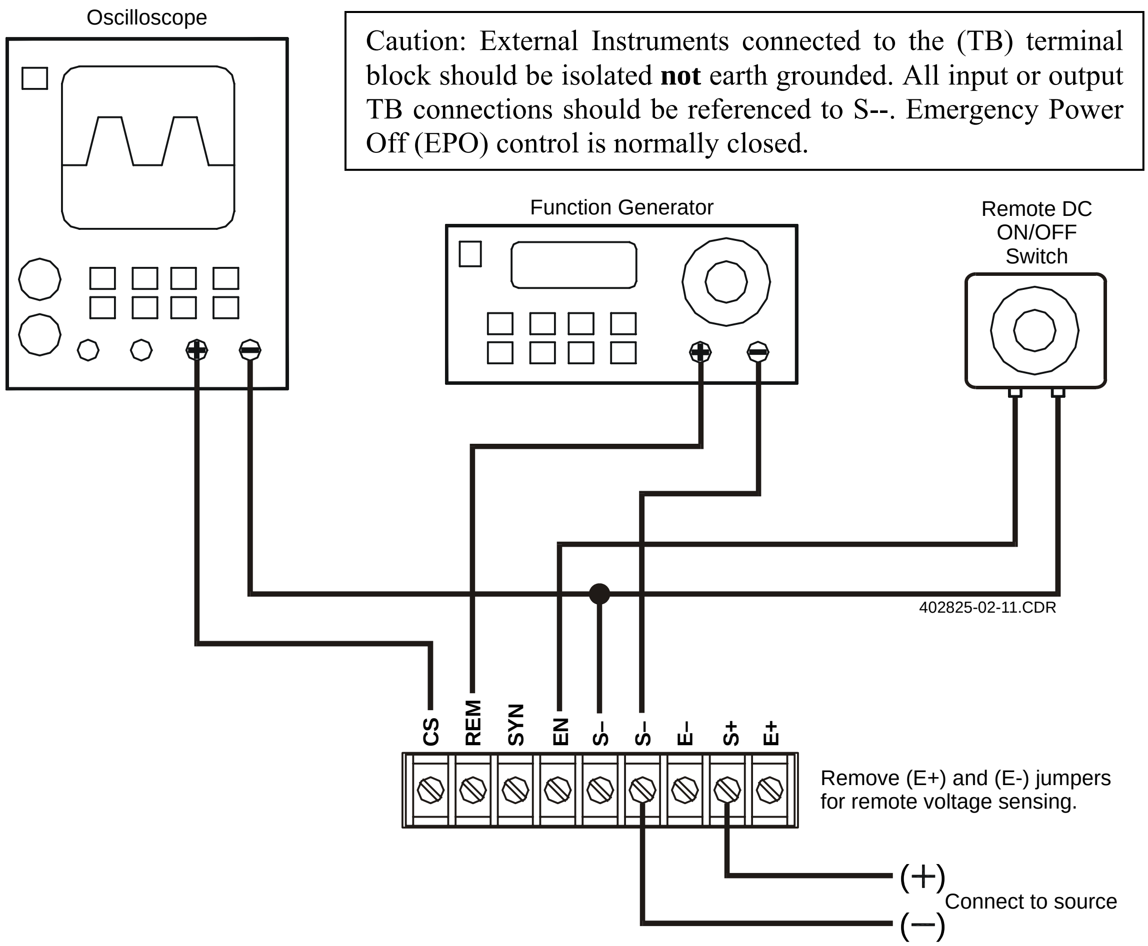



***Figure 10, Terminal Block Connections Optional Equipment Wiring***

## Terminal Block Connections Optional Equipment Wiring

An oscilloscope, function generator and remote DC ON/OFF switch are shown installed to the Dynaload. The terminal block may also be used to connect various optional equipment to the Dynaload as shown in the example, figure 10.

**Note: All XBL's have a, factory installed, jumper across E- and S- to enable "Load On". A normally closed emergency cut off switch can be connected at this point.**

## Effects of Cable Length

### *Current Oscillation*

The Dynaload regulation loop is designed to operate at a fast response time of 10µS. This is not affected by manipulating the slew rate. When operating in any of the constant DC modes, the external cable length can affect the performance of the load. If the total inductance of the power cables is excessive, oscillation could occur. It is always recommended to monitor the current sample output to verify that the load is operating without current oscillation.

***CAUTION:*** If this situation occurs refer to the section on “Effects of cable inductance on pulse loading” for recommended solutions in *Chapter 2.* — Operating Instructions.

### *Line Loss*

If the Dynaload is not configured for remote voltage sensing, the voltage display and voltage read-back will reflect what may appear to be an inaccurate reading.

The voltage display will indicate the voltage present at the input terminals. This number will be affected by the current level.

Wire has resistance, and will lose voltage as the current is increased. A general rule of thumb is to size your wire at 500 circular mils per amp of load current. This will allow a maximum of 10 degrees centigrade rise in temperature of the wire. The resistance of wire is approximately 107 ohms per 1000 feet for 100 circular mils of cross-sectional area.

You can use Ohm’s law (E = I x R) to calculate the line losses for your particular application. For detailed information about the maximum current capacity of conductors refer to Table D.

***Table D. Wire Gauge/Ampere Rating Reference Table***

| | MIL-W-5088 | | | | | UL[2] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Copper | | Aluminum | | | | | | |
| **Size AWG** | **Single wire** | **Wire bundled** | **Single wire** | **Wire bundled** | **NEC[1]** | **60°C** | **80°C** | **AIA[3]** | **500 c mils/A** |
| 30 | — | — | — | — | — | 0.2 | 0.4 | — | 0.20 |
| 28 | — | — | — | — | — | 0.4 | 0.6 | — | 0.32 |
| 26 | — | — | — | — | — | 0.6 | 1.0 | — | 0.51 |
| 24 | — | — | — | — | — | 1.0 | 1.6 | — | 0.81 |
| 22 | 9 | 5 | — | — | — | 1.6 | 2.5 | — | 1.28 |
| 20 | 11 | 7.5 | — | — | — | 2.5 | 4.0 | 3 | 2.04 |
| 18 | 16 | 10 | — | — | 6 | 4.0 | 6.0 | 5 | 3.24 |
| 16 | 22 | 13 | — | — | 10 | 6.0 | 10.0 | 7 | 5.16 |
| 14 | 32 | 17 | — | — | 20 | 10.0 | 16.0 | 15 | 8.22 |
| 12 | 41 | 23 | — | — | 30 | 16.0 | 26.0 | 20 | 13.05 |
| 10 | 55 | 33 | — | — | 35 | — | — | 25 | 20.8 |
| 8 | 73 | 46 | 58 | 36 | 50 | — | — | 35 | 33.0 |
| 6 | 101 | 60 | 86 | 51 | 70 | — | — | 50 | 52.6 |
| 4 | 135 | 80 | 108 | 64 | 90 | — | — | 70 | 83.4 |
| 2 | 181 | 100 | 149 | 82 | 125 | — | — | 90 | 132.8 |
| 1 | 211 | 125 | 177 | 105 | 150 | — | — | 100 | 167.5 |
| 0 | 245 | 150 | 204 | 125 | 200 | — | — | 125 | 212.0 |
| 00 | 283 | 175 | 237 | 146 | 225 | — | — | 150 | 266.0 |
| 000 | 328 | 200 | — | — | 275 | — | — | 175 | 336.0 |
| 0000 | 380 | 225 | — | — | 325 | — | — | 225 | 424.0 |

[1] National Electrical Code
[2] Underwriters Laboratory
[3] American Insurance Association

# Recommended Operating Procedure

The following procedure is recommended for Dynaload operation:

(1) AC switch should be turned off.

(2) Connect DC source to E+ and E– connections. Always watch for correct polarity.

(3) If external analog programming is to be used, connect signal source. If IEEE-488, Ethernet, or RS232 (optional) is to be used, connect the cable.

(4) Be sure ALL electrical connections, including peripheral equipment, are secure and in the correct polarity before applying AC or DC voltages to the load.

(5) Be sure you have selected the correct AC input position on the load. Connect AC power to the load.

(6) Turn on AC power; meters should come on and fan should run.

(7) Step through the Menu settings to be sure the set points are appropriate to the application. Check to see that the voltage and current ranges selected are appropriate.

(8) Turn on the power source to be tested.

(9) Press the DC-ON button, or send the LOAD ON command via the IEEE controller. This will close the relays and connect the source to the power dissipating circuitry. The DC on LED will illuminate.

(10) Press the mode select button for the mode you wish to operate in. The LCD display will prompt you for a numeric value. Enter an appropriate number for the level desired then press ENTER. The load will now be operating at the set level.

**NOTE:**
For computer controlled operation, Begin sending the appropriate commands. (See IEEE-488 syntax for command listing.)

# Operating Mode Guidelines

## CI — Constant Current Mode (Basic Mode)

This mode of operation allows the user to set a fixed current. Three ranges are available. This set level will not change regardless of changes in the source voltage. Some power sources such as variable power supplies are rated at a fixed maximum load current and adjustable over a predetermined voltage range, example: 5-30V @ 20A. If the resistive load characteristic were used for this type of a test, it would be necessary to reset the load each time the power supply voltage was changed in order to maintain desired load current. However, when the load is in the constant current mode, the current is constant regardless of input voltage fluctuations.

It should be noted that many power supplies are designed for short circuit protection by internal current limiting and foldback; therefore, the supply may not start up into a constant current load. Accordingly, it is suggested that the Constant Resistance mode be used as a load when simulating short circuit protection and recovery of most power supplies, unless otherwise specified by the manufacturer.

> **Caution:**
> The constant current mode should never be used to test a constant current source. The regulation of the two units will fight for control of the current and an unstable oscillation will result causing damage to the unit.

## CR — Constant Resistance Mode (Basic Mode)

The constant resistance mode regulates the load current in direct proportion to the load voltage. There are eighteen different resistance ranges available. These are derived from the nine different voltage and current combinations available, and the two different resistance modes (HIGH and LOW). The actual resistance values, expressed in Ohms, are outlined in the specification section of this manual. In general, select the appropriate voltage and current range for the source, and then determine if the high resistance range or the low resistance range is required. Other ranges may be selected to tailor the response to a particular application.

> **EXAMPLE:**
> Given a 48V source capable of 60A, select the 200V, and 200A ranges. If the high resistance mode is selected, the maximum current capability is 0.5 Amps/Volt X 48 Volts = 24 Amps MAX. — Too Low!
>
> Select the low resistance mode: 5 Amps/Volt X 48 Volts = 240 Amps MAX. — sufficient current capability.
>
> The resolution of the load may be improved by selecting the 400V range. This yields:
> 2.5 Amps/Volt X 48 Volts = 120 Amps MAX. This provides double the resolution, but it reduces voltage sensitivity.
>
> **NOTE:**
> The resistance may be entered in Ohms or Amps/Volt (1/R). This option is selected through the front panel menus.

### CV — Constant Voltage Mode (Basic Mode)

The constant voltage mode can best be described as a shunt regulator or a zener diode. There are three voltage ranges available. The load will not conduct any current until the source voltage tries to exceed the voltage set point. Once the source voltage is high enough the load will shunt current in order to regulate the voltage. The regulating voltage is adjustable from full scale of the range selected to approximately zero. The constant voltage mode is used to simulate a battery to a battery charger or for special applications, such as a shunt regulator.

**CAUTION**:

***Never use the constant voltage mode for testing a constant voltage source. The regulators of the two devices will buck each other trying to gain control of the voltage, which in turn will lead to an unstable condition causing damage to the load***

### CP — Constant Power Mode (Basic Mode)

In constant power mode, the Dynaload will dissipate a set wattage anywhere up to the maximum power rating of the unit. The Dynaload will automatically adjust the current level inversely in response to a change in voltage. The constant power mode is NOT affected by changes of the voltage or current range. **However the XBL has a 2V minimum for CP operation. If the input signal is less than 2.0 V the CP mode will not activate.**

**CAUTION: - RBL/ XBL difference-**

***An RBL In CP mode, If the source voltage decays to zero volts the load will attempt to draw infinite current until current limit is reached.***

### Full Scale Range Switching

The XBL Series provides selection of one of three full scale input voltage ranges and one of three full scale input current ranges. The full scale voltage and current ranges may be selected in any combination resulting in nine operational ranges per unit. These are selectable over the bus as ranges (1 thru 9 refers to IEEE-488 syntax section).

The selectable ranges provide increased resolution. For example: Setting 10 amps may be difficult using the 1000 amp full scale. By selecting a lower full scale, 100 amps, the resolution of the meters, IEEE-488 control, programming input and the current sample output are greatly increased.

### Master/Slave Parallel Operation

The synchronized paralleling function allows the user to connect two loads in parallel. One unit is controlled through normal operation, the master. The additional unit, the slave, is connected via a RJ 11/ RJ 12 telephone type cable and responds to the control signals sent by the master. In all operating modes, the slave units are controlled by the master.

Operating two XBL Dynaload units in parallel requires a number of control signals to be shared among the units. These signals are present on two RJ 11/ RJ 12 connectors on the rear of the XBL See “Master Slave Connections”.

**NOTE:**
Slave mode selects the remote constant current mode of operation. The master unit provides the appropriate control input with respect to mode and amplitude.

**CAUTION:**
***Master/slave operation is intended as an extension of the current and power capabilities when testing a single output power source. The slave units cannot be connected to a second source or output. This will cause damage to any or all of the loads in the system.***

**DANGER:** ***Loads are not to be connected in series***

In systems with parallel loads, the system fault indicator will illuminate if any load in the system has a fault. The DC-ON indicator illuminates when the load is active. If a load is in the slave mode, the indicator will illuminate when the slave is enabled. When the master is turned on, the slave indicator will flash continuously.

### Short Circuit Feature

In order to test current limited power sources that require short circuit testing, the XBL provides a Short Circuit feature. When this feature is activated it applies a simulated short circuit across the device being tested.

The load simulates a short circuit by driving all of its power semiconductors hard into a saturated on state. Caution must be exercised to only use this feature when testing current limited sources as the Power Limit and Current Limit are disabled while it is activated. A Saturation fault will indicate while the short is activated.

Programmable Under Voltage (UV) remains active while the Short Circuit feature is used. These will disconnect the load from the device under test if they are not turned off or set to zero first..

This feature is activated when the “Short” button on the front panel is depressed. It can also be remotely programmed using the SHORT ON/OFF command. Since a short circuit could cause damage to the load or the device under test in many applications, front panel use of this feature is normally locked out. This feature must first be enabled through the menu to use it from the front panel.

**CAUTION:**
***This function is intended for use only when testing current limited power sources. Use of the Short Circuit feature with power sources which do not limit their current to values within the load’s ratings could result in damage to the load, damage to the device under test, FIRE or EXPLOSION.***

***Note:*** Please refer to Table F for a list of major and minor fault indicators.

### MEM — Memory Recall Locations

The configuration of the load may be stored in 6 settable memory locations labeled 1 thru 6. To recall a memory location, press the MEM key on the front panel. Enter the numeric location number, and then press ENTER. When using the RS 232, Ethernet or IEEE-488 bus the setup can be stored with the MS command and recalled with the MR command. Setting the memory can also be accomplished through the front panel menu.

## Manual Adjust

The round knob above the MAN ADJ key is used to manually adjust certain features within the Dynaload. This knob can be activated by pressing the MAN ADJ key.

## Remote Programming

The XBL series is analog programmable in the CC mode of operation. A 0 to 10 volt programming signal would correspond to 0 to full-scale load in CC mode. For example: If the constant current mode is selected and the 200A range is selected, a programming voltage of 5 volts is required to program the load to 100A.

Waveforms can be programmed with the remote programming input as long as they do not exceed the capability of the load. There is no slew rate adjustment in remote programming mode.

## Local Control

The local button on the front panel will allow the user to resume front panel control of the load when operating through the RS 232, Ethernet or IEEE-488 bus. Pressing this button will enable all the front panel controls.

> **NOTE:**
> A controlling computer program should be stopped before local control is used. When in local mode, the XBL will only respond to queries on the RS 232, Ethernet or IEEE-488 bus.

## Fault Indicators

The Dynaload fault indications include both major (Red LED) and minor (Yellow LED) faults.

Major faults are an alarm and are displayed in red. If they occur, the Dynaloads internal relays will open disconnecting the load from the source; however, the fan will continue to run.

Minor faults are a warning and are displayed in yellow. If they occur, the Dynaload may continue to operate, however, it may be out of regulation.

Refer to Table E, for additional information about fault indicators.

***Table E. Major and Minor Fault Indicators***

| Fault Category | Fault Indicator | Description |
|---|---|---|

| | | |
|---|---|---|
| **Major Faults** | **UV** — Undervoltage | DC ON will not function until voltage is greater than the Under Voltage setting. See the **Error! Reference source not found.** section below. |
| | **OV** — Overvoltage | Units internal relays will open disconnecting the load from the source. |
| | **Temp -** Overtemperature | Units internal relays will open disconnecting the load from the source. |
| | **AC** — AC | Indicates that there is an low AC line voltage. |
| **Minor Faults** | **I-Lim** — Overcurrent | Unit has reached the set current limit or the current limit of the selected range. |
| | **P-Lim** — Overpower | Unit has reached the set power limit. |
| | **SAT** — Saturation | Saturation condition whereby one or more of the electronic power components are completely saturated. This may be due to insufficient source voltage, inadequate wiring, or excessive line loss. This may also indicate an open power device. |

## Programmable Under Voltage

The XBL also has a Programmable Under Voltage feature. This feature provides a means to have the load automatically stop loading when the input voltage from the device under test, drops below the defined threshold.

The Programmable Under Voltage can be set to generate a fault when the Voltage drops below its defined Voltage. The Voltage level can be programmed through menu item #18 or the through the RS 232, Ethernet, IEEE 488 interface using the UV command. This will open the load connect relay and generate a UV fault. Once the input voltage has dropped below the Programmable Under Voltage threshold causing a UV fault, the load will not re-connect until a DC LOAD ON is commanded. For this reason the input Voltage must be above the Programmable Under Voltage setting before performing a DC LOAD ON. Otherwise a UV fault will occur immediately and the DC LOAD ON will be canceled. Setting the Programmable Under Voltage to zero disables this feature.

## Menu Commands

The menu commands are accessible through the front panel by pressing the MENU key and turning the encoder knob through the menu selections. Table F lists the menu commands and their relative number in appearance. The subsections in this section detail each of the menu commands. Referring to Table F, the menu features are as follows:

***Table F. Menu Commands***

| Number | Menu Command |
|---|---|
| 1 | MODEL |

| | |
|---|---|
| 2 | SERIAL |
| 3 | VERSION |
| 4 | BUILD DATE |
| 5 | WARRANTY DATE |
| 6 | MAC ADDRESS |
| 7 | MAX VOLTS (clear) |
| 8 | MAX AMPS (clear) |
| 9 | MAX POWER (clear) |
| 10 | IP ADDRESS |
| 11 | NET MASK |
| 12 | GATEWAY |
| 13 | TCP PORT |
| 14 | IEEE ADDRESS |
| 15 | IEEE CMD TERM |
| 16 | RS232 XXXXX N81 |
| 17 | KEY CLICK |
| 18 | SHORT BTN |
| 19 | MASTER SLAVE IND |
| 20 | SLEW RATE |
| 21 | UNDERVOLTAGE |
| 22 | VOLTAGE LIMIT |
| 23 | CURRENT LIMIT |
| 24 | POWER LIMIT |
| 25 | IWV |
| 26 | RESET |
| 27 | SELF TEST |

### #1 MODEL
The XBL model number is displayed on the LCD display.

### #2 SERIAL
The XBL serial number is displayed on the LCD display.

### #3 VERSION
The XBL software version number is displayed on the LCD display.

**#4 BUILD DATE**
The XBL manufacture date is displayed on the LCD display.

**#5 WARRANTY DATE**
The XBL warranty date is displayed on the LCD display.

**#6 MAC ADDRESS**
The XBL Ethernet MAC address is displayed on the LCD display.

**#7 MAX VOLTS (clear)**
The LCD displays the maximum voltage measured by the XBL. This value is reset to 0 by pressing the ENTER key.

**#8 MAX AMPS (clear)**
The LCD displays the maximum current measured by the XBL. This value is reset to 0 by pressing the ENTER key.

**#9 MAX POWER (clear)**
The LCD displays the maximum power measured by the XBL. This value is reset to 0 by pressing the ENTER key.

**#10 IP ADDRESS**
The LCD displays the current Ethernet IP address of the unit. This value may be changed via the keypad and the ENTER key. The factory default setting is 192.168.1.10

**#11 NET MASK**
The LCD displays the current Ethernet net mask of the unit. This value may be changed via the keypad and the ENTER key. The factory default setting is 255.255.0.0

**#12 GATEWAY**
The LCD displays the current Ethernet gateway address of the unit. This value may be changed via the keypad and the ENTER key. The factory default setting is 192.168.1.1

**#13 TCP PORT**
The LCD displays the current TCP port of the unit. This value may be changed via the keypad and the ENTER key. The factory default setting is 9760

**#14 IEEE ADDRESS**

The LCD displays the current IEEE 488 bus address of the unit. This value may be changed via the keypad and the ENTER key. The factory default setting is 10

**#15 IEEE CMD TERM**

The LCD displays the current IEEE command terminator of the unit. This value may be changed via the keypad and the ENTER key. The factory default setting is 1 (CR LF). The alternate setting is 0 (CR).

**#16 RS232 XXXXX N81**

The LCD displays the current RS 232 baud rate. This value may be changed via the keypad and the ENTER key. The factory default setting is 9600.

**#17 KEY CLICK**

The LCD displays the current key click setting. This value may be changed via the keypad and the ENTER key. The factory default setting is 1 (ON). The alternate setting is 0 (OFF).

**#18 SHORT BTN**

The LCD displays the current short button setting. This value may be changed via the keypad and the ENTER key. The factory default setting is 0 (OFF – short button is inactive). The alternate setting is 1 (ON – short button is active).

**#19 MASTER SLAVE IND**

The LCD displays the current master, slave, or independent setting. This value may be changed via the keypad and the ENTER key. The factory default setting is 0 (independent or stand alone mode). The alternate settings are: 1 (slave mode), 2 (master mode).

**#20 SLEW RATE**

The LCD displays the current slew rate setting. This value may be changed via the keypad and the ENTER key. The factory default setting is 1 (normal – 100 µsec 0 to FS). The alternate settings are: 0 (slow -1 sec 0 to FS) and 2 (fast – 10 µsec 0 to FS).

**#21 UNDER VOLTAGE**

The LCD displays the current under voltage setting. This value may be changed via the keypad and the ENTER key. The factory default setting is 0 (VDC).

**#22 VOLTAGE LIMIT**

The LCD displays the current voltage limit setting. This value may be changed via the keypad and the ENTER key. The factory default setting is the actual model voltage.

#23 CURRENT **LIMIT**
The LCD displays the current limit setting. This value may be changed via the keypad and the ENTER key. The factory default setting is the actual model current.

#24 POWER **LIMIT**
The LCD displays the current power limit setting. This value may be changed via the keypad and the ENTER key. The factory default setting is the actual model power.

#25 **IWV**
The LCD displays the current IWV setting. This value may be changed via the keypad and the ENTER key. The factory default setting is 0 (amps). This command will instruct the unit to set the programmed current only after sufficient voltage has been applied to the load.

#26 **RESET**
Selecting the ENTER key resets the load to its default power on condition.

#27 **SELF** TEST
Selecting the ENTER key executes the unit's internal self test routine.

## Pulse Mode

Pulse mode loading is available in three modes of operation (Constant Current, Constant Resistance and Constant Power). Use the following steps when operating in pulse mode:

## Manual Operation

To manually operate the Dynaload, use the following procedure:

(1) Use the CI, CP CR button to set the baseline current, power, or resistance respectively.

(2) Use the FREQ button to set the frequency.

(3) Use the DUTY CYCLE button to set the duty cycle. For applications that require the period to be set, the Time HI and Time LO functions should be used. The Time HI function will set the time that the pulse remains at the peak setting. The Time LO function will set the time that the pulse remains at the baseline setting.

(4) Use the PEAK button to set the amplitude of the pulse.

(5) Use the RUN button to initiate pulse loading. Press RUN a second time to turn pulse off..

It is recommended to monitor the current sample output with an oscilloscope (No earth ground) to observe the actual current amplitude and waveform. If waveforms other than square waves are required, this can be accomplished by programming the loads using an external analog program source (refer to the *Remote Programming* section that follows).

## Operation using IEEE-488 Programming

This section covers basic operation only. For detailed information on pulse loading with the IEEE-488 commands, refer to the IEEE-488 Commands and Programming section and the Language Ele*ments* Chapter 3 later in this manual.

## Effects of Cable Inductance On Pulse Loading

When the Dynaload is used for high current pulse loading, the effects of cable inductance must be considered. The critical parameters are the rise time of the current and the minimum compliance voltage specifications. If the inductance of the cables from the voltage source is great enough to cause the voltage at the Dynaload to go below the minimum compliance level, then excessive current wave form distortion will occur. This is the result of the power devices driving into saturation. They attempt to reach the programmed current, however they cannot because of the low drain voltage. Once in a saturated state, the response time is much slower. The result is a significant overshoot on the rising edge of the pulse.

In order to prevent this from occurring, it should be noted that:

- 1 micro Henry = 2.4 feet of wire (total)
- 50A @ 50 microseconds rise time = 1 volt drop with 1 micro Henry
- The inductive drop cannot exceed the difference between the source voltage and the minimum compliance.

**EXAMPLE:**
Referring to

Equation 1 that follows, to test a 10V source with a 100A pulse, and assuming a 3 Volt minimum compliance, the maximum cable length would be:

E Max drop = 7V

$$E = L\left(\frac{di}{dt}\right) \qquad 7V = L\left(\frac{100A}{50\mu s}\right)$$

L = 3.5 microhenries maximum

402825-02-12.CDR

***Equation 1. Establishing Maximum Cable Length***

In the example above, the maximum cable length is equal to 8.4 feet total or 4.2 feet per cable from the source to the Dynaload.

If the distance from the load to the source must be greater than this, there are several methods to increase the maximum distance. One way is to use several "Twisted Pair" insulated conductors. This cuts the inductance in half if 4 are used instead of 2, or by 1/3 if 6 are used. This double or triples the maximum length, respectively.

Another method is to slow down the rise time of the pulse generator before applying it to the regulation loop. Increasing the slew rate to 100 microseconds will double the maximum cable length.

The third method is to use a large electrolytic capacitor at the Dynaload input terminals that can supply current necessary to counteract the inductive drop of the cable.

**EXAMPLE:**
If the previous example required 15 feet of total cable length or 6.25 microhenries, which would be 12.5V of inductive drop, then the capacitor would have to supply 5.5V @ 100A

for 50 microseconds. The capacitance of this capacitor is computed using Equation 2 below:

$$C = \frac{I\ T}{E}$$

Where: I is current in Amps (A)
T is time in microseconds (μs)
E is Voltage in Volts (V)
C is capacitance in microfarads (μF)

Substituting the values from the example into this equation results in:

$$C = \frac{100A \times 50\mu s}{5.5V} = 910\mu F$$

402825-02-13.CDR

***Equation 2. Formula to Establish Capacitor Requirements***

## Transconductance

One characteristic of power MOSFET'S is called transconductance. Today's MOSFET'S are designed for high speed switch mode operation where the operation is full ON or full OFF. The Dynaload uses these FET's in their linear region where the transconductance effect becomes apparent. When the gate of a FET is pulsed, the drive circuitry must overcome the inherent miller capacitance to reach the desired gate voltage. When the pulsed gate signal is very small the transconductance of the component will limit the rise time of the FET.

When operating the Dynaload at pulsed currents less than 10% of full scale, the rise time of the current waveform will be much slower than expected. Since this roll off in response is dependent on the number of FET's used in the power tray and the actual current pulse desired, it is very difficult to provide exact equations to define the effect.

> **NOTE:** It is suggested to select a load that will provide the desired pulse level while operating at current levels greater than 10% of the full current rating of the load.

If the baseline current is greater than 10% of full scale current and the pulsed waveform is added above this baseline the effects of transconductance will be eliminated. The greatest distortion occurs when pulsing from a zero current baseline. It is recommended to add a baseline current which will greatly reduce this distortion.

> **NOTE:**
> Range switching will have no effect on operation in the transconductance region.

## Location, Airflow, Maintenance

The figures shown in Appendix C — Outline Drawings by Model are the dimensions of your Dynaload. In addition to the rack mounting ears, the use of slides or shelf type supports is required. The RBL chassis is equipped with mounting holes that match Jonathan 110-QD-24-2 slides. The slide mounting screws ***must*** be #10 - 32 x 1/4 truss head.

The internal fan cools the unit by drawing in air from the front and exhausting it out the back. Keeping the airflow inlet and outlet screens open and free of dust and other airflow inhibitors will help keep your Dynaload unit's operating temperature within the intended design limits. We suggest that the loads be cleaned and free of dust build-up at least once a year.

The load can operate without performance de-rating over the temperature range of 0 to 40°C and with de-rated power dissipation capability up to 50°C.

# Troubleshooting Guide

Table G includes a brief description of fault conditions and indicators while Table H addresses symptoms, possible causes, and explanations and corrective actions.

***Table G. Troubleshooting Fault Conditions and Indicators***

| | |
|---|---|
| **"SYS" (System) Fault LED** | ■ Lights yellow for a major fault. A major fault means the load will not draw current and will not connect to the source under test. Major faults include "OV", "UV", "OT" and AC fail. |
| **"OV" (Overvoltage) Fault LED** | ■ Lights red when the loads input voltage exceeds the voltage limit setpoint menu item number 2. The DC load relay will not close until the input voltage is less than the setpoint. |
| **"UV" (Undervoltage) Fault LED** | ■ Lights red when the input voltage is between zero and 0.4 volts and the "UV" switch on the rear panel is on. The DC load relay will not close in a "UV" condition. |
| **"TEMP" (Temperature) Fault LED** | ■ Lights red when one or more internal power modules overheat. This will disconnect the load and reset once the ubit is allowed to cool it will reset. |
| **"I LIM" (Current Limit) Fault LED** | ■ Lights yellow when the loads current reaches the current limit setpoint menu item number 1. This is a "minor" fault. |
| **"P LIM" (Power Limit) Fault LED** | ■ Lights yellow when the loads power reaches the power limit setpoint menu item number 3. This is a "minor" fault. |
| **"SAT" (Saturation) LED** | ■ Lights yellow when there is insufficient source voltage to support the programmed current.*<br>■ May also indicate one or more component failures in the loads power section. This is a "minor" fault. |
| **"AC" (AC) Fault LED** | ■ Lights when there is a low operating AC line voltage condition |

- Compliance Voltage: The minimum input voltage at which the load can sink its maximum rated current. Loads can operate below the minimum compliance voltage but will not be able to achieve full rated current.

***Table H. Troubleshooting (Symptoms/Possible Causes/Explanations and Corrective Actions)***

| Symptom | Possible Cause | Explanation/Corrective Action |
|---|---|---|
| AC power button does not function. | AC input fuse on the rear panel has blown. | Check fuse and replace as necessary. |
| | AC power cord is loose or not connected. | Secure AC power cord. |

| | | |
|---|---|---|
| | AC select on the rear panel is not set properly. | *2-Position Switch Models Positions:*<br>Low switch position 110 volts AC<br>High switch position 220 volts AC<br><br>*4-Position Switch Models Positions:*<br>Lowest switch position 100 volts AC<br>Next switch position 120 volts AC<br>Next switch position 200 volts AC<br>Highest switch position 240 volts AC<br><br>Select the AC voltage you are using. |
| Load powers up but the AC fault LED lights and the DC LOAD LED will not come on. | AC line voltage may be too low. | The load detects low incoming AC voltage (88% or less) and turns the load off for self-protection.<br><br>Measure the AC input and correct or change the AC switch position as above. |
| Load powers up and the “SAT” LED lights before a “Load On” is initiated. | There are one or more defective components in the load. | The “SAT” LED should never come on during a load off condition.<br><br>Send the unit in for service. |
| Load will not “Load On” with a green LED indicator. | The “Slave” button may have been pressed. | The load is in the slave mode, press any mode select button to clear from the slave mode. |

| Symptom | Possible Cause | Explanation/Corrective Action |
|---|---|---|
| Load powers up but, the “SYS” and “UV” LEDs light red. The “DC Load” LED will not come on. | Programmable UV is set above Zero volts | Set Programmable UV above Zero volts. |
| Unit “Loads Off” by itself. The “OV” and “SYS” LEDs light . | The voltage applied to the loads input has exceeded the voltage limit setpoint, menu item number 2. | The load detects DC input voltage above its over voltage setpoint and “Loads Off” for self-protection. Measure the DC input voltage and reduce as necessary.<br><br>Check the loads voltage limit setpoint by pressing the menu button until item 22 “Voltage Limit” appears. This voltage limit can set for zero to 105% of the voltage range selected. |
| Unit “Loads Off” by itself with no fault lights. | The voltage applied to the loads input has exceeded the maximum voltage of the load for its present range and then reduced to within range, as with a voltage spike. | The loads voltage detection circuit is very fast and will “Load Off” when a voltage spike above it’s over voltage setpoint appears. The fault lights do not latch they are self-resetting. Measure for voltage spikes at the loads input and correct as necessary. Once the input voltage is within range, manually press the load on button to resume operation. |

| Symptom | Possible Cause | Explanation/Corrective Action |
|---|---|---|
| Load powers up, "Loads On" but will not draw current. | The "EXT PROG" button or a range button has been pressed after setting the current (CI 5 for example). | Pressing the "EXT PROG" or a range button will reset the current to zero.<br><br>Repeat your required current entry. |
| | In the constant resistance mode, the voltage sense leads may be improperly wired. | If the voltage sense read zero applied voltage, the load will calculate infinite resistance (zero current).<br><br>Units are shipped with internal voltage sense lead jumpers installed on the rear terminal strip. These can be removed and remote sense leads can be installed. Refer to the voltage sense-related sections of Chapter 1. |
| Unit powers up, "Loads On" "SYS" and "SAT" LEDs are yellow and will not draw current. | There is little or no DC voltage applied to the loads input. | The "SAT" LED indicates the loads inability to draw the proper set point current, due to lack of input voltage. Measure the input voltage; it must exceed the compliance voltage specification for your model. |
| With the unit in a "Load On" condition, the "SYS" and "SAT" LEDs light yellow. The load is set for "CI 0" and has no input DC voltage connected to it. | The "SYS" fault LED will light whenever the "SAT" LED lights. Both these LED's under these conditions can be on or off. This is normal. | At "CI 0" the load may normally leak a small amount of current (30 milli amps for example). When the loads input voltage is zero, it can't even provide the 30ma leakage current and the "SAT" LED lights.<br><br>Connect an input voltage to the load and these LEDs will turn off. |

| Symptom | Possible Cause | Explanation/Corrective Action |
|---|---|---|
| Load is set to draw a current. The current is correct but the "SYS" and "SAT" LEDs light yellow. | DC voltage applied to the load is too low. | Raise the input voltage. |
| | If the voltage is above the compliance voltage specification, one or more components in the power section may be defective. | Send the unit in for service. |
| Load draws current when it is not programmed for current. | Loads rear terminal strip has a programming (0 to 10 VDC) signal applied to "REM" (positive) and S– (return) and the "EXT PROG" button has been pressed. | The load is in the external programming mode. Press the "EXT PROG" button to clear the unit to the constant current mode. |
| | Peak button has been set for a current other than zero and the pulse "RUN" button has been pushed. | The load is in the pulse mode. Press the "RUN" button to clear the unit to the constant current mode. |
| | In the constant power mode, the voltage sense leads may be improperly wired. | If the voltage sense leads read zero applied voltage, the load will try to draw to draw infinite current to achieve the proper power.<br><br>Units are shipped with internal voltage sense lead jumpers installed on the rear terminal strip. These can be removed and remote sense leads can be installed. Refer to the voltage sense-related sections of Chapter 1. |
| | Loads power section may have one or more defective components. | Send the unit in for service. |
| Loads voltmeter reading does not match the voltage sense leads measured on the rear terminal strip. | The voltage sense leads may be improperly wired. | Units are shipped with internal voltage sense lead jumpers installed on the rear terminal strip. These can be removed and remote sense leads can be installed. Refer to the voltage sense-related sections of Chapter 1. |

| Symptom | Possible Cause | Explanation/Corrective Action |
|---|---|---|
| During normal operation the loads red "SYS", "TEMP" and "AC" LEDs light. | One or more power modules in the power tray are overheating. | Check that there is nothing blocking the airflow through the unit. |
| | One of the loads cooling fans may be defective. | Send the unit in for service. |
| Load is set in the constant current mode, constant power mode or the constant resistance mode, and the expected current differs from the actual current.<br><br>An audible sound may also be heard. | System (includes the load, power source, metering, etc.) may be oscillating.<br><br>Prolonged use of the load while the system is oscillating may cause damage to the load. | To check for oscillation, connect an oscilloscope to the "CS" (current sample) with respect to the S– on the rear terminal strip.<br><br>Oscillation is usually caused by the inductance of the cabling between the DC source and the load. This cabling should be as short as possible and the positive and negative wires should be twisted, to reduce the cable inductance. Also connecting a capacitor across the loads inputs can squelch the oscillation. |
| Load does not communicate over the IEEE bus. | IEEE address of the load is not matched with the computer program being used to communicate. | Change the IEEE address using menu item 14 to match the computer program being used. |
| | IEEE interconnect cable maybe loose or defective | Tighten or replace the cable. |
| Load communicates commands over the IEEE bus but not queries. | The terminator in the load may not be matched to the terminator of the computer program being used. | Change the terminator in the load, "CR" (carriage return) or "CR-LF" (carriage return, line feed) using the menu item 15 to match the computer program being used. |
| Load does not communicate over the RS 232 bus | Computer program used to run the RS 232 is not properly set up. | The computer program should be set to 9600 Baud N8+1 (8 Bit, 1 Stop Bit, no parity). |
| | RS 232 interconnect cable may be loose or defective. | Tighten or replace the cable. |

**For Customer Service and Repairs contact** bray_k@tdipower.com
Telephone: (908) 850-5088 Facsimile: (908) 850-0679

# *Chapter 3. — PC Control using IEEE-488 Commands and Programming*

## Control of a Dynaload through a Personal Computer

You must have an IEEE 488 communications card installed in your computer. (National Instruments card or the equivalent).

1. Install following the manufactures recommended procedure for the card and software.
2. The loads IEEE address is set to 10 by default.
3. Connect the IEEE cable from the PC to the Load.
4. Labview drivers can be downloaded from our website :

## Introduction

The purpose of this section is to describe the IEEE-488 commands for operating your programmable Dynaload. This section assumes that your XBL has been installed, is operating properly, and that an IEEE-488 bus controller has been attached to it. It is also assumed that the IEEE-488 address and terminator has been set through the front panel menu selections. Be sure to read *Chapter 2.* — Operating Instructions, especially the *Operator Safety Instructions* section, before proceeding. Note that all commands operate identically via the RS232 or Ethernet interfaces.

## IEEE-488 Bus Subsets

The programmable Dynaload has the IEEE-488 bus subset capabilities indicated in Table I.

***Table I. Bus Subset Capabilities***

| Subset | Category | Response |
|---|---|---|
| Acceptor Handshake | AH1 | Full capability - the load can generate the handshake for receiving data. |
| Source Handshake | SH1 | Full capability - the load can generate the handshake for transmitting data |
| Talker | T6 | The load can:<br>A. Transmit data<br>B. Not be a talker and a listener at the same time. |
| Listener | L1 | The load can:<br>A. Receive data<br>B. Not be a talker and a listener at the same time. |
| Service Request | SR1 | The load will set the SRQ line if there is an enabled |

| | | |
|---|---|---|
| | | service request condition. Serial poll is not available |
| Remote Local | RL1 | The load can be switched to local operation. |
| Parallel Poll | PPO | No capability. |
| Device Clear | DC1 | The Dynaload responds to device clear (DCL) and selected device clear (SDC) commands according to IEEE-488.2 specifications. |
| Device Trigger | DTO | No capability. |

## Data Separators

It is not necessary to separate numerical data from the previous command by any character. White space is ignored. The use of a space is recommended, however, as it aids in command string legibility.

## Program Line Terminators

The terminator instructs the Dynaload that the end of an incoming command line has been reached and that command decoding can begin. In a like manner, the Dynaload terminates each of its outgoing response strings with a terminator.

Normally the terminator for command strings is appended automatically by the IEEE-488 bus controller in the system computer. The terminator must be established as both a carriage return and a line feed or as a carriage return only by following the IEEE-488 bus configuration procedure.

## Numerical Data Formats

The programmable Dynaload accepts the two numerical data formats listed below (see Table J). These are described in more detail in IEEE Standard 488.2 — *Standard Digital Interface for Programmable Instruments*.

***Table J. Numerical Data Formats***

| Symbol | Data Form(s) |
|---|---|
| NR1 | Digits with no decimal point. The decimal point is assumed to be to the right of the least significant digit. For example: 314, 0314. |
| NR2 | Digits with a decimal point. For example: 314.0, 31.41, 0.0314 |
| adr | Ethernet address format. For Example: 192.168.1.10 |
| param | RS232 parameters. For Example: 9600N81 |
| string | any text string |

## Numerical Data Units

The numerical units in which the XBL receives and transmits quantities are fixed. They are listed in Table K

***Table K. Numerical Data Units***

| Item | Description | Unit | Format |
|---|---|---|---|
| APV | First resistance value (A/V mode) | Amps/Volt | Amps/Volt |
| AV1 | First resistance value (A/V mode) | Amps/Volt | Amps/Volt |
| AV2 | Second resistance value (A/V mode) | Amps/Volt | Amps/Volt |
| AVH | Constant resistance setpoint | (High A/V) Amps/Volt | Amps/Volt |
| AVL | Constant resistance setpoint | (Low A/V) Amps/Volt | Amps/Volt |
| CI | Constant current setpoint | Amperes | Amps |
| CP | Constant power setpoint | Watts | Watts |
| CR | Constant resistance setpoint | (Low Ω) ohms | Ohms |
| CRH | Constant resistance setpoint | (High Ω) ohms | Ohms |
| CRL | Constant resistance setpoint | (Low Ω) ohms | Ohms |
| CV | Constant voltage setpoint | Volts | Volts |
| DU | Square wave duty cycle | Percent | % |
| ET | Elapsed time (Available) | Hours/Min/Sec. | — |
| FQ | Square wave frequency | Hertz | Hz |
| I? | Load current | Amperes | Amps |
| I1 | First current value | Amperes | Amps |
| I2 | Second current value | Amperes | Amps |
| P? | Load power | Watts | Watts |
| P1 | First power value | Watts | Watts |
| P2 | Second power value | Watts | Watts |
| R1 | First resistance value (ohms mode) | Ohms | Ohms |

| | | | |
|---|---|---|---|
| R2 | Second resistance value (ohms mode) | Ohms | Ohms |
| S1 | First slew (Sets rise and fall times) | Microseconds | µs |
| S2 | Second slew (Sets fall time only) | Microseconds | µs |
| SR | Slew rate (Sets rise and fall times) | Microseconds | µs |
| T1 | First duration | Microseconds | µs |
| T2 | Second duration | Microseconds | µs |
| V? | Load voltage | Volts | Volts |
| V1 | First voltage value | Volts | Volts |
| V2 | Second voltage value | Volts | Volts |
| XM PLUS (XM +) | External modulation constant current offset | Amperes | Amps |

# Power-on Defaults

The following table indicates the factory default conditions are in effect every time the load is switched on. This can be re-configured by the user in memory location zero (0).

***Table L. Power-on Defaults***

| Parameter | Setting |
|---|---|
| CI — Constant current setpoint | 0 |
| CP — Constant power setpoint | 0 |
| CR — Constant resistance setpoint | ∞ |
| CV — Constant voltage setpoint | Vmax |
| DU — Square wave duty cycle | 50% |
| FQ — Square wave frequency | 1000 Hz |
| I1 — First current value | 0 |
| I2 — Second current value | 0 |
| IL — Current limit | 100% of full scale |
| LOAD — Relay | Open |
| MODE — Mode | Constant current |
| P1 — First power value | 0 |
| P2 — Second power value | 0 |
| PL — Power limit | 100% of full scale |
| R1 — First resistance value | ∞ |
| R2 — Second resistance value | ∞ |
| RNG — Range | High Volts, High Amps |
| S1 — First slew rate | 100 microseconds (0-FS) |
| S2 — Second slew rate | 100 microseconds (FS-0) |
| SHORT — Short | OFF |
| STATXT — Status text | ON (factory default) |
| T1 — First duration | 500 microseconds |
| T2 — Second duration | 500 microseconds |
| TEXT — Text | ON |
| V1 — First voltage value | Vmax |
| V2 — Second voltage value | Vmax |
| VL — Voltage limit | 100% of full scale |
| XM — External modulation | OFF |

## Queries

Commands followed by a question mark “?” are queries. When received by the Dynaload, the appropriate information is stored for reading by the IEEE-488 bus controller. It is important to note that the results of a query must be read back before sending another command to the Dynaload. If this is not the case, the information requested is lost.

There are two categories of queries. One is a request for real time load values: voltage, current, and power. The second is request for the present value of programmed parameters or status.

Many of the commands may be turned into queries by the addition of a question mark (?). The Dynaload will respond with the requested information when the load is addressed to talk over the IEEE-488 bus.

**EXAMPLE:**
**CI?** This requests the present value of the Constant Current program.
**LOAD?** This requests the state of the load’s input relay.

## XBL Command and Queries List (alphabetically)

| | |
|---|---|
| **APV<NR2>** | Set Amps/Volt pulse base level |
| **AV1 <NR2>** | Set Amps/Volt pulse base level |
| **AV1?** | Read Amps/Volt pulse base setting |
| **AV2 <NR2>** | Set Amps/Volt pulse peak level |
| **AV2?** | Read Amps/Volt pulse peak setting |
| **AV?** | Read Amps/Volt setting |
| **AVH <NR2>** | Set Amps/Volt High mode |
| **AVL <NR2>** | Set Amps/Volt Low mode |
| **BLDDTE?** | Read Build Date |
| **BLDLOC?** | Read Build Location |
| **CI <NR2>** | Set Constant Current Mode |
| **CI?** | Read Constant Current setting |
| **CLRBB** | Resets Telemetry Data |
| **CON?** | Read Condition register |
| **CP <NR2>** | Set Constant Power mode |
| **CP?** | Read Constant Power setting |
| **CR<NR2>** | Set Constant Resistance Low mode |
| **CR?** | Read Constant Resistance setting |
| **CRH <NR2>** | Set Constant Resistance High mode |
| **CRL <NR2>** | Set Constant Resistance Low mode |

| | |
|---|---|
| **CV <NR2>** | Set Constant Voltage mode |
| **CV?** | Read Constant Voltage setting |
| **DU <NR2>** | Set Duty Cycle |
| **DU?** | Read Duty Cycle setting |
| **ERR?** | Read Error Register |
| **ET RST** | Reset Elapsed Timer |
| **ET?** | Read Elapsed Time |
| **FQ <NR2>** | Set Frequency |
| **FQ?** | Read Frequency Setting |
| **GPRCLS** | GP Relay 0,1,2 Closed |
| **GPROPN** | GP Relay 0,1,2 Open |
| **GWY <adr>** | Set the Ethernet Gateway Address |
| **GWY?** | Read the Ethernet Gateway Address |
| **I?** | Read Current |
| **I1 <NR2>** | Set Constant Current pulse base level |
| **I1?** | Read Constant Current pulse base setting |
| **I2 <NR2>** | Set Constant Current pulse peak level |
| **I2?** | Read Constant Current pulse peak setting |
| **ID?** | Read Identification string (Returns the Model Number) |
| **IEEEADR<NR1>** | Set the IEEE 488 Address |
| **IEEEADR?** | Read the IEEE 488 Address |
| **IEEEOFF** | Turn off the IEEE 488 bus |
| **IEEETRM<NR1>** | Sets IEEE 488 Command Terminator |
| **IEEETRM?** | Read the IEEE 488 Command Terminator |
| **IL <NR2>** | Set Current Limit |
| **IL?** | Read Current Limit Setting |
| **IP<adr>** | Set the Ethernet IP Address |
| **IP?** | Read the Ethernet IP Address |
| **IST?** | Execute self test and read result |
| **IWV<NR2>** | Set IWV current |
| **KEYOFF** | Keyboard sounds on |
| **KEYON** | Keyboard sounds off |
| **LAT <NR1>** | Set the fault Latch register |
| **LAT?** | Read the Latch register setting |
| **LOAD OFF** | Open load connect relay |

| | |
|---|---|
| **LOAD ON** | Close load connect relay |
| **LOAD?** | Read load connect relay setting |
| **LOCK OFF** | Unlock front panel |
| **LOCK ON** | Lock front panel |
| **LOCK?** | Read front panel lock setting |
| **MAC?** | Read Ethernet MAC Address |
| **MAXCUR?** | Read measured maximum current |
| **MAXPWR?** | Read measured maximum power |
| **MAXVOL?** | Read measured maximum voltage |
| **MDL?** | Read unit model number |
| **MODE?** | Read mode |
| **MR <NR1>** | Memory Recall |
| **MS <NR1>** | Memory Save |
| **NM<adr>** | Set Ethernet Net Mask |
| **NM?** | Read Ethernet Net Mask |
| **P?** | Read Power |
| **P1 <NR2>** | Set Constant Power pulse base level |
| **P1?** | Read Constant Power pulse base setting |
| **P2 <NR2>** | Set Constant Power pulse peak level |
| **P2?** | Read Constant Power pulse peak setting |
| **PL <NR2>** | Set Power Limit |
| **PL?** | Read Power Limit setting |
| **PORT<NR1>** | Sets TCP Port |
| **PORT?** | Reads TCP Port |
| **R1 <NR2>** | Set Constant Resistance pulse base level |
| **R1?** | Read Constant Resistance pulse base setting |
| **R2 <NR2>** | Set Constant Resistance pulse peak level |
| **R2?** | Read Constant Resistance pulse peak setting |
| **RNG <NR1>** | Set Voltage/Current Range |
| **RNG?** | Read Voltage/Current Range status |
| **RNGS?** | Read Voltage/Current Range setting |
| **RS232<param>** | Set RS232 parameters |
| **RS232?** | Read RS232 parameters |
| **RS232OFF** | Turns the RS232 interface off |
| **RST** | Reset |

| | |
|---|---|
| **S1 <NR2>** | Set rising and falling edge slew rate |
| **S1?** | Read rising edge slew setting |
| **S2 <NR2>** | Set falling edge slew rate |
| **S2?** | Read falling edge slew setting |
| **SBE <NR1>** | Set Summary Bit Enable register |
| **SBE?** | Read Summary Bit Enable register |
| **SDN <NR1>** | Set Shutdown register |
| **SDN?** | Read Shutdown register |
| **SERNO?** | Read unit serial number |
| **SF** | Set for Fast Slew rates |
| **SHORT OFF** | Remove Short circuit from input |
| **SHORT ON** | Apply Short circuit to input |
| **SHORT?** | Read Short circuit setting |
| **SLAVE** | Set unit to slave mode |
| **SR <NR2>** | Set Slew Rate |
| **SR?** | Read Slew Rate settings |
| **SRQ <NR1>** | Set Service Request register |
| **SRQ?** | Read Service Request register |
| **SS** | Set for Slow Slew rates |
| **STA?** | Read Status register |
| **STATUS?** | Read Alarms as HEX code |
| **STATXT ON** | Status Text On |
| **STATXT OFF** | Status Text Off |
| **STATXT?** | Read Status (Reads back Clear) |
| **SW [<NR1>]** | Set Square Wave pulsing on |
| **SW OFF** | Set Square Wave pulsing off |
| **SW?** | Returns GPIB errors |
| **T1 <NR2>** | Set pulse base duration |
| **T1?** | Read pulse base duration |
| **T2 <NR2>** | Set pulse peak duration |
| **T2?** | Read pulse peak duration |
| **TEXT OFF** | Set numeric query responses |
| **TEXT ON** | Set descriptive query responses |
| **TEXT?** | Returns GPIB errors |
| **UV <NR2>** | Set programmable Under Voltage |

| | |
|---|---|
| **UV?** | Read programmable Under Voltage setting |
| **V?** | Read Voltage |
| **V1 <NR2>** | Set Constant Voltage pulse base level |
| **V1?** | Read Constant Voltage pulse base level |
| **V2 <NR2>** | Set Constant Voltage pulse peak level |
| **V2?** | Read Constant Voltage pulse peak level |
| **VER?** | Returns software version number |
| **VL <NR2>** | Set Voltage Limit |
| **VL?** | Read Voltage Limit setting |
| **WARRDTE?** | Read warranty expiration date |
| **WF [<NR1>]** | Set Square Wave pulsing on |
| **WF OFF** | Set Square Wave pulsing off |
| **WF?** | Returns GPIB errors |
| **XM ON** | Set External Modulation on |
| **XM OFF** | Set External Modulation off |
| **XM PLUS <NR2>** | Set External Modulation with programmed offset |
| **XM + <NR2>** | Alternate Syntax for XM PLUS <NR2> |
| **XM?** | Read External Modulation setting |

Detail Language Elements

This is an alphanumerical listing that gives the syntax and required parameters for all elements in the programmable load's syntax. The syntax is generic for all load ratings.

The following section provides the following information below for each command:

- **DESCRIPTION:** Describes the function of the command and gives information about its use.
- **COMMAND SYNTAX:** Shows the proper form(s) of the command. Spaces are optional as the command processor ignores these.
- **EXAMPLE:** Gives an example of command usage.
- **QUERY SYNTAX:** Provides the proper query form.
- **RETURNED PARAMETERS:** Indicates the response format(s) to the query form of the command. Where the TEXT ON and TEXT OFF modes responses differ, both will be indicated.

## *IDN? Identification

| | |
|---|---|
| **Description** | This query returns the load's identification string. |
| **Command Syntax** | NONE |
| **Example** | N/A |
| **Query Syntax** | *IDN? |
| **Returned Parameters** | Model: XBL <voltage><current><power><type> |

## *RST Reset

| | |
|---|---|
| **Description** | This command resets the load to its factory default settings as specified in the IEEE-488.2 specifications. This does not affect the loads IEEE-488 bus address, any of the status registers or the output queue. |
| **Command Syntax** | *RST |
| **Example** | *RST<br>This will reset the load to its factory default settings. |
| **Query Syntax** | NONE |
| **Returned Parameters** | N/A |

## *TST? Alternate form of IST? query.

### AV1 Amps/Volt Pulsing Base Level

| | |
|---|---|
| **Description** | This command is used to set the base level when pulse loading in the Amps/Volt mode.<br>**NOTE:**<br>AVL or AVH must have been previously set. |
| **Command Syntax** | AV1 <NR2> |
| **Example** | AV1 25.0<br>This will set the base Amps/Volt level to 25 amps/volt |
| **Query Syntax** | AV1? |
| **Returned Parameters** | TEXT ON: <NR2> amps/v<br><br>TEXT OFF: <NR2> |

### AV2 Amps/Volt Pulsing Peak Level

| | |
|---|---|
| **Description** | This command is used to set the peak level relative to the base level when pulse loading in the Amps/Volt mode.<br>**NOTE:**<br>AVL or AVH must have been previously set. |
| **Command Syntax** | AV2 <NR2> |
| **Example** | AV2 50.0<br>This will set the peak level to 50 Amps per Volt above the base level. Therefore if the base level setting is 25A, the peaks will be 75 Amps per Volt. |
| **Query Syntax** | AV2? |
| **Returned Parameters** | TEXT ON: <NR2> amps/v<br><br>TEXT OFF: <NR2> |

## AV?

See query form of AVH and AVL that immediately follow.

### APV Amps/Volt High alternate command

| | |
|---|---|
| **Description** | This command places the load into Amps/Volt High mode at the specified level. |
| **Command Syntax** | APV <NR2> |
| **Example** | APV 25.0<br>This will place the load in Amps/Volt High mode at 25 Amps per Volt. |
| **Query Syntax** | AV? |
| **Returned Parameters** | TEXT ON: <NR2> amps/v<br><br>TEXT OFF: <NR2> |

### AVH Amps/Volt High

| | |
|---|---|
| **Description** | This command places the load into Amps/Volt High mode at the specified level. |
| **Command Syntax** | AVH <NR2> |
| **Example** | AVH 25.0<br>This will place the load in Amps/Volt High mode at 25 Amps per Volt. |
| **Query Syntax** | AV? |
| **Returned Parameters** | TEXT ON: <NR2> amps/v<br><br>TEXT OFF: <NR2> |

### VL *Amps/Volt Low*

| | |
|---|---|
| **Description** | This command places the load into Amps/Volt Low mode at the specified level. |
| **Command Syntax** | AVL <NR2> |
| **Example** | AVL 2.5<br>This will place the load in Amps/Volt Low mode at 2.5 Amps per Volt. |

| | |
|---|---|
| **Query Syntax** | AV? |
| **Returned Parameters** | TEXT ON: <NR2> amps/v<br><br>TEXT OFF: <NR2> |

## DDTE?

| | |
|---|---|
| **Description** | This command returns the XBL factory build date. |
| **Command Syntax** | BLDDTE? |
| **Example** | BLDDTE?<br>This will return the XBL factory build date. |
| **Query Syntax** | BLDDTE? |
| **Returned Parameters** | TEXT ON: MMDDYYYY or MM-DD-YYYY<br><br>TEXT OFF: MMDDYYYY or MM-DD-YYYY |

## BLDLOC?

| | |
|---|---|
| **Description** | This command returns the XBL factory build location. |
| **Command Syntax** | BLDLOC? |
| **Example** | BLDLOC?<br>This will return the XBL factory build location. |
| **Query Syntax** | BLDLOC? |
| **Returned Parameters** | TEXT ON: HACK<br><br>TEXT OFF: HACK |

## CI *Constant Current*

Set Constant Current mode and current value

| | |
|---|---|
| **Description** | This command places the load into Constant Current mode at the specified level. |
| **Command Syntax** | CI <NR2> |
| **Example** | CI 10.5<br>This will place the load in Constant Current at 10.5 Amps. |
| **Query Syntax** | CI? |
| **Returned Parameters** | TEXT ON: <NR2> amps<br><br>TEXT OFF: <NR2> |

### CLRBB

| | |
|---|---|
| **Description** | This command resets the XBL telemetry data. |
| **Command Syntax** | CLRBB |
| **Example** | CLRBB<br>This will reset the units telemetry data (returned by the commands MAXVOL?, MAXCUR?, MAXPWR?) to zero. |
| **Query Syntax** | CLRBB |
| **Returned Parameters** | NONE |

### CON? *Condition register*

**Description**

This query returns the contents of the Condition register and clears its contents. The response is either numeric or a text description depending on the TEXT ON/OFF and STATXT ON/OFF settings.

Each bit in this register provides information about the load's condition. A bit being set indicates that the condition is present or has occurred. Normally the bit will clear when the condition clears unless its respective bit in the Latch (LAT) register is set. Furthermore if its respective bit in the Shutdown (SDN) register is set the load will shutdown.

The returned value will be between 0 and 255 and is the sum of the individual bit weights. A *CLS command will clear this register as well. The individual bits are defined below.

| Bit | Weight | Description | Text On Response Message |
|---|---|---|---|
| 7 | 128 | Under Voltage | UNDER VOLTAGE |
| 6 | 64 | Over Voltage | VOLTAGE LIMIT |
| 5 | 32 | Over Temperature | TEMPERATURE LIMIT |
| 4 | 16 | Minor Fault | MINOR FAULT |
| 3 | 8 | Over Current | CURRENT LIMIT |
| 2 | 4 | Over Power | POWER LIMIT |
| 1 | 2 | Saturation | LOAD SATURATED |
| 0 | 1 | Major Fault | MAJOR FAULT |

| | |
|---|---|
| | The text response will return a string containing the Text On Response Message as listed above for each bit that is set. These will be separated by commas. If no bits are set, “CLEAR” will be returned. |
| **Command Syntax** | NONE |
| **Example** | N/A |
| **Query Syntax** | CON? |
| **Returned Parameters** | TEXT ON and STATXT ON: <text response string><br><br>TEXT OFF or STATXT OFF: <NR1> |

### CP *Constant Power*

| | |
|---|---|
| **Description** | This command places the load into Constant Power mode at the specified level. |
| **Command Syntax** | CP <NR2> |
| **Example** | CP 20.0<br>This will place the load in Constant Power at 20 Amps. |
| **Query Syntax** | CP? |
| **Returned Parameters** | TEXT ON: <NR2> watts<br><br>TEXT OFF: <NR2> |

## CR?

See query form of CRH and CRL that immediately follow.

## CR *Constant Resistance Low alternate command*

| | |
|---|---|
| **Description** | This command places the load into Constant Resistance Low mode at the specified level. |
| **Command Syntax** | CR <NR2> |
| **Example** | CR 1.5<br>This will place the load in Constant Resistance Low mode at 1.5 Ohms. |
| **Query Syntax** | CR? |
| **Returned Parameters** | TEXT ON: <NR2> ohms<br><br>TEXT OFF: <NR2> |

### CRH *Constant Resistance High*

| | |
|---|---|
| **Description** | This command places the load into Constant Resistance High mode at the specified level. |
| **Command Syntax** | CRH <NR2> |
| **Example** | CRH 100.0<br>This will place the load in Constant Resistance High mode at 100 Ohms. |
| **Query Syntax** | CR? |
| **Returned Parameters** | TEXT ON: <NR2> ohms<br><br>TEXT OFF: <NR2> |

## CRL *Constant Resistance Low*

| | |
|---|---|
| **Description** | This command places the load into Constant Resistance Low mode at the specified level. |
| **Command Syntax** | CRL <NR2> |
| **Example** | CRL 1.5<br>This will place the load in Constant Resistance Low mode at 1.5 Ohms. |
| **Query Syntax** | CR? |
| **Returned Parameters** | TEXT ON: <NR2> ohms<br><br>TEXT OFF: <NR2> |

## CV *Constant Voltage*

| | |
|---|---|
| **Description** | This command places the load into Constant Voltage mode at the specified level. |
| **Command Syntax** | CV <NR2> |
| **Example** | CV 100.0<br>This will place the load in Constant Voltage at 100 Volts. |
| **Query Syntax** | CV? |
| **Returned Parameters** | TEXT ON: <NR2> volts<br><br>TEXT OFF: <NR2> |

## DU *Duty Cycle*

| | |
|---|---|
| **Description** | This command is used to set the Duty Cycle for square wave pulsing. This defines the percentage of peak pulse time and will set the Pulsing Base Time (T1) and Pulsing Peak Time (T2) accordingly based upon the defined frequency. |
| **Command Syntax** | DU <NR2> |
| **Example** | DU 40.0<br>This will set the duty cycle to 40%. If the frequency was 100Hz meaning a pulse period of 10,000µs, T2 will be set to 4000µs and T1 will be set to 6000µs. |
| **Query Syntax** | DU? |
| **Returned Parameters** | TEXT ON: <NR2> %<br><br>TEXT OFF: <NR2> |

## ERR? *Error Register*

| | |
|---|---|
| **Description** | This query returns the contents of the Error register and then clears its contents. The response is either numeric or a text description depending on the TEXT ON/OFF and STATXT ON/OFF settings.<br><br>This register contains information about command errors and serves a function that is similar to the Error Status Register (*ESR?) in the IEEE-488.2 status structure. This query is provided for backward compatibility with systems designed to use the pre-IEEE 488.2 status structure.<br><br>The value in this register is a number between 0 and 255 and is the sum of the individual bit weights as defined below. |

| Bit | Weight | Description | Text On Response Message |
|---|---|---|---|
| 7 | 128 | — | — |
| 6 | 64 | — | — |
| 5 | 32 | Command not allowed | NOT ALLOWED |
| 4 | 16 | Command too long | TOO LONG |
| 3 | 8 | Numeric Error | NUMERIC |
| 2 | 4 | — | — |
| 1 | 2 | Out of Range | RANGE |

| | | | | |
|---|---|---|---|---|
| | 0 | 1 | Unrecognized Command | UNRECOGNIZED |
| | The text response will return a string containing the Text On Response Message as listed above for each bit that is set. These will be separated by commas. If no bits are set, “NO COMMAND ERROR” will be returned. | | | |
| **Command Syntax** | NONE | | | |
| **Example** | N/A | | | |
| **Query Syntax** | ERR? | | | |
| **Returned Parameters** | TEXT ON and STATXT ON: <text response string><br><br>TEXT OFF or STATXT OFF: <NR1> | | | |

## ET RST *Elapsed Timer Reset*

| | |
|---|---|
| **Description** | This command resets the XBL elapsed timer to zero. |
| **Command Syntax** | ET RST |
| **Example** | ET RST<br>This will reset the elapsed timer to zero. |
| **Query Syntax** | ET? |
| **Returned Parameters** | NONE |

## ET? *Elapsed Timer*

| | |
|---|---|
| **Description** | This command returns the elapsed timer value in hours:minutes:seconds format or in decimal hours format depending on the state of the TEXT parameter. The elapsed timer starts upon a LOAD ON command. |
| **Command Syntax** | ET? |
| **Example** | ET? |
| **Query Syntax** | ET? |
| **Returned Parameters** | TEXT ON: Elapsd <Hours NR1>:<Minutes NR1>:<Seconds NR1><br><br>TEXT OFF: < Decimal Hours NR1> |

## FQ Frequency

| | |
|---|---|
| **Description** | This command is used to set the Frequency in Hertz for square wave pulsing. The Pulsing Base Time (T1) and Pulsing Peak Time (T2) will be adjusted accordingly based upon the defined duty cycle. |
| **Command Syntax** | FQ <NR2> |
| **Example** | FQ 1000.0<br>This will set the frequency to 1000Hz. If the duty cycle was 30%, T2 will be set to 300µs and T1 will be set to 700µs. |
| **Query Syntax** | FQ? |
| **Returned Parameters** | TEXT ON: <NR2> Hz<br><br>TEXT OFF: <NR2> |

## GPRCLS Close General Purpose Relay

| | |
|---|---|
| **Description** | This command is used to close the general purpose relay drivers. |
| **Command Syntax** | GPRCLS <NR1> |
| **Example** | GPRCLS 0<br>This will close the general purpose relay driver number 0. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

## GPROPN Open General Purpose Relay

| | |
|---|---|
| **Description** | This command is used to open the general purpose relay drivers. |

| | |
|---|---|
| **Command Syntax** | GPROPN <NR1> |
| **Example** | GPROPN 0<br>This will close the general purpose relay driver number 0. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

### GWY *Set Ethernet Gateway*

| | |
|---|---|
| **Description** | This command is used to set the Ethernet interface gateway. |
| **Command Syntax** | GWY <adr> |
| **Example** | GWY 192.168.1.1<br>This will set the Ethernet interface gateway to 192.168.1.1 |
| **Query Syntax** | GWY? |
| **Returned Parameters** | TEXT ON: <adr><br><br>TEXT OFF: <adr> |

## I? *Read Current*

| | |
|---|---|
| **Description** | This query returns the actual current reading in Amps passing through the load. |
| **Command Syntax** | NONE |
| **Example** | N/A |
| **Query Syntax** | I? |
| **Returned Parameters** | TEXT ON: <NR2> amps<br><br>TEXT OFF: <NR2> |

## I1 *Constant Current Pulsing Base Level*

| | |
|---|---|
| **Description** | This command is used to set the base level when pulse loading in the Constant Current mode. |
| **Command Syntax** | I1 <NR2> |
| **Example** | I1 10.5<br>This will set the base Constant Current level to 10.5 Amps. |
| **Query Syntax** | I1? |
| **Returned Parameters** | TEXT ON: <NR2> amps<br><br>TEXT OFF: <NR2> |

## I2 *Constant Current Pulsing Peak Level*

| | |
|---|---|
| **Description** | This command is used to set the peak level relative to the base level when pulse loading in the Constant Current mode. |
| **Command Syntax** | I2 <NR2> |
| **Example** | I2 25.0<br>This will set the peak level to 25 Amps above the base level. Therefore if the base level setting is 10.5A, the peaks will be 35.5 Amps. |
| **Query Syntax** | I2? |
| **Returned Parameters** | TEXT ON: <NR2> amps<br><br>TEXT OFF: <NR2> |

## ID? *Identification*

| | |
|---|---|
| **Description** | This query returns the load’s model identification string that includes its rated voltage, current, power and type in the format:<br><br>Model:XBL <rated voltage>-<rated current>-<rated power><type> |
| **Command Syntax** | ID? |
| **Example** | ID? |
| **Query Syntax** | ID? |
| **Returned Parameters** | Model:XBL <voltage>-<current>-<power><type> |

**IEEEADR** IEEE ***488 Address***

| | |
|---|---|
| **Description** | This command sets the XBL IEEE 488 bus address. |
| **Command Syntax** | IEEEADR <NR1> |
| **Example** | IEEEADR 9<br>This will set the XBL IEEE 488 bus address to 9. |
| **Query Syntax** | IEEEADR? |
| **Returned Parameters** | TEXT ON: <NR1><br>TEXT OFF: <NR1> |

**IEEEOFF** Turn ***off IEEE 488 interface***

| | |
|---|---|
| **Description** | This command turns off the XBL IEEE 488 bus interface. The interface will remain in the off state until the XBL is restarted. |
| **Command Syntax** | IEEEOFF |
| **Example** | IEEEOFF<br>This will turn off the IEEE 488 interface. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

**IEEETRM** Sets ***the IEEE488 Command Terminator***

| | |
|---|---|
| **Description** | This command sets the the XBL IEEE 488 command terminator to either use a carriage return <CR> or a carriage return and line feed <CR LF>. |
| **Command Syntax** | IEEETRM <NR1> |
| **Example** | IEEETRM 1<br>This will set the XBL IEEE 488 command terminator to <CRLF>.<br><br>IEEETRM 0<br>This will set the XBL IEEE 488 command terminator to <CR> |
| **Query Syntax** | IEEETRM? |
| **Returned Parameters** | TEXT ON: <NR1><br><br>TEXT OFF: <NR1> |

## INDEP *Independent Mode*

| | |
|---|---|
| **Description** | This command is used to put the load in independent mode. In independent mode the load operates as a "stand alone" unit. |
| **Command Syntax** | INDEP |
| **Example** | INDEP<br>This will place the unit in independent mode. |
| **Query Syntax** | NONE |
| **Returned Parameters** | N/A |

## IL *Current Limit*

| | |
|---|---|
| **Description** | This command is used to set the Current Limit set point. The Current Limit circuit will not allow the load current to exceed this level. |
| **Command Syntax** | IL <NR2> |
| **Example** | IL 50.0<br>This will set the Current Limit to 50 Volts. |
| **Query Syntax** | IL? |
| **Returned Parameters** | TEXT ON: <NR2> amps<br><br>TEXT OFF: <NR2> |

## IP *Set Ethernet Address*

| | |
|---|---|
| **Description** | This command is used to set the Ethernet address. |
| **Command Syntax** | IP <adr> |
| **Example** | IP 192.168.1.10<br>This will set the Ethernet interface address to 192.168.1.1 |
| **Query Syntax** | IP? |
| **Returned Parameters** | TEXT ON: <adr><br><br>TEXT OFF: <adr> |

## IST? *Internal Self Test*

| | |
|---|---|
| **Description** | This command performs the XBL internal self test and returns the result. |
| **Command Syntax** | IST? |
| **Example** | IST? |
| **Query Syntax** | IST? |
| **Returned Parameters** | TEXT ON: SELF TEST PASSED<br>SELF TEST FAILED<br><br>TEXT OFF: 0<br>non zero |

## IWV *Constant Current Mode After Compliance Voltage Reached*

Set Constant Current mode and current value after compliance voltage has been reached.

| | |
|---|---|
| **Description** | This command places the load into Constant Current mode at the specified level. This command is similar to the CI command except that the load does not draw current until triggered, that is when the voltage at the load exceeds the XBL's compliance voltage (usually .5 VDC). This greatly reduces the overshoot current usually experienced when turning on a power supply into a preset constant current or "hot" load. This command functions in "single shot" mode in that the command must be repeated once the load has been triggered by the supply voltage. |
| **Command Syntax** | IWV <NR2> |
| **Example** | IWV 10.5<br>This will place the load in Constant Current at 10.5 Amps once the compliance voltage is reached. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

**KEYOFF** Turn ***off keyboard sounds***

| | |
|---|---|
| **Description** | This command turns off the XBL keyboard sounds. |
| **Command Syntax** | KEYOFF |
| **Example** | KEYOFF<br>This will turn off the XBL keyboard sounds. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

**KEYON** Turn ***on keyboard sounds***

| | |
|---|---|
| **Description** | This command turns on the XBL keyboard sounds. |
| **Command Syntax** | KEYON |
| **Example** | KEYON<br>This will turn on the XBL keyboard sounds. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

## LAT *Latch register*

**Description**

This command provides access to the Latch register. The bits in this register define which bits of the Condition (CON) register will latch on if set until the CON register is read. Setting one bit by writing its bit weight into the LAT register enables its equivalent bit in the CON register.

The individual bits are defined below. More than one bit can be enabled by writing a value that is a sum of the individual bit weights. The Over Voltage and Over Temperature bits in this register will remain set regardless of what value is written to this register. The value in this register is a number between 0 and 255 and is the sum of the individual bit weights as defined below.

| Bit | Weight | Description | Text On Response Message | Default Value |
|---|---|---|---|---|
| 7 | 128 | Under Voltage | UV | 0 |
| 6 | 64 | Over Voltage | OV | 0 |
| 5 | 32 | Over Temperature | OT | 0 |
| 4 | 16 | Minor Fault | — | 0 |
| 3 | 8 | Over Current | OC | 0 |
| 2 | 4 | Over Power | OP | 0 |
| 1 | 2 | Saturation | SAT | 0 |
| 0 | 1 | Major Fault | MOD FLT | 0 |

The query form of this command will either return a numeric or a text response depending on the TEXT ON/OFF and STATXT ON/OFF settings. The text response will return a string containing the Text On Response Message as listed above for each bit that is set. These will be separated by commas. If no bits are set "CLEAR" will be returned.

**Command Syntax**

LAT <NR1>

**Example**

LAT 12
This will write the value of 12 into the LAT register. This enables bit 2 (Over Power) and bit 3 (Over Current) in the CON register so that if either is set they will remain set until the CON register is read or a *CLS command is received. Since the Over Voltage and Over Temperature bits remain unaffected these will remain enabled. Therefore the value in the LAT after this command will be 108.

**Query Syntax**

LAT?

**Returned Parameters**

TEXT ON and STATXT ON: <text response string>

TEXT OFF or STATXT OFF: <NR1>

## LOAD *Load On/Off Control*

| | |
|---|---|
| **Description** | This command is used to instruct to load to close its load connect relay and apply loading, or to open its connect relay removing the load from the device under test. |
| **Command Syntax** | LOAD ON<br>LOAD OFF |
| **Example** | LOAD ON<br>This will close the load connect relay and start loading the device under test at the programmed settings.<br><br>LOAD OFF<br>This will open the load connect relay and stop loading. |
| **Query Syntax** | LOAD? |
| **Returned Parameters** | TEXT ON: LOAD ON<br>LOAD OFF<br><br>TEXT OFF: 1 (meaning On)<br>0 (meaning Off) |

## LOCK *Front Panel Lock*

| | |
|---|---|
| **Description** | This command is used to lock or unlock the load's front panel. When locked, manual operation through the load's front panel is inhibited. |
| **Command Syntax** | LOCK ON<br>LOCK OFF |
| **Example** | LOCK ON<br>This will lock the front panel.<br><br>LOCK OFF<br>This will unlock the front panel. |
| **Query Syntax** | LOCK? |
| **Returned Parameters** | Text On: LOCK ON<br>LOCK OFF<br><br>Text Off: 1 (meaning On)<br>0 (meaning Off) |

## MAC? *Ethernet MAC Address*

| | |
|---|---|
| **Description** | This command is used to retrieve the Ethernet MAC address. |
| **Command Syntax** | MAC? <string> |
| **Example** | MAC? |
| **Query Syntax** | IP? |
| **Returned Parameters** | TEXT ON: <string><br><br>TEXT OFF: <string> |

## MASTER *Master Mode*

| | |
|---|---|
| **Description** | This command is used to put the load in master mode. In master mode the load will control the operation of the slave. The unit will indicate master mode by displaying XBL Master on the LCD. |
| **Command Syntax** | MASTER |
| **Example** | MASTER<br>This will place the unit in master mode. |
| **Query Syntax** | NONE |
| **Returned Parameters** | N/A |

## MAXCUR? *Maximum Current Measured*

| | |
|---|---|
| **Description** | This command is used to retrieve the maximum current measured by the XBL. |
| **Command Syntax** | MAXCUR? |
| **Example** | MAXCUR? |
| **Query Syntax** | MAXCUR? |
| **Returned Parameters** | TEXT ON: <NR2> amps<br><br>TEXT OFF: <NR2> |

## MAXPWR? *Maximum Power Measured*

| | |
|---|---|
| **Description** | This command is used to retrieve the maximum power measured by the XBL. |
| **Command Syntax** | MAXPWR? |
| **Example** | MAXPWR? |
| **Query Syntax** | MAXPWR? |
| **Returned Parameters** | TEXT ON: <NR2> watts<br><br>TEXT OFF: <NR2> |

## MAXVOL? *Maximum Voltage Measured*

| | |
|---|---|
| **Description** | This command is used to retrieve the maximum voltage measured by the XBL. |
| **Command Syntax** | MAXVOL? |
| **Example** | MAXVOL? |
| **Query Syntax** | MAXVOL? |
| **Returned Parameters** | TEXT ON: <NR2> volts<br><br>TEXT OFF: <NR2> |

**MDL?**
Alternate form of ID? query.

## MODE? *Operating Mode*

**Description**

This query returns the load’s operating mode. The response is either numeric or a text description depending on the TEXT ON/OFF and STATXT ON/OFF settings. The returned value will be the sum of the individual bit weights of the mode plus any mode modifiers. The individual bits are defined below.

**Mode Modifiers**

| Bit | Weight | Description | Text On Response Message |
|---|---|---|---|
| 8 | 256 | Pulsing | PULSING |
| 7 | 128 | External Modulation | EXT MOD |

**Operating Modes**

| Bit | Weight | Description | Text On Response Message |
|---|---|---|---|
| 6 | 64 | Slave Mode | SLAVE |
| 5 | 32 | Not Used | |
| 4 | 16 | Not Used | |
| 3 | 8 | Constant Resistance High | CR HIGH |
| 2 | 4 | Constant Resistance Low | CR LOW |
| 1 | 2 | Constant Power | CP |
| 0 | 1 | Constant Voltage | CV |
| Default | | Constant Current | CI |

The text response will return a string containing the Text On Response Message as listed above for each bit that is set. These will be separated by commas.

| | |
|---|---|
| **Command Syntax** | NONE |
| **Example** | N/A |
| **Query Syntax** | MODE? |
| **Returned Parameters** | TEXT ON and STATXT ON: <text response string><br><br>TEXT OFF or STATXT OFF: <NR1> |

## MR *Memory Recall*

| | |
|---|---|
| **Description** | This command recalls the load's setup stored in the specified memory location. The memory location number must be a value from 1 through 6. |
| **Command Syntax** | MR <NR1> |
| **Example** | MR 3<br>This will recall the setup stored in memory location 3. |
| **Query Syntax** | NONE |
| **Returned Parameters** | N/A |

## MS *Memory Save*

| | |
|---|---|
| **Description** | This command saves the load's setup into the specified memory location. The memory location number must be a value from 1 through 6. |
| **Command Syntax** | MS <NR1> |
| **Example** | MS 3<br>This will store the load's current setup in memory location 3. |
| **Query Syntax** | NONE |
| **Returned Parameters** | N/A |

**NETOFF** Turn ***off Ethernet interface***

| | |
|---|---|
| **Description** | This command turns off the XBL Ethernet interface. The interface will remain in the off state until the XBL is restarted. |
| **Command Syntax** | NETOFF |
| **Example** | NETOFF<br>This will turn off the Ethernet interface. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

**NM _Set Ethernet Net Mask_**

| | |
|---|---|
| **Description** | This command is used to set the Ethernet net mask. |
| **Command Syntax** | NM <adr> |
| **Example** | NM 255.255.0.0<br>This will set the Ethernet interface net mask to 255.255.0.0 |
| **Query Syntax** | NM? |
| **Returned Parameters** | TEXT ON: <adr><br><br>TEXT OFF: <adr> |

## P? *Read Power*

| | |
|---|---|
| **Description** | This query returns the computed load power in Watts. This value is computed from the load's current (I?) and Voltage (V?) readings. |
| **Command Syntax** | NONE |
| **Example** | N/A |
| **Query Syntax** | P? |
| **Returned Parameters** | TEXT ON: <NR2> watts<br><br>TEXT OFF: <NR2> |

## P1 *Constant Power Pulsing Base Level*

| | |
|---|---|
| **Description** | This command is used to set the base level when pulse loading in the Constant Power mode. |
| **Command Syntax** | P1 <NR2> |
| **Example** | P1 25.3<br>This will set the base Constant Power level to 25.3 Watts. |
| **Query Syntax** | P1? |
| **Returned Parameters** | TEXT ON: <NR2> watts<br><br>TEXT OFF: <NR2> |

## P2 *Constant Power Pulsing Peak Level*

| | |
|---|---|
| **Description** | This command is used to set the peak level relative to the base level when pulse loading in the Constant Power mode. |
| **Command Syntax** | P2 <NR2> |
| **Example** | P2 20.0<br>This will set the peak level to 20 Watts above the base level. Therefore if the base level setting is 25.3, the peaks will be 45.3 Watts. |
| **Query Syntax** | P2? |
| **Returned Parameters** | TEXT ON: <NR2> watts<br><br>TEXT OFF: <NR2> |

## PL *Power Limit*

| | |
|---|---|
| **Description** | This command is used to set the Power Limit set point. The Power Limit circuit will not allow the load power to exceed this level. |
| **Command Syntax** | PL <NR2> |
| **Example** | PL 250.0<br>This will set the Power Limit to 250 Watts. |
| **Query Syntax** | PL? |
| **Returned Parameters** | TEXT ON: <NR2> watts<br><br>TEXT OFF: <NR2> |

**PORT** ***Set Ethernet TCP Port***

| | |
|---|---|
| **Description** | This command is used to set the Ethernet port for TCP communications. |
| **Command Syntax** | PORT <NR1> |
| **Example** | PORT 9760<br>This will set the Ethernet port for TCP communications to 9760 |
| **Query Syntax** | PORT? |
| **Returned Parameters** | TEXT ON: <NR1><br><br>TEXT OFF: <NR1> |

## R1 *Constant Resistance Pulsing Base Level*

| | |
|---|---|
| **Description** | This command is used to set the base level when pulse loading in the Constant Resistance mode.<br>**NOTE:**<br>CRH or CRL must have been previously set. |
| **Command Syntax** | R1 <NR2> |
| **Example** | R1 10.0<br>This will set the base resistance to 10 Ohms. |
| **Query Syntax** | R1? |
| **Returned Parameters** | TEXT ON: <NR2> ohms<br><br>TEXT OFF: <NR2> |

## R2 *Constant Resistance Pulsing Peak Level*

| | |
|---|---|
| **Description** | This command is used to set the peak level relative to the base level when pulse loading in the Constant Resistance mode. This resistance will be applied in parallel to the base resistance.<br>**NOTE:**<br>CRH or CRL must have been previously set. |
| **Command Syntax** | R2 <NR2> |
| **Example** | R2 1.1<br>This will set the peak level to 1.1 Ohms that will be applied in parallel with the base level. Therefore if the base level setting is 10 Ohms, the peaks will be 0.99 Ohm. |
| **Query Syntax** | R2? |
| **Returned Parameters** | TEXT ON: <NR2> ohms<br><br>TEXT OFF: <NR2> |

## RNG *Range*

<table>
<tr><td>Description</td><td>This command is used to set the load’s Voltage and current range settings. This is done by writing a value from 1 through 9 as indicated below.
<table>
<tr><th>Range Number</th><th>Voltage</th><th>Current</th></tr>
<tr><td>1</td><td>High</td><td>High</td></tr>
<tr><td>2</td><td>Medium</td><td>High</td></tr>
<tr><td>3</td><td>Low</td><td>High</td></tr>
<tr><td>4</td><td>High</td><td>Medium</td></tr>
<tr><td>5</td><td>Medium</td><td>Medium</td></tr>
<tr><td>6</td><td>Low</td><td>Medium</td></tr>
<tr><td>7</td><td>High</td><td>Low</td></tr>
<tr><td>8</td><td>Medium</td><td>Low</td></tr>
<tr><td>9</td><td>Low</td><td>Low</td></tr>
</table>
The Query form of this command returns actual operating range. This can be different than the range setting when the load is connected in the master/slave arrangement. The range setting can be read back by the RNGS? query.<br><br>The text response to a query will be a string specifying the Voltage and current ranges. The numeric response will be the range number.</td></tr>
<tr><td>Command Syntax</td><td>RNG <NR1></td></tr>
<tr><td>Example</td><td>RNG 2<br>This will set the load to the medium Voltage and high current range.</td></tr>
<tr><td>Query Syntax</td><td>RNG?</td></tr>
<tr><td>Returned Parameters</td><td>TEXT ON: <V range> VOLT, <I range> AMP<br><br>TEXT OFF: <NR1></td></tr>
</table>

**RNGS?**
Alternate form of RNG? Query.

### RS232 *RS232 Settings*

| | |
|---|---|
| **Description** | This command sets the XBL RS232 communications setting. |
| **Command Syntax** | RS232 |
| **Example** | RS232 9600N81<br>This will set the XBL RS 232 communications to 9600 bps, no parity bit, 8 bits, 1 stop bit. Only the following parameters are valid:<br>2400N81, 4800N81, 9600N81, 19200N81 |
| **Related Query** | RS232? |
| **Returned Parameters** | TEXT ON: <string><br><br>TEXT OFF: <string> |

**RS232OFF** Turn ***off RS232 interface***

| | |
|---|---|
| **Description** | This command turns off the XBL RS232 interface. The interface will remain in the off state until the XBL is restarted. |
| **Command Syntax** | RS232OFF |
| **Example** | RS232OFF<br>This will turn off the RS 232 interface. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

## RST *Reset*

### Also see

*RST Reset on page 58 for the IEEE-488.2 version of this command.

| | |
|---|---|
| **Description** | This command resets the load to its factory default power-on settings. |
| **Command Syntax** | RST |
| **Example** | RST<br>This will reset the load to its factory default power-on settings. |
| **Related Query** | NONE |
| **Returned Parameters** | N/A |

## S1 *Rising Slew Rate*

| | |
|---|---|
| **Description** | This command is used to set the rise time in microseconds for a full-scale transition within the selected range.<br><br>**NOTE:**<br>Unless different rising and falling slew limits are required, it is recommended that the SR command be used to set both limits simultaneously. If the rising limit is not the same as the falling limit, the load set point will have small offset errors. |
| **Command Syntax** | S1 <NR2> |
| **Example** | S1 500.0<br>Sets the rise time to 500 microseconds for a zero to full-scale transition within the selected range. |
| **Query Syntax** | S1? |
| **Returned Parameters** | TEXT ON: <NR2> us zero to full<br><br>TEXT OFF: <NR2> |

## S2 *Falling Slew Rate*

| | |
|---|---|
| **Description** | This command is used to set the fall time in microseconds for a full-scale transition within the selected range.<br>**NOTE:**<br>Unless different rising and falling slew limits are required, it is recommended that the SR command be used to set both limits simultaneously. If the rising limit is not the same as the falling limit, the load set point will have small offset errors. |
| **Command Syntax** | S2 <NR2> |
| **Example** | S2 500.0<br>Sets the rise time to 500 microseconds for a full-scale to zero transition within the selected range. |
| **Query Syntax** | S2? |
| **Returned Parameters** | TEXT ON: <NR2> us full to zero<br><br>TEXT OFF: <NR2> |

## SBE *Summary Bit Enable register*

<table>
<tr><td>Description</td><td>This command provides access to the Summary Bit Enable register. The bits in this register define which bits of the Condition (CON) register will set the Major Fault and Minor Fault summary bits in the Status Byte (STB) and the Status Register (STA). Setting one bit by writing its bit weight into the SBE register enables its equivalent bit in the CON register. The individual bits are defined below. More than one bit can be enabled by writing a value that is a sum of the individual bit weights.
<table>
<tr><th>Bit</th><th>Weight</th><th>Description</th><th>Text On Response Message</th><th>Default Value</th></tr>
<tr><td>7</td><td>128</td><td>Under Voltage</td><td>UV</td><td>1</td></tr>
<tr><td>6</td><td>64</td><td>Over Voltage</td><td>OV</td><td>1</td></tr>
<tr><td>5</td><td>32</td><td>Over Temperature</td><td>OT</td><td>1</td></tr>
<tr><td>4</td><td>16</td><td>Minor Fault</td><td>Minor Fault</td><td>0</td></tr>
<tr><td>3</td><td>8</td><td>Over Current</td><td>OC</td><td>1</td></tr>
<tr><td>2</td><td>4</td><td>Over Power</td><td>OP</td><td>1</td></tr>
<tr><td>1</td><td>2</td><td>Saturation</td><td>SAT</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>Major Fault</td><td>MAJOR FAULT</td><td>1</td></tr>
</table>
The query form of this command will either return a numeric or a text response depending on the TEXT ON/OFF and STATXT ON/OFF settings. The text response will return a string containing the Text On Response Message as listed above for each bit that is set. These will be separated by commas. If no bits are set “CLEAR” will be returned.</td></tr>
<tr><td>Command Syntax</td><td>SBE <NR1></td></tr>
<tr><td>Example</td><td>SBE 12<br>This will write the value of 12 into the SBE register. This enables bit 2 (Over Power) and bit 3 (Over Current) in the CON register so that if either is set the relevant summary bit(s) in the STB and STA register will be set.</td></tr>
<tr><td>Related Query</td><td>SBE?</td></tr>
<tr><td>Returned Parameters</td><td>TEXT ON and STATXT ON: <text response string><br><br>TEXT OFF or STATXT OFF: <NR1></td></tr>
</table>

## SDN *Shutdown register*

**Description**

This command provides access to the Shutdown register. The bits in this register define which bits of the Condition (CON) register will cause the load to shutdown. Setting one bit by writing its bit weight into the SDN register enables its equivalent bit in the CON register. The individual bits are defined below. More than one bit can be enabled by writing a value that is a sum of the individual bit weights. The Over Voltage and Over Temperature bits in this register will remain set regardless of what value is written to this register.

**Note: AC fail always resets the load**

| Bit | Weight | Description | Text On Response Message | Default Value |
|---|---|---|---|---|
| 7 | 128 | Under Voltage | UV | 0 |
| 6 | 64 | Over Voltage | OV | 1 |
| 5 | 32 | Over Temperature | OT | 1 |
| 4 | 16 | Minor Fault | MINOR FAULT | 0 |
| 3 | 8 | Over Current | OC | 0 |
| 2 | 4 | Over Power | OP | 0 |
| 1 | 2 | Saturation | SAT | 0 |
| 0 | 1 | Minor Fault | MINOR FAULT | 0 |

The query form of this command will either return a numeric or a text response depending on the TEXT ON/OFF and STATXT ON/OFF settings. The text response will return a string containing the Text On Response Message as listed in the table above for each bit that is set. These will be separated by commas. If no bits are set "CLEAR" will be returned.

| | |
|---|---|
| **Command Syntax** | SDN <NR1> |
| **Example** | SDN 12<br>This will write the value of 12 into the SBE register. This enables bit 2 (Over Power) and bit 3 (Over Current) in the CON register so that if either becomes set the load will shutdown. Since the Over Voltage and Over Temperature bits remain unaffected these will remain enabled. Therefore the value in the SDN register after this command will be 108. |
| **Related Query** | SDN? |
| **Returned Parameters** | TEXT ON and STATXT ON: <text response string><br><br>TEXT OFF or STATXT OFF: <NR1> |

## SERNO? *XBL Serial Number*

| | |
|---|---|
| **Description** | This command is used to retrieve the XBL serial number. |
| **Command Syntax** | SERNO? <string> |
| **Example** | SERNO? |
| **Query Syntax** | SERNO? |
| **Returned Parameters** | TEXT ON: <string><br><br>TEXT OFF: <string> |

## SF *Slew Fast*

Set for fast slew range

| | |
|---|---|
| **Description** | This command is used to set the slew rate limiter to the fast range. In the fast range, full-scale rise and fall times can be programmed between 10µs and 4000µs using the SR, S1 or S2 commands.<br><br>**NOTE:**<br>Maximum slew rate is highly dependent on factors including power source, source to load wiring, and operating mode. |
| **Command Syntax** | SF |
| **Example** | SF<br>Sets the slew rate limiter to the fast range. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

## SHORT *Short Circuit*

| | |
|---|---|
| **Description** | This command is used to apply or remove a simulated short circuit from the device being tested while the load connect relay is closed.<br>**CAUTION:**<br>***This function is intended for use only when testing current limited power sources. Use of the Short Circuit feature with power sources which do not limit their current to values within the load's ratings could result in damage to the load or device under test, FIRE or EXPLOSION.*** |
| **Command Syntax** | SHORT ON<br>SHORT OFF |
| **Example** | SHORT ON<br>This will apply a simulated short circuit at the load's input terminals.<br><br>SHORT OFF<br>This will remove the simulated short circuit from the load's input terminals. |
| **Query Syntax** | SHORT? |
| **Returned Parameters** | Text On: SHORT ON<br>SHORT OFF<br><br>Text Off: 0 (meaning Off)<br>1 (meaning On) |

## SLAVE *Slave Mode*

| | |
|---|---|
| **Description** | This command is used to put the load in slave mode. In slave mode the load will be controlled by the master. The unit will exit slave mode and become independent if no master unit is found withing the first 10 seconds of operation. |
| **Command Syntax** | SLAVE |
| **Example** | SLAVE<br>This will place the unit in slave mode. |
| **Query Syntax** | NONE |
| **Returned Parameters** | N/A |

**SN?**
Alternate form of SERNO? query.

## SR _Slew Rate_

| | |
|---|---|
| **Description** | This command is used to set both the rise and fall time in microseconds for a full-scale transition within the selected range. The query form of this command returns the Rising Slew Rate (S1). The rising and falling slew rates should be identical as long as the S1 and S2 commands are not used. |
| **Command Syntax** | SR <NR2> |
| **Example** | SR 200<br>Sets the rise or fall time for a full-scale transition to 200 microseconds. |
| **Query Syntax** | SR? |
| **Returned Parameters** | TEXT ON: <NR2> us<br><br>TEXT OFF: <NR2> |

## SRQ *Service Request Register*

**Description**

This command provides access to the Service Request register. In IEEE-488 equipped units the bits in this register define which bits of the Status Register (STA) will generate a service request. A query form is provided so the setting can be read back.

The function of this register is similar to that of the Service Request Enable (*SRE) register in the IEEE-488.2 status structure. This query is provided for backward compatibility with systems designed to use the pre-IEEE-488.2 status structure.

The value in this register is a number between 0 and 255 and is the sum of the individual bit weights as defined below.

| Bit | Weight | Description | Text On Response Message |
|---|---|---|---|
| 7 | 128 | Reserved | RESERVED |
| 6 | 64 | Change In Status | STA CHANGE |
| 5 | 32 | Single Shot Complete | SINGLE SHOT COMPLETE |
| 4 | 16 | Command Error | COMMAND ERROR |
| 3 | 8 | Minor Fault | MINOR FAULT |
| 2 | 4 | Major Fault | MAJOR FAULT |
| 1 | 2 | System Minor Fault | SYSTEM MINOR |
| 0 | 1 | System Major Fault | SYSTEM MAJOR |

The query form of this command will either return a numeric or a text response depending on the TEXT ON/OFF and STATXT ON/OFF settings. The text response will return a string containing the Text On Response Message as listed above for each bit that is set. These will be separated by commas. If no bits are set "CLEAR" will be returned.

| | |
|---|---|
| **Command Syntax** | SRQ <NR1> |
| **Example** | SRQ 12<br>This will write the value of 12 into the SRQ register. This enables bit 2 (Major Fault) and bit 3 (Minor Fault) in the STA register so that if either is set a service request will be generated. |
| **Query Syntax** | SRQ? |
| **Returned Parameters** | TEXT ON and STATXT ON: <text response string><br><br>TEXT OFF or STATXT OFF: <NR1> |

## SS *Slew Slow*

| | |
|---|---|
| **Description** | This command is used to set the slew rate limiter to the slow range. In the slow range, full-scale rise and fall times can be programmed between 1,000µs and 400,000µs using the SR, S1 or S2 commands.<br>**NOTE:**<br>Maximum slew rate is highly dependent on factors including power source, source to load wiring and operating mode. |
| **Command Syntax** | SS |
| **Example** | SS<br>Sets the slew rate limiter to the slow range. |
| **Query Syntax** | NONE |
| **Returned Parameters** | NONE |

## STA? *Status Register*

**Description**

This query returns the contents of the Status register and then clears its contents. The response is either numeric or a text description depending on the TEXT ON/OFF and STATXT ON/OFF settings.

This register contains summary status information and serves a function that is similar to the Status Byte (*STB?) in the IEEE 488.2 status structure. This query is provided for backward compatibility with systems designed to use the pre-IEEE 488.2 status structure.

The value in this register is a number between 0 and 255 and is the sum of the individual bit weights as defined below.

| Bit | Weight | Description | Text On Response Message |
|---|---|---|---|
| 7 | 128 | Reserved | RESERVED |
| 6 | 64 | Change In Status | STA CHANGE |
| 5 | 32 | Single Shot Complete | SINGLE SHOT COMPLETE |
| 4 | 16 | Command Error | COMMAND ERROR |
| 3 | 8 | Minor Fault | MINOR FAULT |
| 2 | 4 | Major Fault | MAJOR FAULT |
| 1 | 2 | System Minor Fault | SYSTEM MINOR |
| 0 | 1 | System Major Fault | SYSTEM MAJOR |

The text response will return a string containing the Text On Response Message as listed above for each bit that is set. These will be separated by commas. If no bits are set, “CLEAR” will be returned.

| | |
|---|---|
| **Command Syntax** | NONE |
| **Example** | N/A |
| **Query Syntax** | STA? |
| **Returned Parameters** | TEXT ON and STATXT ON: <text response string><br><br>TEXT OFF or STATXT OFF: <NR1> |

## STATUS? _XBL Alarm Status (HEX)_

**Description**

This query returns the XBL alarm status in hexadecimal format.

| Bit | Weight | Description | |
|---|---|---|---|
| 15 | 32768 | SAT Alarm | |
| 14 | 16384 | Relay Status | |
| 13 | 4096 | Over Power Alarm | |
| 12 | 2048 | Over Current Alarm | |
| 11 | 1024 | AC Fail Alarm | |
| 10 | 512 | Over Temp Alarm | |
| 9 | 256 | Under Voltage Alarm | |
| 8 | 128 | Over Voltage Alarm | |
| 7 | 64 | Minor Fault Alarm | |
| 6 | 32 | Major Fault Alarm | |
| 5 | 16 | Not Used | |
| 4 | 8 | Not Used | |
| 3 | 4 | Not Used | |
| 2 | 2 | Not Used | |
| 1 | 1 | Not Used | |
| 0 | 0 | Not Used | |

| | |
|---|---|
| **Command Syntax** | NONE |
| **Example** | STATUS? |
| **Query Syntax** | STATUS? |
| **Returned Parameters** | TEXT ON: <string><br><br>TEXT OFF: <string> |

## STATXT Status Text

| | |
|---|---|
| **Description** | This command is used to turn off descriptive responses for the CON?, ERR?, LAT?, SBE?, SDN?, SRQ? and STA? queries without affecting other Text Mode responses. This allows the status related registers to be read in an easily decoded numeric form while all other queries retain their descriptive responses. This differs from the TEXT ON/OFF command in that it only applies to the status related queries while TEXT ON/OFF applies to all queries. Both the STATXT and TEXT must be on for descriptive responses to the above queries.<br><br>Unlike most other commands, the load will retain its STATXT setting even after powering it down. |
| **Command Syntax** | STATXT ON<br>STATXT OFF |
| **Example** | STATXT ON<br>This will enable descriptive responses to the CON?, ERR?, LAT?, SBE?, SDN?, SRQ? and STA? queries provided Text Mode is also on.<br><br>STATXT OFF<br>This will force a numerical responses to the CON?, ERR?, LAT?, SBE?, SDN?, SRQ? and STA? queries regardless of the Text Mode setting. |
| **Query Syntax** | STATXT? |
| **Returned Parameters** | Text On: STATXT ON<br>STATXT OFF<br><br>Text Off: 1 (meaning On)<br>0 (meaning Off) |

### SW *Square Wave Pulsing*

| | |
|---|---|
| **Description** | This command is used to turn on and off Square Wave pulsing. It functions exactly the same as the WF command with all the same forms. This is done to provide compatibility with other model types. |
| **Command Syntax** | SW<br>SW OFF |
| **Example** | SW<br>This will turn on Square Wave pulsing until explicitly turned off.<br><br>SW OFF<br>This will turn off Square Wave pulsing. |
| **Query Syntax** | SW? |
| **Returned Parameters** | Text On: SW ON<br>SW OFF<br><br>Text Off: 1 (meaning On)<br>0 (meaning Off) |

## T1 *Pulsing Base Time*

| | |
|---|---|
| **Description** | This command is used to directly set the base time in microseconds for square wave pulsing. This will also set the Duty Cycle (DU) and Frequency (FQ) accordingly based upon the Pulsing Peak Time (T2). |
| **Command Syntax** | T1 <NR1> |
| **Example** | T1 2000<br>This will set the pulse base time to 2000µs. If T2 were 3000µs, the duty cycle (DU) would be 60% and frequency would be 200Hz. |
| **Query Syntax** | T1? |
| **Returned Parameters** | TEXT ON: <NR1> us<br><br>TEXT OFF: <NR1> |

## T2 *Pulsing Peak Time*

| | |
|---|---|
| **Description** | This command is used to directly set the peak time in microseconds for square wave pulsing. This will also set the Duty Cycle (DU) and Frequency (FQ) accordingly based upon the Pulsing Base Time (T1). |
| **Command Syntax** | T2 <NR1> |
| **Example** | T2 4000<br>This will set the pulse base time to 4000µs. If T1 were 6000µs, the duty cycle (DU) would be 40% and frequency would be 100Hz. |
| **Query Syntax** | T2? |
| **Returned Parameters** | TEXT ON: <NR1> us<br><br>TEXT OFF: <NR1> |

## TEXT *Text Mode*

| | |
|---|---|
| **Description** | This command is used to turn on or off the descriptive responses that are available on many queries. |
| **Command Syntax** | TEXT ON<br>TEXT OFF |
| **Example** | TEXT ON<br>This will turn on the descriptive responses.<br><br>TEXT OFF<br>This will turn off the descriptive responses. |
| **Query Syntax** | TEXT? |
| **Returned Parameters** | Text On: TEXT ON<br><br>Text Off: 0 (meaning Off) |

## UV *Under Voltage*

| | |
|---|---|
| **Description** | This command is used to set the Programmable Under Voltage threshold. When the input voltage drops below this threshold the load will disconnect from the device under test and indicate an Under Voltage fault. Unlike the hardware Under Voltage, the load will not automatically reconnect when the Voltage rises above the threshold. Setting the Programmable Under Voltage to zero will disable it. The programmable Under Voltage operation is not affected by the UV bit in the Shutdown (SDN) register. |
| **Command Syntax** | UV <NR2> |
| **Example** | UV 9.6<br>This will set the Programmable Under Voltage to 9.6 Volts. The load will shutdown if the Voltage on its input terminals drops below this threshold.<br><br>UV 0<br>This will disable the Programmable Under Voltage feature. |
| **Query Syntax** | UV? |
| **Returned Parameters** | Text On: <NR2> volts<br><br>Text Off: <NR2> |

## V? *Read Voltage*

| | |
|---|---|
| **Description** | This query returns the actual Voltage in Volts measured at the load's Voltage sense terminals.<br><br>**NOTE:**<br>If remote Voltage sensing is not used, this voltage may differ from the output voltage of the device. This is due to the Voltage drops in the conductors between the load and the device under test. Therefore remote voltage sensing is recommended when high currents are involved. |
| **Command Syntax** | NONE |
| **Example** | N/A |
| **Query Syntax** | V? |
| **Returned Parameters** | TEXT ON: <NR2> volts<br><br>TEXT OFF: <NR2> |

## V1 *Constant Voltage Pulsing Base Level*

| | |
|---|---|
| **Description** | This command is used to set the base level when pulse loading in the Constant Voltage mode.<br><br>**NOTE:**<br>When pulsing in constant voltage mode, higher voltage corresponds to less drive. Therefore, V1 is a higher value than V2. |
| **Command Syntax** | V1 <NR2> |
| **Example** | V1 75.0<br>This will set the base Constant Voltage level to 75.0 Volts. |
| **Query Syntax** | V1? |
| **Returned Parameters** | TEXT ON: <NR2> volts<br><br>TEXT OFF: <NR2> |

## V2 *Constant Voltage Pulsing Peak Level*

| | |
|---|---|
| **Description** | This command is used to set the peak level relative to the base level when pulse loading in the Constant Voltage mode. In Constant Voltage, peak refers to peak drive hence lower Voltage. Therefore the peak level this command specifies is the Voltage to be subtracted from the base level (V1). |
| **Command Syntax** | V2 <NR2> |
| **Example** | V2 24.3<br>This will set the peak level to 24.3 Volts below the base level. Therefore if the base level setting is 75.0, the peaks will be 50.7 Volts. |
| **Query Syntax** | V2? |
| **Returned Parameters** | TEXT ON: <NR2> volts<br><br>TEXT OFF: <NR2> |

## VER? *Version*

| | |
|---|---|
| **Description** | This query returns the load's firmware version as a variable length alphanumeric string. |
| **Command Syntax** | NONE |
| **Example** | N/A |
| **Query Syntax** | VER? |
| **Returned Parameters** | <version string> |

## VL *Voltage Limit*

| | |
|---|---|
| **Description** | This command is used to set the Voltage Limit trip level. The load will disconnect from the device under test if the Voltage exceeds this level. |
| **Command Syntax** | VL <NR2> |
| **Example** | VL 16.5<br>This will set the Voltage Limit to 16.5 Volts. |
| **Query Syntax** | VL? |
| **Returned Parameters** | TEXT ON: <NR2> volts<br><br>TEXT OFF: <NR2> |

## WARRDTE?

| | |
|---|---|
| **Description** | This command returns the XBL factory warranty expiration date. |
| **Command Syntax** | WARRDTE? |
| **Example** | WARRDTE?<br>This will return the XBL factory warranty expiration date. |
| **Query Syntax** | WARRDTE? |
| **Returned Parameters** | TEXT ON: MMDDYYYY or MM-DD-YYYY<br><br>TEXT OFF: MMDDYYYY or MM-DD-YYYY |

## WF *Waveform*

| | |
|---|---|
| **Description** | This command is used to turn on and off Square Wave pulsing. It functions exactly the same as the SW command with all the same forms. This is done to provide compatibility with other model types. |
| **Command Syntax** | WF<br>WF OFF |
| **Example** | WF<br>This will turn on Square Wave pulsing until explicitly turned off.<br><br>WF OFF<br>This will turn off Square Wave pulsing. |
| **Query Syntax** | WF? |
| **Returned Parameters** | Text On: SW ON<br>SW OFF<br><br>Text Off: 1 (meaning On)<br>0 (meaning Off) |

## XM *External Modulation*

| | |
|---|---|
| **Description** | This command places the load in Remote Programming mode. In this mode a 0 to 10V signal at the load's Remote Programming Input terminal on the back of the unit will program the load from zero to full scale of the selected range. This is inverted when in Constant Voltage mode so that zero programs full scale while 10V programs zero.<br><br>When in Constant Current mode a digitally programmed offset current can be specified. This is done using the "XM PLUS <NR2>" syntax. "XM + <NR2>" is an alternate syntax that can be used as well. In any mode other than Constant Current the offset specification will be ignored.<br><br>The query form of this command returns only the XM ON/OFF status. The digitally programmed current offset issued with a XM PLUS (or XM +) command can be read back using either a CI? or I1? query. |
| **Command Syntax** | XM ON<br>XM OFF<br>XM PLUS <NR2> or XM + <NR2> |
| **Example** | XM ON<br>This will place the load in Remote Programming mode.<br><br>XM PLUS 45.0 (or XM + 45.0)<br>When in Constant Current mode this will place the load into Remote Programming and apply a digitally programmed offset of 45 Amps. In any mode other than Constant Current it will act the same as the XM ON command.<br><br>XM OFF<br>This turns off Remote Programming and resumes internal digitally programmed operation. |
| **Query Syntax** | XM? |
| **Returned Parameters** | Text On: EXTERNAL MODULATION ON<br>EXTERNAL MODULATION OFF<br><br>Text Off: 1 (meaning On)<br>0 (meaning Off) |

# Status and Event Registers —Status Structure

The Status Logic illustration shows the logical relationship between the status registers. Three of the registers, the condition (CON) register, the error (ERR) register, and the status (STA) register reflect the condition of the load.

Two of the registers, the fault shutdown mask (SDN) and the fault latch mask (LAT) control which of the condition register bits cause a load shutdown (shutdown mask) and/or are latched until read (latch mask).

The summary bit enable (SBE) register controls, which condition bits, are passed through to the system status register (STA). The system status register is available either in response to an STA? query

The service request (SRQ) enable mask controls which bits in the status register can assert the SRQ line. Additional information about the registers appears in tables that follow.

Refer to the CON?, ERR?, LAT, SBE, SDN, SRQ and STA? in the Detail Language Elements section of Chapter 3 for additional information about the specific registers.

**Condition, Latch, Shutdown and Summary Bit Enable Registers**

| Bit | Mnemonic | Interpretation |
|---|---|---|
| 7 | UV | Indicates an under voltage condition |
| 6 | OV | Indicates an over voltage condition |
| 5 | OT | Indicates an over temperature condition |
| 4 | GPIB ERROR | Indicates a GPIB bus error |
| 3 | OC | Indicates current limit condition |
| 2 | OP | Indicates a power limit condition |
| 1 | SAT | Indicates a load or module saturation condition |
| 0 | MOD | Indicates a module level fault |

**Error Register**

| Bit | Mnemonic | Interpretation |
|---|---|---|
| 7 | Reserved | Reserved for future use. |
| 6 | Reserved | Reserved for future use. |
| 5 | Not allowed | The received command is not permitted in the loads present state. For example, a LOAD ON in the face of a HARDWARE FAIL. |
| 4 | Too long | The program line length exceeds the loads input buffer. |

| | | |
|---|---|---|
| 3 | Numeric | A number has been received that can not be interpreted for example, 3.14A2 instead of 3.14. |
| 2 | Reserved | Reserved for future use. |
| 1 | Range | A numerical value either too low or too high has been received. |
| 0 | Unrecognized | A command has been received that is not in the loads syntax. |

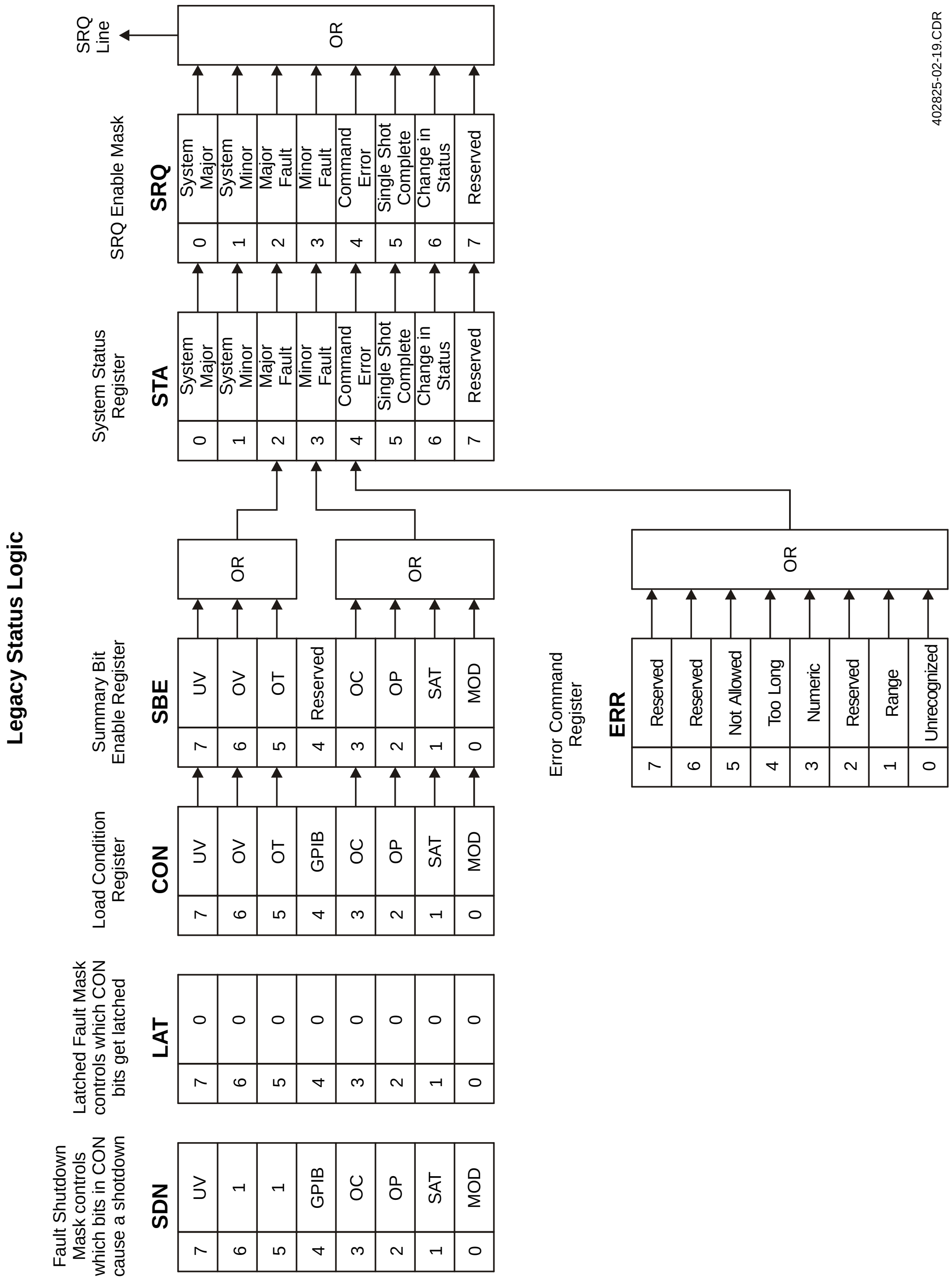



**Figure 11. Load Status Structure**

# Glossary

This glossary includes explanations and definitions of terms that may be found in this manual or encountered while working with the Dynaload. Many of these words are commonly used in electrical, electronic and computer related technologies.

## A

| | |
|---|---|
| **AC** | *Alternating Current.* |
| **AC Power Supply** | Power supply that delivers an AC voltage. |
| **A/D Conversion** | *Analog-To-Digital Conversion.* The process of changing an analog signal into a digital value. |
| **Alternating Current** | Electric current that rises to a maximum in one direction, falls back to zero, and then rises to a maximum in the opposite direction and then repeats. |
| **Ammeter** | Instrument for measuring the current in amps, milliamps or microamps. |
| **Ampere** | Also referred to as an Amp. The unit of electrical current (represented by the symbol “A”). |
| **Amplitude** | The highest value reached by voltage, current or power during a complete cycle. |
| **Analog** | System in which data is represented as a continuously varying voltage. Also spelled *Analogue*. |
| **ANSI** | *American National Standards Institute.* |
| **ASCII** | *American Standard Code for Information Interchange*. Standardized method of encoding alphanumeric characters into 7 or 8 binary bits. |
| **Apparent Power** | Power attained in an AC circuit as a product of effective voltage and current (which reach their peak at different times). |

**Astable** Circuit that does not have a stable state and as a result oscillates at a frequency dependent upon component values.

**AWG** *American Wire Gauge.* A system that assigns a number value to the diameter of a wire.

# B

**Base** One terminal of a transistor that is usually the input lead. It separates the collector and emitter regions of a transistor.

**Battery** DC voltage source containing two or more cells that convert chemical energy to electrical energy.

**Baud** Unit of signaling speed equal to the number of signal events per second.

**Binary** System based on the number 2. (The binary digits are 0 and 1.)

**Binary-Coded Decimal** Code for representing decimal digits in a binary format. Also referred to as *BCD*.

**Bit** *Binary Digit*. Smallest unit of binary data.

**Bleeder Current** Current drawn continuously from a source and is used to stabilize the output voltage of a source.

**Bus** In Electricity. A bus bar.
In Computer Science. A parallel circuit that connects the major components of a computer, allowing the transfer of electric impulses from one connected component to any other.

**Byte** A sequence of adjacent bits operated on as a unit by a computer.

# C

| | |
|---|---|
| **Capacitance** | Ability of a capacitor to store an electrical charge. The basic unit of capacitance is the Farad. |
| **Capacitor** | Electronic component that stores an electrical charge. |
| **Cascade** | Method of connecting circuits in series so that the output of one is the input of the next. |
| **Charge** | Quantity of electrical energy. |
| **Chassis** | Metal box or frame into which components are mounted. |
| **Chassis Ground** | Connection to a chassis. |
| **Choke** | Inductor designed to present a high impedance to alternating current. |
| **Circuit** | Interconnection of components to provide an electrical path between two or more components |
| **Circuit Breaker** | Protective device used to open a circuit when current is greater than a maximum value. A circuit breaker acts as a reusable fuse. |
| **Circuit Diagram** | Structural or procedural diagram of an electrical system. Also see Schematic. |
| **Closed Circuit** | Circuit having a complete path for current flow. |
| **Coil** | Conductor wound in a series of turns. |
| **Collector** | One of three terminals of a transistor. |
| **Continuity** | The state that occurs when a complete path for current is present. |
| **Current** | Passage of electrons measured in amps (milliamps and microamps). |

# D

| | |
|---|---|
| **D/A Conversion** | *Digital-To-Analog Conversion.* Translating discrete data into continuously varying signals. |
| **DC** | *Direct Current.* Current that flows in one direction. |
| **DC Power Supply** | Any source of DC power for electrical equipment. |
| **Digital Electronics** | Branch of electronics dealing with information in binary form. |
| **Distortion** | Amount by which a circuit or component fails to accurately reproduce the characteristics of the input. |
| **Duplex Transmission** | Ability to both send and receive data at the same time over the same communications line. |

# E

| | |
|---|---|
| **Earth** | *Ground.* Connection to the earth itself or the negative lead to a chassis or to any point to zero voltage. |
| **Electron Flow** | Direction in which electrons flow (from negative to positive since electrons are negatively charged). |
| **EMF** | *Electromotive Force.* Force that causes the motion of electrons due to potential difference between two points (voltage). |
| **Emitter** | One of three terminals of a transistor. |

# F

**Farad** Basic measuring unit of capacitance.

**Feedback** Portion of the output signal of an amplifier that is connected back to the input of the same amplifier.

**Firmware** Computer software usually permanently stored in a computer.

**Fuse** Protective device in the current path that melts or breaks when current is over a predetermined maximum value.

# G

**Gain** Ratio of the output level of a circuit to the input.

**GFCI** *Ground Fault Circuit Interrupt*. Used for AC convenience outlets to provide maximum personal protection from electrical shock. A GFCI is not suitable for use with certain portable test equipment.

**Ground** A large conducting body, such as the earth or an electric circuit connected to the earth, used as an arbitrary zero of potential. A ground is often used as the common wiring point or reference in a circuit.

**Ground Plane** Earth or negative rail of a circuit and a considerable mass that presents the effect of earth (ground) to a signal.

# H

**Handshaking** Exchange of signals (usually part of a communications protocol) between two devices to establish a connection.

**Henry** Basic unit of inductance.

**Hertz** Number of cycles per second for any periodic waveform (measured in cycles per second). One hertz is equal to one cycle per second.

# I

**Impedance** Impedance is similar to resistance but applies to alternating current circuits and is measured in ohms (represented by the symbol “Z”).

**Input** The part of a circuit that accepts a signal for processing.

**Insulator** Material that resists the flow of current.

**Interface** Usually the hardware that provides communication between various items of equipment using common physical interconnection characteristics, signal characteristics, and meanings of interchanged signals.

**Inverter** A device used to convert direct current into alternating current.

**I/O** *Input/Output.*

# K

| | |
|---|---|
| **Kilowatt - hour kWh** | Unit of energy when one kilowatt of power is expended for one hour. |

# L

| | |
|---|---|
| **Leakage** | Passage of small electric current through an insulator or dielectric that is unintended and undesirable. |
| **LED** | *Light-emitting diode,* a semi-conductor that emits light, used in displays such as meters, clocks and calculators. |
| **Limiter** | Circuit or device that prevents some portion of its input from reaching the output. |
| **Line Regulation** | Ability of a voltage regulator to maintain a constant voltage when the regulator input voltage varies. |
| **Load** | Component or piece of equipment connected to a source and draws current from a source is a load on that source. |
| **Load Current** | Current drawn from a source by a load. |
| **Load Impedance** | Sum of reactance and resistance in a load. |
| **Load Regulation** | Ability of a voltage regulator to maintain a constant output voltage under varying load currents. |
| **Load Resistance** | The resistance of a load. |
| **Logic** | The principle and applications of gates, relays and switches. |

# M

| | |
|---|---|
| **Matched Impedance** | Condition that exists when the output impedance of a source is equal to the input impedance of a load. |
| **Megohm** | One million ohms (represented by the symbol "M"). |
| **Memonic** | Relating to, assisting, or intended to assist the memory. A device, such as a formula used as an aid in remembering. |
| **MOSFET** | *Metal Oxide Field Effect Transistor*. Field effect transistor with a metal oxide insulating layer between the gate electrode and the channel. Also referred to as an *insulated gate field effect transistor*. |
| **Multimeter** | Electronic test equipment that can perform multiple tasks (such as measuring AC and DC voltage, current and resistance. A digital multimeter is often referred to as a DVM. |
| **Multiplexer** | Device that sends messages or signals simultaneously using a multiplex system. |
| **Mutual Inductance** | The ability of one inductor's lines of force to link with another inductor. |
| **MUX** | *Multiplexer*. |

# N

| | |
|---|---|
| **Noise** | Unwanted electromagnetic radiation within an electrical system. |
| **Normally Closed** | When the contacts of a switch or relay are closed or connected when at rest. When activated, the contacts open or separate. |
| **Normally Open** | When the contacts of a switch or relay are normally open or not connected. When activated the contacts close or are connected. |

| | |
|---|---|
| **NPN** | Transistor using n-type p-type n-type semiconductor material. |

# O

| | |
|---|---|
| **Ohm** | Unit of resistance (represented by the Greek capital letter omega "Ω" and the symbol "R"). |
| **Ohm's Law** | I=V/R where I is the current flowing, V is the voltage and R is the resistance. |
| **Open Circuit** | Circuit having an incomplete path for current flow. |
| **Oscilloscope** | Electronic instrument that produces an instantaneous trace on the screen of a cathode ray tube corresponding to oscillations of voltage and current. |
| **Output** | Part of a circuit where the processed signal is available. |
| **Output Impedance** | Impedance measured at the output terminals of a device, without a load connected. |
| **Output Power** | Amount of power that a component, circuit or system can deliver to a load. |
| **Overload** | Condition that occurs when the load is greater than a system can handle. |
| **Overload Protection** | Protective device such as a circuit breaker that automatically disconnects a load when current exceeds a predetermined value. |

# P

| | |
|---|---|
| **Parallel Circuit** | Circuit having two or more paths for current flow. |
| **Passive Component** | Component that does not amplify a signal (such as resistors and capacitors). |
| **PCB** | *Printed Circuit Board.* See also PWB. |
| **Phase** | The angular relationship between two waves. |
| **Polarity** | Terminology used to describe positive and negative charges. |
| **Polarized** | Component that must be connected in correct polarity to function and/or prevent destruction. |
| **Power** | The amount of energy converted by a circuit or component in a specific unit of time, normally seconds. Measured in watts. |
| **Power Factor** | The ratio of actual power to apparent power. |
| **Power Loss** | The ratio of power absorbed to power delivered. |
| **Power Supply** | Electrical equipment used to deliver either voltage (either AC or DC). |
| **PNP** | Transistor using p-type, n-type, n-type semiconductor material. |
| **PWB** | *Printed Wiring Board.* See also PCB. |

# R

**Real Time** Data that is immediately acted upon rather than being accumulated and processed at a later time.

**Rectifier** AC-to-DC converter with output typically connected in parallel with battery backup.

**Regulated Power Supply** A power supply that maintains a constant output voltage under changing load conditions.

**Relay** An electromechanical device that opens or closes contacts when current is passed through a coil.

**Resistance** Opposition of a body or substance to current passing through it (resulting in a change of electrical energy into heat or another form of energy).

**Resistor** Passive component with a known resistance.

**Rheostat** Variable resistor used to control current.

# S

**Schematic** Structural or procedural diagram of an electrical or electronic circuit with the components represented by symbols. Also see Circuit Diagram.

**Semiconductor** Any of various solid crystalline substances, such as silicon, having electrical conductivity greater than insulators but less than good conductors. S semiconductors properties can be altered by a control voltage.

**Series Circuit** Circuit in which the components are connected end to end so that current has only one path to follow.

**Series Parallel Circuit** Circuit that contains components connected in both series and parallel.

| | |
|---|---|
| **Short-Circuit** | Unintended path that conducts electricity that typically causes excessive current. |
| **Signal** | Impulse or a fluctuating electric quantity, such as voltage, current, or electric field strength, whose variations represent coded information. |
| **Signal Generator** | Circuit that produces a variable and controllable signal. |
| **Simplex Transmission** | Data transmission in only one direction at a time. |
| **Sink** | Load or other device that consumes power or conducts away heat from a circuit. |
| **Source** | A device that provides signal power or energy to a load. |
| **Spike** | A brief and sudden change (usually an increase) in the voltage on a power line. A surge is similar to a spike, but is of longer duration. |
| **Step-Down Transformer** | A transformer in which the output AC voltage is less than the input AC voltage. |
| **Step-Up Transformer** | A transformer in which the output AC voltage is greater than the input AC voltage. |
| **Supply Voltage** | The voltage that is provided by a power source. |
| **Surge** | A sudden change (usually an increase) in the voltage on a power line. A surge is similar to a spike, but is of longer duration. |
| **Surge Current** | The high charging current that flows into a power supply filter capacitor when power is first turned on. |

**Switch** Device for connecting and disconnecting power to a circuit.

# T

**Telemetry** Usually refers to transmission of alarm, status, and other information by an embedded data channel multiplexed into a digital bit stream.

**Terminal** A point at which electrical connections are made.

**Test** A methodical sequence of operations or steps intended to verify the correct operation or malfunctioning of a piece of a system or piece of equipment.

**Thermistor** Resistor that varies according to temperature.

**Three Phase Supply** AC power supply that has three AC voltages, 120° out of phase with each other.

**Threshold** Minimum point at which an effect is produced or detected.

**Transducer** Device that receives energy in one form and supplies an output in another form.

**Transformer** An inductor with two or more windings.

**Transformer Coupling** The coupling of two circuits using mutual inductance provided by a transformer.

**Transistor** Three leaded device (Collector, Base, Emitter) used for amplifying or switching.

**Trigger** A pulse used to start a circuit action.

**Trimmer** Small value variable resistor, capacitor, or inductor used to finely adjust a larger value.

**Troubleshooting** A methodical or systematic series of steps for locating the cause of a fault or problem in an electronic circuit or system.

**Tuned Circuit** Circuit in resonance at a particular frequency.

# U

**Uncontrolled Environment** In thermal and humidity terms this mean to be without heating or air-conditioning and therefore subject to the normal range of outdoor conditions. Electronics must generally be "hardened" for use in such an environment. In safety terms (for example, UL), a building or space in a building that is accessible by untrained personnel.

**UPS** *Uninterruptible Power Supply.*

# V

**VA** *Volt Ampere.*

**VFC** *Voltage-To-Frequency Converter.* Device that converts an analog input voltage into a sequence of digital pulses.

**Volt** Unit of voltage.

**Volt-ampere** A unit of electric power equal to the product of one volt and one ampere, equivalent to one watt.

**Voltage** Electromotive force or potential difference, usually expressed in volts.

**Voltage Drop** Due to current flow, the voltage or difference in potential developed across a component.

**Voltage** Voltage feedback where a portion of the output voltage is fed back to the

**Feedback** input of an amplifier.

**Voltage Rating** The maximum voltage a component can withstand without breaking down.

**Voltage Regulator** A circuit or device that maintains a constant output voltage even when there is changing line voltage and/or load current.

**Voltage Source** Circuit or device that supplies voltage to a load.

## W

**Watt** Unit of power. One watt is the product of one volt and one amp (represented by the symbol “W”).

**Wattage** An amount of power, especially electric power, expressed in watts or kilowatts. Also, the electric power required by an appliance or a device.

**Wattage Rating** The maximum amount of power a device can continuously safely handle.

## X -Z

**X-ON/X-OFF** *Transmitter On/Transmitter Off.* Used for flow control, instructing a terminal to start transmission and end transmission.

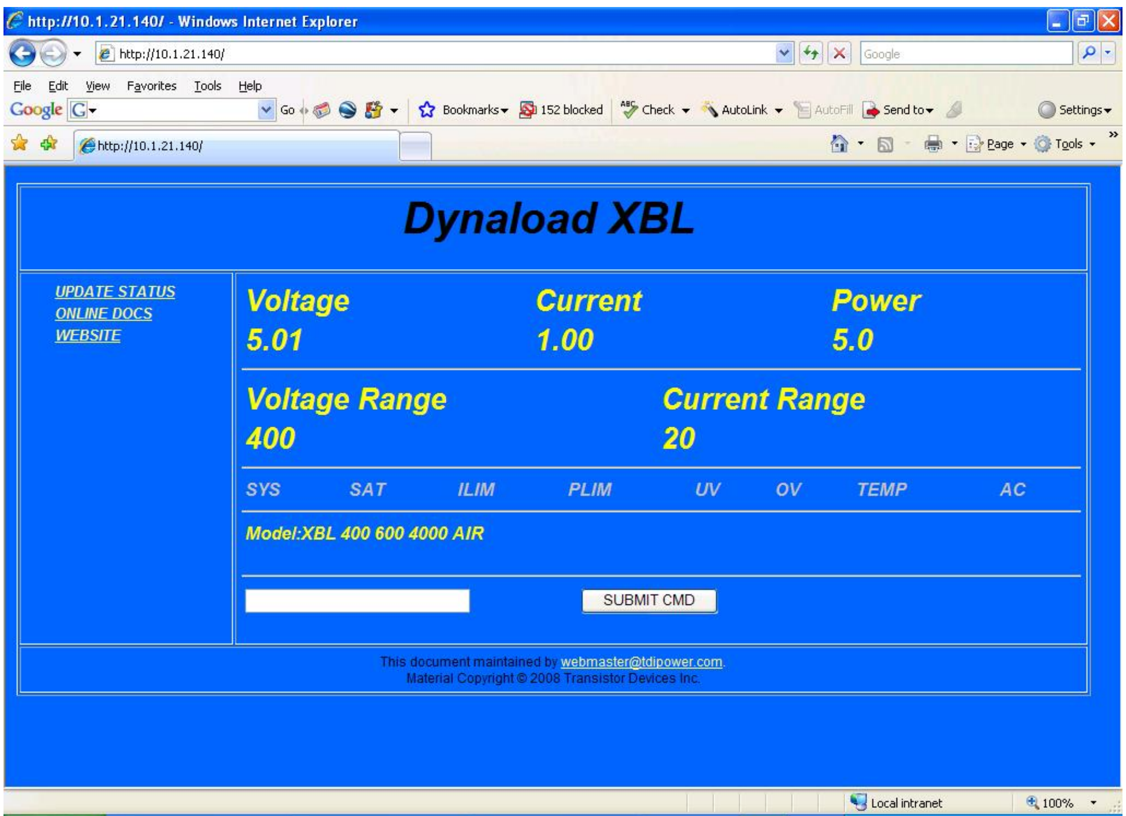
**Zener Diode** Silicon semiconductor device used as a voltage regulator because of its ability to maintain an almost constant voltage with a wide range of currents.

# *Setting up Ethernet Communications*

1. The Ethernet communications module (ECM) is provided pre-configured as follows:
   a. IP address: **192.168.1.10**
   b. Net Mask: 255.255.0.0
   c. Gateway: 192.168.1.1
   d. Port number for TCP communications: 9760

2. To change the settings use the appropriate front panel menu commands or use the IP, NM, GWY and PORT commands via the RS232 or IEEE 488 interface.

3. Simply run your **browser** and type 192.168.1.10 into the address bar of your browser.




**Telnet Communications**

Please note that Telnet capability is also available at this address on port 23.

### TCP Communications

The XBL will accept commands sent via TCP.  The destination address is defined via the IP command (192.168.1.10 default) and PORT command (9760 default).

# *Chapter 4. — Appendix A — List of Commands*

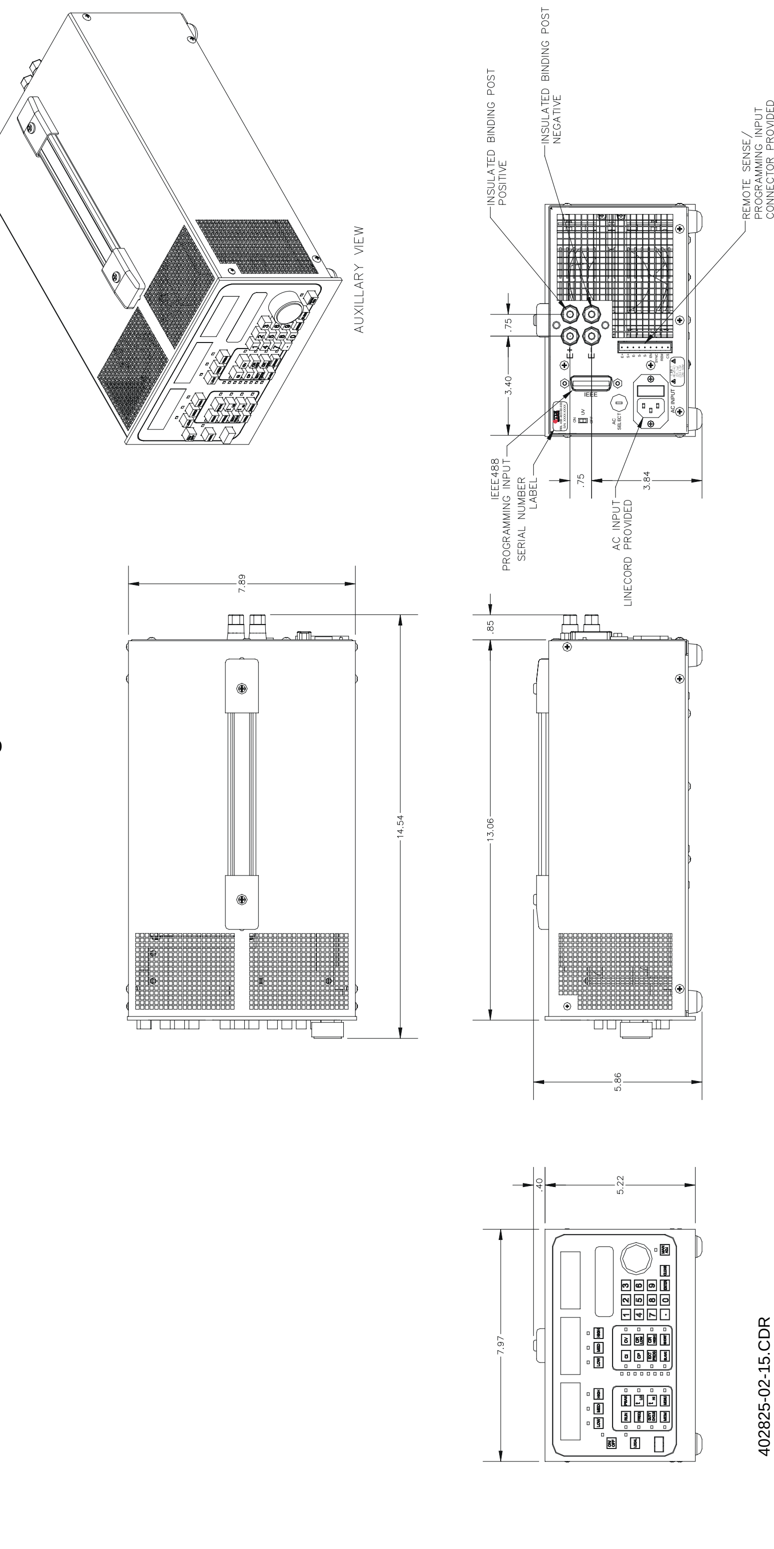
AV1 <NR2>
AV2 <NR2>
AVH <NR2>
AVL <NR2>
CI <NR2>
CP <NR2>
CRH <NR2>
CRL <NR2>
CV <NR2>
DU <NR2>
FQ <NR2>
I1 <NR2>
I2 <NR2>
IL <NR2>
LAT <NR2>
P1 <NR2>
P2 <NR2>
PL <NR2>
R1 <NR2>
R2 <NR2>
RNG <NR1>
RST
S1 <NR2>
S2 <NR2>
SBE <NR1>
SF
SHORT OFF
SHORT ON
SLAVE
SR <NR2>
T1 <NR2>
T2 <NR2>
TEXT OFF
TEXT ON
UV <NR2>
V1 <NR2>
V2 <NR2>
VL <NR2>
WF [<NR1>]
WF OFF
XM
XM PLUS <NR2>
XM + <NR2>

# *Appendix B — List of Queries*

AV1?
AV2?
AV?
CI?
CON?
CP?
CR?
CV?
DU?
ERR?
FQ?
LOCK?
MODE?
P1?
P2?
P?
PL?
R1?
R2?
RNG?
RNGS?
S2?
T1?
T2?
TEXT?
UV?
V1?
V2?
V?
VER?
VL?
WF?

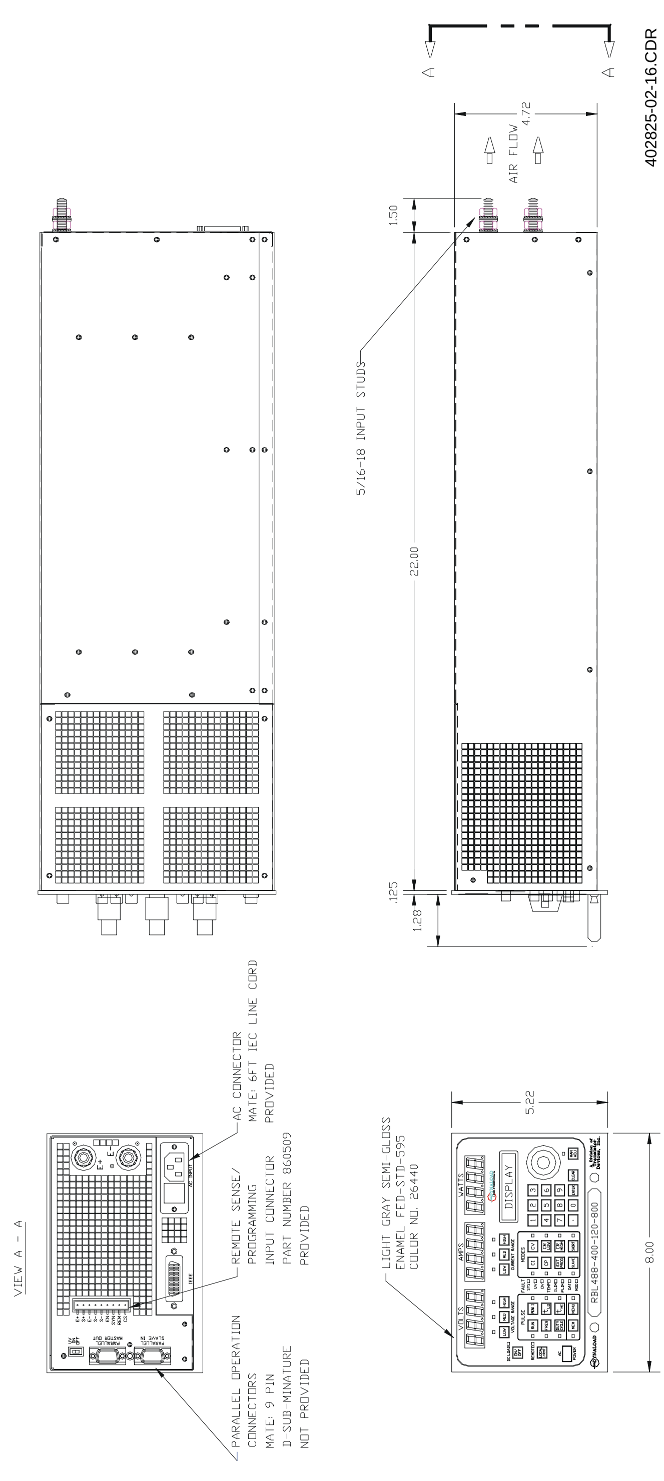
I1? SBE?

# Appendix C — Outline Drawings by Model

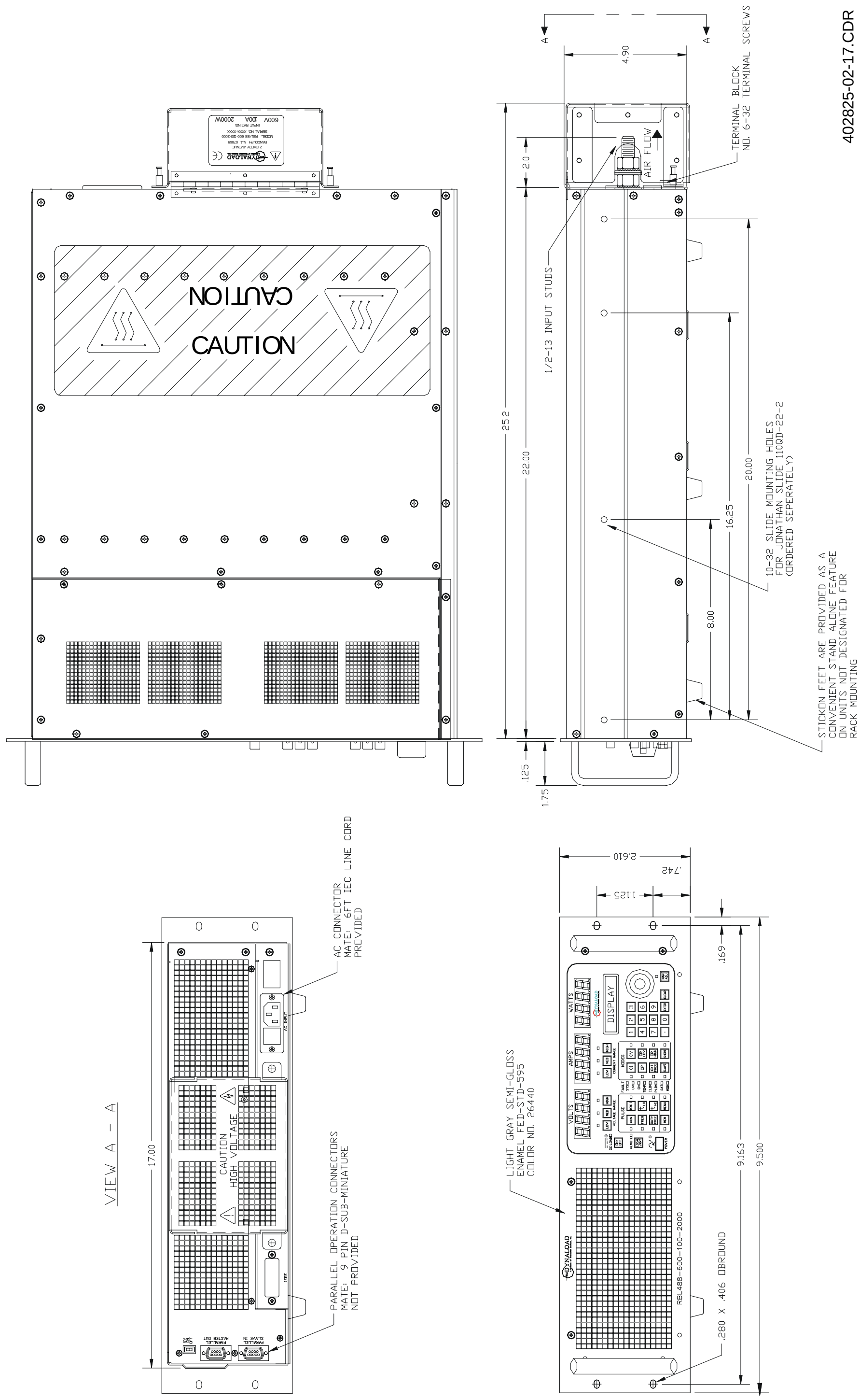



**Outline Drawing of RBL 400 Watt**

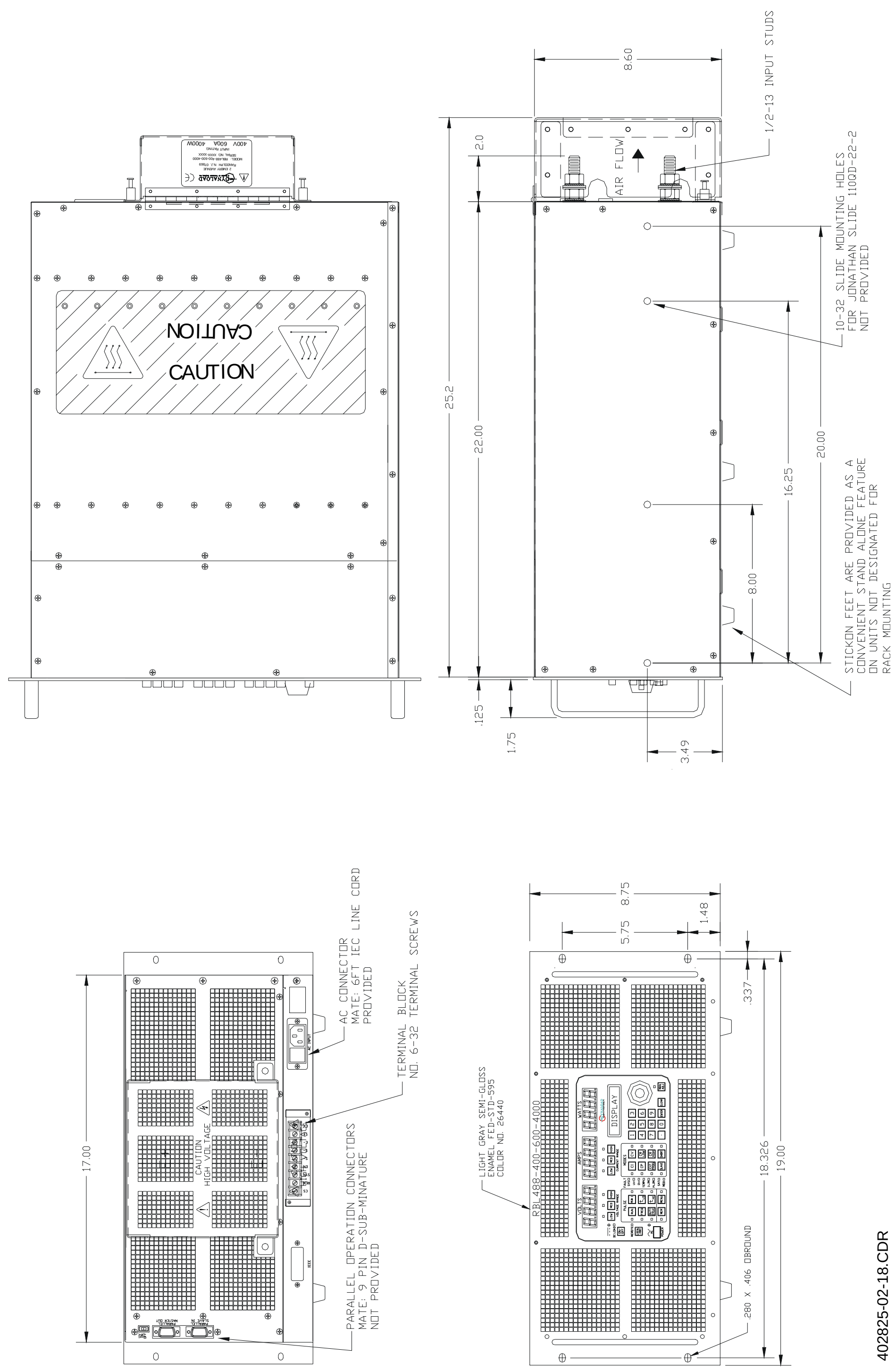
# Outline Drawing of RBL 800 Watt



## Outline Drawing of RBL 2000 Watt



## Outline Drawing of RBL 4000 Watt



# INDEX

Command and Queries List ........ 52
Constant Current ........ 28
Constant Current Mode ........ 11
Constant Power ........ 29
Constant Power Mod ........ 12
Constant Resistance ........ 28
Constant Resistance Mode ........ 12
Constant Voltage ........ 29
Constant Voltage Mode ........ 12
Contents ........ 4
Current Interrupt ........ 19
Current Oscillation ........ 25
Current Sample ........ 21
Customer Services
  Contacts ........ 2
Data Formats ........ 48
Data Separators ........ 48
Data Units ........ 49
Disclaimer ........ 2
E– and E+ Power Input Connections ........ 18
Effects of Cable Inductance ........ 38
Ethernet ........ 18
Ethernet Communications ........ 164
Fault Indicators ........ 31
Front Panel Features ........ 13
Full Scale ........ 29
Fuse Replacement ........ 19
Glossary ........ 149
IEEE-488 ........ 18
IEEE-488 Programming ........ 38
Input ........ 23
Introduction ........ 10
Language Elements ........ 57
Line Los ........ 25
Line Terminators ........ 48
Local Control ........ 31
Location, Airflow, Maintenance ........ 40
Manual Adjust ........ 31
Manual Operation ........ 36
Master/Slave ........ 20
Memory Recall ........ 31
Menu Commands ........ 32
Model Number ........ 11
Modes of Operation ........ 11
Online Availability ........ 2
Operating ........ 27
Operating Instructions ........ 16
Operating Mode ........ 28
Ordering
  Parts ........ 2

Parallel Operation ........ 29
PC Control ........ 47
Power-on Defaults ........ 51
Programmable Under Voltage ........ 32
Pulse Mode ........ 12, 36
Queries ........ 52
Range Switching ........ 29
Rear Panel Description ........ 17
Remote or External Programming ........ 21
Remote Programming ........ 31
Short Circuit ........ 30
Terminal Block ........ 20
Trademarks ........ 2
Transconductance ........ 39
Troubleshooting ........ 41
Voltage Sense ........ 22