



OPERATION MANUAL

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This manual covers:

LPL Series Programmable Air-cooled Electronic Loads

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WARRANTY INFORMATION

CERTIFICATION

American Reliance certifies that this product met its published specifications at time of shipment from the factory.

ONE-YEAR LIMITED WARRANTY

American Reliance warrants to the original user or purchaser that your unit is free from any defects in material or workmanship for a period of one year from the date of purchase. If any defect is discovered within the warranty period, American Reliance will repair or replace the unit, subject to verification of the defect or malfunction, upon delivery or prepaid shipment to American Reliance.

IMPORTANT:

- (1) Unless a problem is discovered upon initial inspection after purchase of the unit, please do not return the product to the distributor where it was purchased. American Reliance Inc. accepts the responsibility of keeping you a satisfied customer.**
- (2) If your product requires troubleshooting, warranty service or need a RMA number for return, contact your merchant. Or if you are unable to contact your merchant, or the merchant is unable to provide service, contact American Reliance Inc. directly at:**

Phone:	626-443-6818
Toll Free #:	1-800-654-9838
Fax:	626-443-8600
Email:	ariinfo@amrel.com

This warranty does not apply to defects or to physical damage resulting from abuse, neglect, accident, unauthorized repair, alteration, or unreasonable use of the unit, resulting in (but not limited to) cracked or broken cases or parts, or to units damaged by excessive heat. Warranty is voided if warranty sticker is altered or removed from the unit. Except upon initial purchase, this warranty does not cover finish or appearance items nor does it cover items damaged in shipment to American Reliance for repair or calibration. American Reliance assumes no responsibility for shipping and handling. However, repaired units will be shipped back to the customer with return shipping charges paid by American Reliance.

To receive service under this warranty, you must include proof of purchase; including date and place of purchase (a copy of your purchase receipt) or American Reliance will not be responsible for repairs or replacement of the unit under warranty.

Any applicable implied warranties, including warranties of merchantable and fitness for a particular use, are hereby limited to one year from the date of purchase (invoice). Consequential or incidental damages resulting from loss of use or from a breach of any applicable express or implied warranties are hereby excluded.

This warranty is in lieu of all other agreements and warranties, general or specific, express or implied. No representative or person is authorized to assume for American Reliance any other liability in connection with the sale or use of this American Reliance product.

Some states do not allow limitations on how long implied warranties last and do not allow exclusion of incidental or consequential damages, so the above limitations and exclusions may not apply. This warranty gives the customer specific legal rights, which may vary from state to state.

NON-WARRANTY SERVICE

Any American Reliance out-of-warranty instrument that is thought to be defective, but is considered repairable, should be sent in for non-warranty service. Please contact our service department at (800) 654-9838 for current repair charges.

The instrument should be returned to American Reliance, by following the directions under the heading "Shipping Instructions" in this section.

EXCLUSIVE REMEDIES

This remedies provided herein are the customer’s sole and exclusive remedies. American Reliance Inc. shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any legal theory.

RMA RETURNS

Product returned for warranty and non-warranty service to American Reliance for service must be shipped, freight prepaid (will not accept COD shipments).

American Reliance Inc.
3445 Fletcher Ave.
El Monte, CA 91731
Attn: RMA # _____

- *Please call our service department at 1-800-654-9838 to obtain a return authorization (RMA #) from AMREL before returning any product.*

The instrument must be carefully packed, preferably in its original carton, and should be accompanied by a letter or note containing the following information:

User's Name	Proof of Purchase
User's Address	Description of problem
Model number	Serial number

If service is desired, such as calibration, it must be stated in the enclosed letter. For non-warranty repairs, and for calibration, the correct service charge must accompany the unit in the form of a check or money order payable to American Reliance Inc. Please do not send cash. Contact our service department at (800) 654-9838.

American Reliance will return the serviced instrument, with freight paid by American Reliance, via UPS ground service unless otherwise requested.

***NOTE: ALL INSTRUMENTS THAT ARE RETURNED FOR REPAIR OR CALIBRATION MUST HAVE AN ASSIGNED R.M.A. NUMBER WRITTEN ON THE FRONT OF THE PACKAGE. THIS NUMBER MAY BE OBTAINED BY OUR SERVICE DEPARTMENT. ANY INSTRUMENT DELIVERED WITHOUT THIS NUMBER WILL BE REFUSED AND RETURNED.**

SAFETY SUMMARY

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

WARNING

Servicing instructions are for use by service-trained personnel. To avoid dangerous electrical shock, do not perform any servicing unless you are qualified to do so. Some procedures described in this manual are performed with power supplied to the instrument while its protective covers are removed. If contacted, the energy available at many points may result in personal injury.

ENVIRONMENTAL CONDITIONS

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

BEFORE APPLYING POWER

Verify that the product is set to the appropriate line voltage, the correct line fuse is installed, and all safety precautions are taken.

GROUND THE INSTRUMENT

Before switching on the instrument, the protective earth terminal of the instrument must be connected to the protective conductor of the main power cord. The mains plug shall be inserted only in an outlet socket that is provided with a protective earth contact. This protective action must not be negated by the use of an extension cord that does not have a protective conductor. Any interruption of the protective grounding or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

FUSES

Only fuses with the required rated current, voltage, and specified type should be used. Do not use repaired fuses or short-circuited fuse holder. To do so could cause a shock or fire hazard.

AVOID ACCESS TO LIVE CIRCUITS

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

AVOID TROUBLESHOOTING ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present. Any adjustment, maintenance, and repair of this instrument while it is opened and under voltage should be avoided as much as possible. If this is unavoidable, adjustment, maintenance, and repair should be carried out by only qualified personnel who are aware of the hazard involved.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform an unauthorized modification to the instrument. Return the instrument to an American Reliance Service Department for service and repair to ensure that safety features are maintained.

SAFETY SYMBOLS

WARNING The WARNING symbol denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING symbol until the indicated conditions are fully understood and met.

CAUTION The CAUTION symbol denotes a hazard. It calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of parts or all of the products. Do not proceed beyond a CAUTION symbol until the indicated conditions are fully understood and met.

SAFETY SYMBOL DEFINITIONS

Symbol **Description**



Direct current.



Alternating current.



Both direct and alternating current.



Earth (ground) terminal.



Protective earth (ground) terminal.



Terminal for Neutral conductor on permanently installed equipment.



Terminal for Line conductor on permanently installed equipment.



Standby (supply)

Units with this symbol are not completely disconnect the unit from AC mains, either disconnect the power cord or have a qualified electrician install an external switch.



Warning, risk of electric shock.



Caution (refer to accompanying documents).

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ONE: FEATURES AND SPECIFICATION

INTRODUCTION

This LPL Series Programmable DC Electronic Load from American Reliance Inc. offers a complete solution to the electronic load system requirements. This instrument was designed to assist in the development and testing of new products, as well as is being a standard instrument for automatic test systems and evaluation of dc power supplies, batteries, and power components. Other applications include use as a power circuit breaker or crowbar, high current function or pulse generator, fuel-cell and photovoltaic cell test, and de-energizing super conducting magnets. This instrument uses advanced power MOSFETs to dissipate the input power. The electronic load consumes minimum power to control maximum input power handling capability. Complex circuits are used to control the power balance and dissipation of the MOSFET. This control circuit also supports the Constant Voltage (CV), Constant Current (CC), Constant Resistance (CR), and Constant Power (CP) modes of operation. It comes with Standard Commands for Programmable Instrument (SCPI) commands, remote monitoring of input voltage and currents is a standard features. Use this electronic load can be used either on your bench or in a standard 19 in. (483 mm) rack: The programming electronic load occupies 1.75 in. (1 U) of vertical rack space. Designed for continuous use in standalone or systems applications, this electronic load is typically used to evaluate DC equipment, control circuits, or burn-in power applications.

TABLE 1.1 GENERAL VOLTAGE AND CURRENT RANGES

Model	Voltage Input Range	Current Input Range	Power Input Range
LPL600-120-60	120 Vmax.	60 Amax.	600 Wmax.
LPL600-60-100	60 Vmax	100 Amax	600 Wmax
LPL600-400-30	400 Vmax.	30 Amax.	600 Wmax
LPL600-600-20	600 Vmax.	20 Amax.	600 Wmax

MODEL NUMBER DESCRIPTION



FEATURES AND OPTIONS

- Four constant operating modes: Constant current (CC), constant voltage (CV), constant resistance (CR), and constant current (CP) mode operation.
- Local control and remote programming for plus amplitude, pulse width, and pulse cycle.
- Trig-In/Trig-Out and measurement functions.
- GPIB, RS-232, Ethernet, and USB interface programming with SCPI command language. (Ethernet and USB are available as part of the E-Package).
- Front panel control with keypad and rotary knob (Tune Mode) for accurate setting.
- Built in pulse generator for continuous, pulsed, and toggled transient operation.
- Seven programmable protection modes: Over Voltage Protection (OVP), Under Voltage Protection (UVP), Over Current Protection (OCP), Under Current Protection (UCP), Over Power Protection (OPP), and Under Power Protection (UPP).
- Fan speed control for reduced acoustic noise under light load conditions.
- “C” Operand for battery testing.
- 0-10Vdc analog programmable.
- Simple closed-case calibration.
- Highest power density: up to 18KW in 2U height
- Field-upgradeable capability for GPIB, RS232, USB and Ethernet.
- Three ranges for each operating mode; Auto or Manual
- External analog programming control for each mode and range

- Panel lock capability
- Program the Slew rise time and Slew fall time independently
- 50us transient time at CC mode; 500us transient time at CV mode
- Anti-Oscillation controls: System bandwidth controls
- Oscillation detection and protection
- Anti-Saturation controls: Under Voltage Lockout
- 16 bits programming and read back capability
- Cross mode and Cross range capability; default off
- Remote Inhibit and Dry contact Fault output
- Pulse power capability with Over Power Protection
- Field-upgradeable firmware
- Self-diagnostic capability
- Redundant Over Temperature Protection
- Four Step profiles; 32 step points for each profile
- Soft-Start Functionality
- Convenient and efficient Hot Keys for mode and transient mode selection, Input and Transient On/Off, Slew Settings, Front panel trigger, and Short.
- Independent Large Numerical Voltage and Current LED display

General Information and Operating Notes

Operating Modes:

The four modes of operation are:

Constant Current (CC):

The electronic load will sink a current in accordance with the programmed value regardless of the input voltage.

Note 1: Never use CC mode for testing a constant current source. The regulation of the two units will fight for control of the current and an unstable oscillation will result.

Note 2: During CC mode, the electronic load can operate under the fastest transient time.

Constant Voltage (CV):

The electronic load will attempt to sink enough current to control the source voltage to the programmed value. It acts as a shunt voltage regulator when operating in the CV mode.

Note 1: Never use CV 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 will lead to an unstable condition.

Note 2: In CV mode, the transient time will be adjusted to a slower setting to ensure stable operation.

Constant Resistance (CR):

The electronic load will sink a current linearly proportional to the input voltage in accordance with the programmed value.

Constant Power (CP):

The electronic load will dissipate the power in accordance with the programmed value. It will automatically adjust the current level inversely in response to a change in voltage.

Note: If the source voltage decays to zero volts the load will attempt to draw max rated current. If the OCP limit of the electronic load is greater than the current limit of the voltage source, the voltage source will be latched to the CC state. Otherwise the OCP will trip to shutdown the load.

Programming Mode Parameters:

When programmed to a mode, the electronic load remains in that mode until the mode is changed or until a fault condition, such as an over power or over temperature occurrence. The current, voltage, resistance and power mode parameters can be programmed whether or not the mode is presently activated. When a mode is selected via the front panel or via the digital interfaces, the associated parameters will then take effect at the instance of turning the input on.

Cross Mode:

According to AMREL eLOAD design, the electronic load has four operating modes. As part of our factory default settings, when switching from one mode to another mode in manual range (i.e. CV Low to CC High), the final switched state will have the input turned off. If an application requires the input to stay on when switching modes, the option “cross mode” must be changed from “input off” to “input remain.” By changing the option, the load will switch between modes while keeping the input on, to accommodate for the different applications of the DUT.

Note: Cross mode operation will work under both “manual” and “auto” range control mode.

Ranges:

Parameters may be programmed in any of the three overlapping ranges. The low range provides better resolution at low settings. The range can be set using the front panel or via SCPI command. For auto-range control: when you program a value, the electronic load automatically selects the range that corresponds to the value you program. If the value falls in a region where ranges overlap, the electronic load selects one with the highest resolution. In manual-range control: the programmed values will be limited by the current range setting, an OUT OF RANGE message will appear on the front panel display when an invalid value is entered. When a range is selected, the associated parameters (preset value or value from memory) will take into effect.

Cross Range Operation:

According to AMREL eLOAD design specification, the electronic load has three overlapping operating ranges in each mode. As part of our factory default settings, when switching from one range to another range in manual mode (i.e. CV Low to CV High), the final switched state will have the input turned off. If an application requires the input to stay on when switching ranges, the option “cross range” must be changed from “input off” to “input remain.” By changing the option, the load will switch ranges while keeping the input on, to accommodate for the different applications of the DUT. The cross range feature allows the user to effectively switch between ranges based on the application needed by the DUT.

Note: Cross range operation will work under both “manual” and “auto” range control mode.

Immediate Level:

The immediate level can be set at front panel or via the digital interfaces. If the selected mode is active (Input on), the new setting immediately changes the input at a rate determined by the soft-start turn-on sequence of the unit. If the electronic load is not in the selected mode, the new setting is saved until that particular mode is activated.

Transient Level:

The transient level can be set at front panel or via digital interfaces. The electronic load input will switch between the main level and the transient level when transient operation is turned on. During transient operation, the load will switch from the immediate level to the transient level determined by the programmed slew time.

Triggered Level:

The level can be preset (stored in the electronic load) allowing the input to be updated when a trigger is received. Trigger level can only be changed via digital interfaces, and can be programmed to any value within the mode’s range settings.

Slew Rate:

The slew rate determines the rate at which the input to the electronic load changes to a new programmed value. Slew time (positive and negative) and level change can be set at the front panel or via the digital interfaces. To better accommodate user applications, the positive and negative edge of the slew rate can be set independently. The programmed slew rate remains in effect for the triggered and transient level changes previously described.

Input Control:

Short On/Off:

The electronic load can simulate a short circuit at its input by turning the load on with full-scale current. The short circuit can be toggled on/off at the front panel or via the digital interfaces while Short On/Off is enabled. The short on/off switch-over uses the slew rate setting of the active mode and range. The actual value of the electronic short is dependent on the mode and range that are active when the short is turned on. In CV mode it is equivalent to programming zero volts. In CC mode it is equivalent to programming full-scale current for the present current range. In CR mode it is equivalent to programming the minimum resistance for the present resistance range.

Important Notes:

- 1) Turning the short on in CV mode may cause the load to draw so much current that the software current limit triggers, which may turn the input off (Protection Mode).
- 2) It is dangerous to activate short operation when testing batteries or other DUT without current limit. The eLOAD will act as an infinite current sink, and drain Maximum Current until severe damages occur to both the DUT and eLOAD. In the worse case scenario, the DUT/battery could catch on fire or explode.

Turning the short circuit on does not affect the programmed settings, and the load input will return to the previously programmed values when the short is turned off.

Input On/Off:

The electronic load's input can be toggled on/off at the front panel, or via the digital interfaces. Turning the input off (zero current) does not affect the programmed settings. The input will return to the previously programmed settings when the input is activated again.

Note: The input on/off command supersedes the mode and short on/off command.

Transient Operation:

Transient operation enables the electronic load to periodically switch between two load levels. Transient operation can be turned on and off at the front panel or via the digital interfaces. Before you turn on the transient operation, you should set the desired mode of operation as well as all of the parameters associated with transient operation under varying combinations of load levels, frequency, duty cycle, and slew rate. Transient operation may be used in CC, CR, CV or CP modes and can be continuous, pulsed, triggered, stepped or toggled. During transient operation, the load will switch from the immediate level to the transient level determined by the programmed slew time.

Continuous Transient Operation

Generate a repetitive pulse train switches between two load levels via CONT (hot key) key or SCPI command. The two load levels in the transient operation are main level and transient level for each mode. The rate at which the level switches between is determined by the slew time setting.

Pulsed Transient Operation

Generate a load change that returns to its original state after some time period via SINGLE (hot key) key or SCPI commands.

Toggled Transient Operation

Toggled transient operation allows the eLOAD input to alternate between two pre-defined load levels as in Continuous Mode except that the transient points can be controlled by explicit triggers instead of an internal transient generator.

STEP Operation:

Step mode lets you generate complex sequences of input changes with rapid, precise timing, which may be synchronized with internal or external signals.

You can program up to 32 settings (or steps) in the profile, the time interval (dwell) that each setting is maintained, the number of times that the list will be executed, and the setting's change in response to the triggers. The step data can be stored in Profile 0, 1, 2 or 3 via either the front panel or the digital interfaces. Use RCL command to recall the saved state.

Trigger Operation:

The electronic load has various triggering modes to allow synchronization with other test equipment or events.

Triggering a preset level

Transfers all pending preset levels to the actual level. For the presently active mode, the new level appears at the input. For the modes which are not presently active, the present levels will not take effect at the input until the applicable mode becomes active. However you must first initiate the trigger function by executing the TRIG:IMMED command.

Triggering a transient pulse

A trigger signal will generate a transient pulse of programmable width when pulsed transient operation is in effect. Triggers can be sent from the front panel by pressing the TRIGGER key or via Remote Interface.

Toggling

A trigger signal will change the input between the main level and the transient level when toggled transient operation is in effect. Triggers can be sent from the front panel by pressing the TRIGGER key or via Remote Interface.

Protection Features:

The electronic load includes the following protection features:

Over Voltage (OV):

The eLOAD has an Over Voltage Protection (OV) set at 105% of the full voltage rating. If the input voltage exceeds 105% of the over voltage threshold, the input will shut off and an alarm message "OV" will display.

Over Current (OC):

The eLOAD has an Over Current Protection (OC) set at 110% of the full current rating. If the input current exceeds 110% of the over current threshold, the input will shut off and an alarm message "OC" will display.

Over Power Protection:

In the case of an over-energy condition, the Over Power Protection will control the eLOAD's operating current to limit the operating power to below 120% of P_{MAX} and force off the eLOAD input.

Over Temperature (OTP):

The electronic load has an over temperature protection circuit, which will turn off the input if the internal temperature exceeds safe limits. Over-temperature is usually the worse condition to happen to an electronic load due its highly destructive effects. During high temperature operation (OTP condition), all internal MOSFETS are working near their full capacity and can fail due to excessive heat. To prevent over temperature, the electronic load has a built in redundant over temperature protection. In short, the OTP offers both a temperature sensor circuit that controls the internal cooling system and a hardware thermal switch that shuts down the input when the temperature threshold is exceeded.

over temperature protection. In short, the OTP offers both a temperature sensor circuit that controls the internal cooling system and a hardware thermal switch that shuts down the input when the temperature threshold is exceeded.

Reverse Voltage (RCP):

The electronic load has the internal parallel diodes to short the input in the presence of a reversed DC voltage input. The front panel display with the alarm message “RCP” will indicate this condition has been detected.

Remote Sense Fault (RSF):

If the connection to the sense leads is not proper when operating under remote sense mode, the input will be forced off with the alarm message “RSF”; Remote Sense Fault. Two common errors that can result in “RSF” failure are while the “Measure Sense” is set to remote, the sense leads are not connected or if the leads are connected and the connection is lost. The latter can become a serious problem in CP mode. In Constant Power mode, the electronic load will maintain the set wattage by balancing the voltage and current. If the remote sense leads are disconnected, the V_{MON} of the load will sense zero voltage and sink the amount of current needed to keep the same power level until OC or other protection are triggered. The “RSF” protection will trigger if the voltage deviation between the actual measured voltage and remote sense voltage exceeds a set limit, forcing the input off until the conditions is cleared. “RSF” detection can be disabled via Menu → Local Control → RSF Detection → OFF.

Note: “RSF” error signal has precedence over OC with remote sense enabled, and will trigger if connection is lost.

Unregulated state (UNR):

The “UNR” message cautions that the power stage of the electronic load is operating at its minimum resistance or equivalent to it being shorted (marginal region for the load). Another indication is that the load is being operated improperly, i.e. not enough supply current/voltage or incorrect calibration data.

Supply Current and Voltage Below Main Level

A common cause for entering the unregulated state is supplying the load with a voltage or a current below the value set for electronic load’s main level. For example, if the input is off in CV mode and the main level of the load is set at 3 volts and the power supply is programmed for 2 volts. An “UNR” alarm message will appear when turning the input on. The message is caused by the lack of voltage needed to bring the main to 3 volts, and the voltage and current readings will be unstable during this state. The same condition will occur for CC mode, if the needed current is lower than the supplied current. To fix the problem, increase the voltage or current above the needed main value. The “UNR” threshold is set as 1% deviation from the maximum value in that mode and/or range.

Re-Calibration

Verify that the supply current and voltage is sufficient for the operating condition. If the “UNR” message still occurs, check the current or voltage read back and compare it with the main value setting (CC mode: current; CV mode: voltage) to make sure the difference is below 1%. If the difference is above 1% for CC/CV mode, 30% for CR mode or 0.3% for CP mode, that particular mode will need to be recalibrated. As a factory default, all loads are calibrated to its optimal condition. Please verify the calibration inaccuracy carefully or contact AMREL Technical Support before re-calibrating the unit.

CR and CP Mode

In CR and CP mode, if the voltage or current is below the needed value to reach a certain resistance or wattage, an “UNR” alarm message will appear. For example, in order to obtain 300 watts the input current value multiplied by the input voltage value will need to equal 300 watts, otherwise an error will occur. For CR mode, the input voltage value divided by the input current value will need to equal the resistance value entered. To fix the problem, increase the voltage or current above the needed power or resistance. The “UNR” threshold for constant power mode is set as 0.3% deviation from the maximum value in that mode and/or range. The constant resistance mode has a higher fluctuation in its value, so it will have a higher “UNR” deviation range.

Note: When testing power supplies, a sudden current sink by the eLOAD in CP mode may cause the power supply to latch in CC mode. At that time, the eLOAD will sink no current and display “UNR”. Simply power cycle the power supply and repeat the application with a higher voltage setting to prevent the power supply from entering an uncontrollable state.

Precautions for Testing Batteries

As a precaution, when testing batteries prevent from operating in CV mode and make sure that the load does not enter the unregulated state. If a battery is connected to a short circuited load (UNR state), the load will draw infinite current and cause permanent damage to the load, battery under test and possibly start a fire.

Under Voltage Lockout Protection (UVL or V-ON VOLTAGE):

The programmable under voltage lockout feature allows the user to set a trip point between zero and full-scale voltage (V-On Voltage Threshold). The input will remain off until the input voltage is greater than the pre-programmed value or the V-On Voltage threshold. For the V-On (UVL) feature, there are two modes that can be set. In “continuous” mode, the UVL detection will remain active, and each time the voltage drops below the set threshold voltage, the UVL protection will shut off the input. Under “input on” mode, the UVL detection will only trigger once to shut down the input and will reset each time the input is cycled. The only way to clear a UVL protection message is to increase the input voltage beyond the V-On threshold. When operating under strict turn-on sequences, such as sending power via a power supply into an eLOAD with the input already turned on, current overshoot, bounce or ringing may occur. As a recommendation for improved performance without changing the turn-on sequence, the V-On threshold can be increased to a voltage closer to the application’s operating voltage and the V-On detection mode changed to “Continuous”. By making the necessary adjustments, both the DUT and eLOAD can operate under stable conditions to avoid irregular results. To achieve best results, the V-On Voltage should be set to a level higher than the stabilizing voltage of the power supply or DUT, and higher than the eLOAD’s minimum operating voltage.

Oscillation Protection (OSC):

The eLOAD offers oscillation protection to prevent the system or DUT from being damaged during unstable operating conditions. If the oscillation exceeds the frequency threshold for longer than the programmed oscillation delay, the input will shutdown and an alarm message “OSC” will display. For applications that are oscillatory in nature, the OSC protection can be disabled. Please refer to the menu tree for further disabling procedures.

Anti-Oscillation:

In addition to the “OSC” protection, the eLOAD has five selectable bandwidth controls: Default, OSC1, OSC2, OSC3, and DISABLE that will adjust the system speed for different types of applications. The slew time ranges will vary according to the range selected. At Default state, it has the widest bandwidth and fast transient time. At OSC1 state, it has the normal bandwidth and transient time. At OSC2 and OSC3 state, they have the slower transient time in order to have better stability. The selection of different bandwidth ranges allows for higher speed or slower stable applications.

For applications that utilize non-pure DC output power to the eLOAD input, the OSC detection can be disabled by selecting the “DISABLE” menu choice. The OSC Protection Delay can be increased to 10 seconds for applications that require a buffer to avoid false protection trigger. **Please refer to the menu tree for detailed selection procedures**

Self-Test Failure:

The self-test assures early detection of hardware problems and forces the input off when a failure does occur. The appropriate bit(s) in the status registers are set when any of the above protection features are active. The front panel display will indicate which condition(s) have been detected.

Resetting Latched Protection

All of the protection features remain latched (set) when they are tripped. The latched protection features can be reset via the front panel PROT (CLEAR) key or the digital interfaces. The condition that caused the protection feature to trip must be removed or it will trip again as soon as it is reset.

Bias Voltage Protection (VPP & VNP)

For the electronic load to operate properly it requires an internal +12 V_{DC} and -12V_{DC} voltage to bias different parts of the system. In the case that the +12V bias voltage malfunctions, a “VPP” error message will appear indicating a voltage positive power error. If the -12V bias voltage malfunctions, a “VNP” error will appear indicating a voltage negative power error. For either of these error messages, please contact AMREL Technical Support. The electronic load most likely had a serious internal malfunction that caused the system to shutdown.

***Note:** For VPP and VNP failures, please refrain from repairing the unit, for it may inflict further damage.*

In Fault Protection (INF)

If the electronic load is forced to sustain too much power, current or voltage in a short amount of time, the internal power stage may have been damaged. If the damage is serious enough, the system hardware will shutdown and the display will show an “In_Fault” error message. When this message occurs, please contact AMREL customer service. The electronic load most likely has a power stage malfunction and will no longer operate normally.

Note: For INF failure, please refrain from repairing the unit, for it may inflict further damage.

User-Defined Over Current, Voltage, and Power Protection:

Over Voltage (OVP):

OVP is a programmable voltage trip point. Limits can be programmed to “shut down” the electronic load input if the voltage exceeds pre-programmed value (default to off). The default programmable over voltage (OVP) trip point is 105% of full voltage rating

Over Current (OCP):

Over Current Protection (OCP) is a programmable current trip point. Limits can be programmed to “shut down” the electronic load input if the current exceeds pre-programmed value for longer than the pre-set time interval (default to off). The default programmable over current (OCP) trip point is 105% of full current rating.

Over Power (OPP):

The over power protection (OPP) is a programmable power trip point. If the input power exceeds the over power limit, the electronic load input will shutdown and display an OPP alarm message. The default programmable over power trip point is 110% of full power rating for PLW Models and 105% of full power rating for PLA Models.

User-Defined Under Current, Voltage, and Power Protection

For flexible customer application, AMREL’s electronic load provides a user-defined under current (UCP), under voltage (UVP) and under power protection (UPP). If there are any applications that require a minimum voltage, current or power level for normal operation, the system will shutdown when the level drops below the set value.

Custom Max/Min Value Setting

The maximum and minimum value for each mode and range is programmable.

Note: The max and min value settings must be within the limits of each individual range and mode

Low Voltage (LV) Protection

When the input voltage drops below 1% of the maximum voltage, a “LV” message will appear to indicate the electronic load is operating under a low voltage condition. During “LV” mode, the load will automatically switch to a slower slew time to soften high in-rush currents by limiting the speed of the current rise. The “LV” message notifies the user of a change in the slew time, so they can modify their settings to ensure proper test operation.

Self-Diagnostic Capability

Based on the system error message displayed on the front panel, certain troubleshooting analysis can be concluded and may be fixed accordingly. The error messages or alarms displayed due to “over limit” faults or erroneous operation will trigger an internal relay that shuts off the system input. For more serious failures, such as “VPP”, “VNP” or “INF,” the system has permanently shutdown and will need to be shipped back to AMREL for repair. There are other fault protections that could occur under different applications, for an in-depth analysis of the system errors, please refer to the protection features section. The eLOAD also provides error bit for the different types of error. Utilizing any of the interfaces, the fault condition can be diagnosed based on the returned error bit.

VFD STATUS ENUNCIATOR

VACUUM FLUORESCENT DISPLAY:

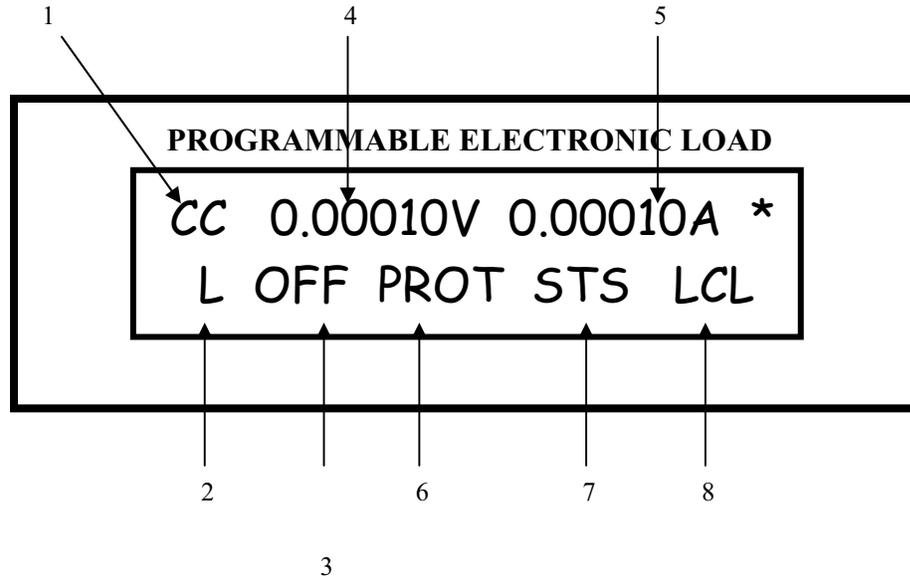


FIGURE 1.3 VACUUM FLUORESCENT DISPLAYS

<NOTE> The VFD displays real time input Voltage/Current & mode status. These messages are viewed in either local or remote mode.

VFD DESCRIPTION

1. Mode indicator: Constant Voltage (CV), Constant Current (CC), Constant Resistor (CR), and Constant Power (CP).
2. RNG operating range indicator: Low range (L), Middle range (M), and High range (H).
3. INPUT ON/OFF indicator, and Short Mode (SHT).
4. Voltage reading indicator.
5. Current reading indicator.
6. PROT operating protection indicator: (Un-regular (UNR), Over/Under Voltage Protection (OVP/UVP), Over/Under Current Protection (OCP/UCP), Over/Under Power Protection (OPP/UPP), Reverse Current Protection (RCP), Remote Sense Fault (RSF), Under Voltage Lockout (UVL), Oscillation (OSC), Bias Voltage Protection (VPP/VNP), In Fault Protection (In_Fault), and Over Temperature Protection (OTP).
7. STS operating status indicator: Transient Mode (CONT), Toggle Mode (TOGG), Stepping Mode (STEP / AUTO / ONCE), Pulse Mode (PULS), and TRIGGER (TRIG)
8. Local mode (LCL) / Remote mode (RMT) indicator.

FRONT PANEL KEYPAD

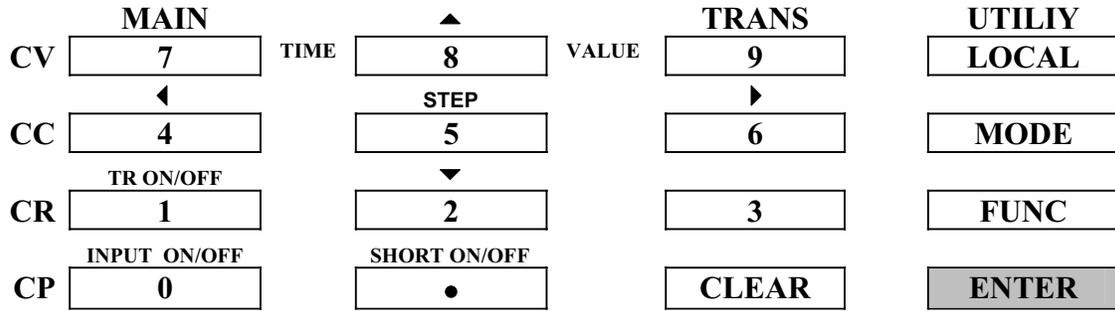


FIGURE 1.2 FRONT PANEL KEYPAD

FRONT KEYPAD DEFINITIONS

- Key “0” Numeric entry key for number 0. Enables / Disables INPUT ON/OFF key.
- Key “.” Numeric entry key for decimal dot. Enables SHORT ON/OFF, toggle key.
- Key “1” Numeric entry key for number 1. Enables Constant Resistance mode of operating, TR transient enable key, and ST stepping enable key.
- Key “2” Numeric entry key for number 2. Step Down ▼ key to decrease the step number in the stepping program function.
- Key “3” Numeric entry key for number 3.
- Key “4” Numeric entry key for number 4. Constant Current mode enable key and the Left Shift key ◀.
- Key “5” Numeric entry key for number 5. STEP function key for step editing mode.
- Key “6” Numeric entry key for number 6. Right Shift key ▶.
- Key “7” Numeric entry key for number 7. Constant Voltage mode enable key. MAIN programming level entry key and TIME programming key in the step function operation.
- Key “8” Numeric entry key for number 8. Step Up ▲ key to increase step number in stepping programming function.
- Key “9” Numeric entry key for number 9. TRANS transient programming level entry key and VALUE setting in the step function operation.
- Key “CLEAR” Clears partially set commands and return the unit to the metering mode. By pressing the "Clear" with no entry will display "AMREL Model number and software version.
- Key “MODE” Enable CV/CC/CR/CP operating mode.
- Key “LOCAL” Returns the GPIB or RS-232 mode to local operations. Enable the system utility and allows GPIB, RS-232, Calibration, and System operation parameter and setting to be changed. Pressing the LOCAL key will change status from RMT to LCL (local operation).
- Key “FUNC” Allows programming value settings for Frequency, Pulse, Duty cycle and Slew rate for Transient mode operation.
- Key “ENTER” Enters the values in the set mode and returns the unit to the metering mode.

ROTARY KNOB OPERATION (Tune Mode)

The LPL/PLW series comes with standard rotary knob (Tune Mode) at front control panel. Tune mode provides a simple and accurate setting for the inputs voltage, current, resistance, and power from decimals to the rated input.

When LPL/PLW's input is ON, user may press or hold the rotary knob to enter into the tune mode. This function allows you to edit the required setting, and select the right digit for increment or decrement the value.

In Tune Mode, the default cursor positioned at the lowest digit of voltage/current/resistance/power value. When turn right, it increment the digit value and carries to next digit. And when turn left, it decrement the digit and borrows to next digit. The input values also refresh according to the new values setting. See definition below.

***Definitions for knob "Turn":**

Turn right:

- 1) At "Menu Mode", it is similar to "▶" key.
- 2) At "Input Mode" or "Tune Mode", it increases the digit value where the cursor stays.

Turn left:

- 1) At "Menu Mode", it is similar to "◀" key.
- 2) At "Input Mode" or "Tune Mode", it decreases the digit value where the cursor stays.

***Definitions for knob Press / Hold**

Press: (Press and release very quick)

- 1) At "Menu Mode", it is similar to "CLEAR" keys.
- 2) At "Input Mode" or "Tune Mode", it moves the cursor to left.

Hold: (Press and Hold for 2 seconds)

- 1) At "Menu Mode", it is similar to "ENTER" key.
- 2) At "Meter Mode", it is similar to "UTILITY" key.

Mode and Menu Navigation

Mode selection

- 1) In meter mode, press MODE key to enter into mode selection mode.
- 2) The first row displays current mode and range (if manual range), the second row displays the value range.
- 3) Press "CV (7)", "CC (4)", "CR (1)", or "CP (0)" key to select mode. If the range operation is set to manual, press same mode key to select range. Or press "▲" or "▼" key to select range.
- 4) Press "ENTER" key to confirm mode and range, and go back to meter mode.
- 5) Press "CLEAR" key to go back to meter mode.
- 6) Press knob, same as CLEAR key.
- 7) Press and hold knob, similar to ENTER key.

Function selection mode

- 1) Press "FUNC" key to enter into function selection mode.
- 2) The first row displays the current value for each function: SLEW+, SLEW-, DUTY, FREQ, and PULSE.
- 3) Press ◀, ▶, ▲, ▼ key to select desired function to configure.
- 4) Press "ENTER" key to accept the value.
- 5) Press "CLEAR" key to go back to meter mode.
- 6) Press knob, same as CLEAR key.
- 7) Press and hold knob, similar to ENTER key.

Menu mode

- 8) Press UTILITY key, or press and hold knob to enter into menu mode.
- 9) Press ◀ ▶ key to select menu item.
- 1) Press “ENTER”, or ▼ key, or press and hold the knob to enter sub menu, or set the selected item.
- 2) Press “ENTER” or press and hold the knob to accept the setting.
- 3) Press “CLEAR”, or press knob to go back to meter mode.

Notes: Please refer to the front panel menu tree section for detailed menu selections.

Panel Lock

- 1) When LCD is in “Menu Mode”, select “PANEL LOCK” can set PANEL ENABLE, and PANEL PASSWORD.
- 2) When “PANEL ENABLE” is set to OFF, power off the PD unit and power on again, the local panel is disabled. All other keys are locked except “LOCAL” key. When these keys are pressed, LCD displays “LOCAL LOCKED”.
- 3) Press “LOCAL” key, users must enter PASSWORD. If the PASSWORD is correct, the LCD goes back to normal state. Press “ENTER” key and “LOCAL” key in the same time locks all the keys again.
- 4) If users forget the password, they can use “55555” as default password.

List step edit mode

- 1) When LCD display is in meter mode, press “STEP (5)” key to enter into list step edit mode.
- 2) Press ◀ or ▶ to select step point one by one. Press ▲ or ▼ to select step point ten by ten.
- 3) Press “TIME (7)” key to edit step dwelling time.
- 4) Press “VALUE (9)” key to edit step value.
- 5) Press “CLEAR” key to go back to meter mode.

Front Panel Menu Tree

UTILITY MENU

All Words in Bold are Factory Default Settings

LOAD CONTROL	TRANS. MODE	→ TRIGGER → CONTINUOUS → TOGGLE → PULSE → STEP → STEP AUTO → STEP ONCE
	BOOT INPUT	→ OFF → ON
	MEASURE SENSE	→ LOCAL → REMOTE
	RANGE CONTROL	→ AUTO → MANUAL
	PORT0	→ OFF → ON
	EXT. CONTROL	→ OFF → ON
	SHORT CONTROL	→ OFF

	→ ON		
CROSS MODE	→ INPUT OFF → INPUT REMAIN		
CROSS RANGE	→ INPUT OFF → INPUT REMAIN		
RSF DETECT	→ ON → OFF		
TRIGGER	→ SOURCE	→ HOLD → BUS → EXTERNAL → ETHERNET	
	→ DELAY	→ 01000mS	
STEP PARAM.	→ COUNT	→ 1	
PROTECTION	→ OV-PROTECTION	→ OV STATE → OFF → ON → OV LIMIT → $1.05 \cdot V_{MAX}$ → OV DELAY → 01000mS	
	→ UV-PROTECTION	→ UV STATE → OFF → ON → UV LIMIT → 000.000V → UV DELAY → 01000mS	
	→ OC-PROTECTION	→ OC STATE → OFF → ON → OC LIMIT → $1.05 \cdot I_{MAX}$ → OC DELAY → 01000mS	
	→ UC-PROTECTION	→ UC STATE → OFF → ON → UC LIMIT 000.000A → UC DELAY 01000mS	
	→ OP-PROTECTION	→ OP STATE → OFF → ON → OP LIMIT → $1.1 \cdot P_{MAX}$ → OP DELAY → 01000mS	
	→ UP-PROTECTION	→ UP STATE → OFF → ON → UP LIMIT → 000.000W → UP DELAY → 01000mS	
	→ V-ON CONTROL	→ V-ON STATE → INPUT ON → CONTINUE → V-ON THRESHOLD → 01.000V	
MAX/MIN LIMIT	→ MAX VOLTAGE → MIN VOLTAGE → MAX CURRENT → MIN CURRENT → MAX RESIST. → MIN RESIST. → MAX POWER	→ V_{MAX} → 000.000V → I_{MAX} → 000.000A → R_{MAX} → R_{MIN} → P_{MAX}	

		→ MIN POWER	→ 000.000W
	CAL. PARAM.	→ MEASURE LOW → MEASURE HIGH → TRAN. OFFSET	→ 06400 COUNT → 32000 COUNT → 06400 COUNT
	OSCILLATE	→ OSC. CONTROL	→ DISABLE → DEFAULT → OSC1 → OSC2 → OSC3 → OSC. DELAY
			→ 05000mS
PROFILE	RECALL	→ 0 → 1 → 2 → 3	→ - DONE - → - DONE - → - DONE - → - DONE -
	SAVE	→ 0 → 1 → 2 → 3	→ - DONE - → - DONE - → - DONE - → - DONE -
	RESET	→ ENTER TO RESET	→ - DONE -
DISPLAY	METER MODE	→ V+I → V+P → V+C → V+R → I+P → I+C → I+R → R+P → R+C → P+C → V+T → I+T → R+T → P+T → C+T	
	'C' VALUE	→ 001.000A	
	MEASURE BUFFER	→ 8 → 16 → 32 → 64 → 128 → 256	
SYSTEM	GPIB ADDRESS	→ 12	
	RS-232 SPEED	→ 2400 → 4800 → 9600 → 19200 → 38400 → 57600 → 115200	
	SYNTAX MODE	→ PLA/PLW → PEL	

	EOS CODE	→ CR+LF → NULL → CR → LF	
	BUZZER	→ ON → OFF	
	PANEL LOCK	→ PANEL ENABLE → PANEL PASSWD	→ ON → OFF Default: 123456
	ETHERNET	→ ADDRESS → NETMASK → GATEWAY	0.0.0.0 0.0.0.0 0.0.0.0
AUTHENTICATE	SERIAL NO.	→ 000B87XXXXXX	
	INTERFACE	→ GPIB ETHER USB	
	CODE	→ _____	

MODE

By default the range is set to AUTO RANGE and mode is set to CCL

CV [7]	→ CV AUTO RANGE
CC [4]	→ CC AUTO RANGE
CR [1]	→ CR AUTO RANGE
CP [0]	→ CP AUTO RANGE

FUNC

→ SLEW+	→ 0.25s
→ SLEW-	→ 0.2ms
→ DUTY	→ 50%
→ FREQ	→ 1.000 HZ
→ PULS	→ 500.0 ms

STEP

TIME [Press #7 Key]	→ 00000 mS
VALUE [Press #9 Key]	→ 000.000V/A/Ω/W
UP [Press #8 Key]	→ +1 for Point of step (increment step# by 1)
Down [Press #2 Key]	→ -1 for point of step (decrement step# by 1)
RIGHT [Press #6 Key]	→ +10 for point of step (increment step# by 10)
LEFT [Press #4 Key]	→ -10 for point of step (decrement step# by 10)
MODE	→ CV (Press #7 Key)
	→ CC (Press #4 Key)
	→ CR (Press #1 Key)
	→ CP (Press #0 Key)

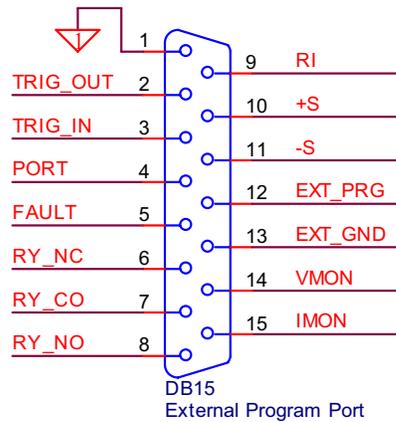
MAIN (#7 Key) 000.000 A

TRANS (#9 Key) 000.000 A

All Contents in Bold are Factory Default Settings

EXTERNAL PROGRAMMING PORT

The external programming port provides remote sense inputs, input voltage monitoring, input current monitoring, external trigger input, external trigger output, and analog programming signal.



1	EGND	Earth Ground. Provides the common (reference) connection for TRIG_IN (PIN 3), TRIG_OUT (PIN 4), RI_1(PIN 9). Fault(PIN 5), PORT(PIN 4).
2	TRIG_OUT	External trigger signal output. A TTL compatible signal that is activated via the Trig-in or GPIB command *TRG. This output follows the state of the TRIG_IN input. External trigger output is used for triggering oscilloscopes, power supplies, or other electronic loads that have external trigger input.
3	TRIG_IN	External trigger signal input. By default, it will remain in a TTL compatible high signal and has a Negative-Edge trigger property. A TTL compatible low signal is used to activate the electronic load. TRIG_IN is used to change to a preset mode or switch between settings in the following transient modes, such as trigger the step once mode step auto mode, trigger mode, toggle mode, or pulse mode. In order to enable TRIG_IN, the trigger source must be set to External.
4	PORT	Digital port output. Port can be activated via front panel operation or by SCPI command PORT 0 1 off on. PORT becomes active (high) when the PORT is on.
5	FAULT	Fault signal output. A TTL compatible signal that becomes active (high) when any of the protections are triggered.
6	RY_NC	Dry Contacts alarm: a fault alarm is declared if there is a loss of AC power or protections are triggered. The fault alarm outputs provide a normally closed relay configuration that provides users flexibility and isolation required to an external controller or an external alarm panel. The delay is 3 second.
7	RY_CO	Relay Common. Provides the common (reference) connection only for RY_NC or RY_NO.
8	RY_NO	Dry Contacts alarm: a fault alarm is declared if there is a loss of AC power or protections are triggered. The fault alarm outputs provide a normally open relay configuration that provides users flexibility and isolation required to an external controller or an external alarm panel. The delay is 3 second.
9	RI_1	Remote Inhibited (RI) is used as an emergency switch to disable the system. RI can be connecting to a switch or an open collector device that shorts the RI pin to common (EGND) whenever it is necessary to disable input of the unit. Once RI is activated, it will turn off the dc output. In order to re-activate the unit, the connection between common and RI pin needs to be open again, and it will have 3 seconds delay.

10	+S	Positive remote sense.
11	-S	Negative remote sense.
12	EXT_PRG	External analog programming input signal. The electronic load can be programmed externally by 0-10Volts DC or DC + AC voltage. When external analog programming function is not used, connect this point to AGND pin 13 to prevent EMI Noise.
13	EXT_GND	Analog Ground. Provides common (reference) connection for EXT_PRG (PIN 12), VMON (PIN 14), and IMON (PIN 15). When an external programming function is not used, connect this point to Analog pin 12 to prevent EMI Noise.
14	VMON	Input voltage monitoring signal. Generates a 0-10Volt, 0-5Volt, or 0-1Volt output signal that is linearly proportional to the electronic load's CV Mode High, Middle, and Low range from 0 to full-scale voltage.
15	IMON	Input current monitoring signal. Generates a 0-10Volt, 0-5Volt, or 0-1Volt output signals that is linearly proportional to the electronic load's CC Mode High, Middle, and Low range from 0 to full-scale current.

INPUT VOLTAGE LIMIT

The programming electronic load can handle voltages within nominal values and surge voltages less than 10% above nominal value. The Over-voltage protection will be tripped when the input voltage exceeds 10% of nominal value.

For CV mode application, the input power source should have current limit capability to prevent exceeding the electronic load's input current range.



WARNING

Insure that the maximum voltage applied to electronic load will not cause the unit to sink more current and exceed the power rating. Damage to the power module will occur if the power source is capable of providing more power than the load can handle.

INPUT CURRENT LIMIT

The nominal current handling capability of the programming electronic load is described in the specification section. Care should be taken when the Load Bank is operating in the CV mode in order to prevent the load from drawing more than the maximum current rating. Although, an Over-current circuit to limit the maximum current to less than 10% above nominal rated power has been provided, at times the total power may exceed maximum rated power for a short term only. However, the load will be severely damaged if the total power consumption is continued to operate above maximum power rating. For CC mode operation, the input power source should have a Constant Voltage capability to prevent exceeding the loads input power rating.

Three over current protection features have been provided. 1) Over current protection to limit maximum current to 10% above nominal value. 2) Software selectable, the user can set and read back the input protection current level. 3) Each power MOSFET has its own fuse to protect the power module in the worst-case condition.



CAUTION

In the event the over current circuit is not fast enough to limit the input current, a protective fuse for each power MOSFET is provided and will open if the input surge current exceeds maximum rating.

INPUT POWER LIMIT

The programming electronic load is designed for rated power handling capability within an input voltage of within the maximum input voltage and input current values as described in the system specification section. Careful attention should be made to insure that the input power source does not exceed the rated power. Above all, fault or error precautions need to be taken into consideration to prevent the individual input voltage, current, and/or power from exceeding the input range settings of the unit



WARNING

Anticipate the Maximum output of the power source carefully and consider the worst-case scenario. The maximum power range of the load should be higher than the output power of the source.

For CP mode application, the programming electronic load can be set to maximum power dissipation with the following limitations. Input must be within maximum voltage and current ratings. For example, LPL600-300-30, the max rated values are 300V/30A/600W. Therefore, the maximum power will be limited to a combination of “voltage x current values” equating to 600W. Thus, CP mode is limited by the hardware's maximum current, voltage and power ratings.

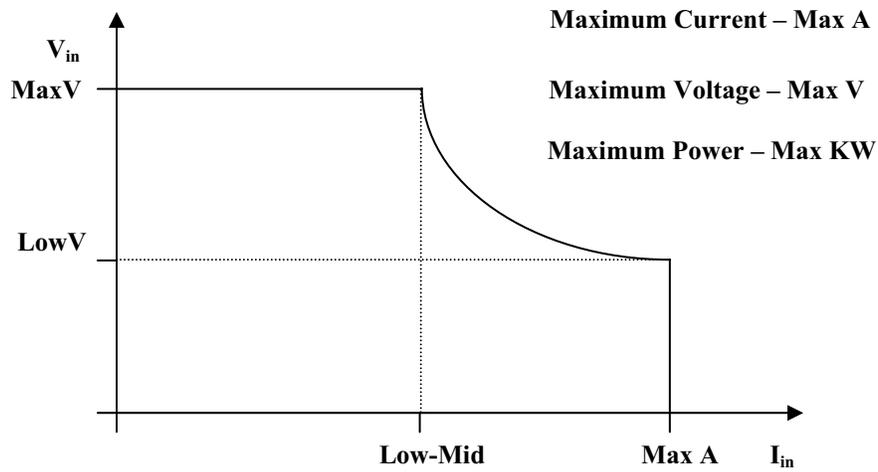
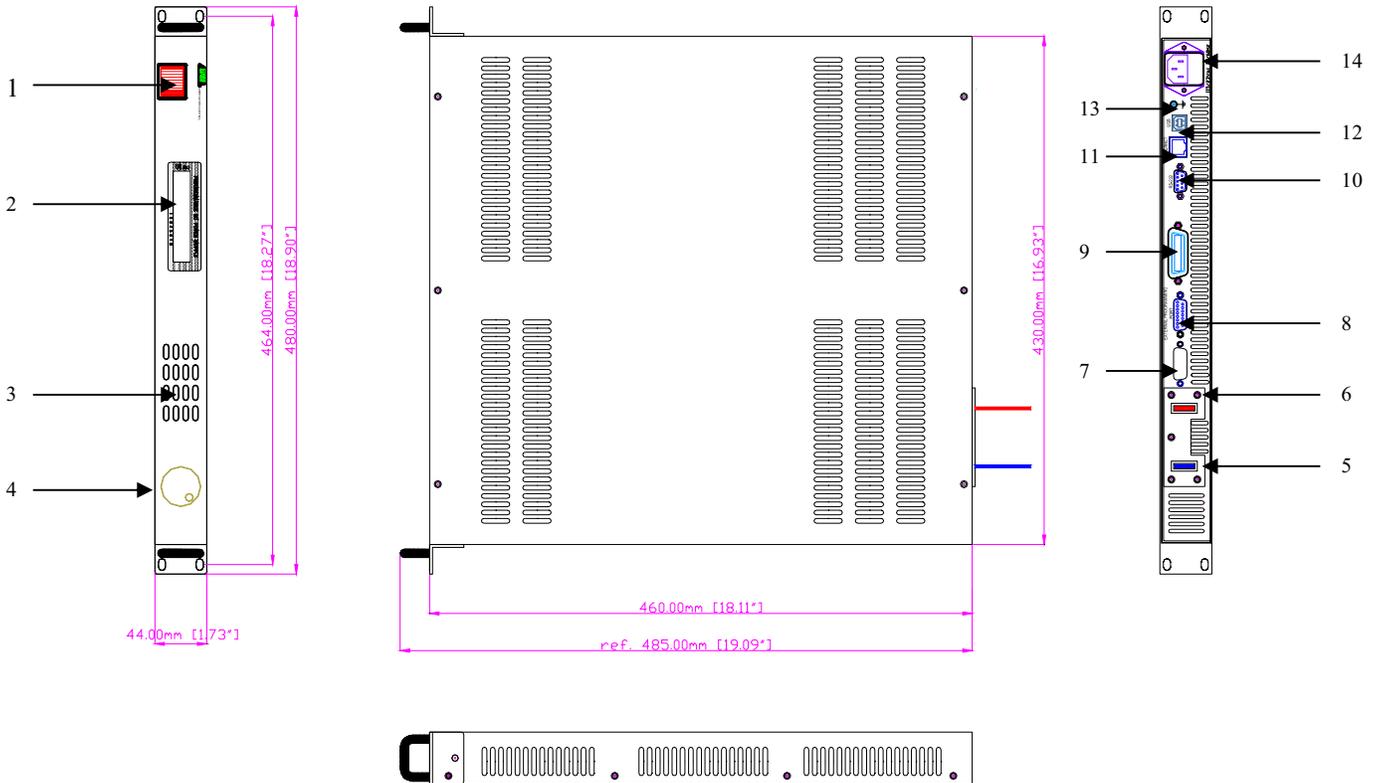


FIGURE 1.5 INPUT VOLTAGE/CURRENT/POWER RELATION DIAGRAM

The theory of the CP operation comes from the divider circuit built in the load. Because of the nonlinear characteristic of the divider, the input voltage, input current, and power setting will limit the CP mode of operation. The CP mode will not allow the load to operate beyond the full range of the Constant Power setting. Operation of load at maximum current and maximum voltage rating will permanently damage the load.

DIMENSIONAL DRAWINGS & DESCRIPTIONS



1. Power ON/OFF switch.
2. Front panel Liquid Crystal Display (VFD) module.
3. Front panel keypad.
4. Front panel rotary knob (Tune Mode).
5. (-) Negative input terminal.
6. (+) Positive input terminal.
7. DC Input connector. (No implement).
8. External programming port.
9. Standard GPIB interface connector.
10. Standard RS-232 interface connector.
11. Standard RJ45 connector for Ethernet interface (LAN).
12. Standard USB interface connector.
13. Chassis / Line ground lug screw.
14. AC power inlet with external fuse holder.

TWO: INSTALLATION

INTRODUCTION

This section provides recommendations and procedures for inspecting, installing, and testing the electronic load.

BASIC SETUP PROCEDURE

Use Table 2.1 to summarize the basic setup procedure and an overall view of the subsections. Use the procedure as a quick reference if you are familiar with the installation requirements for the programming electronic load. If you want more information, each step in the procedure refers to subsequent sections, which contain more details. Execute each step in the sequence provided.

TABLE 2.1 BASIC SETUP PROCEDURE

Step#	Description	Action	Reference
1	Inspection	Perform an initial physical inspection of the load.	Inspection, cleaning, and packaging.
2	Installation	Install the instrument on bench or rack mount, ensuring adequate ventilation.	Location, mounting, and ventilation.
3	Input power	Connect AC input power	AC input power connection.
4	Test	Perform functional tests for CV mode, CC mode, and front panel controls.	Functional test.
5	Source	Connect the source.	Source connection.
6	Sense	Connect sensing lines.	Local and Remote sense.

INSPECTION, CLEANING, AND PACKAGING

- **INITIAL INSPECTION:** When you first receive your unit, perform a quick physical check.
 1. Inspect the instrument for cracks, scratches, broken switches, connectors, and display.
 2. Make sure there is not damage on the AC power cord; the AC input cover is installed properly and with the strain relief.
 3. Make sure there is no loose component in the unit that may cause by the long distance shipping.

If the unit is damaged, save all the packing materials and notify the carrier immediately.

- **MAINTENANCE:** No routine servicing of the electronic load is required except for periodic cleaning. Whenever the instrument is removed from operation, first use a low pressure air to blow dust from in and around components on the printed circuit board, clean the front panel with dry cloths or with a weak solution of soap and water, clean the metal surfaces with naphtha or an equivalent solvent when used in high humidity. Then use the low-pressure air to blow it again.

RETURNING ELECTRONIC LOAD TO THE MANUFACTURER

Return Material Authorization Policy for warranty and non-warranty service:

Before returning a product directly to American Reliance Inc. you must obtain a Return Material Authorization (RMA) number and the correct manufactory Ship To: address. Products must also be shipped prepaid. Product shipments will be refused and returned at sender expense if they are unauthorized shipped without RMA # clearly marked on the outside of the shipping box, shipped "COD", or if they are shipped to the wrong location.

Please have the following information when contacting American Reliance for RMA #:

- 1- The model number of your product.
- 2- The serial number of your product.
- 3- Information about the failure and/or reason for the return.
- 4- A copy of your dated proof of purchase.

When returning the product to American Reliance Inc.:

- 1- Package the unit safely, preferably using the original box and packing materials. Please ensure that your product is shipped fully insured in the original packaging or equivalent. **THIS WARRANTY WILL NOT APPLY WHERE THE PRODUCT IS DAMAGED DUE TO IMPROPER PACKAGING.**
- 2- Include the following information:
 - The RMA# supplied by American Reliance Inc. clearly marked on the outside of the box.
 - A return address where the unit can be shipped. Post office boxes are not acceptable.
 - A contact person, telephone, email where sender can be reached during work hours.
 - A brief description of the problem.

Ship the unit prepaid to the address provided by AMREL customer service representative.

If you are returning a product from outside of the United States:

In addition to the above, you must include return freight funds if you instrument is out of warranty and are fully responsible for all documents, duties, tariff, and deposits.

PACKAGING FOR SHIPPING OR STORAGE

Instructions to prepare the instrument for shipping or storage.

- 1- When returning the unit or sending it to the service center, attach a tag to the unit stating its model number (available at the front panel label) and its serial number (available at the rear panel label). Give the date of purchase and an invoice number, if you have it, as well as a brief description of the problem.
- 2- For storage or shipping, repack the electronic load in its original box. If the original box is not available, seal the instrument in a plastic bag and pack it in a 200 lb. (90Kg) test corrugated cardboard carton large enough allow 3 inches (76.2mm) of cushioning material to surround the unit or use a material such as foam slabs or chips or an appropriate wooden crate used. Please consult with AMREL shipping department for proper packing material and handling.
- 3- Label the package as shown in Figure 2.1.
- 4- Mark the address of the service center and your return address carton.
- 5- For storing, no more than two cartons high. The storage temperature should be between -40°C to 70°C.

<p>PROGRAMMABLE DC ELECTRONIC LOAD</p> <p>Model #: _____</p> <p>Serial #: _____</p> <p>FRAGILE – ELECTRONIC EQUIPMENT (PLEASE HANDLE WITH CARE)</p>

FIGURE 2.1 SHIPPING OR STORAGE PACKAGE LABEL

LOCATION, MOUNTING, AND VENTILATION

Electronic load is designed for rack-mounted or bench top applications.

RACK MOUNTING INTALLATION:

- 1- Use the integral rack-mount ears at both sides of the front panel to install the electronic load in a rack mount application.
- 2- Provide adequate support for the rear of the instrument without obstructing the ventilation inlets on the sides and rear of the unit. Use a support bar at the bottom or rear of the unit. Follow the rack-mount manufacturer's instructions to install the support bar.

VENTILATION:

Whether you place the electronic load in a rack or on a bench, allow cooling air to reach the ventilation inlets on the sides of the instrument and allow 4 in. (101.6mm) of unrestricted air space at the rear of the unit for the fan exhaust. Any ventilation space at the top and bottom of the supply will further lower internal operating temperatures.

FUSE REPLACEMENT

If the fuse is suspected to be defective, it should be inspected and, if necessary, replaced. To inspect or replace the fuse, please contact to American Reliance service department before perform the following steps:

- (1) Disconnect the AC line cord from the unit to reduce electrical shock hazard.
- (2) Remove the fuse by sliding out the fuse holder. The fuse holder is beneath the AC receptacle. Test the fuse for electrical continuity with an ohmmeter. Other fuse holder located at the printed circuit board.
- (3) If the fuse is found to be defective, replace it with a replacement fuse as specified in the following table:

Model Type	Fuse Rating	Specification	Location
LPL600	2.5A/250V	Slow Blow	External Fuse (Beneath the AC receptacle)

- (4) Replace the fuse in the fuse holder and re-install.
- (5) Re-install the cover and connect the AC power cord.



CAUTION

USE OF ANY FUSE OTHER THAN THE ONE SPECIFIED MAY CAUSE DAMAGE TO THE UNIT, POSE A SEVERE FIRE HAZARD, AND WILL VOID THE WARRANTY.

AC INPUT POWER CONNECTION



WARNING

Disconnect AC power from the instrument before removing the cover. Even with the front panel power switch in the OFF position, live line voltages are exposed when the cover is removed and the AC cord is attached. Repairs must be made by experienced service technicians only.

NOTE: You must obtain an authorization from Amrel first before removing the cover of the instrument. Otherwise the warranty will be voided.



WARNING

There is a potential shock hazard if the electronic load chassis and cover are not connected to an electrical ground via the safety ground in the AC input connector. Ensure that the electronic load is connected to a grounded AC outlet with the recommended AC input connector configured for the available line voltage.

AC INPUT CONNECTOR AND VOLTAGE SELECTION



CAUTION

To prevent damage to the electronic load, turn off AC power to the unit before changing from one AC input voltage range to another. Example 115Vac to 230Vac.

LPL series has an auto range selection function. This function allows you to connect to either low or high AC input voltage without making any adjustment to the unit.

AC INPUT CORD



WARNING

The AC input cord is the disconnect device for the electronic load. The plug must be readily identifiable to the operator. The input cord must be no longer than 3 m (9.84 feet).

The AC input cord we recommend is specified in Table 2.3, “AC Cord Specification”. If you require a special cord, call our sales representative.

TABLE 2.3 AC CORD SPECIFICATION

WIRE SIZE DIMENSIONS AWG	TYPE OF CONDUCTOR	RATINGS	LENGTH (feet)
16/3	SJT	105°C	6
18/3	SJT	105°C	6

LOAD WIRING

To select wiring for connecting the load to the electronic load, consider the following factors:

- Insulation rating of the wire
- Current carrying capacity of the wire
- Maximum load wiring length for operation with sense lines
- Noise and impedance effects of the load lines

CURRENT CARRYING CAPACITY: As a minimum, load wiring must have a current capacity greater than the output current rating of the power supply. This ensures that the wiring will not be damaged even if the load is shorted. Table 2.4 shows the maximum current rating, based on 450 A/cm², for various gauges of wire rate for 105°C operations. Operate at the maximum current rating results in an approximately 30°C temperature rise for a wire operating in free air. Where load wiring must operate in areas with elevated ambient temperatures or bundled with other wiring, use larger gauges or wiring rated for higher temperature.

TABLE 2.4 CURRENT CARRYING CAPACITY FOR LOAD WIRING

WIRE SIZE (AWG)	MAXIMUM CURRENT (A)
2/0	303
1/0	247
1	192
2	155
4	97
6	61
8	36
10	21
12	16
14	10

LOAD WIRING LENGTH FOR OPERATION WITH SENSE LINES

For applications using remote sensing, you must limit the voltage drop across each source line. We recommend that you use the larger load wiring or ensure a smaller voltage drop (1V typical max.) along the wire, although the unit will compensate for up to 5V drop in each line.

NOISE AND IMPEDANCE EFFECTS

To minimize noise pickup or radiation, use shielded pair wiring or shortest possible length for source wires. Connect the shield to the chassis via a rear panel mounting screw. Where shielding is impossible or impractical, simply twisting the wires together will offer some noise immunity. When using local sense connections, the user must use the largest practical wire size to minimize the effects of load line impedance on the regulation of the load.

LOAD CONNECTIONS

The electronic load is designed with an air-cooling system that provides airflow through the heat sink to remove the heat generated by the Power MOSFETs. For higher efficiency heat exchange rate between heat sink and power MOSFETs, the user needs to follow the instruction outlined below to insure heat is removed from heat sink and prevent excess heat from accumulating in the power module. The efficiency of the heat exchanger is the key factor of the power handling of the load. Better efficiency results in higher reliability of the unit.

INPUT TERMINAL



CAUTION

For the safety of personnel and to prevent electrical shock due to high voltage, do not come in contact or obstruct the input terminals. Refer to the next page diagram, for the location of the input terminals.

Observe the maximum current handling capability of the power cables from DUT to the Load Bank. Please refer to the Table 2.4 for higher current rating cables. Observe the maximum input current and voltage of the terminals. Do not underrate the cable, excessive current will cause the temperature to increase and cause melting of the insulation rubber of the terminal and cable insulation sleeves resulting in input cable shorts.

For the high current applications, large diameter power cables are necessary to prevent load oscillation. The power cables should be as short as possible to reduce inductance from the power cable and cause oscillation between power sources and the load unit.

INPUT TERMINAL CONNECTOR



WARNING

There is a shock hazard at the load when using an electronic load with a rated output greater than 40V. To protect personnel against contact with hazardous voltages, ensure that the load, including connections, has no live parts, which are accessible. Also ensure that the insulation rating of the source wiring and circuitry is greater than or equal to the maximum output voltage of the electronic load.



CAUTION

When making connections to the bus bars. Ensure that each terminal's mounting hardware and wiring assembly are placed to avoid touching the other terminal and shorting the electronic load input. Heavy connecting cables must have some form of strain relief to avoid loosening the connections or bending the bus bars. Make sure the power cable are securely fastened to the bus bars, to prevent overheating caused by loose cables.

LOCAL SENSE CONFIGURATION

When the Electronic Load is strapped for local sensing, an unavoidable voltage drop is incurred in the load leads and this adds to the load regulation. Hence, local sensing is usually used in applications where the lead lengths are relatively short or load regulation is not critical. Local or remote sense can be set by accessing: **UTILITY**→**LOAD CONTROL**→**REMOTE SENSE** →**REMOTE** and pressing enter to confirm.

To meet safety requirement, load wire size should be large enough to carry electric current of the source to the Electronic Load without overheating. Stranded, copper wires are recommended. The wires should be large enough to limit the voltage drop to less than 1V per lead. Refer to Table 2.4 for proper wire size selection. Input wire connections are made to the "+" and "-" terminals on the rear panel of the Load.

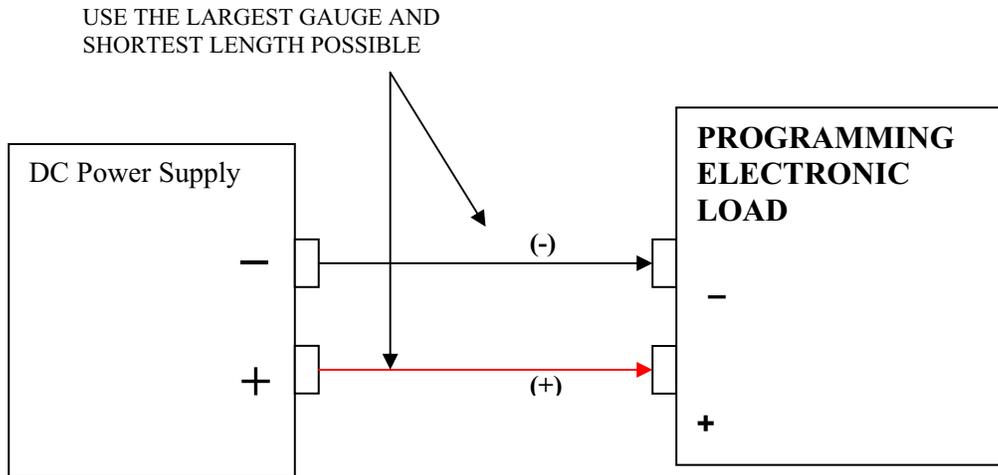


FIGURE 2.2 LOCAL SENSE CONFIGURATIONS



WARNING

To protect personnel against accidental contact with hazardous voltages, ensure that the load, including connections, have no live parts, which are accessible. Also ensure that the insulation rating of the load wiring and circuitry is greater than or equal to the maximum input voltage of the electronic load.



WARNING

Never touch the input terminal when your hands are wet. Dry your hands first before operate the instrument.

REMOTE SENSE CONFIGURATION



CAUTION

Turn off the electronic load before making any connections on the rear panel terminal block.

In remote sense operation, the electronic load senses the input at output terminals of the source. As shown in figure 2.3, the remote sense terminals of the Load are connected to the output of the source. Remote sensing compensates for the voltage drop in applications that require long leads. It is only useful when the electronic load is operating in CV or CR mode, or when using voltage readback in any mode. Load leads should be bundled or tied together to minimize inductance.

<NOTE>: USE THE LARGEST GAUGE AND SHORTEST LENGTH POSSIBLE FOR THE SOURCE LINE.

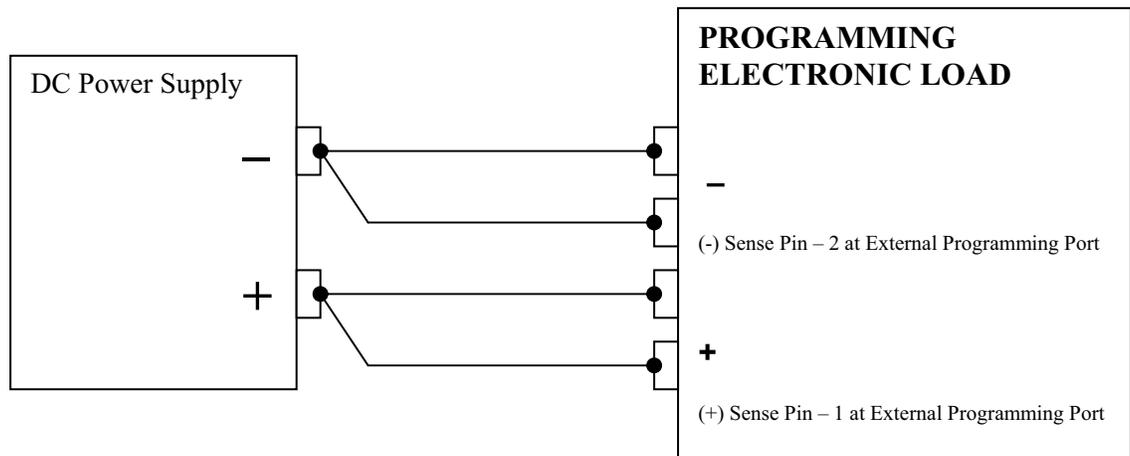


FIGURE 2.3 REMOTE SENSE CONFIGURATIONS

PARALLEL CONNECTIONS

The electronic loads can be connected in parallel to increase power dissipation. Up to 5 Electronic Loads can be directly paralleled in CC or CR mode. The electronic load cannot be paralleled in CV mode. Each Electronic Load will dissipate the power it has been programmed for. If two Electronic Loads are connected in parallel, with Load 1 programmed for 10 A and Load 2 programmed for 15 A, the total current drawn from the source is 25 A. In another scenario, if Load 1 is programmed for 0.5 ohm and Load 2 is programmed for 0.5 ohm, the total equivalent resistance of the two paralleled Loads is 0.25 ohm.

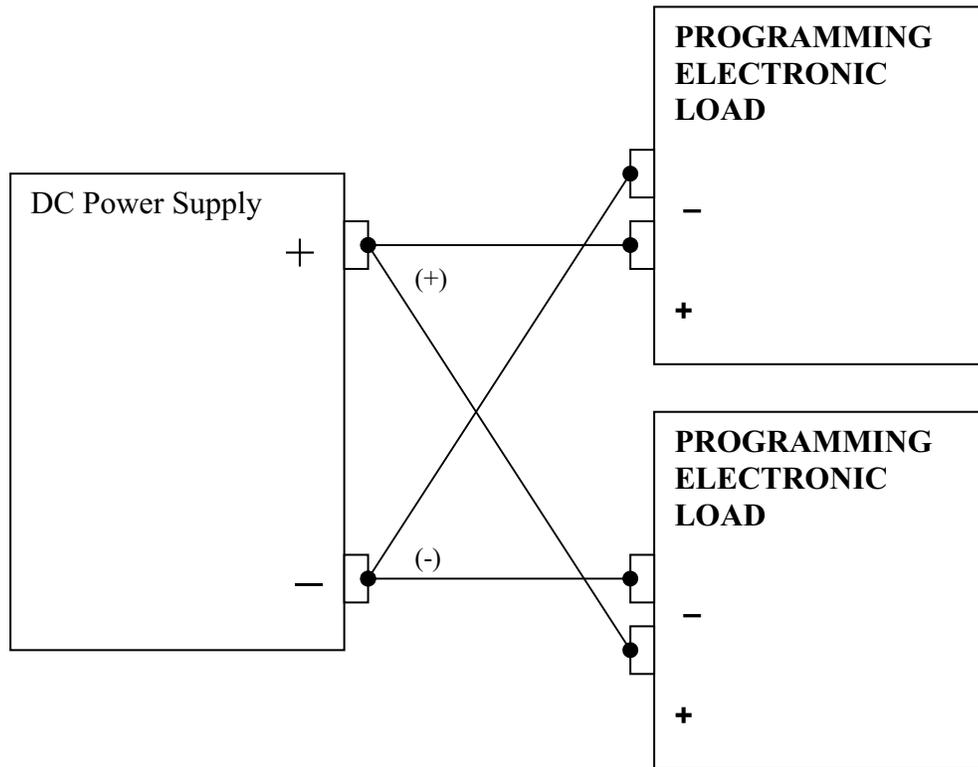


FIGURE 2.4 PARALLEL CONFIGURATION

TRIGGER OPERATION

Figure 2.5 depicts the method of triggering the Electronic Loads. The TRIGOUT signal of the Electronic Load is connected to the Trigger input of DMM. Additional instruments can be daisy chained to a DMM in the same manner. Once the preset settings of the instruments have been programmed, one trigger signal can simultaneously set all instruments to their transient settings.

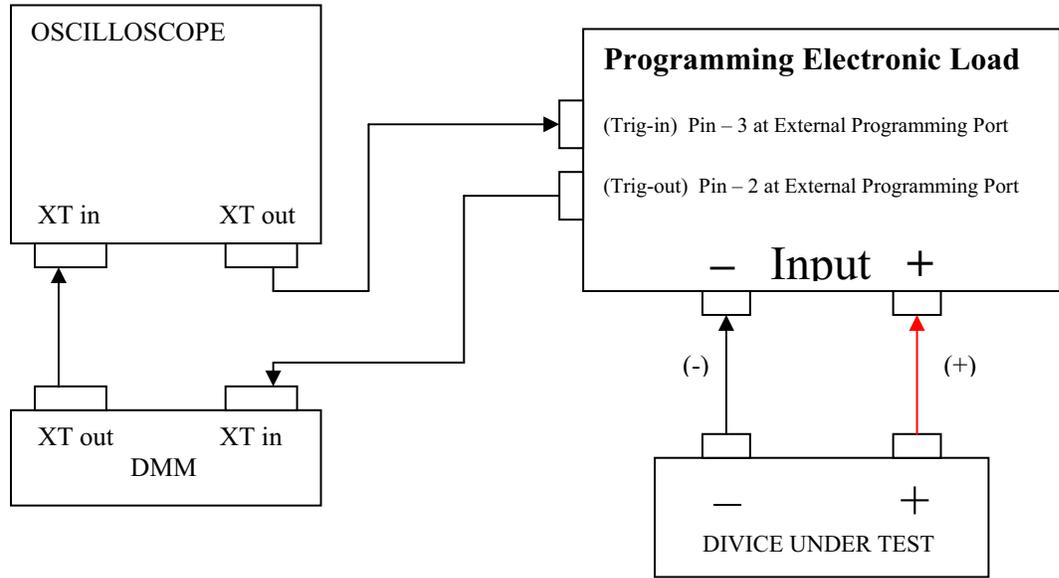


FIGURE 2.5 TRIGGER CONFIGURATION

ZERO-VOLT LOADING CONNECTION

The Electronic Load can be connected in series with voltage sources greater than 3 V so the Electronic Load can test the devices at its full current capacity down to a zero-volt level.

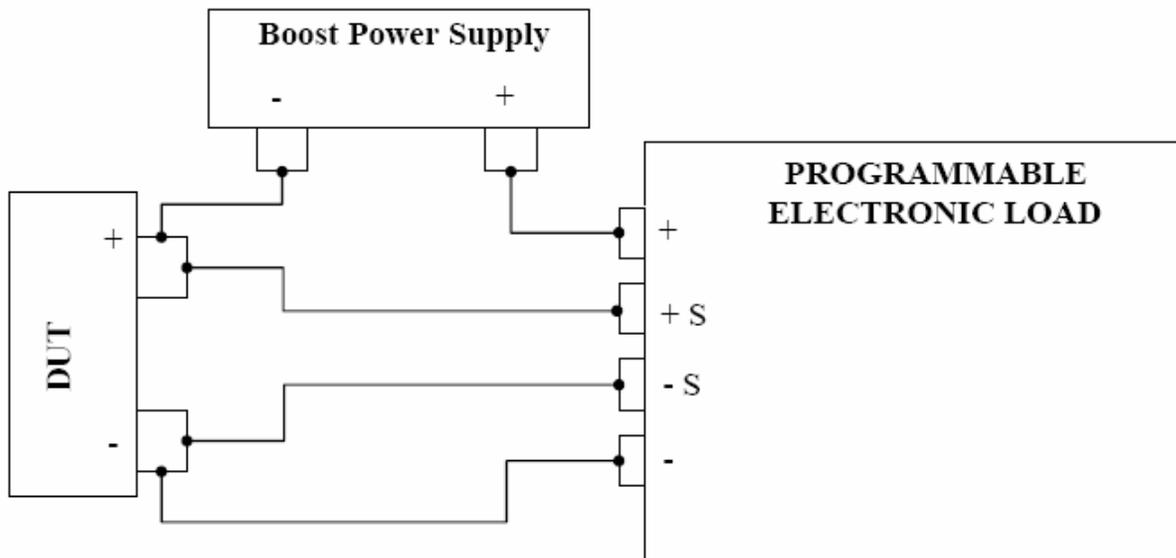


FIGURE 2.6 ZERO-VOLTS LOADING

THREE: LOCAL OPERATION

INTRODUCTION

The programming electronic load provides powerful control capabilities, which consist of four operating modes CV/CC/CR/CP. To complement and enhance these features, a Transient mode is provided to simulate transient conditions. The Transient operation provides three programmable features that can be set by the user, Transient frequency, Transient duty cycle, and Transient slew rate. These features can help the user to control the LPL more efficiently and precisely and provide a comprehensive power source test.

The programming electronic load provides additional functions and capabilities, such as 99 point step programming, 255 recording points, and clock. For battery testing, we provide the “C” operand to help user in testing battery parameters without troublesome calculations.

The wide operating modes and specifications and flexibility of the electronic load enable the user to control different levels of power source. Programmable OVP, OCP, OPP protection features are provided to protect the electronic load in any load conditions. Refer to the specifications to check the maximum input current, voltage, and power range in order to safely test and obtain the best results.

VOLTAGE AND CURRENT METERING INFORMATION

The programming electronic load uses a DAC with a guaranteed 14-bit resolution in the metering system and is active once the unit is turn on. With sophisticated control circuits, the load can measure full-scale input voltages and currents with Auto-Scaling capability. For example, when low voltages levels are applied, the display's decimal point will move to accurately display the lower value. The same is true for the larger input values, the decimal will move to accurately display the higher value. Refer to the Specifications for more programming and read back accuracy information.

OPERATING STATUS INFORMATION

All operating status information will be displayed when they become active. For example, when the Over-voltage is tripped, the LCD module will display OVP.

SYMBOL	TYPE	DESCRIPTIONS
UNR	WARNING	unregulated
OVP	ALARM	over voltage protection
UVP	ALARM	under voltage protection
OCP	ALARM	over current protection
UCP	ALARM	under current protection
OPP	ALARM	over power protection
UPP	ALARM	under power protection
OTP	ALARM	over temperature protection
OSC	ALARM	oscillation
LV	WARNING	low voltage
OV	ALARM	over voltage
OC	ALARM	over current
OP	ALARM	over power
RCP	ALARM	reverse current protection
RSF	ALARM	remote sense fault
UVL	WARNING	under voltage lockout



WARNING

Do not deliberately try to trip the OVP circuit on when performing battery-testing applications. When an Over-voltage condition occurs, the electronic load will try to sink more current in order to drop the input voltage source. In other words, the input source is supplying more power than the electronic load is capable of handling. By trying to trip the Over-voltage circuit, you may severely damage both the input source and the load.

LOCAL AND GPIB OPERATION INFORMATION

When the programming electronic load is first turn on, the LCD will display LCL for local communication (via keypad). When the electronic load is communicating via GPIB, USB, Ethernet or RS-232 remote control operation, the LCD module will display RMT to inform the user that the keypad is disabled and the load is being controlled remotely. Pressing the LOCAL key will change status from RMT to LCL (local operation).

MODE MENU OPERATION AND RANGE SETTING

The LPL provides a wide range of input operating modes CV/CC/CR/CP and range operation (Manual/Automatic). The user is capable of activating any mode during the operation of the unit; however, careful attention needs to be adhered to prior to entering the programming values for each operating mode and correct range.



WARNING

The "MODE" key plays an important role in switching operating mode (CV, CC, CR, and CP) and range selection. The LPL needs to be in the OFF status prior to enabling mode-switching capability. For safety purposes and to prevent over sourcing the LPL, do not activate the mode switching when the LPL is in the ON status.

TO SELECT THE MANUAL MODE AND RANGE, SIMPLY FOLLOW THE PROCEDURE:

1. Set manual mode at the Range Operation by pressing UTILITY, press ENTER key when you see LOAD CONTROL, press the key # 6 () to scroll till you see RANGE CONTROL and then press ENTER. Use "   " to select manual then press ENTER. Press CLEAR key to back space to metering mode.
2. Press MODE key to enter mode menu.
3. Select the mode by pressing CV (7)/CC (4)/CR (1)/CP (0) key then press ENTER.
4. After selecting the mode. Press the up-arrow (8) or down-arrow (2) key to set the correct range for your operation, then press ENTER key to end the range setting mode and will return to metering mode.

TO SELECT THE AUTOMATIC MODE AND RANGE, SIMPLY FOLLOW THE PROCEDURE:

Example: 60A is maximum current = middle/high range, then 6A = low range.

- a. Set automatic mode at the Range Operation by pressing UTILITY, press ENTER key when you see LOAD CONTROL, press the key # 6 () to scroll till you see RANGE CONTROL and then press ENTER. Use "   " to select automatic then press ENTER. Press CLEAR key to back space to main menu.
- b. Press MODE key to enter mode menu.
- c. Select the mode by pressing CV (7)/CC (4)/CR (1)/CP (0) key then press ENTER.
- d. The load will automatic change by factory's default, Simply input the value main value, and will automatic select the suitable range for the user.

MAIN LEVEL LOCAL OPERATION

There are two levels of operations MAIN level and TRANSIENT level. The MAIN level operation and its associated set of values are for normal and continuous operation. TRANSIENT operation is for short intervals to simulate start-up conditions or special events.

The main level programming values for the four different operating modes are entered the same; the difference is the unit of measurement for each operating mode. For example CV mode is in V (Voltage) unit, CC mode is in A (Amps) unit, CR mode is in Ω (Ohm) unit and CP mode is in W (Watts) unit.

The CC, CP and CR modes have more than one operating range. The low ranges provide better resolution for low settings. Each mode's range is selected by pressing the up or down keys in the MODE menu. See example below.

Example 1.

1. Press "MODE" key and select CC mode by pressing "4" (CC) key, then pressing the "ENTER" key. Select the programming range by pressing the up or down keys and then pressing the "ENTER" key. Let's assume main level programming value indicates 10 amps, in the low range. Try to set the programming value to 15.0 Amps.
2. Press "7" (MAIN) key and the LPL will enter the editing mode and wait for a numerical key entry for a new value. On the second line of the LCD module the following format will be displayed: CURR = 10.000A
3. Enter the following numerical key sequence "1", "5", "." and "0".
4. If the number that was entered is not correct, then press the "CLEAR" key to erase the wrong entry and repeat step 3.
5. Press the "ENTER" key to complete the entry operation.
6. If the entered value is over the maximum rating of the current range, then the LPL will discard the new value and LCD module will return back to entry step. Either change the entered value to a number that is within the current range or select the correct range by pressing the MODE key as indicated in step 1.

Example 2.

1. Assume that the LPL is in the CP mode and main level programming value indicates 40 Watts. Try to set the programming value up to 50.0 Watts.
2. Press "7" (MAIN) key and the unit will enter the editing mode and wait for a numerical key entry for the new value. On the second line of the LCD module the following format will be displayed: POWER = 40 W
3. Enter the following numerical key sequence "5", "0", "." and "0".
4. If the number that was entered is not correct, then press the "CLEAR" key to erase the wrong entry and repeat step 3.
5. Press the "ENTER" key to complete the entry operation.
6. If the entered value is over the maximum rating, then the LPL will discard the new value and LCD module will return back to entry step and display the old value.

After the entry steps have been completed, the new main level programming values will immediately be in effect and the LPL will return to the metering mode.

SPECIAL EDITING KEYS

In the main operating mode the "◀ (Key #4), ▶ (Key #6), ▲ (Key #8), ▼ (Key #2)" keys can be used to edit the CV/CC/CR/CP set values. Use the "◀ ▶" keys to increment or decrement the multiplier (decimal placement value), then use the "▲ ▼" keys to increment or decrement the set value by the multiplier factor.

Example: The LPL is in CV mode and we need to decrement or increment the voltage set value by (100.00) from 20.00 to 302.00V.

Press the ◀ or ▶ key once to enable the multiplier edit mode then press the ◀ key to decrement or ▶ key to increment the value located on the top-left corner of the display next to the CV indicator. Continue pressing either key until the displays reads (100.00). Then press the "▲ or ▼" key once to enable the set value edit mode use the "▲" to increment the set value by the multiplier or the ▼ key to decrement the set value by the multiplier value. In this example the original set value was 20.00, by pressing the ▲ key (3) times the display should read (320.00).

UTILITY MENU FUNCTION

The Utility function allows the user to set the different system configurations such as GPIB, Stepping, Max/Min setting, Protection, Recording, and Calibration. It is to help users to do more functional testing in using LPL in the different situations or configurations. The Utility function is the start of the tree structure, which enables the user to branch.

Press **UTILITY** key:

- * (Use ◀ ▶ to select the next menu setting then press ENTER key to enter the selected menu).
- * (Use CLEAR key to back space or to correct the wrong value).

(A: LOAD CONTROL ◀ ▶ B: PROFILE ◀ ▶ C: DISPLAY ◀ ▶ D: SYSTEM ◀ ▶ E: AUTHENTICATE)

A: Load Control Menu - press ENTER key:

- *Use ◀ ▶ to select the next menu setting then press ENTER key to enter the selected menu.
- * (Use CLEAR key to back space or to correct the wrong value).

1: TRANS. MODE ◀ ▶ 2: BOOT INPUT ◀ ▶ 3: MEASURE SENSE ◀ ▶ 4: RANGE CONTROL ◀ ▶
5: PORT0 ◀ ▶ 6: EXT. CONTROL ◀ ▶ 7: SHORT CONTROL ◀ ▶ 8: CROSS MODE ◀ ▶ 9: CROSS
RANGE ◀ ▶ 10: TRIGGER ◀ ▶ 11: STEP PARAM. ◀ ▶ 12: PROTECTION ◀ ▶ 13: MAX/MIN LIMIT
◀ ▶ 14: CAL. PARAM. ◀ ▶ 15: OSCILLATE

1. TRANS. MODE-----press ENTER key, use ◀ ▶ to select transient mode (Continuous, Toggle, Pulse, Step, Step AUTO, Step ONCE) then press ENTER
2. BOOT INPUT-----press ENTER key, use ◀ ▶ to select ON / OFF then press ENTER.
3. MEASURE SENSE--press ENTER key, use ◀ ▶ to select LOCAL / REMOTE sense then press ENTER.
4. RANGE CONTROL--press ENTER key, use ◀ ▶ to select AUTO / MANUAL then press ENTER
5. PORT0 -----press ENTER key, use ◀ ▶ to enables or disables digit port the press ENTER.
6. EXT. CONTROL----press ENTER key, use ◀ ▶ to select ON / OFF then press ENTER.
7. SHORT CONTROL--press ENTER key, use ◀ ▶ to select ON / OFF then press ENTER.
8. CROSS MODE-----press ENTER key, use ◀ ▶ to select INPUT OFF / INPUT REMAIN then press ENTER.
9. CROSS RANGE----- press ENTER key, use ◀ ▶ to select INPUT OFF / INPUT REMAIN then press ENTER.
10. TRIGGER-----press ENTER key, use ◀ ▶ to select Source (Held, BUS, EXTERNAL, ETHERNET) / DELAY (in milli-second), then press ENTER.
11. STEP PARAM.----- press ENTER key, use ◀ ▶ to select number of Step COUNT then press ENTER. (0 = infinite)

12. PROTECTION-----press ENTER key,

1: OV PROTECTION ◀ ▶ 2: UV PROTECTION ◀ ▶ 3: OC PROTECTION ◀ ▶ 4: UC PROTECTION
◀ ▶ 5: OP PROTECTION ◀ ▶ 6: UP PROTECTION ◀ ▶ 7: V-ON CONTROL

1. OV PROTECTION-----press ENTER key, input the STATE/LIMIT/DELAY then press ENTER.
2. UV PROTECTION-----press ENTER key, input the STATE/LIMIT/DELAY then press ENTER.
3. OC PROTECTION-----press ENTER key, input the STATE/LIMIT/DELAY then press ENTER.
4. UC PROTECTION-----press ENTER key, input the STATE/LIMIT/DELAY then press ENTER.
5. OP PROTECTION-----press ENTER key, input the STATE/LIMIT/DELAY then press ENTER.
6. UP PROTECTION-----press ENTER key, input the STATE/LIMIT/DELAY then press ENTER.
7. V-ON CONTROL-----press ENTER key, input the STATE/V-ON THRESHOLD then press ENTER.

13. MAX/MIN LIMIT---press ENTER key,

1: MAX VOLTAGE ◀ ▶ 2: MIN VOLTAGE ◀ ▶ 3: MAX CURRENT ◀ ▶ 4: MIN CURRENT ◀ ▶
5: MAX RESISTOR ◀ ▶ 6: MIN RESISTOR ◀ ▶ 7: MAX POWER ◀ ▶ 8: MIN POWER

1. MAX VOLTAGE-----press ENTER key, input the maximum voltage then press ENTER
2. MIN VOLTAGE -----press ENTER key, input the minimum voltage then press ENTER.
3. MAX CURRENT-----press ENTER key, input the maximum current then press ENTER.
4. MIN CURREN-----press ENTER key, input the minimum current then press ENTER.
5. MAX RESISTANCE----press ENTER key, input the maximum resistance then press ENTER
6. MIN RESISTANCE----press ENTER key, input the minimum resistance then press ENTER
7. MAX POWER----- press ENTER key, input the maximum power then press ENTER
8. MIN POWER----- press ENTER key, input the minimum power then press ENTER

14. CAL. PARAM.-----press ENTER key, input the MEASURE LOW/ MEASURE HIGH / TRAN. OFFSET, , then press ENTER.

1: LOW MEAS POINT ◀ ▶ 2: HIGH MEAS POINT ◀ ▶ 3: TRANS OFFSET

1: LOW MEASURE
POINT--press

ENTER key, set the low measure count value then press ENTER.

2: HIGH MEASURE POINT--press ENTER key, set the high measure count value then press ENTER.

3: TRANSIENT OFFSET---- press ENTER key, set the transient offset count then press ENTER.

15. OSCILLATE-----press ENTER key, select the OSC. CONTROL/ OSC. DELAY, then press ENTER.

B: Profile Menu - press ENTER key:

*Use ◀ ▶ to select the next menu setting then press ENTER key to enter the selected menu.

* (Use **CLEAR** key to back space or to correct the wrong value).

1: RECALL ◀ ▶ 2: SAVE ◀ ▶ 3: RESET

1. RECALL-----press ENTER key, use ◀ ▶ to select the profile 0/1/2/3 then press ENTER to recall.
2. SAVE-----press ENTER key, use ◀ ▶ to select the profile 0/1/2/3 then press ENTER to save.
3. RESET-----press ENTER key, then press ENTER to reset.

C: Display Menu - press ENTER key:

*Use ◀ ▶ to select the next menu setting then press ENTER key to enter the selected menu.

* (Use **CLEAR** key to back space or to correct the wrong value).

1: Meter Mode ◀ ▶ 2: 'C' Value

1. METER MODE---press ENTER key, use ◀ ▶ to select display mode (V+I, V+P, V+C, V+R, I+P, I+C, I+R, R+P, R+C, P+C, V+T, I+T, R+T, P+T, C+T) then press ENTER.
2. 'C' Value-----press ENTER key, then input the C value in Ampere.

D: System Menu - press ENTER key:

- *Use ◀ ▶ to select the next menu setting then press ENTER key to enter the selected menu.
- * (Use CLEAR key to back space or to correct the wrong value).

1: GPIB ADDRESS ◀ ▶ 2: RS-232 SPEED ◀ ▶ 3: SYNTAX MODE ◀ ▶ 4: EOS CODE ◀ ▶ 5:
BUZZER ◀ ▶ 6: PANEL LOCK ◀ ▶ 7: ETHERNET

1. GPIB ADDRESS--press ENTER key, use ◀ ▶ to set the GPIB address (0 – 31) then press ENTER.
2. RS-232 SPEED----press ENTER key, use ◀ ▶ to set the BAUD RATE (2400 – 115200) then press ENTER.
3. EOS CODE-----press ENTER key, use ◀ ▶ to set end of interface code then press ENTER.
4. BUZZER-----press ENTER key, use ◀ ▶ to select ON / OFF then press ENTER.
5. PANEL LOCK
6. ETHERNET-----press ENTER key, use ◀ ▶ to select ADDRESS/NETMASK/GATEWAY, then press ENTER.

E: Authenticate Menu - press ENTER key:

- *Use ◀ ▶ to select the next menu setting then press ENTER key to enter the selected menu.
- * (Use CLEAR key to back space or to correct the wrong value).

1: SERIAL NO. ◀ ▶ 2: INTERFACE ◀ ▶ 3: CODE

1. SERIAL NO.-----press ENTER key. Serial NO. should start with 000B87xxxxxx.
2. INTERFACE-----press ENTER key. GPIB/ETHER/USB should be display according to customer's order.
3. CODE-----press ENTER key, Input the code from AMREL, then press ENTER.

FUNCTION MENU REFERENCE

The Function reference allows the user to set the different system configurations such as Slew Rate, Duty Cycle, Frequency, and Pulse Time. It is to help users to do more functional testing in using LPL in the different situations or configurations. The Function reference is also the start of the tree structure, which enables the user to branch.

FUNCTION Menu - press ENTER key:

- *Use ◀ ▶ to select the next menu setting then press ENTER key to enter the selected menu.
- * (Use CLEAR key to back space or to correct the wrong value).

1: SLEW +◀ ▶ 2: SLEW -◀ ▶ 3: DUTY ◀ ▶ 4:FREQ ◀ ▶ 4: PULSE

1. SLEW (positive)-----press ENTER key, input the positive slew rate value (uS) then press ENTER.
2. SLEW (negative)-----press ENTER key, input the negative slew rate value (uS) then press ENTER.
3. DUTY -----press ENTER key, input the value of the duty cycle (%) then press ENTER.
4. FREQUENCY-----press ENTER key, input the frequency (Hz) then press ENTER.
5. PULSE-----press ENTER key, input the pulse time (mS) then press ENTER.

SYSTEM FUNCTIONS

To enter a value for a particular function, please follow the correct key sequence indicated in the Utility Menu Function above. Press the "Utility/Local" to enter the utility command level then the ◀ ▶ keys to select the desired function. Then press the "ENTER" and ◀ ▶ keys to further select the next level of commands. Press the Enter key to confirm the selection.

For example to enter the Min Current value; press the "Utility/Local" key, then the ◀ or ▶ key until "Max/Min Setting" is displayed. Then press the "ENTER" key and the ◀ or ▶ key until the "Min Current" is displayed. Then press the "ENTER" key and enter the value for the Min Current setting.

You can press the "Clear" key repeatedly at any time to exit the function or mode level.

Measure Sense: Local
 Remote

<NOTE>: The LPL's voltage measuring points (positive and negative) can be configured in two locations. One is from the power input terminals called Local; the other is from the remote sense terminal block in the rear panel called Remote (Remote option is only available in certain models). The purpose of the Remote sense is for more accurate voltage measurement.

Press the "Utility/Local" key then the "ENTER" key. Use ◀ ▶ keys to select the Measure Sense function, and then press the "ENTER" key to confirm the selection. Press "Clear" key to escape the Measure Mode.

Display Mode:	V + I (Voltage + Current)	V + C (Voltage + "C" operand)
	V + P (Voltage + Power)	V + R (Voltage + Resistance)
	I + C (Current + "C" operand)	I + P (Current + Power)
	P + C (Power + "C" operand)	I + R (Current + Resistance)
	R + P (Resistance + Power)	R + C (Resistance + "C" operand)
	V + T (Voltage + Temperature)	I + T (Current + Temperature)
	R + T (Resistance + Temperature)	P + T (Power + Temperature)
	C + T ("C" operand + Temperature)	

The LCD display module of the LPL can be configured to the different measuring combinations.

Press the "Utility/Local" key. Use ◀ ▶ keys to select the Display, and then press the "ENTER" key and ◀ ▶ keys to select the desired function. Press the "ENTER" key to confirm the selection. Press "CLEAR" key to escape the Display Mode.

"C" Value: 0.0000A

The LPL provides the "C" operand. This is especially useful for battery testing applications that use "C" as the battery capacity unit. The user can avoid troublesome calculations by monitoring and testing the battery directly. After the user changes the display combination to V + C, all current values entered and/or measured will be in "C" automatically.

Press the "Utility/Local" key, select display mode then press ENTER. Use ◀ ▶ keys to select the "C" value. Then the "ENTER" key and the desired value and "ENTER" to confirm. Press "CLEAR" to exit the "C" operand mode.

GPIB FUNCTION

The LPL provides the GPIB/SCPI interface control capability. The following are user configurable GPIB commands:

PRIMARY ADDR: 0 → 31

Primary address for GPIB interface has a range from 0 to 31.

Press the "Utility/Local" key then use the ◀ ▶ keys to select the System function, and select GPIB Address then press the "ENTER" key. Use ◀ ▶ keys to select the PRIMARY ADDR function then use the ◀ ▶ keys to increase or decrease the GPIB address, then press the "ENTER" key to confirm the value. The number displayed with the "◀" annunciated behind it is the current selected value. Press the "CLEAR" to escape the Primary ADDR mode. LPL needs to be restart in order to synchronize the change.

EOS CODE: NULL only
CR only
LF only
CR + LF

In the GPIB communication, the users can define the different End of Interface (EOS) code for each end of the data or command.

Press the "Utility/Local" key then use the ◀ ▶ keys to select the System function then the "ENTER" key. Use ◀ ▶ keys to select the EOS function then use the ◀ ▶ keys to select the desired EOS code method and press "ENTER" key to confirm the selection. Press "CLEAR" key to escape the EOS CODE.

In the Transient mode, the LPL has 7 functions: continuous, toggle, pulse, step, step auto, step once and trigger. TRANS ON/OFF key can operate 7 types of functions depending on which mode is activated in the TRANSIENT MODE. If the TRANSIENT operation is activated, the TRANSIENT will be on after TRANS ON/OFF is activated. If any of the STEP modes is activated, then the corresponding STEP mode will operate after TRANS ON/OFF key is activated.

Press the "Utility/Local" key then use the ◀ ▶ keys to select the LOAD CONTROL function then the "ENTER" key. Use ◀ ▶ keys to select the TRANSIENT MODE function by pressing the "ENTER" key then use the ◀ ▶ keys to select the CONTINUOUS, TOGGLE, PULSE, STEP, STEP AUTO, STEP ONCE, or TRIGGER mode and press the "ENTER" key to confirm the selection. Press "CLEAR" key to clear the TRANSIENT MODE.

The LPL provides seven different trigger TRANSIENT modes for different applications and testing procedures

For continuous mode, the trigger source comes from TRIGIN. Each trigger will switch LPL once between main level and transient level based on the duty cycle and frequency.

For pulse mode operation when amplitude and duration is programmed via GPIB or RS-232 bus. The trigger source comes from GPIB or external TTL trigger.

For toggle mode operation, the LPL will toggle once between main level and transient level whenever it receives a trigger signal from GPIB or external TTL trigger.

For Step/Step Auto/Step Once operation, the LPL will switch to the new value setting based on the length and value of the programmed step.

TRIGGER OUT: TRANSIENT
 TRIGGER

TRIGGER OUT signal is for multiple loads or instrument application when user requires synchronizing of the input time, and trigger out signal to start another load or instrument.

TRANSIENT: Trigger out signal is in phase with transient signal generated from the LPL internal frequency generator.

RS-232 FUNCTION

The LPL provides an RS-232 interface for remote control. To save setup time for the RS-232 interface configuration, the LPL has default settings for parity check bit, data length, and stop bit.

Default settings:

Data Length: 8 bits	Parity Check bit: No Parity	Stop Bit: 1 bit
Handshake: Xon/Xoff	BAUD RATE: 2400/4800//9600/19200/38400/57600/115200	

The LPL only provide seven-baud rate settings for RS-232 communication. Press the "Utility/Local" key and use the ◀ ▶ keys to select the System function, then use the ◀ ▶ keys to select the RS-232 function then press the "ENTER" key twice to select BAUD RATE function. Use ◀ ▶ keys to select between 2400 and 115200 then press the "ENTER" key to confirm selection. Press "CLEAR" key to escape the BAUD RATE MODE.

ETHERNET FUNCTION

The LPL provides an Ethernet programming interface. All SCPI commands are also available through Ethernet interface. Obtaining Network Information to connect the LPL to the network, you only need a network cable with RJ-45 connector. No transceiver is necessary. However, you need to obtain the following information from the LPL and your network administrator:

1. LPL Ethernet MAC Address:

It's a twelve digits string that unequally identifies the LPL unit. It can be obtained from the control board.

2. Network information:

- 1) DHCP server enabled? Yes or no.
- 2) LPL IP address: ____ . ____ . ____ . ____
- 3) Gateway IP address: ____ . ____ . ____ . ____
- 4) Subnet mask: ____ . ____ . ____ . ____

Setting the LPL Ethernet Parameters

You need to set the LPL Ethernet IP address first. The LPL IP address uniquely identifies the load to other devices on the network, and is required for the LPL to communicate over the network.

1. Ethernet Network settings: DHCP supported. The purpose of a DHCP (Dynamic Host Configuration Protocol) server is to issue an IP address to a network device that requests an address.
2. The IP address enables the device to communicate with the network. This is similar to personal computer Plug & Play concept.

The following procedure presumes that your LPL has the Ethernet option and you have connected the LPL to your network.

If your network supports DHCP server, do the following:

- 1) Power on the LPL
- 2) Press the LOCAL key on the front panel, and press ◀ ▶ to scroll to the “SYSTEM” menu option.
- 3) Press ENTER to select.
- 4) Choose “ETHERNET” and Press ENTER to select option.
- 5) Select “ADDRESS” and press ENTER to select option.
- 6) Enter the IP address as “0.0.0.0” if it is not and press ENTER.
- 7) Choose “NETMASK” by pressing ◀ ▶ to scroll and press ENTER to select option.
- 8) Enter the value as “0.0.0.0” if it is not and press ENTER to set value.
- 9) Choose “GATEWAY” by pressing ◀ ▶ to scroll and press ENTER to select.
- 10) Enter the default gateway IP address as “0.0.0.0” if it is not and press ENTER to set desired address.

To Exit, press LOCAL to go back to the start-up screen

***Note:** Because the DHCP server assigns a dynamic IP address, the value of the LPL IP address maybe different each time you power on the LPL. However, if you intend to remotely control the LPL, a static IP address is more convenient, as the LPL IP address does not change, making it easier for remote devices to access the LPL*

If your network does not support DHCP server, you must enter the Ethernet settings manually which you obtained from your network administrator.

***Note:** The following procedure presumes that your LPL has the Ethernet option and you have connected the LPL to your network.*

If your network does not support DHCP server, do the following:

- 1) Power on the LPL
- 2) Press the LOCAL key on the front panel, and press ◀ ▶ to scroll to the “SYSTEM” menu option.
- 3) Press ENTER to select.
- 4) Choose “ETHERNET” and Press ENTER to select option.
- 5) Select “ADDRESS” and press ENTER to select option.
- 6) Enter the IP address obtained from your network administrator and press ENTER.
- 7) Choose “NETMASK” by pressing ◀ ▶ to scroll and press ENTER to select option.
- 8) Enter the value obtained from your network administrator and press ENTER.
- 9) Choose “GATEWAY” by pressing ◀ ▶ to scroll and press ENTER to select.
- 10) Enter the default gateway IP address obtained from your network administrator and press ENTER

To Exit, press LOCAL to go back to the start-up screen

USB FUNCTION

The LPL also provides a USB remote interface to connect to your computer. You need to install USB driver included in a CD-ROM shipped with your LPL .

After your USB driver is installed, the USB port is converted to a virtual COM port. Refer to the “Verify Installed USB Driver using Hyper Terminal (Windows XP/2000/98)” section for detailed procedures on how to verify the USB driver.

Windows XP USB Driver Installation Procedures

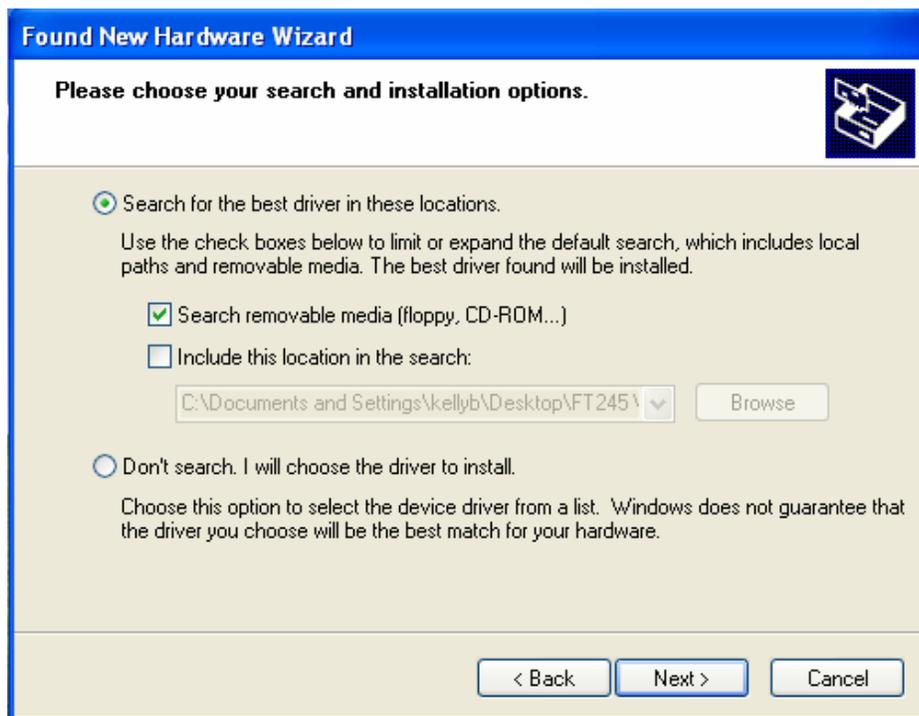
Note: You must have administrative privileges to install the USB driver

- 1) Connect LPL Unit using USB cable
- 2) Click on found new hardware bubble (bottom right hand corner of screen)
- 3) Found New Hardware Wizard installation window will pop up



4) Select the “install from a list or specific location [Advanced]” radio button and click next to continue

5) Select the “Search for the best driver in these locations.” Radio (default) and check only the “search removable media [floppy, CD-ROM...]” checkbox.



6) Click next

7) The Wizard will search for the needed drivers



8) After the driver has been found, the wizard will display the “completing the Found New Hardware Wizard” screen

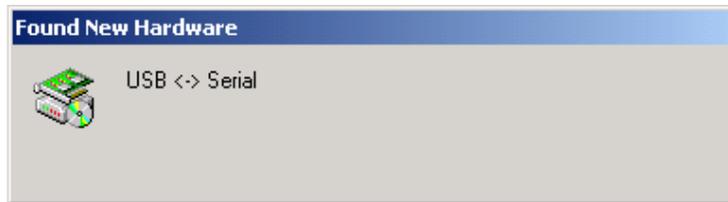


9) Click finish to complete USB driver installation

10) A pop-up balloon will notify you that the USB Serial Device is ready for use

Windows 2000 USB Driver Installation Procedures

1) Connect LPL-1 using USB cable



2) A new hardware will be detected



3) The "Found New Hardware Wizard" screen will appear

4) Click Next to continue



- 5) Select the “Search for suitable driver for my device (recommended)” to search for the appropriate driver
- 6) Click Next to continue



- 7) The driver files are located in the pre-packaged CD
- 8) Check the “Specify a location” check box and click Next to continue



9) Select the drive corresponding to your CD-ROM, and locate the folder name “FT245VCP driver 2104 XP certified”

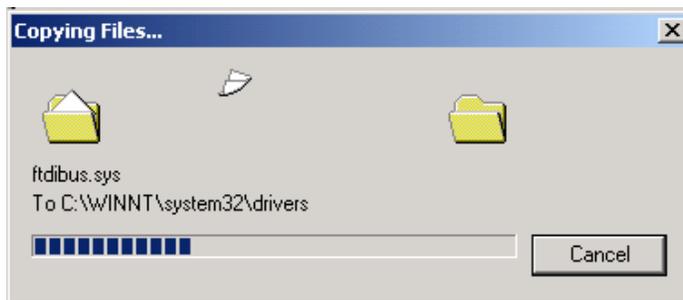
10) Click OK to continue



11) The correct driver has been located, click Next to continue installation



12) Windows will check for the validity of the device driver, click Yes to continue installation



13) Windows will copy the needed drivers to the PC

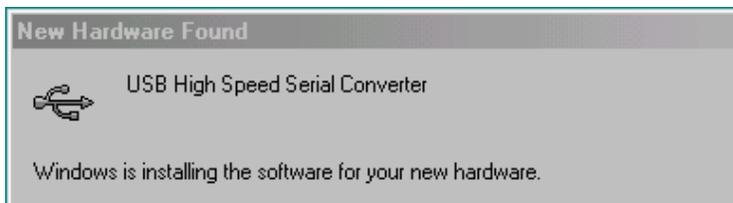


14) The above screen will appear to notify the end of the installation process and the USB Serial Port will now function properly.

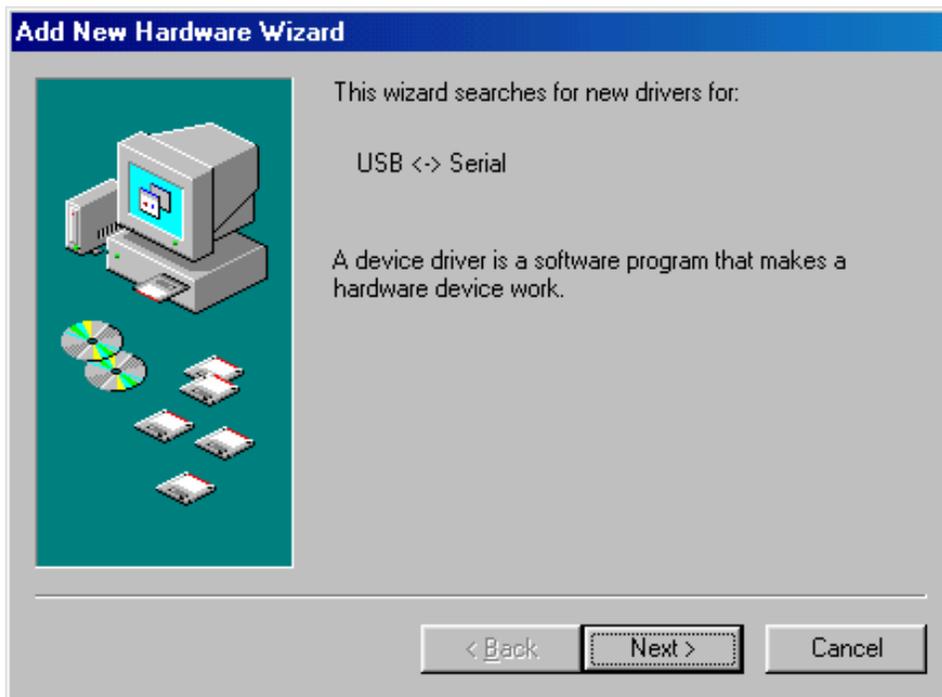
15) Click Finish to complete setup

Windows 98 USB Driver Installation Procedures

1) Connect LPL Unit using USB cable



2) A new hardware will be detected



- 2) The “Add New Hardware Wizard” window will appear
- 3) Click next to continue



- 4) Select the “Search for the best driver for your device.” radio button, and click Next to continue

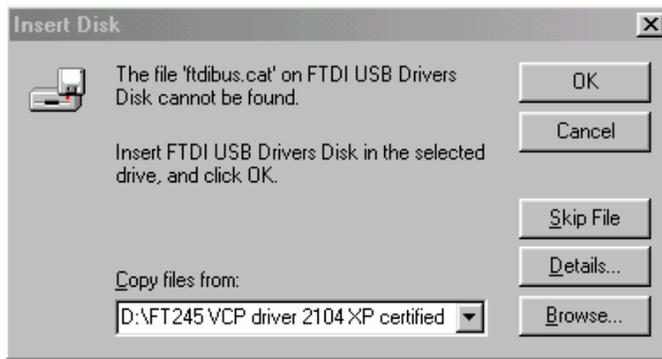


5) Check the “Specify a location” check box and browse to select the file “FT245 VCP driver 2104 XP certified” from your CD-ROM drive

6) Click Next to continue



7) Now the location of the driver has been set, and click next to install the driver



8) Click Cancel and the wizard will automatically locate the needed driver



9) The drivers have been installed successfully, and now the High Speed Serial Converter will work properly

10) Click Finish to complete the installation process

Verify Installed USB Driver using Hyper Terminal (Windows XP/2000/98)

- 1) Enter into Device Manager window
- 2) Locate and record the “USB Serial Port” COM Port number (under ports)
- 3) Enter into hyper terminal [Start → Accessories → Communications → Hyper Terminal]
- 4) Enter connection name, i.e. AMREL
- 5) Choose the corresponding “USB Serial Port” COM Port [To check, right click on My Computer → Properties → Hardware → Device Manager → Ports (note the COM port the High Speed Serial Port is connected to)]
- 6) Choose BPS according to the Baud Rate set on the LPL unit (the two baud rates have to be the same)
- 7) Click Okay to connect
- 8) Test any SCPI command as desired (i.e. *idn?, addr?..)

MAX/MIN SETTING FUNCTION

The following are special LPL MAX/MIN setting that protects the load from error data entry for specific settings or power sources that could cause damage to unit.

MAX VOLTAGE - Max V	MIN CURRENT - 0.0000 A	MAX POWER - Max W
MIN VOLTAGE - 0.000V	MAX RESISTANCE - Max OHM	MIN POWER - 0.00 W
MAX CURRENT - Max A	MIN RESISTANCE - 0.00 OHM	

To change the values, press the "Utility/Local" key press Enter, then use the ◀ ▶ keys to select the Max/Min Limit function then the "ENTER" key. Use ◀ ▶ keys to select the appropriate Min/Max setting by pressing the "ENTER" key. The LCD will display the current value, press the "ENTER" key to enter a new value and press the "ENTER" key to confirm entry. Press "CLEAR" key to escape the Max/Min Setting MODE.

STEPPING OPERATION SET-UP



WARNING

Every time the Stepping mode is enabled, it is critical that you re-enter or check for the correct number steps in the STEP NUMBER function under Utility/Stepping mode to avoid initiating erroneous step. If the value is set higher than expected the system may perform previous steps that may exceed the power rating for the application and may damage the LPL or power source.

All steps must be in the same constant mode (CV, CC, CR, and CP). Stepping error will occur if different modes are programmed.

STEP FUNCTION

The LPL provides 32 points for self-program stepping capability. Parameters are entered in the UTILITY configuration for the total number of steps to process and the number of loops that you want the steps repeat.

At the Meter Mode, press KEY(5). This will lead LPL to its step entry menu. User may press KEY(7) for time duration and KEY(9) for value of each step. Press KEY(8) to increment the step by 1, KEY(6) to increment by 10. Press KEY(2) to decrement the step by 1, KEY(4) to decrement by 10.

STEP: COUNT

COUNT is the number of loops the step program will be repeated. The stepping function provides loop control with COUNT, which instructs the LPL to repeat the stepping function, based on the COUNT. For instance, if the COUNT is set to 10 and the LPL will cycle the desired steps 10 times. If the COUNT is infinity, then LPL will cycle the stepping infinitely.

Press the "Utility/Local" key press ENTER, then use the ◀ ▶ keys to select the STEP PARAM. function then the "ENTER" key. Use ◀ ▶ keys to select the COUNT then press the "ENTER" key twice to enter the value or use the ◀ ▶ keys to increment or decrement the value. Press the "ENTER" key to confirm the selection. Press "CLEAR" key to escape the STEP:COUNT MODE.

The LPL provides 31 points for self-programming capability for which parameters can be programmed in the Utility function. This feature allows the users to create a mini program and automate the control of the LPL without the need of computer, GPIB, USB, ETHERNET or RS-232 communication interface. The user is able to set Programming Points, Loop Number, and Time Duration.

ENTERING STEPPING MODE VALUES

Example:

The test application requires (3) steps to be performed in the Step Mode with the following criteria. Step (1) in the CC mode with 5 amps for 800 mS, step (2) in the CC mode with 10 amps for 400 mS, and step (3) in the CC mode with 50 amps for 200 mS.

<NOTE>: CC Mode has 3 ranges. Therefore, if stepping values are in the high range, main level value must be set to high range.

1. Choose the STEP mode by toggling the Trans. Mode to Step/Step Auto/Step Once via the Utility → Load Control → Transient Mode. Once in the Transient Mode use the ◀ ▶ keys to select the STEP mode and press ENTER key to confirm.
2. Set the Loop Number – Scroll using the ◀ ▶ keys for the total number of times the steps will be processed via the Utility → Load Control → Step Param.
3. Set step value - press "5" key to enter step edit mode, press MODE key then "4" key to set CC mode then the ENTER key to confirm. Press the "9" key to edit the stored amps value. After you have entered the new amps value (5.0) press enter to confirm. Press "7" key to edit the stored time value. After you have entered the new time value (800) press enter to confirm.
4. Set step (2) values - Use the "▲" key to increment to the next step number and press enter to confirm. Press MODE key then "4" key to set CC mode then the ENTER key to confirm. Press the "4" key to edit the stored amps value. After you have entered the new amps value (10.0) press enter to confirm. Press "7" key to edit the stored time value. After you have entered the new time value (400) press enter to confirm.
5. Set step (3) values - Use the "▲" key to increment to the next step number and press enter to confirm. Press MODE key then "4" key to set CC mode then the ENTER key to confirm. Press the "9" key to edit the stored amps value. After you have entered the new amps value (50.0) press enter to confirm. Press "7" key to edit the stored time value. After you have entered the new time value (200) press enter to confirm. Press clear to return to Main operation mode.
6. To start the selected STEP mode presses the "0" key to turn the INPUT ON.
7. To enable the STEP mode press "1" key, and then STEP should be displayed.
8. The INPUT will be turned off automatically when the program completes the number of step and loops.

To edit any entry press the "5" key and use the "◀ ▶ ▲ ▼" to select the appropriate step number, then press ENTER to edit the step. Use the "▲ ▼" keys to increment or decrement the selected step by (1). Use the "◀ ▶" keys to increment or decrement the selected step by (10). To re-run the steps just press the "0".

PROTECTION FUNCTION

OV PROTECTION
OV DELAY
UV PROTECTION
UV DELAY
OC PROTECTION
OC DELAY

UC PROTECTION
UC DELAY
OP PROTECTION
OP DELAY
UP PROTECTION
UP DELAY

LPL provides programmable OVP/OCP/OPP and UVP/UCP/UPP over-limit and under-limit protection capabilities. The user can program all of the protection values and delay times. Protection will be activated when the protection mode has been tripped the LPL will interrupt the input power source. The delay time provides a programmed delay time to accommodate short duration surges without inadvertently tripping the unit off.

The delay time is 10mS minimum with resolution 10mS also. The protection can be disabled by setting the delay time to 0mS.

Press the "Utility/Local" key then use the ◀ ▶ keys to select the PROTECTION function then the "ENTER" key. Use ◀ ▶ keys to select the appropriate protection or delay function by pressing the "ENTER" key to display the current value. Press the "ENTER" key to edit or enter the new value then press the "ENTER" key to confirm entry. Press "CLEAR" key to escape the PROTECTION MODE.

FAULT signal becomes active TTL high, whenever any of the protections, above, are tripped. When this occurs, the appropriate bits in the status register are set and the fault signal is latched. The status bits will remain set until the electronic load is reset via the GPIB or RS232 (*RST command) or at the front panel (CLEAR key). Of course, the condition that caused the protection feature to trip must be corrected or the load will turn off again.

<NOTE>: Because the protection is done through software, the response time for the delay trip time must be set to at least 50mS for each protection feature. Otherwise the load may not reset correctly if the trip delay time is too short.

PROGRAMMING POINTS

There are 32 programmable points available from step 0 to step 31 for self-programming and can be user define as needed. During operation, the user can program each point from the front panel, GPIB, RS-232, USB, or Ethernet.

STEP PARAMETER

The STEP PARAM. menu option controls the number of times the STEP/STEP AUTO function will repeat itself. The user can enter from 1 up to 65535, or to loop indefinitely: infinity. While using STEP ONCE, only the first step setting will be activated.

ENTERING TRANSIENT MODE VALUES

Example:

The test application requires the main operation to be at 25 volts in a CV mode and a Transient test voltage of 50.0 volts, Frequency of 500Hz, Slew rate of 1.0 volt/ μ s, and a 50% Duty cycle.

1. Set the Transient enable mode by toggling the CONTINUOUS/TOGGLE/PULSE/STEP/STEP AUTO/STEP ONCE/TRIGGER mode to Continuous via the Utility -> Load Control-> Transient Mode. Once in the Transient Mode use the ◀ ▶ keys to select Transient and press ENTER key to confirm.
2. Set CV mode - press MODE key and the "7" key to set the main operation to CV mode.
3. Set main voltage level - press the MAIN key to enter main voltage edit mode and view stored voltage value. After you have entered the new voltage value (25.0) press ENTER to confirm.
4. Set Transient voltage value - press TRANS key to enter transient voltage edit mode and view stored voltage value. After you have entered the new voltage value (50.0) press ENTER to confirm.

5. Set transient Frequency - press the FUNCTION key and use the " ◀ ▶ " to select FREQUENCY and press enter key to edit or change stored value to 500 Hz then press ENTER to confirm.
6. Set transient Slew rate - press the FUNCTION key and use the " ◀ ▶ " to select SLEW and press enter key to edit or change stored value to 1.0 volt/μs then press ENTER to confirm.
7. Set transient Duty Cycle - press the FUNCTION key and use the " ◀ ▶ " to select DUTY and press the enter key to edit or change stored value to 50% then press ENTER to confirm.
8. To enable the Transient mode at start-up press "1" key, then the CONT should be displayed. You can also initiate a transient condition by pressing the "1" on or off any time by during normal operation.
9. To start the Transient mode at start-up initial input enable press the "0" key to turn the INPUT ON.

The Transient condition will terminate after the elapse slew rate has reached the transient setting level then return to main operating settings.

TRANSIENT FREQUENCY, SLEW RATE AND DUTY CYCLE PROGRAMMING

The transient frequency, slew rate and duty cycle can be programmed with the "FUNC" key via the keypad.

1. Press the "FUNC" key to access the transient frequency, slew rate and duty cycle editing mode and LCD module will display the last **FREQ**, **SLEW**, and **DUTY** in sequence by pressing " ◀ ▶ " to select desired function.
2. To change existing values to the appropriate parameter press the "ENTER" key to activate the edit entry mode.
3. For Frequency programming editing, the LCD module will display the following:

FREQ = 1000 Hz

4. Enter the following numerical keys "2", "0", "0", "." and "0" keys in sequence in order to change the Frequency to 200Hz.
5. Make sure that the entered number is correct and press "ENTER" key to complete the entry operation.
6. Press "CLEAR" key to return to the metering mode. By pressing the "Clear" with no entry will display AMREL Model number and software version.

TRANSIENT MODE

Amrel's Programmable Electronic Load can facilitate testing sources and load simulation through the use of its internal transient generator. This transient capability allows the user to determine operating specifications for instruments such as a power supply. This capability also allows for pulse-charging a battery and for simulating battery drain.

LOCAL TRANSIENT OPERATION

LCL Operation:

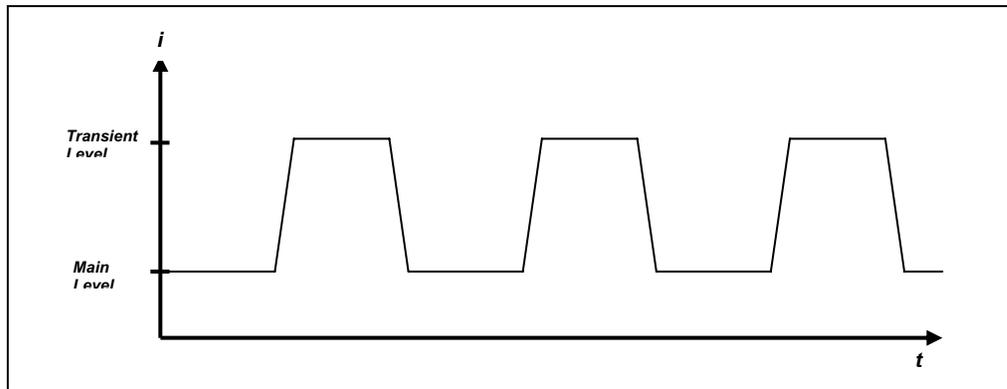
From keypad, press the "Utility/Local" key. Use ◀ ▶ and "Enter" keys to select the following submenus:

UTILITY/LOCAL→LOAD CONTROL→TRANS. MODE →CONTINUOUS
→TOGGLE

- PULSE
- STEP
- STEP AUTO
- STEP ONCE
- TRIGGER

CONTINUOUS MODE

In continuous mode, the LPL input switches between 2 user defined levels; main and transient. The duty cycle and frequency is user defined.



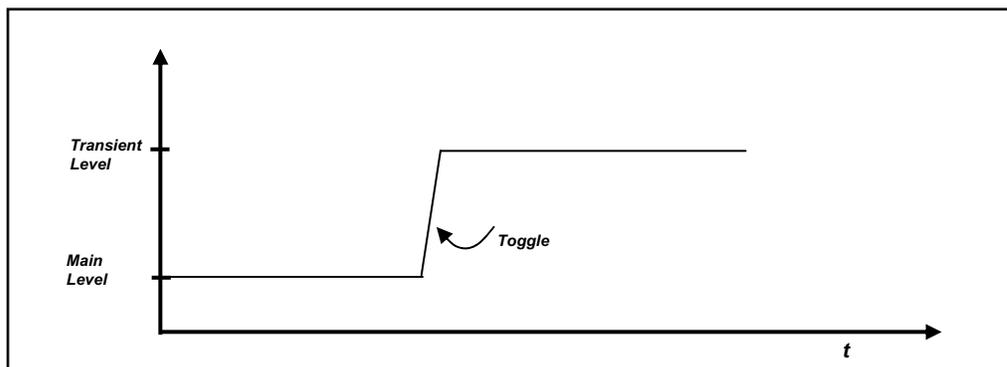
Typical application: Testing the Load Regulation (Effect) of a power Supply, defined as the voltage change in dc output due to a change in load current from minimal resistance (closed circuit) to maximum resistance (open circuit). The LPL Load can be programmed to switch between any two current levels.

LCL Operation:

- From keypad select operating mode (CC, CV, CR, CP)
- Select transient operation for continuous mode.
- Set MAIN and TRANSIENT levels by pressing the “MAIN” and “TRANS” keys.
- Set the duty cycle and frequency by pressing the “Function” key and selecting the DUTY and FREQUENCY submenus. The duty cycle can be set from 2% to 98% and the frequency from 0.1Hz to 20 KHz.
- To begin the transient operation, turn on the input and press the “TR ON/OFF. The LCD will display “ON TR”.

TOGGLE MODE:

In toggle mode, the LPL input alternates between two user-defined input levels. Unlike transient-continuous mode, the input only changes from one level to another, one transition at a time.



Typical Application: Testing the transient recovery time for a CV power supply. The recovery time for a power supply is defined as the time required for the supply to settle to a predefined settling band following a change in load current caused by an induced transient (pulse).

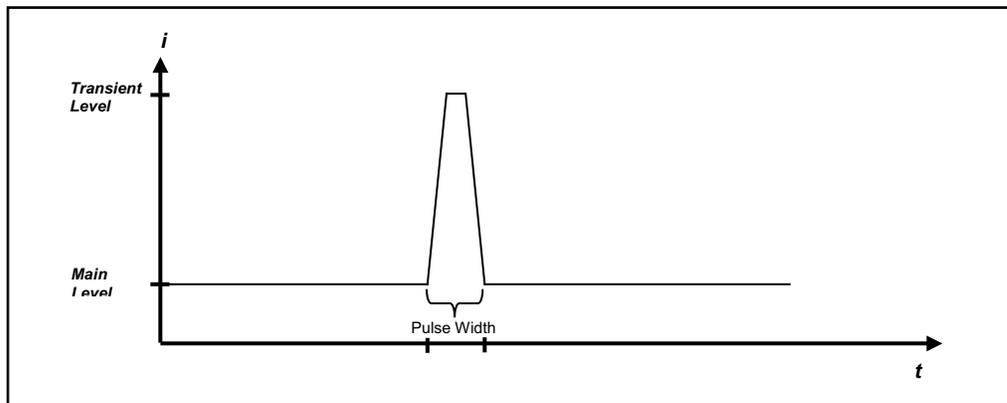
LCL Operation:

- From keypad select operating mode (CC, CV, CR, CP)
- Select transient operation for toggle mode.
- Set MAIN and TRANSIENT levels by pressing the “MAIN” and “TRANS” keys.

To begin the toggle operation, turn on the input and press the “TR ON/OFF. The LCD will display a flashing “TG” to indicate that the LPL is in toggle mode.

PULSE MODE:

In pulse mode, the LPL generates a pulse with a user-defined amplitude and width. The pulse width can be set from **0.5ms to 10seconds**.



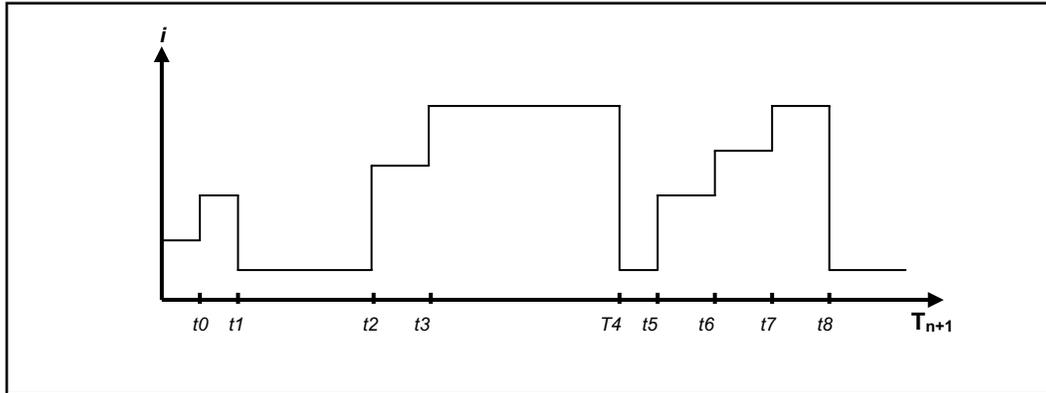
Typical Application: Testing the transient recovery time for a CV power supply. The recovery time for a power supply is defined as the time required for the supply to settle to a predefined settling band following a change in load current caused by an induced transient (pulse).

LCL Operation:

- From keypad select operating mode (CC, CV, CR, CP)
- Select transient operation for pulse mode.
- Set MAIN and TRANSIENT levels by pressing the “MAIN” and “TRANS” keys.
- Set the pulse width by pressing the “Function” key and selecting the PULSE submenu
- To begin the transient operation, turn on the input and press the “TR ON/OFF. The LCD will display a flashing “PS” to indicate that the power supply is in pulse mode.

STEP MODE

In stepping mode the LPL generates customized sequence of different input levels up to a maximum of 32 steps (points) for each mode, with dwell times from 1ms to 65535ms and rise/fall times of 1ms. The step sequence can be cycled for one up to 65535 count(s) or infinity for unlimited repeat. At the end of the step cycle count, turn transient level off and then on to restart the step cycle and count.



STEP: The Step mode will repeat the step cycle until the end of the dwell time without the need for a trigger signal. Once transient level is activated, the STEP mode will start as well.

STEP AUTO: The Step Auto mode will traverse through the user-defined step cycle until the end of the dwell time.

Note: When triggering the STEP AUTO function via the front panel, when the step is activated (it will show “AUTO”), the step cycle will repeat itself until the end of the Step Parameter setting. If the STEP AUTO function is triggered via PC, the step has to be triggered using a *TRG command after the transient level is turned on.

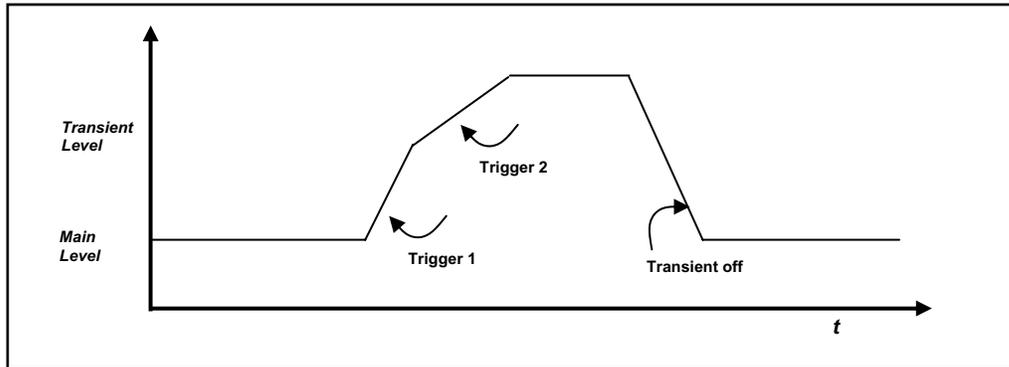
STEP ONCE: The STEP ONCE function will only activate the first step in the step cycle until the next trigger signal is received.

Note: For front panel operation, the STEP ONCE function will only activate the first step in the step cycle. For PC operation, by sending a *TRG command with transient on, the next step in the step cycle can be activated.

Typical Application: Simulating battery drain for testing portable, battery powered products. A cellular phone, for example, has complex battery discharge characteristics due to its different operating modes. A load profile can be created using the LPL load to simulate those characteristics.

TRIGGER MODE

In trigger mode, the PLA waits for a trigger signal from the selected trigger source (**HOLD (local)**, **BUS**, **EXTERNAL** and **ETHERNET**) to switch to the user set trigger level. The trigger level can be set to a value greater or less than the main value. After each trigger level is reached, another trigger level can be set and re-triggered to the new trigger level. The trigger signal can be sent via SCPI commands (GPIB, RS-232, Ethernet & USB) and external port (trig in port).



Typical Applications:

All the operating modes can be programmed via the front panel or by way of the GPIB/RS232/ETHERNET/USB Interface. In addition, each transient can be triggered through an external TTL compatible signal.

TRIGGER SOURCE

All the operating modes can be triggered via the front panel or by way of the GPIB/RS232/ETHERNET/USB Interface. In addition, each transient can be triggered through an external TTL compatible signal.

TRIGGER SOURCE	TRIGGER INPUT				
	EXT_TRG_IN	*TRG Command	Ethernet	TRIG:IMM Command	Front Panel
EXTERNAL	O	X	X	O	O
BUS	X	O	X	O	O
ETHERNET	X	X	O	O	O
HOLD	X	X	X	O	O

<Note>: X = Non-functional & O = Functional

<Note 1>: EXT_TRG_IN & ETHERNET triggers input through the respective interface connections

<Note 2>: *TRG and TRIG:IMM are SCPI commands

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FOUR: REMOTE PROGRAMMING

INTRODUCTION

The Programming Electronic Load is provided with GPIB and RS-232 Standard Commands for Programmable Instruments (SCPI) interface for automated testing applications. The purpose of this section is to introduce the user to SCPI commands used to control the LPL via remote communication.

INTRODUCTION TO GPIB & RS-232 (SCPI) COMMANDS

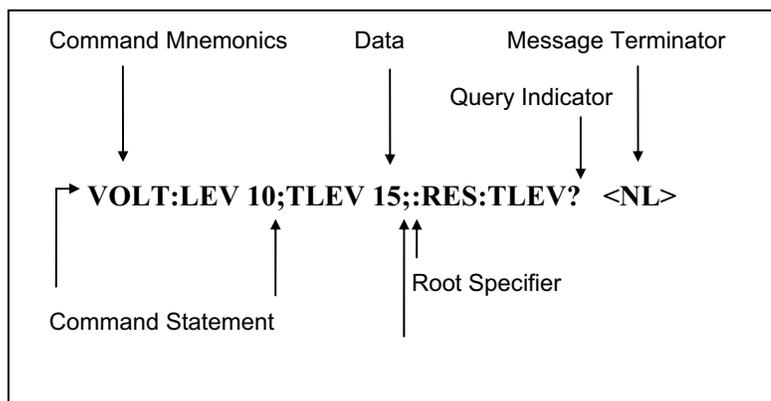
The General Purpose Interface bus is synonymous with HP-IB standard bus used for controlling electronic instruments with a computer. Also called IEEE 488 bus because ANSI/IEEE Standards 488-1978 defines it, 488.1-1987, and 488.2-1987.

Standard Commands for Programmable Instruments (SCPI) is a programming language developed to remotely control different test and measurement instruments over GPIB (IEEE 488) bus. SCPI functions with GPIB hardware conform to the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation. It is a device independent command set and is layered on top of the hardware portion of IEEE 488.2. SCPI simplifies the programming task by defining a single comprehensive command set of programmable instrumentation, regardless of type or manufacturer. The same SCPI command can be applied to different classes of instruments. SCPI systems are much easier to program and maintain. In many cases, you can interchange or upgrade instruments without having to change the test program. SCPI also applies to RS-232 programming.

The electronic load's GPIB address cannot be set via GPIB bus communication or program. The address needs to be set from the front panel keypad in the UTILITY function.

OVER VIEW SCPI LANGUAGE

The SCPI language uses a hierarchical structure in its programming syntax similar to an inverted tree. The command is organized with root level commands positioned at the top, with multiple sub commands below each root-level command. For example, VOLTage, which is a branch of SOURce, is a command mnemonic and it forms a subtree of its own. VOLTage has three sub-level commands: LEVel, SLEW, TLEVel. At the end of a sub-level command, you can attach a parameter, a question mark (for query), a colon (command mnemonics separator), a semicolon (for multiple commands in a message) or an end of line terminator. To execute a sub-level command, you must specify the complete path from root-level. Each command statement is simply I/O ASCII data strings incorporated within high-level programming language (GW-BASIC, HP BASIC, Quick Basic, Pascal, etc.).



Command Message

Syntax Overview

Use of the Colon (:)

A colon is used to separate command mnemonics. It indicates a move down in branch level of the command tree. The command follows a colon is a sub command of the command immediate before the colon. When colon precedes the first command mnemonic of a message unit, it becomes root specifier. Its action places the parser (decoder) at the root of the command tree. Parser can only travel downward the command tree. If another command at different branch needs to be executed, a root specifier (colon) is required to place parser at origin and a complete path from root level should also be defined.

Use of the Semicolon (;)

A semicolon is used to separate two command statements with the same command message string. The semicolon does not change location of the parser in the command tree. Only command statements that are in the current path of the first command statement can be combined to form a command message.

Use of the Space ()

A white space is used to separate a parameter (data) from a command mnemonic. When a command statement includes parameter, data always follows the last keyword of a command.

Use of the Comma (,)

A comma is used to separate adjacent parameters if a command requires more than one parameter.

Use of the Query (?)

A query command is used to instruct the instrument to send a response message. Queries return either measured values or internal instrument setting. When a keyword is followed by a question mark, it becomes a query. The ? follows the last keyword of a command statement. You should read back the result of first query before you send out another query or command. Otherwise, returned data will be lost.

Common Commands:

Commands starting with a * and three-letter mnemonic are called common commands. They are generally not related to specific device operation but to perform the identical function for all instruments that are compliant with the IEEE-488.2 interface standard. Common commands can be mixed in with regular Electronic Load commands. The common command will be executed without affecting the position of the parser.

Root-Level Commands:

The root-level commands are those commands specific to the Electronic Load. They are device specific and can be mixed with common commands.

LANGUAGE DICTIONARY

The syntax and parameters for the IEEE 488.2 common commands and SCPI commands used by the Electronic Load is presented in this section. The section starts with description for common commands and then follows by SCPI commands specific to the electronic load.

COMMANDS STRUCTURE

The electronic load has two command types for GPIB and RS-232 interface.

Programming commands

Query commands

System commands

Programming commands send programming instructions or values to the electronic load to control the CV/CC/CR/CP functions. There are two types of commands, the SCPI command and instruction commands that co-exist in the program. SCPI commands should adhere to their syntax and format structure (command line) in order to be properly process by the electronic load.

Query commands request measured values, status, or programmed settings from the electronic load.

System commands belong to the GPIB bus system commands list to controls GPIB bus condition and electronic load interface system. Some commands are not compatible with RS-232 interface.

SCPI (GPIB & RS-232) COMMAND SET

The following describes the GPIB (IEEE488.2) command set for the Programmable Electronic Load Series. All the electronic load commands follow SCPI format and are RS232 compliant. The **commands in brackets are implicit** and don't have to be written out. The letters in bold is the short form syntax of the command mnemonic. For example, the command **CURRENT[:LEVel][:IMMEDIATE]** has the following equivalent forms:

```
CURRENT:LEVel:IMMEDIATE 5
CURRENT:IMMEDIATE 5
CURR:IMM 5
CURR 5
```

All of the above commands will set the Current value to 5Amps.

***NOTE:** The parameters **MIN** and **MAX** designate minimum and maximum programmable value of the range.

Queries for each of the following commands can be obtained by placing a question mark after the command syntax.

Example: CURR?

CURRENT ⇒Current Programming Functions

This subsystem programs the constant current mode functions of the Electronic Load. The IEEE 488.1 command, "ISET" and "SET" (if current active mode is CC mode), can also be used.

CURR

This command sets the input current level that is to be applied immediately in the constant current mode. If the Electronic Load is not in the CC mode when the command is sent, the programmed level is saved and is applied when the Load changes to CC mode. The rate of input change is in accord with the slew rate in effect.

Parameter: 0 to maximum value; MIN; MAX Units: Amp.
Example: "CURR 50" – sets current input level to 50Amps

CURR:PROT:OVER

This command sets a protection limit to the input current that the Electronic Load will sink. When the input current reaches the programmed current limit for the programmed delay period, the Electronic Load input is off and draws no current.

Parameter: 0 to maximum value; MIN; MAX Units: Amp.
Example: "CURR:PROT:OVER 12"- sets the over-current protection to 12 Amps.

CURR:PROT:OVER:DEL

This command sets the delay time in millisecond for current protection. When the input current reaches the programmed current limit for the programmed delay period, the Electronic Load input is off and draws no current.

Parameter: 0 to maximum value; Units: ms.
Example: "CURR:PROT:OVER:DEL 200"- sets the over-current protection delay time to 200 ms.

CURR:PROT:UND

This command sets an undercurrent protection limit to the input current that the Electronic Load will sink. When the input currents falls below the undercurrent protection limit for the programmed delay period, the load input is off and draws no current.

Parameter: 0 to maximum value; MIN; MAX Units: Amp.
Example: "CURR:PROT:UND 1.5"- sets the undercurrent protection to 1.5 Amps.

CURR:PROT:UND:DEL

This command sets the delay time for under-current protection. When the input currents falls below the undercurrent protection limit for the programmed delay period, the load input is off and draws no current.

Parameter: 0 to maximum value Units: ms
Example: "CURR:PROT:UND:DEL 500"- sets the undercurrent protection delay to 500 ms.

CURR:TRIG

This command sets the input current level that is to be applied on occurrence of a trigger in the constant current mode. If the Electronic Load is not in the CC mode when the command is sent, the programmed TRIG level becomes a stored level that takes effect when the Load changes to CC mode. The rate of input change is in accord with the slew rate in effect.

Parameter: 0 to maximum value; MIN; MAX Units: Amp.
Example: "CURR:TRIG 10" – sets the current trigger level to 10Amps.

CURR:TLEV

This command sets the transient current level in CC mode. When the transient subsystem is on, the Electronic Load will switch between the main level and transient level at a rate determined by the slew rate in effect. If the programmed transient current level is below the main current level, the switching will not occur until the main level is below the value of CURR:TLEV. The IEEE 488.1 command, "ITR" can also be used.

Parameter: Low Range: 0 to maximum value; MIN; MAX Units: Amp.
High Range: 0 to maximum value; MIN; MAX
Example: "CURR:TLEV 30"- sets the current transient level to 30A.

CURR:DUTY

This command sets pulse duty cycle, as a percentage of the total cycle, of continuous transient mode in CC mode. If the Electronic Load is operating in another mode, the duty cycle is stored until the Load changes to continuous mode.

Parameter: 2 to 98; MIN; MAX Unit: %
Example: "CURR:DUTY 50" – sets a 50% duty cycle for transient current mode.

CURR:FREQ

This command sets pulse frequency of continuous transient mode in Hz. If the Electronic Load is operating in another mode, the pulse frequency is stored until the Load changes to continuous mode.

Parameter: 0.25 to 20000; MIN; MAX Unit: Hz
Example: "CURR:FREQ 1000" – sets a 1000Hz frequency for transient current mode.

CURR:SLEW

This command sets the current slew rate for both ranges in CC mode. The programmed slew rate is in effect for all current changes except INP:ON or OFF. The hardware implementation selects a slew rate that is closet to the CURR:SLEW value. To determine the actual value, use the query CURR:SLEW?.

Parameter: Low Range: minimum to maximum value; MIN; MAX Units: Amp/ μ s.
High Range: minimum to maximum value; MIN; MAX
Example: "CURR:SLEW 0.1" - sets the current slew rate to 0.1A/ μ s.

CURR:LIM:MAX

This command sets and queries the maximum input current level that is to be applied immediately in the constant current mode.

Parameter: 0 to maximum value; MIN; MAX Units: Amp.
Example: "CURR:LIM:MAX 50" – sets maximum current input level to 50Amps

CURR:LIM:MIN

This command sets and queries the minimum input current level that is to be applied immediately in the constant current mode.

Parameter: 0 to maximum value; MIN; MAX Units: Amp.
 Example: "CURR:LIM:MIN 50" – sets minimum current input level to 50Amps

RESistance ⇒Resistance Programming Functions

This subsystem programs the constant resistance mode functions of the Electronic Load. The IEEE488.1 command, "RSET" and "SET" (if current active mode is CR mode), can also be used.

RES

This command sets the input resistance level that is to be applied immediately in the constant resistance mode. If the Electronic Load is not in the CR mode when the command is sent, the programmed level is saved and is applied when the Load changes to CR mode. The rate of input change is in accord with the slew rate in effect.

Parameter: Low Range: minimum to maximum value ; MIN; MAX Units: Ω
 Middle Range: minimum to maximum value; MIN: MAX
 High Range: minimum to maximum value; MIN; MAX
 Example: "RES 5" – sets the resistance level to 5ohms.

RES:TRIG

This command sets the input resistance level that is to be applied on occurrence of a trigger in the constant resistance mode. If the Electronic Load is not in the CR mode when the command is sent, the programmed TRIG level becomes a stored IMM level that takes effect when the Load changes to CR mode. The rate of input change is in accord with the slew rate in effect.

Parameter: minimum to maximum value; MIN; MAX Units: Ω

RES:TLEV

This command sets the transient resistance level in the CR mode. When the transient subsystem is on, the Electronic Load will switch between the main level and transient level at a rate determined by the slew rate in effect. The IEEE 488.1 command, "RTR" can also be used. The input resistance transient switching will occur only when RES:TLEV is programmed as following:

Low Range TLEV>LEV
 Middle and high range TLEV<LEV
 Parameter: minimum to maximum value; MIN; MAX Units: Ω
 Example: "RES:TLEV 15" – sets the resistance transient level to 15ohms.

RES:DUTY

This command sets pulse duty cycle, as a percentage of the total cycle, of continuous transient mode in CR mode. If the Electronic Load is operating in another mode, the duty cycle is stored until the Load changes to continuous mode.

Parameter: 2 to 98; MIN; MAX Unit: %
 Example: "RES:DUTY 50" – sets a 50% duty cycle for transient current mode.

RES:FREQ

This command sets pulse frequency of continuous transient mode in Hz. If the Electronic Load is operating in another mode, the pulse frequency is stored until the Load changes to continuous mode.

Parameter: 0.25 to 20000; MIN; MAX Unit: Hz
 Example: "RES:FREQ 1000" – sets a 1000Hz frequency for transient current mode.

RES:SLEW

This command sets the current slew rate for both ranges in CR mode. The programmed slew rate is in effect for all current changes except INP:ON or OFF. The hardware implementation selects a slew rate that is closest to the RES:SLEW value. To determine the actual value, use the query RES:SLEW?.

Parameter: Low Range: minimum to maximum value; MIN; MAX Units: Ohm/μs.

High Range: minimum to maximum value; MIN; MAX
Example: "RES:SLEW 0.1" - sets the resistance slew rate to 0.1A/μs.

RES:LIM:MAX

This command sets and queries the maximum input resistance level that is to be applied immediately in the CR mode.

Parameter: 0 to maximum value; MIN; MAX Units: Ohm.
Example: "RES:LIM:MAX 50" – sets maximum resistance input level to 50 Ohms.

RES:LIM:MIN

This command sets and queries the minimum input resistance level that is to be applied immediately in the CR mode.

Parameter: 0 to maximum value; MIN; MAX Units: Ohm.
Example: "RES:LIM:MIN 50" – sets minimum resistance input level to 50 Ohms.

VOLTage ⇒Voltage Programming Functions

This subsystem programs the constant voltage mode functions of the Electronic Load. The IEEE488.1 command, "VSET" and "SET" (if current active mode is CV mode), can also be used.

VOLT

This command sets the input voltage level that is to be applied immediately in the constant voltage mode. If the Electronic Load is not in the CV mode when the command is sent, the programmed level is saved to be applied when the Load changes to CV mode. The rate of input change is in accord with the slew rate in effect.

Parameter: 0 to maximum value; MIN; MAX Unit: Volt
Example: "VOLT 120" – sets the voltage level to 120V.

VOLT:PROT:OVER

This command sets a protection limit to the input voltage that the Electronic Load will shunt. When the input current reaches the programmed voltage limit for the programmed delay period, the Electronic Load input is off and shunts no voltage.

Parameter: 0 to maximum value; MIN; MAX Units: Volt.
Example: "VOLT:PROT:OVER 12"- sets the over voltage protection to 12 Volts.

VOLT:PROT:OVER:DEL

This command sets the delay times in millisecond for over-voltage protection. When the input voltage reaches the programmed voltage limit for the programmed delay period, the Electronic Load input is off and shunts no voltage.

Parameter: 0 to maximum value; MIN; MAX Units: ms
Example: "VOLT:PROT:OVER:DEL 1000"- sets the over voltage protection delay to 1000 ms.

VOLT:PROT:UND

This command sets an under voltage protection limit to the input voltage that the Electronic Load will shunt. When the input voltage falls below the under voltage protection limit for the programmed delay period, the load input is off and shunts no voltage.

Parameter: 0 to maximum value; MIN; MAX Units: Volt.
Example: "VOLT:PROT:UND 1.5"- sets the under voltage protection to 1.5Volts.

VOLT:PROT:UNDER:DEL

This command sets the delay times in millisecond for under-voltage protection. When the input voltage falls below the programmed the under voltage protection limit for the programmed delay period, the Electronic Load input is off and shunts no voltage.

Parameter: 0 to maximum value; Units: ms
Example: "VOLT:PROT:UNDER:DEL 1000"- sets the under voltage protection delay to 1000 ms.

VOLT:TRIG

This command sets the input voltage level that is to be applied on occurrence of a trigger in the constant voltage mode. If the Electronic Load is not in the CV mode when the command is sent, the programmed TRIG level becomes a stored IMM level that takes effect when the Load changes to CV mode. The rate of input change is in accord with the slew rate in effect.

Parameter: 0 to maximum value; MIN; MAX Unit: Volt
Example: "VOLT:TRIG 100" – sets the voltage trigger value to 100V.

VOLT:TLEV

This command sets the transient voltage level in CV mode. When the transient subsystem is on, the Electronic Load will switch between the main level and transient level at a rate determined by the slew rate in effect. If the programmed transient voltage level is below the main voltage level, the switching will not occur until the main level is below the value of VOLT:TLEV. The IEEE488.1 command, "VTR" can also be used.

Parameter: 0 to maximum value; MIN; MAX Unit: Volt
Example: "VOLT: TLEV 50" – sets the voltage trigger level to 50V

VOLT:SLEW

This command sets the voltage slew rate in CV mode. The programmed slew rate is in effect for all voltage changes except INP:ON or OFF. The hardware implementation selects a slew rate that is closest to the VOLT:SLEW value. To determine the actual value, use the query VOLT:SLEW?.

Parameter: 0 to maximum value; MIN; MAX Unit: V/ μ s
Example: "VOLT:SLEW 6"- sets the voltage slew rate to 6V/ μ s

VOLT:DUTY

This command sets pulse duty cycle, as a percentage of the total cycle, of continuous transient mode in CV mode. If the Electronic Load is operating in another mode, the duty cycle is stored until the Load changes to continuous mode.

Parameter: 2 to 98; MIN; MAX Unit: %
Example: "VOLT:DUTY 50" – sets a 50% duty cycle for transient voltage mode.

VOLT:FREQ

This command sets pulse frequency of continuous transient mode in Hz. If the Electronic Load is operating in another mode, the pulse frequency is stored until the Load changes to continuous mode.

Parameter: 0.25 to 20000; MIN; MAX Unit: Hz
Example: "VOLT:FREQ 1000" – sets a 1000Hz frequency for transient voltage mode.

VOLT:LIM:MAX

This command sets and queries the maximum input voltage level that is to be applied immediately in the constant voltage mode.

Parameter: 0 to maximum value; MIN; MAX Units: Volt.
Example: "VOLT:LIM:MAX 50" – sets maximum voltage input level to 50 Volts

VOLT:LIM:MIN

This command sets and queries the minimum input voltage level that is to be applied immediately in the constant voltage mode.

Parameter: 0 to maximum value; MIN; MAX Units: Volt.
Example: "VOLT:LIM:MIN 50" – sets minimum voltage input level to 50 Volts.

POWER ⇒Power Programming Functions

This subsystem programs the constant power mode functions of the Electronic Load. The IEEE 488.1 command, "PSET" and "SET" (if current active mode is CP mode), can also be used.

POW

This command sets the input power level that is to be applied immediately in the constant power mode. If the Electronic Load is not in the CP mode when the command is sent, the programmed level is saved and is applied when the Load changes to CP mode. The rate of input change is in accord with the slew rate in effect.

Parameter: 0 to maximum value; MIN; MAX Units: Watt.
Example: "POW 50" – sets current input level to 50Watts.

POW:PROT:OVER

This command sets a protection limit to the input power that the Electronic Load will accept. When the input power reaches the programmed power limit for the programmed delay period, the Electronic Load input is off.

Parameter: 0 to maximum value; MIN; MAX Units: Watt.
Example: "POW:PROT:OVER 12"- sets the overpower protection to 120 Watts.

POW:PROT:OVER:DEL

This command sets the delay time for over-power protection. When the input power reaches the programmed power limit for the programmed delay period, the Electronic Load input is off.

Parameter: 0 to maximum value Units: ms.
Example: "POW:PROT:OVER:DEL 1200"- sets the overpower protection delay time to 1200 ms.

POW:PROT:UND

This command sets an under power protection limit to the input power that the Electronic Load accepts. When the input power falls below the under power protection limit for the programmed delay period, the load input is off.

Parameter: 0 to maximum value; MIN; MAX Units: Watt.
Example: "POW:PROT:UND 1.5"- sets the under power protection to 1.5 Watts.

POW:PROT:UNDER:DEL

This command sets the delay time for under-power protection. When the input power falls below the programmed power limit for the programmed delay period, the Electronic Load input is off.

Parameter: 0 to maximum value Units: ms.
Example: "POW:PROT:UNDER:DEL 1200"- sets the under-power protection delay time to 1200 ms.

POW:TRIG

This command sets the input voltage level that is to be applied on occurrence of a trigger in the constant power mode. If the Electronic Load is not in the CP mode when the command is sent, the programmed TRIG level becomes a stored IMM level that takes effect when the Load changes to CP mode. The rate of input change is in accord with the slew rate in effect.

Parameter: 0 to maximum value; MIN; MAX Unit: Watt.
Example: "POW:TRIG 100" – sets the power trigger value to 100 W.

POW:TLEV

This command sets the transient voltage level in CP mode. When the transient subsystem is on, the Electronic Load will switch between the main level and transient level at a rate determined by the slew rate in effect. If the programmed transient power level is below the main voltage level, the switching will not occur until the main level is below the value of POW:TLEV. The IEEE488.1 command, "PTR" can also be used.

Parameter: 0 to maximum value; MIN; MAX Unit: Watt
Example: "POW: TLEV 50" – sets the power trigger level to 50 W

POW:SLEW

This command sets the power slew rate in CP mode. The programmed slew rate is in effect for all voltage changes except INP:ON or OFF. The hardware implementation selects a slew rate that is closest to the POW:SLEW value. To determine the actual value, use the query POW:SLEW?.

Parameter: 0 to maximum value; MIN; MAX Unit: Watt/ μ s
Example: "POW:SLEW 6"- sets the power slew rate to 6W/ μ s

POW:DUTY

This command sets pulse duty cycle, as a percentage of the total cycle, of continuous transient mode in CP mode. If the Electronic Load is operating in another mode, the duty cycle is stored until the Load changes to continuous mode.

Parameter: 2 to 98; MIN; MAX Unit: %
Example: "POW:DUTY 50" – sets a 50% duty cycle for transient power mode.

POW:FREQ

This command sets pulse frequency of continuous transient mode in Hz. If the Electronic Load is operating in another mode, the pulse frequency is stored until the Load changes to continuous mode.

Parameter: 0.25 to 20000; MIN; MAX Unit: Hz
Example: "POW:FREQ 1000" – sets a 1000Hz frequency for transient power mode.

POW:LIM:MAX

This command sets and queries the maximum input power level that is to be applied immediately in the constant power mode.

Parameter: 0 to maximum value; MIN; MAX Units: Watt.
Example: "POW:LIM:MAX 50" – sets maximum power input level to 50 Watts.

POW:LIM:MIN

This command sets and queries the minimum input power level that is to be applied immediately in the constant power mode.

Parameter: 0 to maximum value; MIN; MAX Units: Watt.
Example: "POW:LIM:MIN 50" – sets minimum power input level to 50 Watts.

INPut/OUTPut ⇒Input Programming Functions

This subsystem controls the Electronic Load input.

INP[:STATe]

This command turns the Electronic Load input ON and OFF. When the input is off, the Electronic Load draws minimal current at its input. The input turns on or off at the maximum rate, not in accord with the presently programmed slew rate.

Parameter: OFF or 0; ON or 1
Example: "INP 1"- enables the input to the load.

INP:SHOR[:STATe] or SHOR

This command enables/disables electronic short across the Electronic Load input. The actual short condition depends on the active mode and its active operating range. If a mode or range is changed, the short will be reapplied to the new mode or range.

Parameter: OFF or 0; ON or 1
Example: "INP:SHOR 0" – disables the short across the input.

INP:REL

Programming OFF closes the relay contacts; programming ON opens them.

Syntax INPut:RELAy [STATe]
Parameters 0 | 1; CLOSE | OPEN; OFF | ON

MEASure ⇒Measurement Query

This subsystem queries and returns the current, voltage, and power at the input of the Electronic Load.

MEAS:CURR[:DC]?

Returns the Electronic Load input current value to the buffer.

MEAS:VOLT[:DC]?

Returns the Electronic Load input voltage value to the buffer.

MEAS:DEL

This command is to sets or queries the delay time to obtain read back value for "MEAS:VOLT?" and "MEAS:CURR?" queries.

Parameter: 0 to 100,000 Units: ms.
Example: "MEAS:DEL 600" – sets the delay time to 600 ms.

MODE / MODE? ⇒ Mode Selection Command/Query

This subsystem selects and queries the operating mode of the Electronic Load

MODE CC or MODE:CURR

This command sets Electronic Load to constant current mode.

MODE CR or MODE:RES

This command sets Electronic Load to constant resistance mode.

MODE CV or MODE:VOLT

This command sets Electronic Load to constant voltage mode.

MODE CP or MODE:POW

This command sets Electronic Load to constant power mode.

MODE:RANGe

This command sets the range after the mode is set.

Parameters: 0 – 3

- i. low range
- ii. middle range
- iii. high range
- iv. ultra range

Example: “MODE:RES” – sets the Electronic Load in CR mode;
“MODE:RANG 2” – sets the Electronic Load in high range;
“MODE:RANG? CR” – queries the range for CR mode.

TRANSient ⇒ Transient Programming Function

This subsystem programs the transient functions of three transient modes: **CONTinuous**, **PULSe**, **TOGGle**. The input levels (**TLEVel**) and slew rate (**SLEW**) are programmed from the current, resistance, power and voltage subsystems.

TRAN[:STATe]

This command enables or disables the transient or stepping function. The parameter ON | 1 enables the function and OFF | 0 disables it.

Parameter: ON | 1, OFF | 0

Example: “TRAN ON” – enables the transient function

DUTY

This command sets pulse duty cycle, as a percentage of the total cycle, of continuous transient mode. If the Electronic Load is operating in another mode, the duty cycle is stored until the Load changes to continuous mode.

Parameter: 2 to 98; MIN; MAX Unit: %

Example: “CURR:DUTY 50” – sets a 50% duty cycle for transient current mode.

FREQ

This command sets pulse frequency of continuous transient mode in Hz. If the Electronic Load is operating in another mode, the pulse frequency is stored until the Load changes to continuous mode.

Parameter: 0.25 to 20000; MIN; MAX Unit: Hz

Example: “CURR:FREQ 1000” – sets a 1000Hz frequency for transient current mode.

SLEW

This command sets the power slew rate for the active mode. The programmed slew rate is in effect for all changes except INP:ON or OFF. The hardware implementation selects a slew rate that is closest to the SLEW value. To determine the actual value, use the query SLEW?.

Parameter: 0 to maximum value; MIN; MAX Unit: Depending on mode

Example: “SLEW 6”- sets the slew rate to 6.

TRAN:TWID

This command sets pulse width of pulse transient mode in millisecond. If the Electronic Load is operating in another mode, the pulse width is stored until the Load is powered cycle.

Parameter:	0.05 to 10000	Unit: ms
Example:	“TRAN:TWID 800” – sets the pulse width to 800 ms.	
Query syntax:	“TRAN:TWID?”	
Returned parameter:	Pulse width value in second.	

STEP ⇒ Step Programming Functions

This subsystem programs the stepping functions for stepping mode. The number of loops, step values, and dwell times are programmed for a specified operating mode.

UTIL:STEP:LOOP

This command sets the number of loops the stepping operation will repeat.

Parameter:	0 to 99
Example:	“UTIL:STEP:LOOP 10” - sets the number of loops to 10.

If Parameter is set to 0, the loops will repeat indefinitely.

UTIL:STEP:COUNT

This command sets the number of steps activated

Parameter:	1 to 99
Example:	UTIL:STEP:COUNT 5” – sets the number of steps to 5.

STEP:MODE <STEP COUNT> <MODE>

This command sets the step number for a specified operating mode.

Parameter for Step count:	0 to 99
Parameter for Mode:	0 (CV); 1 (CC); 2 (CR); 3 (CP)
Example:	“STEP:MODE 0 1” – sets to step 0 (first step) in the Constant Current (CC) mode

Note: All steps must be set to same mode and same range.

STEP:VALue <STEP COUNT> <VALUE>

This command sets the step value for a specified step.

Parameter for Step count:	0 to 99
Parameter for Value:	0 to maximum value of operating mode range
Example:	“STEP:VAL 0 5” – sets step 0 to 5Amps(CC Mode)

STEP:TIME <STEP COUNT> <TIME>

This command sets the step (dwell) time for a specified step.

Parameter for Step count:	0 to 99
Parameter for Time:	10ms to 600,000ms(10min)
Example:	“STEP:TIME 0 1000” – sets time to 1000ms for step 0 (first step)

UTILITY ⇒ Utility Functions

This subsystem sets or queries utility configurations.

UTIL:MEAS:SENSE

This command sets or queries the measurement sense (Local / Remote).

Parameter:	0 1 (0 – Local; 1 – Remote)
Example:	UTIL:MEAS:SENS 1 – sets measurement sense to remote sense

UTIL:EOI

This command sets or queries the end of string (EOS) mode for read back.

Parameter: 0 ... 1 (0 – NONE; 1 – CR)

Example: UTIL:EOI 1 – sets the EOS mode to CR

UTIL:TR:MODE

This command sets or queries the transient mode.

Parameter: 0 ... 3 (0 – CONTINUOUS; 1 – STEPPING; 2 – PULSE; 3 – TOGGLE)

Example: UTIL:TR:MODE 0 – sets the transient mode to continuous.

UTIL:CURR <VAL>

This command sets or queries the Electronic Load C value setting.

Example: UTIL:CURR 10.0 – sets C value to 10.0.

UTIL:RANG <VAL>

This command sets or queries the range mode.

Parameters: 0 – Manual range

1 – Auto range

Example: UTIL:RANG 0 – Sets the electronic load to manual range.

SYST:RANG?

This command returns the number of ranges for each mode in a “CV/CC/CR/CP” sequence.

Example: SYST:RANG? – returns “1/2/3/2” means 1 range for CV mode, 2 ranges for CC mode, 3 ranges for CR mode and 2 ranges for CP mode.

COMMON COMMANDS

A common command begins with an * and consists of three letters. It is followed by a “?” if it is a query. They are generally not related to specific device operation but to perform the identical function for all instruments that are compliant with the IEEE488.2 standard. Common commands can be mixed in with regular Electronic Load commands. The LPL responds to 8 common commands that control internal operation, status and event registers, and system data.

***CLS Clear Status Command**

This command clears the Status Byte summary register and all event register.

***ESR? Event Status Register Query**

This command queries the Standard Event Status register. Reading it clears it.

***IDN? Identification Query**

This query requests the Electronic Load to identify itself. It returns the model number of the unit.

***STB? Status Byte Query**

This query reads the Status Byte Register. Reading the register does not clear it.

***TRG Trigger Command**

This command generates a trigger to the Electronic Load.

***TST? Test Query**

This query causes the Electronic Load to go through a self-test.

***SAV Save Command**

This command stores the present state and calibration data to internal back-up flash memory.

COMMAND LIST

COMMAND	FORMAT	ACTION
INPUT enable	INP[?] INP[:STAT][?]	0/1/OFF/ON 0/1/OFF/ON
SHORT enable	SHOR INP:SHOR[:STAT][?]	0/1/OFF/ON 0/1/OFF/ON
<u>SET commands</u>		
SET value	SET[?]	MAX/MIN
SET Voltage	VSET[?] VOLT[:LEV][:IMM][?] VOLT[:LEV]:TRIG[?]	MAX/MIN MAX/MIN MAX/MIN
SET Current	ISET[?] CURR[:LEV][:IMM][?] CURR[:LEV]:TRIG[?]	MAX/MIN MAX/MIN MAX/MIN
SET Resistance	RSET[?] RES[:LEV][:IMM][?] RES[:LEV]:TRIG[?]	MAX/MIN MAX/MIN MAX/MIN
SET Power	PSET[?] POW[:LEV][:IMM][?] POW[:LEV]:TRIG[?]	MAX/MIN MAX/MIN MAX/MIN
<u>TRANSIENT commands</u>		
TRANSient enable	TR[?]	0/1/OFF/ON
TLEV transient level	TLEV[?]	MAX/MIN
TRansient Volatge	VTR[?] VOLT:TLEV[?]	MAX/MIN MAX/MIN
TRansient Current	ITR[?] CURR:TLEV[?]	MAX/MIN MAX/MIN
TRansient Resistance	RTR[?] RES:TLEV[?]	MAX/MIN MAX/MIN
TRansient Power	PTR[?] POW:TLEV[?]	MAX/MIN MAX/MIN
SLEW rate value	SLEW[?]	MAX/MIN
SLEW rate Voltage	VOLT:SLEW[?]	MAX/MIN
SLEW rate Current	CURR:SLEW[?]	MAX/MIN
SLEW rate Resistance	RES:SLEW[?]	MAX/MIN
SLEW rate Power	POW:SLEW[?]	MAX/MIN
DUTY cycle	DUTY[?]	MAX/MIN
DUTY Voltage	VOLT:DUTY[?]	MAX/MIN
DUTY Current	CURR:DUTY[?]	MAX/MIN
DUTY Resistance	RES:DUTY[?]	MAX/MIN
DUTY Power	POW:DUTY[?]	MAX/MIN
FREQuency	FREQ[?]	MAX/MIN
FREQuency voltage	VOLT:FREQ[?]	MAX/MIN
FREQuency current	CURR:FREQ[?]	MAX/MIN
FREQuency resistance	RES:FREQ[?]	MAX/MIN
FREQuency power	POW:FREQ[?]	MAX/MIN
<u>QUERY commands</u>		
MEASure Voltage	MEAS:VOLT[:DC][?]	
MEASure Current	MEAS:CURR[:DC][?]	
MEASure DELay	MEAS:DEL[?]	

PROTECTION commands

OVER Voltage value	VOLT:PROT:OVER[?]
OVER Current value	CURR:PROT:OVER:[?]
OVER Power value	POW:PROT:OVER:[?]
UNDER Voltage value	VOLT:PROT:UND[?]
UNDER Current value	CURR:PROT:UND[?]
UNDER Power value	POW:PROT:UND[?]
OVER-V Time Delay	VOLT:PROT:OVER:DEL[?]
OVER-C Time delay	CURR:PROT:OVER:DEL[?]
OVER-P Time delay	POW:PROT:OVER:DEL[?]
UNDER-V Time Delay	VOLT:PROT:UND:DEL[?]
UNDER-C Time delay	CURR:PROT:UND:DEL[?]
UNDER-P Time delay	POW:PROT:UND:DEL[?]

LIMIT commands

LIMIT Voltage MAX	VOLT:LIM:MAX[?]
LIMIT Current MAX	CURR:LIM:MAX[?]
LIMIT Resistance MAX	RES:LIM:MAX[?]
LIMIT Power MAX	POW:LIM:MAX[?]
LIMIT Voltage MIN	VOLT:LIM:MIN[?]
LIMIT Current MIN	CURR:LIM:MIN[?]
LIMIT Resistance MIN	RES:LIM:MIN[?]
LIMIT Power MIN	POW:LIM:MIN[?]

MODE and RANGE commands

MODE Query	MODE?
CURR MODE	MODE CC MODE:CURR
VOLT MODE	MODE CV MODE:VOLT
RES MODE	MODE CR MODE:RES
POW MODE	MODE CP MODE:POW
MODE RANGE	MODE:RANGe <n> 0...3 MODE:RANGe? <MODE>
SYSTEM RANGE	SYST:RANGe[?]

STEP commands

Utility STEP LOOP	UTIL:STEP:LOOP[?] <VAL>
Utility STEP COUNT	UTIL:STEP:COUNT[?] <VAL>
STEP MODE	STEP:MODE[?] <STEP COUNT> <MODE> (Must be in same mode and range)
STEP VAL	STEP:VAL[?] <STEP COUNT> <VAL>
STEP TIME	STEP:TIME[?] <STEP COUNT> <VAL>

UTILITY commands

Utility MEASure SENSE	UTIL:MEAS:SENSE
Utility End Of Identifier	UTIL:EOI
Utility TRansient Mode	UTIL:TR:MODE
Utility Current value	UTIL:CURR[?] <VAL> C value
Utility Range Operation	UTIL:RANG[?] <VAL>

FIVE: CALIBRATION

INSTRUCTION



WARNING

Exercise caution when using and calibrating an electronic load. High energy levels can be stored at the input voltage terminals on an electronic load in normal operation. In addition, potentially lethal voltages exist in the power circuit and on the input and sense connectors of a power supply with a rated output greater than 40V. Filter capacitors store potentially dangerous energy for some time after power is removed.



CAUTION

Only qualified personnel should attempt the calibration procedure, due to the high level of power.

This procedure describes calibration for the AMREL Programmable DC Electronic Load. The load is calibrated either through local or remote control. The following information provides calibration procedures in local mode.

NO hardware adjustment is necessary since all calibration is accomplished by software. The software sends calibration constants to the via the front panel keys. To maintain electronic load's precision input, calibration should be performed at least annually.

The nineteen parameters that need to be calibrated. After all the electronic load parameters are calibrated, the load returns to normal operating condition. If there are any errors in the calibration, cycle the power and recalibrate. All constants are saved in a non-volatile EEPROM.

CALIBRATION SERVICE ENVIRONMENT AND PRECAUTIONS

- Follow established antistatic procedures.
- Work at a bench with adequate room and support for the test unit and for all equipment required.
- To reduce shock hazard, use only an insulated, straight-bladed screwdriver when calibrating.

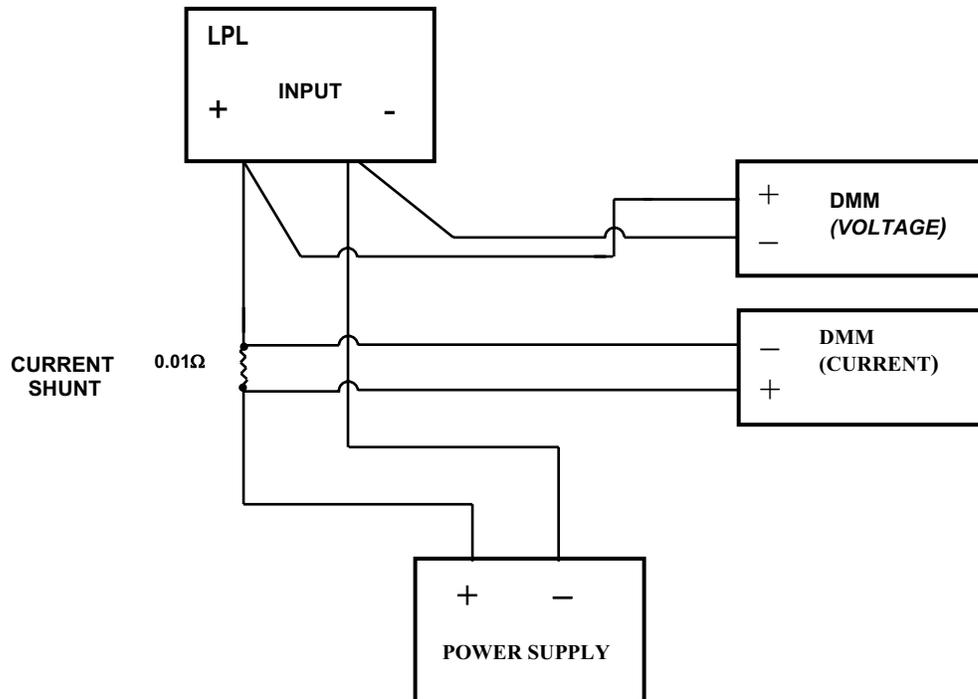
NEVER calibrate these units alone. Ensure that someone is present who can help should an accident occur.

CALIBRATION REQUIRED EQUIPMENT

- DMM
- Current Shunt (Precision Shunt Resistor-0.01ohm, 0.005% accuracy)
- DC power supplies (suitable for CV and CC maximum rating)

CALIBRATION CONFIGURATION

There are two configurations for the calibration of the electronic load. One is for measuring voltage and the other for measuring current.



CALIBRATION PARAMETERS

The following are the parameters that are calibrated.

- CV main level programming.
- CC low range main level programming.
- CC high range main level programming.
- CR low range main level programming.
- CR middle range main level programming.
- CR high range main level programming.
- CP low range main level programming.
- CP high range main level programming.
- CV transient level programming.
- CC low range transient level programming.
- CC high range transient level programming.
- CR low range transient level programming.
- CR middle range transient level programming.
- CR high range transient level programming.
- CP low range transient level programming.
- CP high range transient level programming.
- CV readback.
- CC low range readback.
- CC high range readback.

LOCAL CALIBRATION PROCEDURES

The LPL uses the two point's calibration method whereby the LPL has two preset calibration points for each parameter. The microprocessor does the calculation for the operating slope and offset in programming and readback functions. The default calibration points are low point 6400 count and high point 32000 count. These are the default bit counts (DAC circuit) where the 6400 counts point represents approximately 10% of full scale and the 32000 counts point is at 50% full scale. Although these points can be changed in the "Cal. Param." menu, it is not recommended.

The following is the procedure for the calibration of each parameter.

Presses "ENTER" & "." Keys simultaneously to enable the front panel hot keys. The ON/OFF will flash if it's done properly.

Presses "ENTER" & "8" keys simultaneously to enter into calibration mode. Once in calibration mode, the operator can use "◀" and "▶" key to shift to the different calibration parameters.

All calibration procedures should be done in the local sensing mode. Voltage local sensing is at the input terminal. In the following calibrations steps, the procedures will suggest certain power supply input, voltage, current and power, but the operator must calculate the power consumption of LPL to prevent from damaging the unit during calibration.

After calibration is completed, **all new values entered must be saved in the LPL's flash memory by pressing "3" & ENTER key simultaneously**. It will take approximately 3 seconds for the LPL to save the new calibration values. During this period, the LCD will display "SAVING CONFIG...". Do not turn-off LPL during this period.

CONSTANT VOLTAGE (CV) LOW/ MIDDLE/HIGH RANGE, MAIN LEVEL CALIBRATION

CV main level calibration requires a power supply that covers the full range of input voltage of the load and is capable of operating in CV and CC mode. Estimate the power consumption of the load, because power supply will go to CC mode while calibrating the load. Adjust the CC current level to a safe limit for load.

Note: *Pressing CLEAR key will take you back to previous menu.*

Use "◀" and "▶" until you see MAIN CV0 parameter. Then press enter:

CV0	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CV0	HI =	CNT:	Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS" should be display on the front panel LCD.

Press "▶" to select MAIN CV1. Then press enter.

CV1	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER
CV1	HI =	CNT:	Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

Press "▶" to select MAIN CV2. Then press enter.

CV2	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER
CV2	HI =	CNT:	Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

CONSTANT CURRENT (CC) LOW/MIDDLE/HIGH RANGE, MAIN LEVEL CALIBRATION

CC main level calibration requires a power supply that covers full range high range input current of the load. Estimate the power consumption of the load, and adjust the voltage input to a safe limit for the load.

Use “◀” and “▶” until you see MAIN CC0 parameter. Press enter:

CC0	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CC0	HI =	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

Press “▶” to select MAIN CC1. Then press enter.

CC1	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER
CC1	HI =	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

Press “▶” to select MAIN CC2. Then press enter.

CC2	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER
CC2	HI =	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

CONSTANT RESISTANCE (CR0) LOW RANGE MAIN LEVEL CALIBRATION

CR low range main level calibration requires a power supply that has low voltage and high current, but operator has to estimate the power consumption of load.

Use “◀” and “▶” until you see MAIN CR0 parameter. Press enter:

CR0	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR0	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CR0	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR0	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

CONSTANT RESISTANCE (CR1) MIDDLE MAIN LEVEL CALIBRATION

CR middle range main level calibration requires a power supply that has medium voltage and medium current, but operator has to estimate the power consumption of electronic load.

Use “◀” and “▶” until you see MAIN CR1 parameter. Press enter:

CR1	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR1	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CR1	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR1	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

CONSTANT RESISTANCE (CR2) HIGH RANGE MAIN LEVEL CALIBRATION

CR high range main level calibration requires a power supply that has high voltage and medium current, but operator has to estimate the power consumption of load.

Use “◀” and “▶” until you see MAIN CR2 parameter. Press enter:

CR1	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR1	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CR1	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR1	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

CONSTANT POWER (CP) LOW/MIDDLE/HIGH RANGE, MAIN LEVEL CALIBRATION

CP main level calibration requires a power supply that has enough power output. For example, a PEL60 60V/10A model needs at least 30V/6A power output to calibrate the unit.

Use “◀” and “▶” until you see MAIN CP0 parameter. Then press enter:

CP0	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CP0	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CP0	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CP0	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

Use “◀” and “▶” until you see MAIN CP1 parameter. Press enter:

CP1	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CP1	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CP1	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CP1	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

Use “◀” and “▶” until you see MAIN CP2 parameter. Press enter:

CP2	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CP2	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CP2	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CP2	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

CV TRANCIENT LEVEL CALIBRATION

CV transient level calibration requires a power supply that covers full range of input voltage of load and is capable of operating in CV and CC mode. Estimate the power consumption of LPL, because power supply will go to CC mode while calibrating the load. Adjust the CC current level to a safe limit for load.

Use “◀” and “▶” until you see TRAN CV0 parameter. Then press enter:

CV0 LO= CNT: Input measured voltage from Volt.DMM, then press ENTER.
CV0 HI = CNT: Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS"
should be display on the front panel LCD.

Press "▶" to select TRAN CV1. Then press enter.

CV1 LO= CNT: Input measured voltage from Volt.DMM, then press ENTER
CV1 HI = CNT: Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS" message
should be display on the front panel LCD.

Press "▶" to select TRAN CV2. Then press enter.

CV2 LO= CNT: Input measured voltage from Volt.DMM, then press ENTER
CV2 HI = CNT: Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS" message
should be display on the front panel LCD.

CC LOW/MIDDLE/HIGH RANGE, TRANSIENT LEVEL CALIBRATION

CC transient level calibration requires a power supply that covers full range of high range input current of load. Estimate the power consumption of the electronic load, and adjust the voltage input to a safe limit for the load.

Use "◀" and "▶" until you see TRAN CC0 parameter. Press enter:

CC0 LO= CNT: Input measured voltage from Curr.DMM, then press ENTER.
CC0 HI = CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message
should be display on the front panel LCD.

Press "▶" to select MAIN CC1. Then press enter.

CC1 LO= CNT: Input measured voltage from Curr.DMM, then press ENTER
CC1 HI = CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message
should be display on the front panel LCD.

Press "▶" to select MAIN CC2. Then press enter.

CC2 LO= CNT: Input measured voltage from Curr.DMM, then press ENTER
CC2 HI = CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message
should be display on the front panel LCD.

CR LOW RANGE TRANSIENT LEVEL CALIBRATION

CR low range transient level calibration requires a power supply that has low voltage and high current, but operator has to estimate the power consumption of electronic load.

Use “◀” and “▶” until you see TRAN CR0 parameter. Press enter:

CR0	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR0	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CR0	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR0	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

CR MIDDLE RANGE TRANSIENT LEVEL CALIBRATION

CR middle range transient level calibration requires a power supply that has medium voltage and medium current, but operator has to estimate the power consumption of electronic load.

Use “◀” and “▶” until you see TRAN CR1 parameter. Press enter

CR1	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR1	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CR1	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR1	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD..

CR HIGH RANGE TRANSIENT LEVEL CALIBRATION

CR high range transient level calibration requires a power supply that has high voltage and medium current, but operator has to estimate the power consumption of load.

Use “◀” and “▶” until you see TRAN CR2 parameter. Press enter:

CR2	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR2	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.
CR2	HI=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CR2	HI=	CNT:	Input measured voltage from Curr.DMM then press ENTER key. A “SUCCESS” message should be display on the front panel LCD.

CP LOW RANGE TRANSIENT LEVEL CALIBRATION

CP high range transient level calibration requires a power supply that has enough power output. For example, a PEL60 60V/10A model needs at least 30V/6A power output to calibrate the unit. Only qualified personnel should attempt this calibration, due to the high level of power.

Use “◀” and “▶” until you see TRAN CP0 parameter. Then press enter:

CP0	LO=	CNT:	Input measured voltage from Volt.DMM, then press ENTER.
CP0	LO=	CNT:	Input measured voltage from Curr.DMM, then press ENTER.

CP0 HI= CNT: Input measured voltage from Volt.DMM, then press ENTER.
CP0 HI= CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

Use "◀" and "▶" until you see TRAN CP1 parameter. Press enter:

CP1 LO= CNT: Input measured voltage from Volt.DMM, then press ENTER.
CP1 LO= CNT: Input measured voltage from Curr.DMM, then press ENTER.
CP1 HI= CNT: Input measured voltage from Volt.DMM, then press ENTER.
CP1 HI= CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

Use "◀" and "▶" until you see TRAN CP2 parameter. Press enter:

CP2 LO= CNT: Input measured voltage from Volt.DMM, then press ENTER.
CP2 LO= CNT: Input measured voltage from Curr.DMM, then press ENTER.
CP2 HI= CNT: Input measured voltage from Volt.DMM, then press ENTER.
CP2 HI= CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

CV READBACK LEVEL CALIBRATION

CV readback main level calibration requires a power supply that covers full range of input voltage of load and is capable of operating in CV and CC mode. Estimate the power consumption of load, because power supply will go to CC mode while calibrating the load. Adjust the CC current level to safe limit of load.

Use "◀" and "▶" until you see RB CV0 parameter. Then press enter:

CV0 LO= CNT: Input measured voltage from Volt.DMM, then press ENTER.
CV0 HI = CNT: Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS" should be display on the front panel LCD.

Press "▶" to select RB CV1. Then press enter.

CV1 LO= CNT: Input measured voltage from Volt.DMM, then press ENTER
CV1 HI = CNT: Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

Press "▶" to select RB CV2. Then press enter.

CV2 LO= CNT: Input measured voltage from Volt.DMM, then press ENTER
CV2 HI = CNT: Input measured voltage from Volt.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

CC LOW RANGE READBACK LEVEL CALIBRATION

CC readback low range calibration requires a power supply that covers full range of high range input current of load. Estimate the power consumption of the electronic load, and adjust the voltage input to a safe limit for the load.

Use "◀" and "▶" until you see RB CRO parameter. Press enter:

CC0 LO= CNT: Input measured voltage from Curr.DMM, then press ENTER.

CC0 HI = CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

Press "▶" to select RB CC1. Then press enter.

CC1 LO= CNT: Input measured voltage from Curr.DMM, then press ENTER
CC1 HI = CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

Press "▶" to select RB CC2. Then press enter.

CC2 LO= CNT: Input measured voltage from Curr.DMM, then press ENTER
CC2 HI = CNT: Input measured voltage from Curr.DMM then press ENTER key. A "SUCCESS" message should be display on the front panel LCD.

This completes the calibration for all the input parameters for the electronic load.

Press "3" & "ENTER" key simultaneously to save all new calibration parameters into the load's memory.

RE-INSTALLING CALIBRATION DATA

In case, the calibration data becomes corrupted by abnormal conditions, the Electronic Load has a built in capability for re-installing the last calibration data without having to recalibrate the load.

1. First you need to read the slope and offset values from the electronic load when you receive the unit, or you can call American Reliance Inc to get the calibration information for the electronic load (need serial number)

Get calibration data procedure:

Get slope value:

Run command: "**SYST: SLOPE? <mode>**" to get calibration slope values where "mode" is from 0 to 39. So there should be 40 values for slope data.

Get offset value:

Run command: "**SYST:OFFS? <mode>**" to get calibration offset values where "mode" is from 0 to 39. So there should be 40 values for offset data.

2. Once you obtain all the calibration information, you can resave this calibration information to the electronic load.

Resave calibration slope date to electronic load.

Run command: "**SYST: SLOPE <mode> <value>**" where "mode" is from 0 to 39, and the value is the corresponding slope value obtained from 1.

Resave calibration offset date to electronic load.

Run command: "**SYST: OFFS <mode> <value>**" where "mode" is from 0 to 39, and the value is the corresponding offset value obtained from 1.

After re-saving the calibration information for electronic load, you need test the CV and CC mode, and check if the reading back values are within spec.

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APPENDIX A: PEL AND PLA/PLW/LPL COMMAND COMPATIBILITY

PEL & PLA/PLW/LPL Driver Compatibility Configuration

For PEL and PLA/PLW/LPL driver compatibility, the following procedures are needed.

1. Power on unit
2. Utility → Profile → Recall → 1
3. Recall profile 1
4. Exit Menu
5. Run ARPEL program (program can be installed from the driver file from the CD-ROM or the FTP site)
6. Configure GPIB address/RS-232 Speed
7. Click Start

The ARPEL program provides simple click and select menus to control functions on the load as well as a command prompt for entering SCPI commands.

PEL & PLA/PLW/LPL Command Compatibility Table

The table below is to explain the difference between the PEL, and PLA/PLW/LPL command syntax and parameters. Under the “PEL Syntax & Parameters” and “PLA/PLW/LPL Syntax & Parameters” columns, it lists the commands that will need adjustments when entering it. Please refer to the following table for PEL and PLA/PLW/LPL command syntax descriptions:

PEL & PLA/PLW/LPL PROGRAMMING COMMAND COMPATIBILITY CHART			
PEL COMMANDS	PLA/PLW/LPL COMMANDS	PEL Syntax & Parameters	PLA/PLW/LPL Syntax & Parameters
INP[?]	INP[?]		
INP[:STAT][?]	INP[:STAT][?]		
SHOR	SHOR		
INP:SHOR[:STAT][?]	INP:SHOR[:STAT][?]		
SET[?]	SET[?]		
VSET[?]	VSET[?]		
VOLT[:LEV][:IMM][?]	VOLT[:LEV][:IMM][?]		
VOLT[:LEV]:TRIG[?]	VOLT[:LEV]:TRIG[?]		
ISET[?]	ISET[?]		
CURR[:LEV][:IMM][?]	CURR[:LEV][:IMM][?]		
CURR[:LEV]:TRIG[?]	CURR[:LEV]:TRIG[?]		
RSET[?]	RSET[?]		
RES[:LEV][:IMM][?]	RES[:LEV][:IMM][?]		
RES[:LEV]:TRIG[?]	RES[:LEV]:TRIG[?]		
PSET[?]	PSET[?]		
POW[:LEV][:IMM][?]	POW[:LEV][:IMM][?]		
POW[:LEV]:TRIG[?]	POW[:LEV]:TRIG[?]		
TR[?]	TR[?]		
TLEV[?]	TLEV[?]		
VTR[?]	VTR[?]		
VOLT:TLEV[?]	VOLT:TLEV[?]		
ITR[?]	ITR[?]		
CURR:TLEV[?]	CURR:TLEV[?]		
RTR[?]	RTR[?]		
RES:TLEV[?]	RES:TLEV[?]		

APPENDIX A: PEL AND PLA/PLW/LPL COMMAND COMPATIBILITY

PEL COMMANDS	PLA/PLW/LPL COMMANDS	PEL Syntax & Parameters	PLA/PLW/LPL Syntax & Parameters
PTR[?]	PTR[?]		
POW:TLEV[?]	POW:TLEV[?]		
SLEW[?]	SLEW[?]	Check PEL Slew Rate Specifications	1) PLA/PLW slew rate based on Slew Rate Specifications 2) For PLA/PLW to PEL slew rate conversion, use the following conversion equation: $[(Trans\ Value - Main\ Value) / [Desired\ Slew\ Time\ (ms)]\ (A/us)]$ (Note: This command will change both +/- Slew Rate Value)
VOLT:SLEW[?]	VOLT:SLEW[?]		
CURR:SLEW[?]	CURR:SLEW[?]		
RES:SLEW[?]	RES:SLEW[?]		
POW:SLEW[?]	POW:SLEW[?]		
DUTY[?]	DUTY[?]	PEL Duty Range: 2~98	PLA/PLW/LPL Duty Range 0~100
VOLT:DUTY[?]	VOLT:DUTY[?]		
CURR:DUTY[?]	CURR:DUTY[?]		
RES:DUTY[?]	RES:DUTY[?]		
POW:DUTY[?]	POW:DUTY[?]		
FREQ[?]	FREQ[?]	PEL Frequency Range: 0.1 ~ 20 KHz	LPL/PLW/PLA Frequency Range: 0.1 ~ N KHz (N; maximum range value will vary by model)
VOLT:FREQ[?]	VOLT:FREQ[?]		
CURR:FREQ[?]	CURR:FREQ[?]		
RES:FREQ[?]	RES:FREQ[?]		
POW:FREQ[?]	POW:FREQ[?]		
MEAS:VOLT[:DC][?]	MEAS:VOLT[:DC][?]		
MEAS:CURR[:DC][?]	MEAS:CURR[:DC][?]		
MEAS:DEL[?]	MEAS:DEL[?]		
VOLT:PROT:OVER[?]	VOLT:PROT:OVER[?]		
CURR:PROT:OVER:[?]	CURR:PROT:OVER:[?]		
POW:PROT:OVER:[?]	POW:PROT:OVER:[?]		
VOLT:PROT:UND[?]	VOLT:PROT:UND[?]		
CURR:PROT:UND[?]	CURR:PROT:UND[?]		
POW:PROT:UND[?]	POW:PROT:UND[?]		
VOLT:PROT:OVER:DEL[?]	VOLT:PROT:OVER:DEL[?]		
CURR:PROT:OVER:DEL[?]	CURR:PROT:OVER:DEL[?]		
POW:PROT:OVER:DEL[?]	POW:PROT:OVER:DEL[?]		
VOLT:PROT:UND:DEL[?]	VOLT:PROT:UND:DEL[?]		
CURR:PROT:UND:DEL[?]	CURR:PROT:UND:DEL[?]		
POW:PROT:UND:DEL[?]	POW:PROT:UND:DEL[?]		
VOLT:LIM:MAX[?]	VOLT:LIM:MAX[?]		
CURR:LIM:MAX[?]	CURR:LIM:MAX[?]		
RES:LIM:MAX[?]	RES:LIM:MAX[?]		
POW:LIM:MAX[?]	POW:LIM:MAX[?]		
VOLT:LIM:MIN[?]	VOLT:LIM:MIN[?]		

APPENDIX A: PEL AND PLA/PLW/LPL COMMAND COMPATIBILITY

PEL COMMANDS	PLA/PLW/LPL COMMANDS	PEL Syntax & Parameters	PLA/PLW/LPL Syntax & Parameters
CURR:LIM:MIN[?]	CURR:LIM:MIN[?]		
RES:LIM:MIN[?]	RES:LIM:MIN[?]		
POW:LIM:MIN[?]	POW:LIM:MIN[?]		
MODE?	MODE?	PEL returns CV/CC/CR/CP	PLA returns VOLT/CURR/RES/POW
MODE CC	MODE CC		
MODE:CURR	MODE:CURR		
MODE CV	MODE CV		
MODE:VOLT	MODE:VOLT		
MODE CR	MODE CR		
MODE:RES	MODE:RES		
MODE CP	MODE CP		
MODE:POW	MODE:POW		
MODE:RANGe <n>	MODE:RANGe <n>		
MODE:RANGe? <MODE>	MODE:RANGe? <MODE>		
SYST:RANGe[?]	SYST:RANGe[?]		
UTIL:STEP:LOOP[?] <VAL>	UTIL:STEP:LOOP[?] <VAL>	0 (Infinity) ~ 99	0 (Infinity) ~ 65535
UTIL:STEP:COUNT[?] <VAL>	UTIL:STEP:COUNT[?] <VAL>	1 ~ 99	1~32
STEP:TIME[?] <STEP COUNT> <VAL>	STEP:TIME[?] <STEP COUNT> <VAL>	Step Count - 0~99; VAL (Step Time) - 10 ~ 600000 ms	Step Count - 1~32; VAL (Step Time) - 0 ~ 65535 ms
STEP:VALue <STEP COUNT> <VALUE>	STEP:VALue <STEP COUNT> <VALUE>	Step Count - 0~99; Step Value - Min to Max Value of Mode & Range	Step Count - 1~32; Step Value - Min to Max Value of Mode & Range
UTIL:MEAS:SENSE	UTIL:MEAS:SENSE		
UTIL:EOI	UTIL:EOI		
UTIL:TR:MODE	UTIL:TR:MODE	0 – CONTINUOUS; 1 – STEPPING; 2 – PULSE; 3 – TOGGLE	0 - TRIGger; 1 - CONTinuous; 2 - TOGGle; 3 - PULSe; 4 - STEP; 5 - AUTO; 6 - ONCE Note: Using PEL command to select transient mode will limit the transient operation to only PEL selections
UTIL:CURR[?] <VAL>	UTIL:CURR[?] <VAL>		
UTIL:RANG[?] <VAL>	UTIL:RANG[?] <VAL>		

APPENDIX B: NEW ELOAD FEATURES

FW: 2.17/060216

- Power Interruption (Current Interruption)

FW: 2.29/061005

- Input Contactor Control
- Ultra-low Range Option

1. POWER INTERRUPTION (CURRENT INTERRUPTION) MODE:

For Battery and Fuel Cell Testing, a common method used to measure the internal impedance is the Current/Power Interrupt or just the Interrupt method. The battery or fuel cell is loaded at a constant current, and the current is interrupted by bringing it down to zero or lower current level. During the interrupt period, the battery or fuel cell voltage is measured. As a result the magnitude of the impedance can be determined. The Interrupt method can be achieved in either CC mode or CP mode, with recommendations in the CC mode.

Local Control:

1. Go to UTILITY → LOAD CONTROL → TRANS. MODE and select **POWER INTR.**
2. Press the FUNC key and scroll to locate **PINT: 20000** menu option
3. Press ENTER to edit Power Interrupt (PINT) Value (Range: 200us ~ 25000us)
4. Set the eLOAD in CC or CP Mode
5. Set the Main Level to 0Adc
6. Set the Trans. Level to a current level larger than the Main to load the DUT
Note: Press 9 (TRANS) to edit transient level value
7. Set the System Bandwidth (OSC3, OSC2, OSC1 and DEFAULT)
8. Activate the INPUT by pressing 0 (INPUT ON/OFF)
9. To Activate Power Interruption press 1 (TR ON/OFF) – PULS will appear on display
10. To re-trigger power interruption, deactivate Power Interruption by pressing 1 (TR ON/OFF) and press again to enable Power Interruption

Remote Programming:

Setting up the Remote Connection:

- 1) Connect the eLOAD to the PC via GPIB/RS-232/USB/ETHERNET Cables
- 2) Follow the eTOOL1 Guide to communicate with the eLOAD via remote interface
- 3) Once connected, type *IDN? to query the unit

SCPI Commands:

Set the eLOAD in CC or CP Mode → *MOD:CURR OR MOD:POW*
Set the Main Level to 0Adc or the desired current level → *ISET or CURR <NRF>*
Set the Peak Level (> Main Level Setting) to load the DUT → *CURR:TLEV <NRF>*
Set the Power Interruption Pulse Width → *TRAN:PINT:TWID 200 μs ~ 25000 μs*
Set the System Bandwidth → (OSC3, OSC2, OSC1 and DEFAULT)
Activate PINT (Power Interruption Mode) → *TRAN:MOD PINT or TRAN:MOD 7*
Activate the INPUT → *INP 1 or INP ON*
Activate the PULSE mode → *TRAN 1 or TRAN ON*
Send TRIGGER signal to activate Power Interruption → **TRG or TRIG*

Input Contactor Control:

AMREL's eLOAD provides a selectable dc Contactor control signal via the INPUT CONTACTOR feature. A TTL active high signal (+5Vdc) or TTL active low signal (0Vdc) will be delivered to the Port_0 (Pin 9) of the 12-pin External Programming Port prior to the eLOAD input turning on and after the eLOAD turns off, to activate/deactivate an external contactor/relay. To allow time for an external dc contactor to open or close and activate the output of the DUT, the Input Contactor feature offers a programmable delay (50 ~ 500ms) that will delay the eLOAD input during load on sequence and the Port_0 signal during load off sequence. The TTL signal is useful for controlling driver circuits for external relays or contactors to isolate an eLOAD system from high power DUT during the off-state of the testing application.

Port 0+ @ On	TTL-High Control Signal at input on;
Port 0- @ On	TTL-Low Control Signal at input on;
Disable	Disable Input Contactor function; Port_0 function released
Delay	Time delay constant before input on and after input off. Parameter: 50~500ms

Typical eLOAD Turn-on Sequence

- 1) Close External Contactor/Relay
- 2) DUT output On (During Delay)
- 3) eLOAD input On

Typical eLOAD Turn-off Sequence

- 1) eLOAD input Off
- 2) DUT Output Off (During Delay)
- 3) Open External Contactor/Relay

Local Control

MENU → LOAD CONTROL → INPUT CONTACTOR → CONTROL → DISABLE
→ PORT0 + @ ON
→ PORT0 - @ ON
→ DELAY → 50ms ~ 500ms

Remote Programming

[SOURCE:]INPut:CONtactor

This command configures the INPUT CONTACTOR Mode

Command Syntax	INPut:CONtactor <mode>
Parameters	1: DISABLE 2: PORT0+ @ ON 3: PORT0- @ ON
Query Syntax	INPut:CONtactor?
Returned Parameters	1 2 3

[SOURCE:]INPut:CONtactor:DELay

This command configures the INPUT CONTACTOR Mode

Command Syntax	INPut:CONtactor:DELay <delay-time>
Parameters	50 ~ 500ms
Query Syntax	INPut:CONtactor:DELay?
Returned Parameters	50 ~ 500ms

3. Ultra-low Range CC & CP and Ultra-high Range CR (Optional Feature)

Project requirements are dynamic and over a long time span, so often times it may require high-current applications one day and ultra-low current applications the next. AMREL eLOAD offers an Ultra-low range CC and CP mode and a Ultra-high range CR mode utilizing a unique dual-shunt design which provides precise, accurate, high-resolution and repeatable measurements in thousands of Amps and down to tens of Amps in a single box. The purchase of a single system over the lifetime of the project will yield incredible cost savings in ROI and satisfy dynamic application demands.

Constant Current Ultra Low (CCUL) Range –

- Programming Accuracy: .05% of Setting + .05% of CCUL Max Current
- Read back and Measurement: .05% of Reading + .05% of CCUL Max Current
- Resolution: 14 Bits

Constant Power Ultra Low (CPUL) Range –

- Programming Accuracy: 1% of Setting + .1% of CPUL Max Power
- Read back and Measurement: .05% of Reading + .1% of CPUL Max Power
- Resolution: 14 Bits

Constant Resistance Ultra High (CRUH) Range –

- Programming Accuracy: Please refer to Specifications
- Read back and Measurement: Please refer to Specifications
- Resolution: 14 Bits

Important Notes for CCUL, CPUL and CRUH:

- 1) Cross Mode or Cross Range from one of the normal operating modes into one of the ultra modes will cause the eLOAD input to disable and not sink any power
- 2) The maximum current loading in CPUL and CRUH is $(.01 * I_{MAX})$

Local Control:

MODE

RANGE

MODE → CC

(CONSTANT CURRENT) → AUTO (UTILITY → LOAD CONTROL → RANGE CONTROL → AUTO)
→ MANUAL (UTILITY → LOAD CONTROL → RANGE CONTROL → MANUAL)
→ MANU ULO
→ MANU LOW
→ MANU MID
→ MANU HI

**MODE → CP
(CONSTANT POWER)**

- **AUTO** (UTILITY → LOAD CONTROL → RANGE CONTROL → AUTO)
- **MANUAL** (UTILITY → LOAD CONTROL → RANGE CONTROL → MANUAL)
 - MANU ULO
 - MANU LOW
 - MANU MID
 - MANU HI

**MODE → CR
(CONSTANT RESIST.)**

- **AUTO** (UTILITY → LOAD CONTROL → RANGE CONTROL → AUTO)
- **MANUAL** (UTILITY → LOAD CONTROL → RANGE CONTROL → MANUAL)
 - MANU LOW
 - MANU MID
 - MANU HI
 - MANU UHI

Remote Programming:

[SOURce:]MODE:RANGe

The commands sets and query the operating range at the current operating mode.

Command Syntax

MODE:RANGe <NR1>

Parameters

range index 0 – Low Range
 1 – Middle Range
 2 – High Range
 3 – Ultra High/Ultra Low Range

Query Syntax

MODE:RANGe?

Returned Parameters

<NR1>, range index number