# INSTRUCTION MANUAL

EN




# ALD1120

## 120W Electronic Load

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The latest revisions of this manual, device drivers, and software tools can be downloaded from: http://www.aimtti.com/support

# 1. PRODUCT DESCRIPTION

- Full digital control
- Standard USB Device interface (rear panel)
- 120W / 24A / 120V
- Universal mains input

The ALD1120 electronic loads are developed to meet the requirements of design, test and education customers. This DC electronic load is intended for use in investigating the behaviour of many different types of DC power sources such as batteries, solar cells, fuel cells or wind generators, as well as electronic power supply units.

It is designed to have very low internal resistance to allow operation at high currents with low voltage drop. The voltage of the source can be sensed either internally for convenience or externally for better accuracy.

The unit provides four different operating modes: constant current, constant power, constant resistance and constant voltage. It operates over the current range 0 to 24 Amps and the voltage range 0 to 120 Volts with a continuous power dissipation capability of up to 120 Watts.

Advance functions include pulsed operation with pulse widths down to 100us. Sweep capability offering linear, logarithmic, single and dual sweeps. Battery discharge offering live battery cell capacity monitoring in both Watt hours and Amp hours, and discharge limits in terms of voltage and time.

The unit provides full protection in the form of OCP, OVP, OPP and OTP trips. The unit also contains reverse current and external sense voltage drop detection trips.

The A series models are designed with your workspace in mind. Their compact footprint (213 x 228 x 98 mm (WxDxH)) ensures they won’t take up unnecessary space on your bench or shelf.

This instrument is supported by the Aim-TTi Test Bridge PC software (available as free download from the Aim-TTi website), which can be used to control up to 4 instruments simultaneously.

# 2. SAFETY

## Symbols

This instruction manual contains information and warnings which must be followed by the user to ensure safe operation and to retain the instrument in a safe condition.

The following symbols are displayed on the instrument and throughout the manual, to ensure the safety of the user and the instrument, all information must be read before proceeding.

**WARNING**



Indicates a hazard that, if not avoided, could result in injury or death.

**CAUTION**



Indicates a hazard that could damage the product and may result in loss of important data or invalidation of the warranty.

**NOTE**



Indicates a helpful tip.

**EXAMPLE**



Indicates an example to show further details.

| | | | |
|---|---|---|---|
|  | Warning, possibility of electric shock | UK CA | UKCA 'UK Conformity Assessed' marking is a certification mark that affirms conformity with the applicable requirements for products sold within Great Britain |
|  | Caution, possibility of damage | | |
|  | Mains supply OFF | CE | 'CE' marking is a certification mark that affirms the good's conformity with European health, safety, and environmental protection standards |
|  | Mains supply ON | | |
|  | Standby supply. Instrument is not disconnected from AC mains power when switch is off. |  | WEEE (do not dispose in household waste) |
|  | Alternating current |  | Earth (ground) terminal |
|  | Protective Earth terminal |  | The terminal is connected to chassis ground |
|  | Security lock slot | | |

## Safety Notices

This instrument is:

- A safety Class I instrument according to IEC classification and has been designed to meet the requirements of EN61010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use). It is an Installation Category II instrument intended for operation from a normal single-phase supply.
- Designed for indoor use in a Pollution Degree 2 environment in the temperature range 5°C to 40°C, 20%- 80% RH (non-condensing). It may occasionally be subjected to temperatures between +5°C and –10°C without degradation of its safety. Do not operate while condensation is present.
- Tested in accordance with EN61010-1 and has been supplied in a safe condition. This instruction manual contains some information and warnings which have to be followed by the user to ensure safe operation and to retain the instrument in a safe condition.

**WARNING**



Do not operate while condensation is present. Do not operate outside its rated supply voltages or environmental range.

THIS INSTRUMENT MUST BE EARTHED.

**The unit does not have a fuse in the load circuit:** if the source connected to the load is capable of generating substantial currents in the event of a fault, users should assess the risks involved and consider the inclusion of an appropriate fuse, circuit breaker or switch in the connection between the source and this load.

Ensure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders is prohibited.

**Use of this instrument in a manner not specified by these instructions may impair the safety protection provided.**

**Voltages above 60Vdc are hazardous live according to EN 61010-1 and great care must be taken when using this instrument at voltages above this level.**

**If hazardous voltages could exist, all connections to the front and rear terminals must be made with the power switched off on all voltage sources.**

**Protection against hazardous voltages must be applied in accordance with local Safety legislation.**

**Probes and connectors must be suitable for voltages present conforming to Standard: 61010: Part 031- Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use: Safety requirements for hand-held probe assemblies.**

Any interruption of the mains earth connector, inside or outside, will make the instrument dangerous. Intentional interruption is prohibited. The protective action must not be negated by the use of an extension cord without a protective conductor.

Any adjustment, maintenance, and repair of the opened instrument under voltage must be avoided. When connected, terminals may be live and opening the covers or removal of parts (except those that can be accessed by hand) may expose live parts.

To avoid electric shock or damage to the instrument, never allow water to get inside the case. If the instrument is clearly defective, or has been subject to mechanical damage, excessive moisture, or chemical corrosion, the safety protection may be impaired, and it must be withdrawn from use and returned for repair.

**CAUTION**



Do not wet when cleaning; use only a soft dry cloth to clean the screen.

Do not use a sharp or pointed objects to operate the touch screen.

Take care not to restrict the inlet vents at the front and rear of the instrument.

# 3. INSTALLATION

## Mains Operating Voltage

This instrument has a universal input range and will operate from 100V to 240V mains supply without adjustment. Check that the local supply meets the AC Input requirement given in the Specification see '*Error! Reference source not found.*'.

## Mains Lead

Connect the instrument to the AC supply using the mains lead provided. Should a mains plug be required for a different mains outlet socket, a suitably rated and approved mains lead set should be used, which is fitted with the required wall plug and an IEC60320 C13 connector for the instrument end. To determine the minimum current rating of the lead set for the intended AC supply, refer to the power rating information on the equipment or in the Specification.

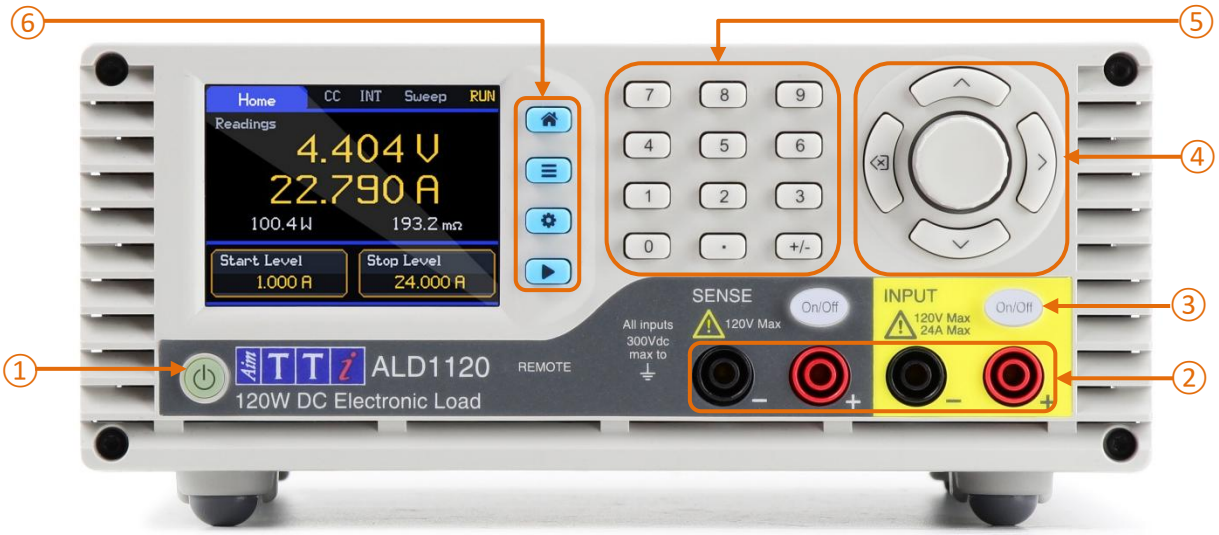
## Mounting

This instrument is suitable for bench use. The front feet include a tilt mechanism for optimal panel angle.

## Ventilation

The instrument is cooled by a variable speed fan which vents at the rear. Take care not to restrict the air inlets at the front or exit at the rear.

# 4. INSTRUMENT OVERVIEW




| | | |
|---|---|---|
| ① | Standby | |
| ② | Terminals | The INPUT and SENSE terminals for the load circuit are 4mm Banana sockets on 19mm spacing. |
| | | **The load circuit is isolated from ground, and potentials up to ± 300 Volts DC to ground are allowed, but it is essential to observe safe insulation practice. The maximum current through these terminals is 24 Amps. The maximum voltage allowed across the load is 120 Volts.**<br>Ensure that the source is connected with the correct polarity. The unit does not have a fuse in the load circuit: ensure that the maximum prospective fault current is limited to a safe level. |
| | | To avoid errors in sensing the voltage of the source caused by voltage drops in the high current wiring, connect the SENSE terminals to the external circuit at the point where the voltage needs to be measured (normally at the output terminals of the source under test).<br>Ensure that the source is connected with the correct polarity. These terminals must not be connected to any voltage other than the source that is connected to the load input. |
| ③ | Input On/Off | Alternate presses of the Input On/Off key turn the input on or off. The on state is indicated by the key being illuminated in white. |
| | External Sense On/Off | Alternate presses of the External Sense On/Off key turn external sense on or off. The on state is indicated by the key being illuminated in white. |
| ④ | Rotary knob and directional keypad | Turn the knob clockwise to initiate, once the desired button/ field has been selected, press to 'okay' an entry. See *'Initial operation'* for more details. |
| ⑤ | Numeric keypad | Numeric keys allow direct entry of a value from the numeric editing screen, see *'Editing a numeric field'* for more details. |
| ⑥ | Function keys | Home , Configure , Utilities, Trigger |

## Instrument Overview




| | | |
|---|---|---|
| ① | AC power inlet | Connect to AC mains using the power lead provided. See '*Mains Lead*' for more details. |
| ② | USB | The USB port accepts a standard USB cable. The Windows plug-and-play functions should automatically recognise that the instrument has been connected. |
| ③ | USB update | Used to update firmware via USB, see '***Error! Reference source not found.***' for more details. |
| ④ | Security lock slot | |
| ⑤ | Earth bond screws ⚠ | Must be fitted to ensure a safe earth bond. |
| ⑥ | Fan Exhaust vents ⚠ | Ensure the fan exhaust vents are not blocked or restricted in any way. |

# 5. GETTING STARTED

## Using this manual

This section is a general introduction to the operation of the instrument and is intended to be read before using the instrument for the first time.

In this manual front panel, keys and sockets are shown in capitals, e.g., ON, OFF. Text and messages displayed on the LCD are shown in a different font, e.g., Mode, Level.

The descriptions in this manual relate to using the instrument via the touch screen, alternatively, the hard keys and rotary knob can be used. See '*Navigation*' for details on how to use the instrument in this way.

This instrument provides the option to select an alternative colour theme for the display, all screenshots in this manual show the default theme. If an alternative theme is used, the instrument will still function in the same way, but displays may vary.

## Switching on

Connect the instrument to the AC supply using the mains lead provided.

Press the STANDBY button. At power up, the instrument displays the product name and firmware version whilst initialising the application.

Loading takes a few seconds, after which the home screen is displayed.

**WARNING**



To fully disconnect from the AC supply, unplug the mains cord from the back of the instrument or switch off at the AC supply outlet; make sure that the means of disconnection are readily accessible. Disconnect from the AC supply when not in use.

## Connecting the Load to the Source

The INPUT terminals of the load must be connected to the source to be tested using sufficiently low resistance and low inductance connections. Inductance in the interconnection can have a significant adverse impact on the stability of the source and load combination. The wiring should be as short and as thick as possible. It is essential that the voltage drop across the connecting leads is sufficiently less than the source voltage to leave enough working voltage across the load. This requirement must be met at the load input terminals even if external sensing is employed. The input terminals may be used for currents up to 24 Amps.

The load terminals of the instrument are floating from ground, and may be used at potentials of up to ± 300 Volts DC from ground. Connection to any AC mains circuit is not permitted. Ensure that all wiring is safely insulated for the working voltage involved.

**CAUTION**



The load has a diode across the input terminals that will conduct current if reverse polarity is applied to the load, even if the load input is disabled.

### Input Warning

The Input status line will display **WARN** when the load cannot achieve the desired level requested. This occurs when the power stage is in the minimum resistance condition, because the voltage available from the source is insufficient to maintain the current level required. The minimum resistance condition will occur either if the source is switched off and is not providing any voltage at all, or if the voltage drop across the connection leads is causing the actual input voltage at the load to be below its minimum operating level.

**NOTE**



If the source voltage is suddenly applied while the load circuit is in this state, then a current transient will probably occur.

### Trip Conditions

The unit detects (in hardware) the following fault conditions:

- Excessive difference between external and internal voltage sense values.
- Excessive heatsink temperature.
- Reverse current.

When any of these trip conditions occur the input is disabled and a pop up is displayed. If a reverse current is detected the unit will continue to show a popup until the reverse polarity is removed.

### External Voltage Sensing

The unit has the ability to remotely sense the external voltage via the front panel external sense inputs. When external sense is enabled, the front panel sense On/Off button will be lit and **EXT** will be displayed on the status line.

When the load is conducting current there will be a voltage drop in the connecting leads. In order to obtain the expected load characteristic in any mode other than Constant Current, external voltage sensing leads should be connected from the terminals of the source to the external sense inputs on the front panel of the load. In Constant Current (CC) mode external voltage sensing only improves the accuracy of the meter readings; it does not affect the behaviour of the load.

To avoid impact on the stability margin do not add phase shift in the sensing circuit; in particular, the use of decoupling capacitors should be avoided. If the sensing connections are likely to be subject to RF or magnetic fields, use twisted pair cable with an overall shield. The shield should be grounded or connected to load negative.

**CAUTION**



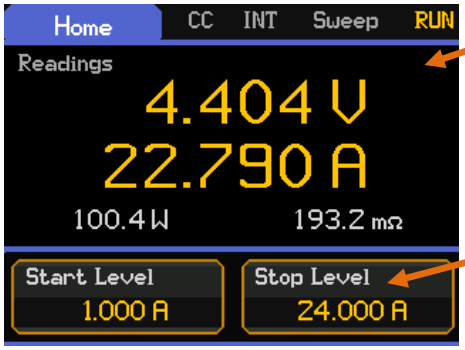
The instrument is designed to permit up to 4 Volts difference between internal and external sensing (in order to permit zero voltage operation using an offsetting battery); if external sense is enabled, but the sense terminals are not connected, the unit will not detect the fault condition until the source voltage exceeds this value. This can result in unexpected operation.

## Power and Current Limit

The unit continuously monitors the internal power dissipation and load current and varies the speed of the fan accordingly. If the dissipation or current rises above the limit of the given range selected, the digital feedback loop constrains and limits the power/current. If the feedback loop fails to constain the power/current (perhaps due to instability) the instrument still has the OCP and OPP protections in place.

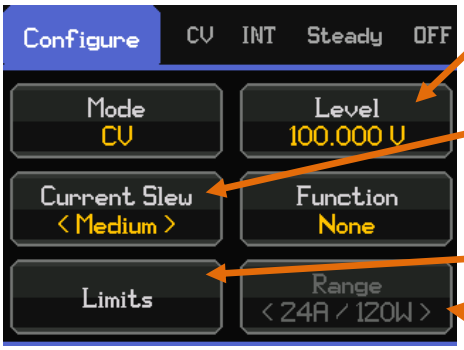
# Overview

## Home Screen




1. Displayed information.
2. Numeric field button – see *'Editing a numeric field button'* for more details.

## Menu Screen




3. Parameter- Displays the description in white and the set value of the field in yellow, press to edit via pop-up or numeric editing screen (see 8 below).
4. Parameter toggle- Displays the description in white and the set value of the field in yellow (with brackets), Press to toggle between the available options.
5. Menu Button- Press to navigate to a further menu.
6. Disabled/ Inactive- Text is greyed out if the action is not available.

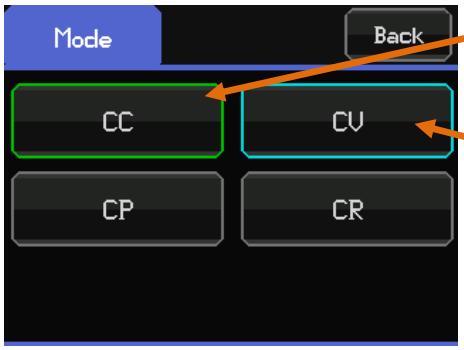
## Editing Screen (Numeric)




7. Back button- Press to return to the previous screen.
8. Numeric Field- See '

*Editing a* numeric field' for more details.

## Editing Screen (Selection)




9. Selected/ Active- Shows the currently selected option. Press to select the required option.
10. Highlighted- Shows the active position of the knob navigation position in blue.

### Status bar

The status bar is located at the top of the home and configuration screen, this contains information about the status of the instrument.




| Displayed text | Description |
|---|---|
| CC, CV, CP or CR | Active Mode. |
| Steady, Sweep, Pulse or Battery | Active Function. |
| INT or EXT | Sense selected. |
| ON, OFF, RUN or WARN | Input and trigger status. See 'Trigger' for more details. WARN is displayed when the load cannot achieve the desired level requested. |

## Initial operation

The user interface can be navigated using the touch screen, rotary knob, front panel keys or a combination of all three options.

Many settings can be made quickly and easily using the touch screen alone; the rotary knob is most useful when, for example, a parameter is being frequently increased or decreased during manual testing.

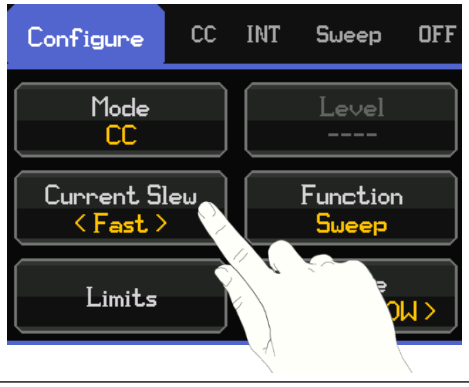
### Navigation

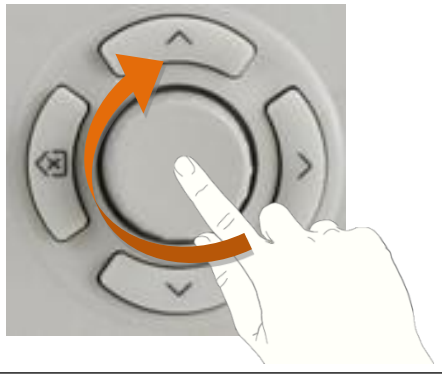
#### Navigation using touch

Touch to select the required button or field.

#### Navigation using the rotary knob and directional keys

Use the left and right arrow keys on the front panel or the rotary knob to highlight the field or button and press the knob to 'okay' the action. When an editable field is selected, adjustments can be made by turning the knob until the required value is selected. Press the knob to action the change.



## Editing a numeric field

All editable numeric fields can be identified by the orange border around the outside of the button. Pressing one of these buttons will activate the numeric field for editing via the encoder or numeric fields, as described below.

### Editing a numeric field using the keypad




When on the editing screen, the digits can be entered directly from the keyboard in any convenient units, e.g. 5.34A can be entered directly in A but can also be entered as 5340mA, press the mA or A unit entry buttons to set units and confirm entry.

The <x] key deletes the last digit that was entered and the Back key returns to the previous screen, leaving the load level unchanged.

Pressing the Revert button on the touch screen while in the editing state will return to the value as set on initial entry of the screen, this value is displayed on the button.

### Editing a numeric field using the rotary knob and directional keys

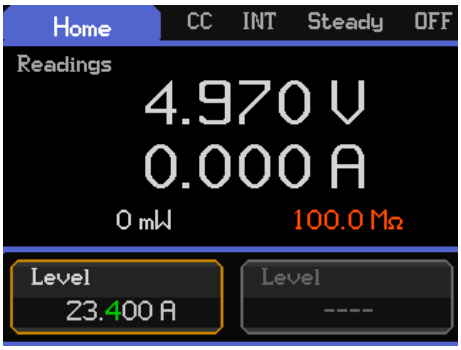



Select the editable field using the knob, press to enter the active editing state. Alternatively, jump straight to the editing state by touching the editable field.

Turning the rotary control will increment or decrement the numeric value in steps determined by the position of the edit cursor (green digit); the cursor is moved by one digit to the left or right using the directional keys. A further press of the knob will exit the editing mode. Alternatively, exit the editing state by touching the editable field.

Pressing the Revert button on the touch screen while in the editing state will return to the value as set on initial entry of the screen this value is displayed on the button.

### Editing a numeric field button




Numeric field buttons allow the parameter digits to be edited directly from the button. To edit, either touch the Level button and use the knob and directional keys to edit, or use the numeric keypad (described above).

# 6. CONFIGURING THE LOAD

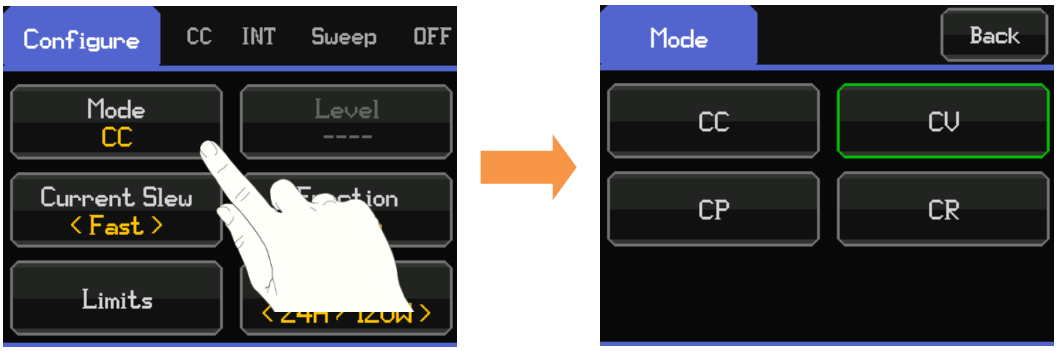
The normal sequence of operation is to select the load mode, set the required operating level, and then enable the input. The configure menu screen shows all the parameter settings, which can be viewed before the input is enabled. Press the [Cnfg] button to access the Configure menu.

**NOTE**

All parameters except load Mode can be adjusted as required while the input is enabled. Changing the load mode while the input is enabled will trip a fault detector and cause the input to be disabled before the change is implemented.

## Selection of Load Mode

The first action in configuring the unit for a particular application is to choose the load mode, which determines how the current drawn by the load varies with the applied voltage (V).




**NOTE**

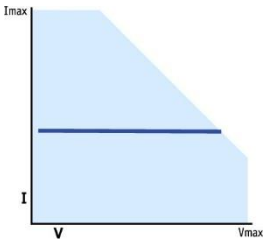
Changing the load mode while the input is enabled will trip a fault detector and cause the input to be disabled before the change is implemented.

The available operating modes are:

| | | |
|---|---|---|
| *CC* | Constant Current | The current is the Level setting, independent of voltage. |
| *CP* | Constant Power | Implements I = W / V where W is the Level setting. |
| *CR* | Constant Resistance | Implements I = V / R where R is the Level setting. |
| *CV* | Constant Voltage | The load sinks whatever current is necessary to maintain the terminal voltage equal to the Level setting. |

When sinking high currents, it is always recommended to use the external sense, to sense the voltage directly at the external source terminals.

## Constant Current (CC)



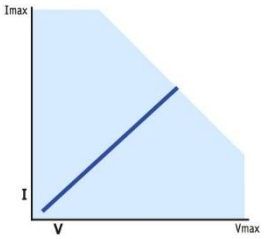

This is the fundamental operating Load mode of this instrument and has the simplest feedback loop. When set to Load Current, the ALD provides rapid measurement of power source regulation (V/I characteristics). The sensed voltage signal is only used for the meters and protection.

Constant current mode is normally used in conjunction with low impedance power supplies and will be quite stable unless there is significant inductance in either the interconnections or the source. It is critical to have low inductance connections in this mode.

**NOTE**

The load cannot be used in constant current mode to test a constant current power supply, as this combination has only two stable conditions: if the load setting is below the supply limit, then the supply will not be in constant current operation and will deliver its maximum output voltage, whereas if the load setting is above the limit of the supply, then the load will saturate at its minimum operating resistance with the supply delivering its designed current. The best way to test a constant current supply is to use the instrument in constant resistance mode.

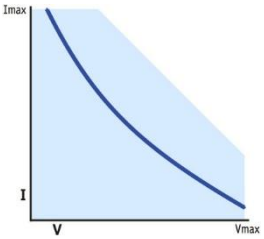
## Constant Resistance (CR)




Constant resistance mode simulates a standard resistive load by providing a current drain proportional to voltage. Unlike fixed resistors or rheostats, the load provides a precisely controllable resistance with high power dissipation and high temperature stability over a wide value range.

The current rises as the applied voltage rises at equivalent resistance settings. When rapidly changing the resistance level setting, the required current is inversely proportional to the linearly changing resistance value, so the resulting current waveform is very non-linear, changing rapidly at the low resistance part of the cycle. This rapid change accentuates the effect of inductance in the interconnecting leads and can easily lead to bottoming and overshoots. Resistance mode is best used at higher voltages and modest currents.

## Constant Power (CP)



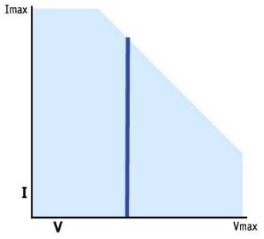

When Constant Power mode is selected, the ALD simulates a load where the power consumption is independent of the applied voltage. This is true of many types of equipment that incorporate switch-mode regulators. This mode may be particularly suitable for testing power sources of portable devices such as Lithium-ion batteries.

Constant Power mode is implemented by the very fast digital feedback loop, used to divide the specified power setting by the actual sensed voltage to calculate the necessary current. If the external source voltage falls, then the load will seek to keep the same power level by reducing its resistance to raise the current. The fact that the current rises as the voltage falls means that the load is acting as a negative resistance. This behaviour is also exhibited by most switch-mode power supply circuits.

This characteristic raises the possibility of a latch-up condition if the external source has a significant output impedance. To avoid immediately entering the latch-up condition, it may be necessary to reduce the slew rate setting to constrain the power demand while the source builds up its output voltage.

As Constant Power mode has the characteristics of a negative resistance, the possibility always exists of forming a negative resistance oscillator in combination with the output impedance of the external source. In practice, constant power mode normally operates well in conjunction with sources designed to supply such a load.

### Constant Voltage (CV)

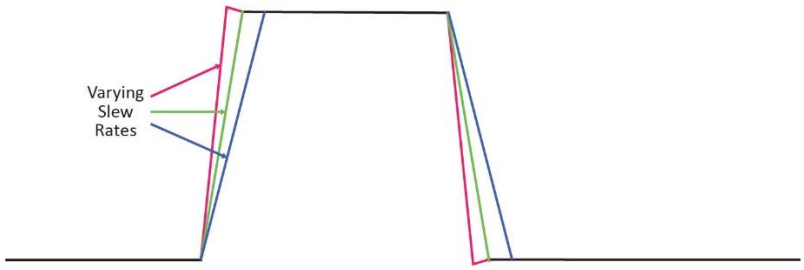



The behaviour required in Constant Voltage mode is the opposite of the fundamental operation of the power stages of the load, which are intrinsically a voltage independent current sink, so its digital feedback loop is implemented in an entirely different manner to all other modes. The difference between the sensed voltage and the required voltage is in effect integrated with a short time constant. The output of this integrator (which is, in effect, a guess at the current required) drives the power stages. The operation of this mode therefore depends entirely on feedback action.

Constant Voltage mode is more likely to exhibit instability than any other mode, especially when used in conjunction with electronically regulated sources. It is primarily useful with true wideband current sources which maintain their high output impedance at all frequencies. It will also operate satisfactorily with resistive sources of moderate impedance, such as photovoltaic cells.

The low frequency transconductance of the load (the change in load current caused by a small change in sensed voltage) is very high: many thousands of Amps per Volt. This combines with the output resistance of the source to produce a system with extremely high loop gain. High frequency instability can result in the normal way if the phase shift around the loop reaches the threshold for oscillation before the gain has rolled off below unity. Generally such oscillations will be roughly sinusoidal, at a frequency of many kHz. The ALD includes a series CR (Zobel) network across the load input, to help eliminate such instability. Alternatively, series resistance between source and load might be helpful. Sometimes instability can be avoided by setting the load threshold well below the open circuit output voltage of the source

## Slew Rate 'Current Slew'




This Slew Rate can be set to Fast, Medium or Slow.

Fast- No slew rate limiting is applied. The input load response is as fast as possible.

Medium- Slew rate limiting is applied to slow the input transition slightly. This is ideal to help reduce the risk of overshoot.

Slow- Significant slew rate limiting is applied. This can be is used when a slow transition is required or instability is of concern.

The slew rate applies to all changes in level whether caused by manual setting, adjustment using the knob, Pulse or sweep functions. It is also applied when the input is enabled, however when the input is disabled the load current is reduced to zero as fast as possible.

In many circumstances, a lower slew rate setting will be needed to avoid aberrations. If an attempt is made to set a slew rate faster than is possible in the circumstances, then overshoots and extended settling times can arise.

When utilizing the sweep or pulse functionalities it is recommended to set the slew rate setting to "Fast". This reduces the risk of the slew rate affecting the performance of either of the functions. For example, if the slew rate is set to "Slow" and the pulse width is set to be very fast then the transition will not complete before the level is updated. As a result, the intended level setting will never be reached.

In practice there are a number of limitations on the fastest slew rate actually attainable. One is the minimum transition time of the power stages of the load (which depends on the operating mode-see *'Error! Reference source not found.'*). The dynamic behaviour of a source and load combination at high slew rates depends on many factors, particularly interconnection inductance and the damping factor of feedback loops. In addition, the response of the power stages of the load is slower when operated at very low or high currents, or at low voltages. In many circumstances, a lower slew rate setting will be needed to avoid aberrations.

When the slew rate is set to "Fast" the response of the input transitions will increase as the current load increase, i.e. the higher the current the faster the response.

### Limits

The ALD has three digital trip protection limits. These are over voltage protection (OVP), over current protection (OCP) and over power protection (OPP). These limits specify values which will cause the load to automatically disable its input if the actual measured voltage, current or power exceeds the set limit. These are not independent hardware trips, but simple comparison against the meter measurements.

These trips react within : 2.5ms

The ALD also contains over temperature protection (OTP). The ALD monitors the temperature of the load FET power stages and will trip the input if the temperature exceeds an acceptable level.

The ALD can also detect reverse currents. If a reverse current is detected the unit will continue to show a popup until the reverse polarity is removed. If the input is enabled at the time, then the hardware will trip the output.

If any of the limits are exceeded a pop-up message is displayed and the load input is disabled.

### Level

Enter the desired level for the chosen mode.

**NOTE**



When either the Sweep or Pulse function is enabled this level is not used.

### Range

The range can be chosen to be either 24A / 120W or 2A / 40W. The default range is 24A / 120W which provides the full range of the instrument. The 2A / 40W range adds the benefit of an extra digit of current setting and measurement resolution and higher speed of response at low currents.

When in the 24A range the ALD will have a slower speed of response (slew rate) at lower currents compared to higher currents. In order to achieve high speeds of response at low currents then the 2A range should be selected.

# 7. ADVANCED FUNCTIONS

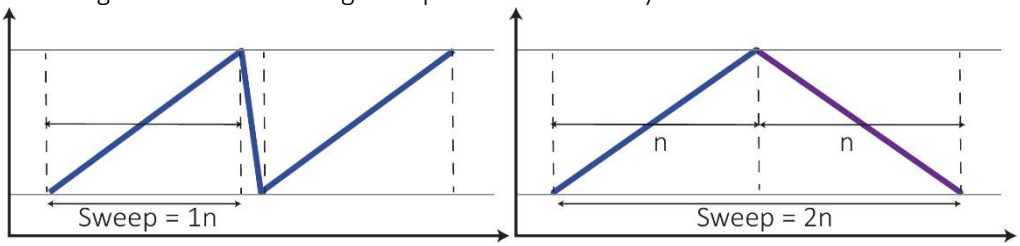
## Sweep Setup

All Sweep setup parameters can be checked and updated from the Sweep Setup menu. The Sweep function is turned on and off by selecting the <Off> button to show the active state as <On>. If any other function is set to On, it will automatically be switched Off.

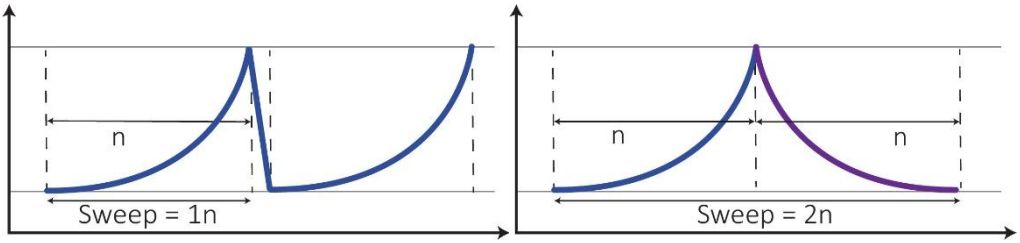



### Principles of Sweep Operation

All modes can be swept from the lowest level up to the maximum level for the selected mode and range. Although the level is stepped, not truly swept, the short step interval (50µs) gives a close approximation to an analogue instrument except for the widest sweeps in the shortest time. The levels are calculated and updated in real-time with full precision, following either a linear or log sweep law as selected by the user.




*Single Linear* *Dual Linear*




*Single Log* *Dual Log*

**NOTE**

The slew rate is still applied within sweep operation.

### Sweep Range

The Sweep range is defined by start and stop levels, which set the two end points of the sweep, these points are editable in the Sweep Setup menu. The Sweep function has the capability of sweeping either up or down in level; the sweep direction is determined by the sweep start and stop levels as the sweep will always run from the start level to the stop level.

### Time per Step

The sweep time defines the time-period per step. The sweep time can be set from 1ms to 1000s with 1ms resolution (100ms to 1000s in CV mode).

### Sweep Steps

The total number of steps within the sweep. The sweeps steps can be set from 2 to 1000.

### Sweep Slope

The Sweep function can be set to produce either a single or dual sweep.

Single: Produces a sweep from the start to the stop level.

Dual: Produces a sweep from the start to the stop level and sweeps back to the start level.

### Sweep Type

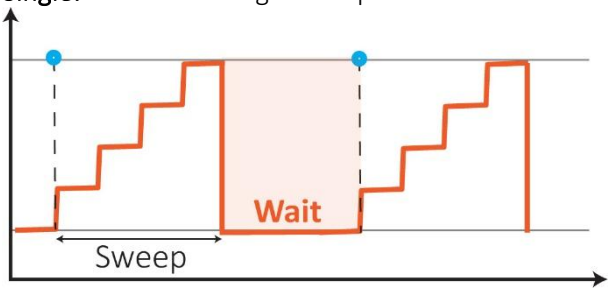
Sweep functionality can produce a swept input that follows either a linear or log sweep law as selected by the user.

### Sweep Triggering

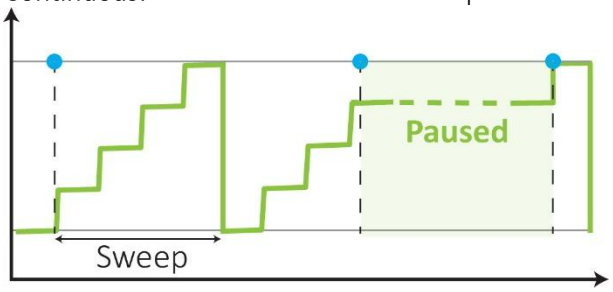
The Triggering mode is set in the menu, see '*Trigger*' for more details.

The trigger can be set to either a single or continuous mode.

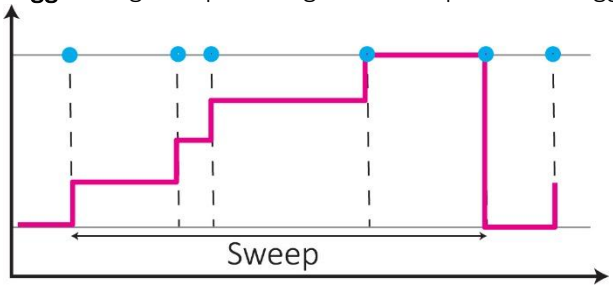
Single: Produces a single sweep from the start to the stop level.




Continuous: Produces continuous sweeps between the start and stop levels.




Toggle: Single steps through the sweep on each trigger.




Sweep is initialised by pressing the [Trigger] key.

If the trigger is set to Continuous and the input is Off, the input key will also activate the trigger when pressed.

Pressing the [Trigger] key whilst a continuous sweep is running will pause the running sweep, press the trigger button again to resume the running sweep.

Pressing the [Trigger] key whilst a single sweep is running will restart the sweep.

**NOTE**



The number of points in a dual sweep refers to the number of points from the start to the end. Hence the total number of points in a dual sweep will be double.

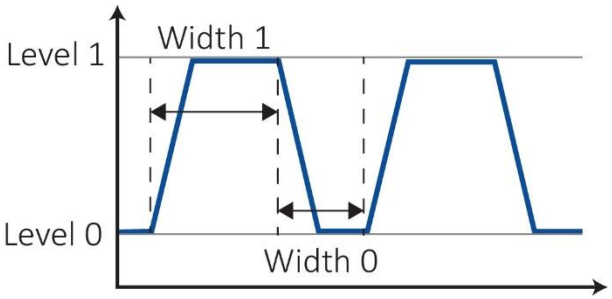
# Pulse

All Pulse setup parameters can be checked and updated from the Pulse Setup menu. The Pulse function is turned on and off by selecting the <Off> button to show the active state as <On>. If any other function is set to On, it will automatically be switched Off.




## Principles of Pulse Operation

All modes can be pulsed between two set levels with variable width control of both set levels.




**NOTE**

The slew rate is still applied within pulse operation.

## Pulse Width

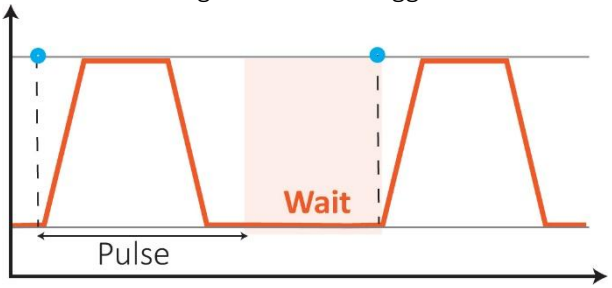
The pulse width time defines the time-period per pulse. The pulse width can be set from 100µs to 1000s with 100us resolution (100ms to 1000s in CV mode).

## Pulse Triggering

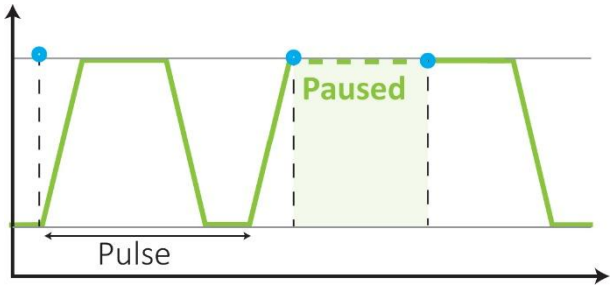
The Triggering mode is set in the menu, see '*Trigger*' for more details.

The trigger can be set to single, continuous or toggle mode.

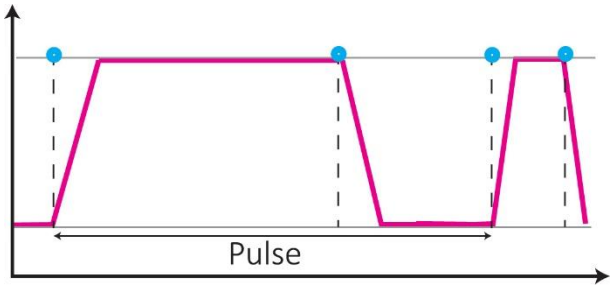
**Single:** Produces a single cycle of pulse 1. Pulse 1 stays at the defined level for the pulse width time defined. The input level then returns to Pulse Level 0 until the next trigger. Pulse width 0 is ignored in this trigger mode.



**Continuous:** Produces continuous pulses. Each pulse stays at the defined level for the pulse width time defined.




**Toggle:** Toggles between the two pulse levels. The pulse width is not used in this trigger mode.




Pulse is initialised by pressing the [Trigger] key.

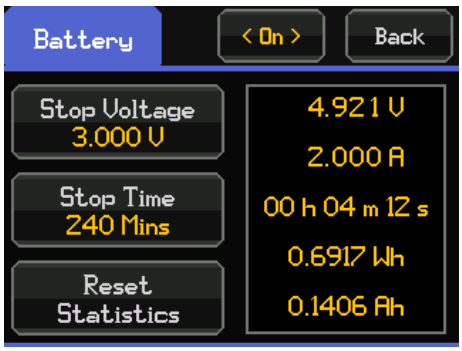
If the trigger is set to continuous and the Input is off, the input key will also activate the trigger when pressed.

Pressing the [Trigger] key whilst a continuous pulse is running will pause the running pulse, press the trigger button again to resume the running pulse.

Pressing the [Trigger] key whilst a single pulse is running will restart the pulse.

# Battery Setup

All Battery setup parameters can be checked and updated from the Battery Setup menu. The Battery function is turned on and off by selecting the <Off> button to show the active state as <On>. If any other function is set to On, it will automatically be switched Off.




## Principles of Battery Operation

This feature allows the characterisation of battery cell discharges and can be used in all load modes except constant voltage mode.

Whilst discharging a battery cell, the live battery cell capacity in both Watt hours and Amp hours are simultaneously shown on the battery setup display.

Start the discharge test by enabling the input which automatically initiates the timer and capacity meters. The live reading of elapsed test (discharge) time is shown on the display, allowing up to 100 hours with 1 sec resolution. Disabling the input during the test, simply pauses the test whilst retaining the cell capacity and elapsed time readings.

## Stop Voltage

A stop (cut-off) voltage can be set that will guarantee to disable the load input as soon as the sensed voltage drops below the cut-off voltage level, to help prevent over discharge of a battery cell. If the sensed voltage drops below the cut-off voltage level whilst the test is running then the test will be stopped (paused), the load input will be disabled, and the timer and capacity meters will be paused for review.

## Stop Time

A cut-off stop time can be set that will guarantee to disable the load input as soon as the elapsed time reaches the stop time defined to help prevent over discharge of a battery cell. If the elapsed test time reaches the defined cut-off stop time then the test will be stopped (paused), the load input will be disabled, and the timer and capacity meters will be paused for review.

## Reset Statistics

Reset the battery cell capacity statistics and elapsed test time ready for the next test.

# 8. APPLICATION NOTES

This chapter is intended to give helpful information concerning practical applications of the unit. All electronic loads are subject to the impact of source characteristics, interconnection inductance and feedback loop characteristics, which can give rise to unexpected instability or poor dynamic behaviour. The information given here will assist in understanding the factors involved.

## Sources

Batteries are a low impedance source and, apart from the possibility of inductance in the interconnecting leads, they are generally easy to use in conjunction with an electronic load. The stop voltage facility within the battery operation should be used to protect batteries from being damaged by excessive discharge.

Electronic supplies have active feedback networks whose dynamic characteristics often interact with the load. When that load (like this instrument) also includes an active feedback controlled network, whose dynamic characteristics in turn depend on the nature of the source, it will be apparent that the behaviour of the resulting system can be impossible to predict.

### Source resistance

If a source has significant resistance (including the resistance of the connecting leads), so that the voltage falls as the current rises, it is important to ensure that the voltage across the load terminals remains at all times above the minimum permissible operating voltage.

The particular considerations concerning source resistance which apply in Constant Power mode are discussed in the section covering that mode below.

### Source inductance

Source and interconnection inductance has a major impact on the behaviour of the load: the fundamental characteristic of an inductance is that it generates an emf to oppose any change in current. As the current rises, the emf generated by the inductance reduces the voltage across the load terminals, perhaps to the point where the load saturates. Possibly giving rise to overshoots or even oscillation.

Whenever the load current falls, the inductor will generate a voltage transient which might exceed the voltage rating of the load. The unit is fitted with a varistor designed to absorb non-repetitive transients up to 75 Joules, but repetitive energy up to only 1 watt. Even if the overvoltage detector disables the load input, the varistor remains connected, so if either of those energy limits is likely to be exceeded then some form of external protection must be added, such as a catching diode across the inductor in the source.

### Shunt capacitance

The load can only sink current, so it can only pull the voltage at its terminals down. The source must pull the voltage up, including providing charging current to any capacitance across the terminals. If the total current available is more than sufficient to charge this capacitance at the slew rate required, then the load will continue to conduct the excess current during the transition and the behaviour will be as expected. However, if the source cannot charge the capacitor at the required slew rate, then the load will cut-off until the final voltage is reached. There will then be an overshoot as it starts to conduct, followed by a ringing as the source responds.

## Stability of Source and Load Combinations

This instrument is optimised for accuracy under constant load conditions by using a high gain feedback loop. Because of this, the possibility exists for combinations of source, interconnection and load characteristics to give rise to instability. There are three major potential causes: inductance in the wiring between source and load (or an inductive output impedance of the source), capacitance in parallel with the connection between source and load (including an output capacitor within the source) and the characteristics of active feedback circuits within the source.

In general, Constant Current mode is the most likely to be stable, but in some cases instability can be avoided by using a different mode. The conditions that affect the dynamic behaviour of the load in transient operation also lead to instability, and some of the suggestions in the sections below may be found helpful.

Constant voltage mode operates in a completely different way, by integrating the voltage error to create a value for the current demand. This results in a system with extremely high gain and significant potential for instability.

Many supplies have L-C output filters to reduce noise; these introduce extra phase shift into the overall source and load combination and can increase the possibility of instability. If there is no damping across the inductor, a resonant circuit can be formed which allows oscillations to build up to significant amplitude.

### Remedial Actions

If instability arises, observe the voltage waveform across the load with a scope: if at any point the voltage rises above the open circuit emf of the source, then there must be an inductive element present to form a resonant circuit. Some means must be found to insert damping into this circuit.

## Dynamic Behaviour in Transient Operations

When the transient capabilities of the load are used, the dynamic behaviour of the source and load combination during the transitions depends on similar considerations to those affecting stability: series inductance, shunt capacitance and feedback loop characteristics. Proper operation depends on the load neither saturating nor cutting off at any point in the cycle. The faster the slew rate sought, the more likely it is that aberrations will occur on the transitions.

Because of changes in the transconductance of the FETs, the dynamic behaviour of the power stages changes at both low and high currents, and also at low voltages when the inter-electrode capacitance increases considerably. In general, behaviour is optimum in the middle of the current range and at voltages between about 3 volts and (if there is significant source impedance) about 3 volts below the open circuit voltage of the source.

Attempting to achieve a slew rate beyond the capabilities of a source and load combination can result in substantial overshoot and ringing. Reducing the slew rate will often improve the response considerably.

### Source Characteristics

The purpose of transient testing is to examine the behaviour of any feedback loops within the source. If the response of the source is under-damped, then in general the use of an active load will accentuate the effect. This is particularly true in the modes where the load responds to changes in voltage. At particular transient frequencies (particularly higher frequencies) the load may excite resonances in L-C filters or match the natural frequency of

a feedback loop. This can result in considerable reaction from the source, possibly to the extent of causing damage.

Mechanical generators have substantial inductance, mechanical inertia and slow response times. Transient response testing of such sources should only be attempted at low slew rates.

## Start-up transients

There are two different start-up conditions to consider depending on whether the source or the load is switched on first.

If the source is switched on first and the load enabled afterwards then the start-up may have a small transient, but this will not generally exceed the magnitude of the Level setting, except at very low current settings (below a few Amps). This transient can be controlled by selecting a slower Slew Rate.

In the other case, when the load is enabled before the source is switched on, much larger transients can be generated. The reason for this is that as soon as the load is enabled the internal feedback loop will attempt to conduct the current demanded by the level setting. In the absence of a source voltage this will result in the gate drivers applying maximum bias voltage to the power FETs, reducing their resistance to minimum (<30mΩ) in an attempt to force a current to flow. This is the condition that produces the warning on the status line of the display. When the source is switched on and starts to produce a voltage it will initially see this 30mΩ load, which will cause a significant current transient until the feedback loop has time to respond and reduce the bias on the FETs. One solution might be to use Constant Resistance (CR) mode, when zero source voltage should cause zero current to flow.

If it is desired to test the start-up behaviour of a power supply, the best approach is to use a small auxiliary supply to pre-bias the load into conduction, together with series isolating diodes to cause the load current to transfer from this bias supply to the supply under test when it starts to produce its output voltage.

## Multiple Unit Operation

It is possible to operate two loads in parallel in Constant Current mode, which will double both the current handling and power dissipation capability of a single unit. The connections to the source should be matched as well as possible.

**NOTE**



Additional stability issues may arise, because of phase response differences between the units; the use of more than two units in parallel is not recommended. Multiple unit operation should not be attempted in any operating mode other than Constant Current.

## Zero Volt Operation

Although this unit is designed with very low internal resistance (less than 30mΩ) to enable operation down to low voltages at high currents, there are occasions when a load is needed capable of conducting the full current down to zero voltage. This can be achieved by connecting an additional voltage supply in series with the source under test to boost the voltage at the input to the load. It is strongly recommended that a diode should also be included (in series) in the circuit, to ensure that reverse current cannot flow.

The additional supply must be capable of providing the full load current and must have a dynamic performance that does not impair the stability of the combination. If possible, the use of batteries is recommended, but note that the direction of the current discharges the battery, so care must be taken to avoid full discharge.

External voltage sensing must be used, with the sense leads connected to the actual source under test. The additional supply must provide a voltage of at least the minimum operating voltage of the load (at the current concerned), plus any voltage drop in the inter-connections, but the maximum voltage permitted by the external sense circuit is 4 Volts.

**NOTE**



If the circuit does not include the series diode recommended, then it is possible for the combination of the additional supply and the load (in a low impedance condition) to apply a reverse voltage to the source under test. It is strongly recommended that a switch, capable of disconnecting the full load current, should be included in the circuit.

**CAUTION**



The load has a diode across the input terminals that will conduct current if reverse polarity is applied to the load, even if the load input is disabled.

# 9. UTILITIES MENU




## Power On

The state in which the instrument will power on can be toggled between Last Settings and Defaults. To change the Power-on state, press the Power-on State button.

Last Settings: Instrument will automatically load the settings that the unit was powered down with.

Defaults: Unit will power up with the default values- see '*Default Values*' for more information.

## Buzzer

A buzzer is incorporated that produces a 'beep' when a touch button is pressed, or an error occurs. By default, the buzzer is disabled <Off>. This can be enabled by pressing the Buzzer button to show <On> as the status.

## Store/ Recall




6 memory slots are provided, allowing the user to store and recall the settings for the instrument.

To save a setup, select the Store menu by pressing the Store tab (1), then press any Slot button (2), a pop-up will appear asking to confirm the store. Press OK to save the file.

To load a setup, select the recall menu by pressing the Recall tab (3), then press the required Slot button (2), a pop-up will appear asking to confirm the Recall. Press OK to recall the file.

Slots that have data saved to them will have Saved as the status, otherwise Empty is shown. Slots can be overwritten with new data at any time.

## Reset Defaults

This function can be used to return most of the instrument settings back to the factory default values as listed in '***Error! Reference source not found.***' The Store memories are unaffected. Press the Reset Defaults button to reset, a pop-up will appear asking to Confirm Reset Defaults.

## Display Settings

### Theme




A range of colour themes are available, each providing a different coloured base for the user interface. Press the Theme button repeatedly to scroll through the options, the user interface colour will change to preview the colour theme. The default theme is Blue.

<Blue> // <Orange> // <Green> // <Pink> // <Light> // <Classic>

### Backlight

To adjust the brightness of the display, press the Backlight button and select from the options.




## Trigger

The behaviour of the trigger will vary depending on what function is active, see *'Advanced functions'* for more details.

The trigger options are Single, Continuous or Toggle. The function is initialised by pressing the [Trigger] key. When the function is actively running RUN will be shown on the status bar. If the trigger is set to continuous and the Input is off, the input key will also activate the trigger when pressed.

**NOTE**

Functions are activated using the On/Off buttons in the specific function menus. It must be set to ON before the function will run using the [Trigger] key. See *'Function'* for further details.

# 10. REMOTE OPERATION

## General

### Remote and Local Operation

At power-on, the instrument will be in the local state. In this state, all front panel operations are possible. When the instrument receives a command from an interface the remote state will be entered, and the Remote LED will illuminate. In this state the front panel and touch control is disabled. The instrument may be returned to the local state by pressing the[Home] key; however, the effect of this action will only remain until the instrument receives another character from the interface, when the remote state will once again be entered. Returning to Local by this action will keep the settings at their last remotely set values.

## Remote Interface Configuration

The ALD1120 can be remotely controlled via its USB connection.

The USB interface enumerates as a Communications Class device and interacts with application software through a standard virtual COM port device driver on the PC. The instrument firmware can be updated in the field via the USB port; see *'Firmware Update'* for more details.

## USB Interface

Using the USB interface for remote control requires a Communications Device Class driver on the PC to provide a virtual COM port instance.

Windows 10 and later will automatically install a suitable driver. In earlier versions of Windows, a suitable driver is provided by Microsoft, but it is not installed by default. The data (.INF) file to control the installation is provided on the website: www.aimtti.com

If required, unzip the contents of the downloaded USB driver.

**NOTE**



The same driver is also used by many other TTi instruments and may already be known to the PC.

### Installing USB driver for the first time

To install the driver for the first time:

- First switch the unit On.
- Then connect the USB port to PC.

**NOTE**



In Windows 10 or later, the driver is automatically installed by the operating system.

The Windows plug and play functions should automatically recognise the attachment of new hardware to the USB interface and (possibly after searching the internet for some time) prompt for the location of a suitable driver.

Follow the Windows prompts and point to the downloaded driver file named USB_ARM_VCP_xxx.INF, where xxx is a version number.

In some cases, Windows will not complete this procedure (especially recent versions which search the internet first, looking for the unique Vendor ID and Product ID), in which case the instrument will show in Device Manager as “not working properly”. If this happens, select this device, right click, and choose “update driver software...”, followed by: “browse this computer for driver software...”; then locate the downloaded .INF file.

Once Windows has installed the device driver it will assign a COM port number to this particular unit. This number will depend on previous COM port assignments on this PC, and it may be necessary to use Device Manager to discover it. Each instrument has a unique USB identifier which is remembered by the system, so it will receive the same COM port number whenever it is attached to the same PC (regardless of the physical interface socket used), even though the COM port will disappear while the instrument is disconnected or switched off. Other instruments will receive different COM port numbers.

**NOTE**



A different PC will not necessarily assign the same COM port number to a particular instrument (it depends on the history of installations). Device Manager can be used to change the assignments given.

### Command Timing

There are no dependent parameters, coupled parameters, overlapping commands, expression program data elements or compound command program headers.

All commands are separate and sequential and are executed when parsed and immediately considered complete. To provide useful functionality, the Operation Complete bit (bit 0) in the Standard Event Status Register is only ever set by the *OPC command. Either the *OPC command or the *OPC? query can be used for device synchronisation due to the sequential nature of remote operations.

## Status Reporting

Error status is maintained using a set of registers; these are described in the following paragraphs and shown on the Status Model at the end of this section. Not all bits or registers are used in this product, see *ALD1120 Status Model* for more details.

### Standard Event Status and Standard Event Status Enable Registers (ESR/ESE)

Any bits set in the Standard Event Status Register which correspond to bits set in the Standard Event Status Enable Register will cause the ESB bit to be set in the Status Byte Register.

The Standard Event Status Register is read and cleared by the *ESR? command. The Standard Event Status Enable register is set by the *ESE<NR1> command and read by the *ESE? command.

On power up this register is set to 0 for all interface instances.

Bit 7 Set when power is first applied to the instrument.

Bit 6 User Request (Not used).

Bit 5 Set when a syntax type error is detected in a command from the bus. The parser is reset and parsing continues at the next byte in the input stream

| | |
|---|---|
| Bit 4 | Set when an error is encountered while attempting to execute a completely parsed command. The appropriate error number will be reported in the Execution Error Register. |
| Bit 3 | Not used. |
| Bit 2 | Set when an error occurs. The appropriate error number will be reported in the Query Error Register, see 'Error messages' section. |
| Bit 1 | Not used. |
| Bit 0 | Set in response to the '*OPC' command |

## Status Byte Register (STB/SRE)

The Status Byte Register is read either by the *STB? command, which will return MSS in bit 6, or by a Serial Poll which will return RQS in bit 6.

On power up this register is set to 0 for all interface instances.

| | | |
|---|---|---|
| Bit 7 | OPEN | This bit is set if any bits in the STATus:OPERation:CONDition register correspond to bits set in the STATus:OPERation:ENABle register. |
| Bit 6 | RQS/ MSS | This bit, as defined by IEEE Std. 488.2, contains both the Requesting Service message and the Master Status Summary message. RQS is returned in response to a Serial Poll and MSS is returned in response to the *STB? command. |
| Bit 5 | ESB | This bit is set if any bits set in the Standard Event Status Register correspond to bits set in the Standard Event Status Enable Register. |
| Bit 4 | MAV | This will be set when the instrument has a response message formatted and ready to send to the controller. The bit will be cleared after the Response Message Terminator has been sent. |
| Bit 3 | | Not used. |
| Bit 2 | EAV | Error Queue is not empty. This will be set when there is one or more entries in the error queue. |
| Bit 1 | | Not used. |
| Bit 0 | INST | Set when a limit/trip has been detected on any of the channels from operation instrument summary register (OISR). |

## Operation Instrument Summary Register (OISR/OISE)

Any bits set in the Operation Instrument Summary Enable registers which correspond to bits set in the Operation Instrument Summary Register will cause the INST bit to be set in the Status Byte Register.

The Operation Instrument Summary Register is read and cleared by the OISR? command. The Operation Instrument Summary Enable register is set by the OISE <NR1> command and read by the OISE? command.

It is a bit field where each bit has the following significance.

On power up this register is set to 0 for all interface instances.

| | |
|---|---|
| Bit 15 | Reserved for future use |
| Bit 14 | Reserved for future use |
| Bit 13 | Reserved for future use |
| Bit 12 | Reserved for future use |
| Bit 11 | Summary of ETR4 and ETE4 registers |
| Bit 10 | Summary of ISR4 and ISE4 registers |
| Bit 9 | Summary of CSR4 and CSE4 registers |
| Bit 8 | Summary of ETR3 and ETE3 registers |
| Bit 7 | Summary of ISR3 and ISE3 registers |

Bit 6 Summary of CSR3 and CSE3 registers
Bit 5 Summary of ETR2 and ETE2 registers
Bit 4 Summary of ISR2 and ISE2 registers
Bit 3 Summary of CSR2 and CSE2 registers
Bit 2 Summary of ETR1 and ETE1 registers
Bit 1 Summary of ISR1 and ISE1 registers
Bit 0 Summary of CSR1 and CSE1 registers

### Channel Status and Channel Status Enable Registers (CSR/CSE)

Their purpose is to inform the controller of entry to and/or exit from any conditions since the last read.

Any bits set in the Channel Status Register (CSR<N>) which correspond to bits set in the Channel Status Enable register (CSE<N>) will cause the CSR<N> bit to be set in the Operation Instrument Summary Register, where <N> is 1 for output 1.

The Channel Status Register is read and cleared by the CSR<N>? command. The Channel Status Enable register is set by the CSE<N> <NR1> command and read by the CSE<N>? command.

On power up this register is set to 0 for all interface instances.

Bit 15 Reserved for future use
Bit 14 Reserved for future use
Bit 13 Reserved for future use
Bit 12 Reserved for future use
Bit 11 Reserved for future use
Bit 10 Reserved for future use
Bit 9 Reserved for future use
Bit 8 Reserved for future use
Bit 7 Reserved for future use
Bit 6 Reserved for future use
Bit 5 Reserved for future use
Bit 4 Set when output modulation is enabled
Bit 3 Set when output is clipped.
Bit 2 Set when output enters power limit (unregulated mode)
Bit 1 Set when output enters current limit (constant current mode)
Bit 0 Set when output enters voltage limit (constant voltage mode)

### Input State Register (ISR/ISE)

The bits in the Input State Register continually reflect the present state of the condition they report. The register can be read by the ISR? query, but this does not change the state of the contents. On power-up it is normally set to 1 (input disabled), unless the power up option on the Utilities menu has been set to retain the previous state.

Bit 15 Reserved for future use
Bit 14 Reserved for future use
Bit 13 Reserved for future use
Bit 12 Reserved for future use
Bit 11 Reserved for future use
Bit 10 Reserved for future use
Bit 9 Reserved for future use
Bit 8 Reserved for future use
Bit 7 Reserved for future use

| | |
|---|---|
| Bit 6 | Reserved for future use |
| Bit 5 | Low Voltage Limiting Event |
| Bit 4 | Duty cycle protect: Set in 2.5ms mode if the permitted power and time limit is exceeded. If no action is taken, an Over Power Protect Trip will follow 10 seconds later. |
| Bit 3 | The load is not conducting current because the source voltage is below the dropout voltage setting. |
| Bit 2 | The load is not conducting the current expected because the power limit circuit is restricting it. |
| Bit 1 | The load cannot conduct the current required because there is insufficient voltage from the source. |
| Bit 0 | Reports the present state of the input enable setting. |

### Event Trip Register (ETR/ETE)

Their purpose is to inform the controller of entry to and/or exit from any conditions since the last read.

Any bits set in the Event Trip Register (ETR<N>) which correspond to bits set in the Event Trip Enable register (ETE<N>) will cause the ETR<N> bit to be set in the Operation Instrument Summary, where <N> is 1 for output 1.

The Input State Register is read and cleared by the ETR<N>? command. The Input State Enable register is set by the ETE<N> <NR1> command and read by the ETE<N>? command.

On power up this register is set to 0 for all interface instances.

| | |
|---|---|
| Bit 15 | Reserved for future use |
| Bit 14 | Reserved for future use |
| Bit 13 | Reserved for future use |
| Bit 12 | Reserved for future use |
| Bit 11 | Reserved for future use |
| Bit 10 | Set when a reverse current trip occurs |
| Bit 9 | Set when a Powerflex event trip occurs. |
| Bit 8 | Set when a low voltage event trip occurs. |
| Bit 7 | Set when a high power event trip occurs. |
| Bit 6 | Set when Triplink event occurs. |
| Bit 5 | Set when hardware fault event occurs. |
| Bit 4 | Set when sense trip event occurs. |
| Bit 3 | Set when OTP event trip occurs. |
| Bit 2 | Set when OPP event trip occurs. |
| Bit 1 | Set when OCP event trip occurs. |
| Bit 0 | Set when OVP event trip occurs. |

### Execution Error Register

This register contains a number representing the last error encountered over the current interface. The Execution Error Register is read and cleared using the ‘EER?’ command. On power up this register is set to 0 for all interface instances.

Error messages have the following meaning:

| | |
|---|---|
| 0 | No error encountered |
| 101 | Command error |
| 103 | Data out of range |
| 104 | Command execution error. The command is valid but a parameter is invalid or the not valid in the current circumstances. |

## Operation Status Register

Any bits set in the Operation Status Enable register which correspond to bits set in the Operation Status Register will cause the OPEN bit to be set in the Status Byte Request Register.

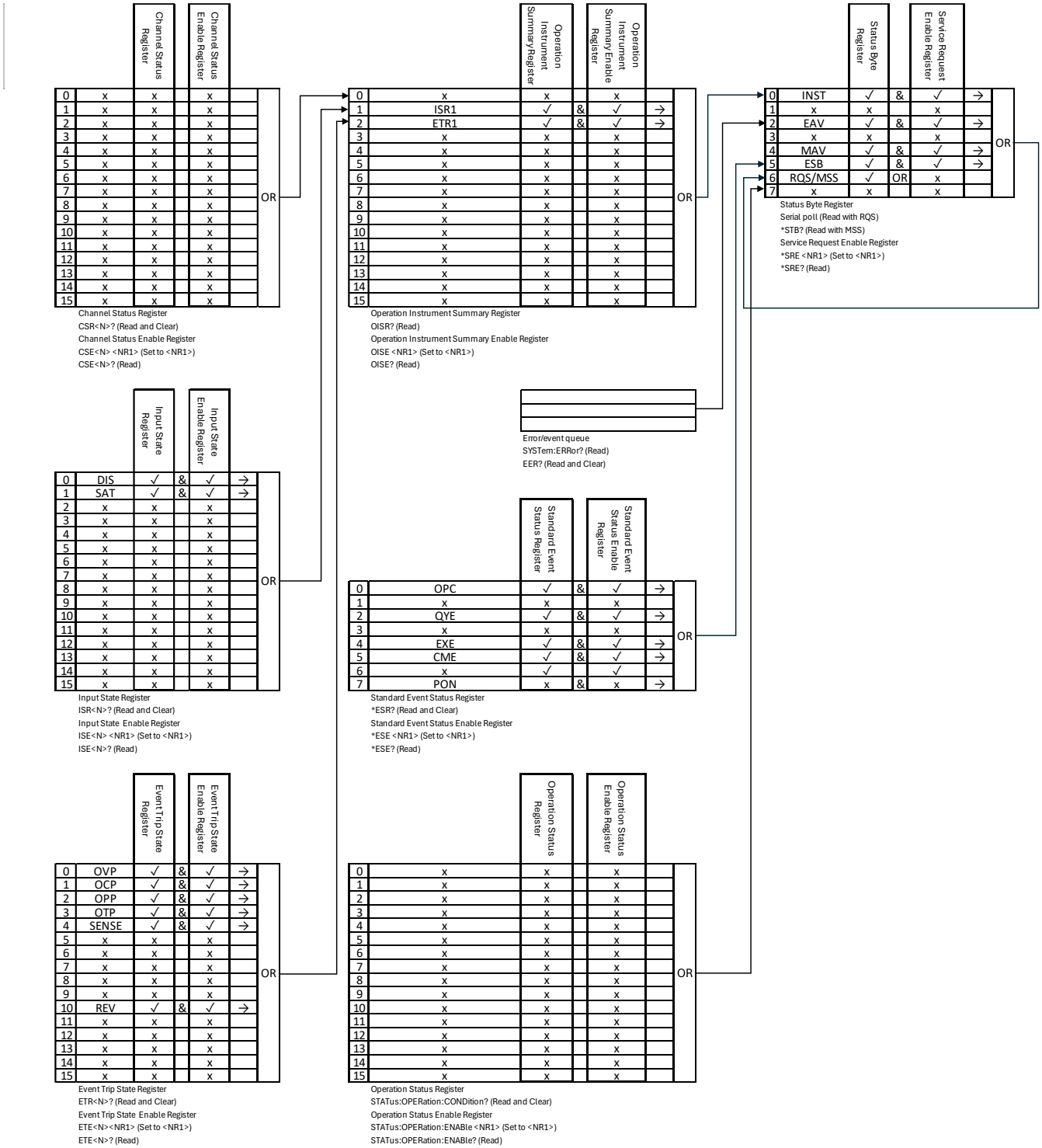
The Operation Status Register is read and cleared by the STATus:OPERation:CONDition? command. The Operation Status Enable register is set by the STATus:OPERation:ENABle <NR1> command and read by the STATus:OPERation:ENABle? command.

On power up this register is set to 0 for all interface instances.

### STATus:OPERation:CONDition / STATus:OPERation:ENABle

| | |
|---|---|
| Bit 15 | Reserved for future use |
| Bit 14 | Reserved for future use |
| Bit 13 | Reserved for future use |
| Bit 12 | There are measurements available in the buffer. |
| Bit 11 | Sequence mode running. |
| Bit 10 | Sequence mode currently active. |
| Bit 9 | Trigger in global pin detected. |
| Bit 8 | Set when the current calibration or test failed. |
| Bit 7 | Set when the instrument is currently performing a correction. |
| Bit 6 | Set when the instrument is in a “wait for arm” state of the trigger model. |
| Bit 5 | Set when the instrument is in a “wait for trigger” state of the trigger model. |
| Bit 4 | Set when the instrument is actively measuring. |
| Bit 3 | Set when a sweep is in progress. |
| Bit 2 | Set when the instrument is currently changing its range. |
| Bit 1 | Set when the instrument is waiting for signals it controls to stabilize enough to begin measurements. |
| Bit 0 | Set when the instrument is currently performing a calibration. |

## ALD1120 Status Model



# 11. SCPI COMMANDS

## SCPI Overview

This instrument uses SCPI (Standard Commands for Programmable Instruments) commands for remote control. The commands are based on SCPI Version 1999 and follow the syntax and rules including commands that are not taken from the SCPI standard. These commands are separated into two groups: common and subsystem.

Common commands are defined by the IEEE 488.2 standard to perform common instrument functions such as querying the status or resetting to default parameters.

Subsystem commands perform instrument specific functions and allow all operating parameters to be configured and queried. They are arranged in groups which correspond to particular functionality of the instrument. A tree structure is used extending to one or more levels below the root.

Square brackets ([ ]) are used to represent a keyword that is optional for the command. Uppercase letters are used to differentiate between the short and long form version of keywords.

**EXAMPLE**



The following command is used to set the start level of a sweep to 5:

[SOURce:]SWEep:LEVel:STARt 5.000

The above command can also be executed in below listed formats and they all will set the start level to 5W in this case.

SOUR:SWE:LEV:STAR 5.000

SWE:LEV:STAR 5

Multiple SCPI commands can be combined into a single message using a semicolon as separator.

**EXAMPLE**



The combined message below will set the start level of a sweep to 5 and the stop level to 20. Using these commands:

[SOURce:]SWEep:LEVel:STARt <NRF>

[SOURce:]SWEep:LEVel:STOP <NRF>

you can send any of the following to get the same result:

SOURce:SWEep:LEVel:STARt 5;:SOURce:SWEep:LEVel:STOP 20

SOUR:SWE:LEVel:STAR 5;:SOUR:SWE:LEV:STOP 20

SOUR:SWE:LEVel:STAR 5; STOP 20

The colon : character after ; in the above example is used to reset the SCPI parser to the root level. If the multiple commands in a single message are from the same SCPI subsystem then the colon may be omitted. A message terminator (typically a ‘new line’ character) completes the message and resets the current path to the root.

### Sweep SCPI Example

**EXAMPLE**



This example shows how to set and start a sweep using SCPI commands.

| | |
|---|---|
| · Reset to defaults. | *RST |
| · Select constant power mode | [SOURce:]MODe CP |
| · Set the sweep start level to 5W | [SOURce:]SWEep:LEVel:STARt 5 |
| · Set the sweep stop level to 20W | [SOURce:]SWEep:LEVel:STOP 20 |
| · Set the sweep time to 1 second per step | [SOURce:]SWEep:TIMe 1 |
| · Set the number of sweep steps to 20 | [SOURce:]SWEep:STEPs 20 |
| · Set the sweep slope to dual | [SOURce:]SWEep:SLOPe DUAL |
| · Set the sweep to be linear | [SOURce:]SWEep:TYPe LINear |
| · Enable function sweep | [SOURce:]FUNCtion SWEep |
| · Turn the input on.<br>The sweep is triggered when the input is turned on. | [INPut:]STATe 1 |

## Parameter Data Format

| | |
|---|---|
| <NR1> | Digits with no fractional part, i.e., an integer Example: 451 |
| <NR2> | Digits with an explicit decimal point. Example: 0.451 |
| <NR3> | Digits with an explicit decimal point and an exponent. Example: 45.1e+01 |
| <NRF> | A number in any format. Example: 12, 12·00, 1·2 e1 and 120 e-1 are all accepted as the number 12 |
| <CPD> | <CHARACTER PROGRAM DATA>, i.e., a short mnemonic or string such as ON or OFF. Multiple CPDs in a command are shown as <CPD1>, <CPD2>, <CPD3>, etc. |
| <CRD> | <CHARACTER RESPONSE DATA> Returns a short mnemonic or string. Only the short form of the parameter is returned. |
| <Bool> | Boolean data. Example: 0 \| 1 or ON \| OFF |
| <Quad> | A number in dotted quad notation. |
| <Unquoted String> | String data without any quotation. |

## SCPI Subsystems

| | |
|---|---|
| :SOURce | The SOURce subsystem contains the commands for configuring instrument setup. |
| :INPut | The INPut subsystem configures the input signal state. |
| :OUTPut | The OUTPut subsystem configures the output signal state. |
| :LIMit | The LIMit subsystem configures the limits. |
| :MEASure | The MEASure subsystem returns the measurement. |
| :STATus | The STATus subsystem is used to query the Operation Condition Register. |
| :SYSTem | The SYSTem subsystem is used for a number of functions not associated with the instrument setup, such as configuring the trigger. |

## Query commands

All commands (with the exception of any set in Orange) can be presented as a query command by adding '?' at the end, this will return the current set value or parameter as <...> Commands set in Blue are query only.

## Global

*IDN?

Query the instrument identification. The exact response is determined by the instrument configuration and is of the form of <Manufacturer, Model, Serial No., XX.xx>

FW?

Query the instrument firmware versions.

### Status

*STB?

Query the value of the Status Byte register in <NR1> numeric format. The response is <NR1>. See Status reporting section for details.

*SRE <NR1>

Set or return the Status Byte Enable register in <NR1> numeric format. The query response is <NR1>. See Status reporting section for details.

OISR?

Query the Operation Instrument Summary Register in <NR1> numeric format. The response is <NR1>. See Status reporting section for details.

OISE <NR1>

Set or return the Operation Instrument Summary Enable register in <NR1> numeric format. The query response is <NR1>. See Status reporting section for details.

CSR1?

Query the value of the Channel Status Register in <NR1> numeric format. The response is <NR1>. See Status reporting section for details.

CSE1 <NR1>

Set or return the value of the Channel Status Enable register in <NR1> numeric format. The query response is <NR1>. See Status reporting section for details.

ETR1?

Query the value of the Event Trip Register in <NR1> numeric format. The response is <NR1>. See Status reporting section for details.

ETE1 <NR1>

Set or return the value of the Event Trip Enable register in <NR1> numeric format. The query response is <NR1>. See Status reporting section for details.

ISR1?

Query the value of the Input State Register. The register reflects the state of the conditions within the register. Reading the register does not change the state of the contents. See Status reporting section for details.

ISE1 <NR1>

**Set** or return the value of the Input State **Enable** register in <NR1> numeric format. The query response is <NR1>. See Status reporting section for details.

EER?

**Query** the most recent error number. The response is <NR1>.

*ESR?

**Query** the value in the Standard Event Status Register in <NR1> numeric format. The register is then cleared. The response is <NR1>. See Status reporting section for details.

*ESE <NR1>

**Query** the value in the Standard Event Status **Enable** register in <NR1> numeric format. The response is <NR1>. See Status reporting section for details.

*OPC

**Set** the Operation Complete bit (bit 0) in the Standard Event Status Register. This will happen immediately when the command is executed because of the sequential nature of all operations. Querying returns a 1 when all pending device operations have completed. Can be used to verify when a long-running command has completed.

STATus:OPERation:CONDition?

**Query** the Status Operation Condition register. The response is <NR1>. See Status reporting section for details.

STATus:OPERation:ENABle <NR1>

**Set** or return the Status Operation **Enable** register. The query response is <NR1>. See Status reporting section for details.

QER?

**Query** and clear **Query** Error Register. The response is <NR1>.

*TRG

Start a Trigger and Hold run.

*RST

Reset the instrument parameters to their default values.

*CLS

**Clear** Status. Clears the Status structure. This indirectly clears the Status Byte Register.

### System

SYSTem:ERRor[:NEXT]?

Query the next error from the error log. If the log is empty "0, No Error" is returned.

SYSTem:TRIGger

Start a Trigger and Hold run.

SYSTem:LOCal

Go to local. Stops the instrument from being in remote mode. Same as pressing Home when the 'Remote' LED is lit. When another command is received, the instrument will return to remote mode.

[SYSTem:]TRIGger:TYPe <String>

Set or return the trigger type to <String> CONTinuous|SINGle|TOGGle. The query response is <String>.

## Source

[SOURce:]LEVel <NRF>

Set the source level to <NRF>

[SOURce:]SLEW <String>

Set the source slew rate to <String> SLOW|MEDium|FAST

[SOURce:]MODe <String>

Set the source mode to <String> CC|CV|CP|CR

[SOURce:]FUNCtion <String>

Set the source function to <String> PULSe|BATTery|SWEep|CONTinuous

[SOURce:]RANGe <NRF>

Set the source current range (a) to <NRF> A

### Pulse

[SOURce:]PULSe:LEVel:0 <NRF>

Set the source pulse level 0 to <NRF>

[SOURce:]PULSe:LEVel:1 <NRF>

Set the source pulse level 1 to <NRF>

[SOURce:]PULSe:TIMe:0 <NRF>

Set the source pulse time 0 (s) to <NRF>

[SOURce:]PULSe:TIMe:1 <NRF>

Set the source pulse time 1 (s) to <NRF>

### Sweep

[SOURce:]SWEep:LEVel:STARt <NRF>

**Set** the source sweep start level to <NRF>

[SOURce:]SWEep:LEVel:STOP <NRF>

**Set** the source sweep stop level to <NRF>

[SOURce:]SWEep:STEPs <NRF>

**Set** the source sweep number of steps to <NRF>

[SOURce:]SWEep:TIMe <NRF>

**Set** the source sweep time to <NRF>

[SOURce:]SWEep:SLOPe <String>

**Set** the source sweep slope to <String> SINGle|DUAL

[SOURce:]SWEep:TYPe <String>

**Set** the source sweep type to <String> LINear|LOGarithmic

### Battery

[SOURce:]BATTery:STOP:VOLTage <NRF>

**Set** the source battery stop voltage (v) to <NRF>

[SOURce:]BATTery:STOP:TIMe <NRF>

**Set** the source battery stop time (s) to <NRF>

[SOURce:]BATTery:CAPacity:Ah?

**Query** the source battery capacity (ah)

[SOURce:]BATTery:CAPacity:Wh?

**Query** the source battery capacity (wh)

[SOURce:]BATTery:TIMe?

**Query** the source battery time (h)

## Measure

[MEASure:]VOLTage?

**Query** the measure voltage (v)

[MEASure:]CURRent?

**Query** the measure current (a)

## Input

[INPut:]STATe <Bool>

Enable the input state to <Bool> OFF|ON|0|1

[INPut:]SENSe <String>

Set the input sense to <String> INTernal|EXTernal

[INPut:]PROTection:CLEar

Set the global system clear all trips

## Limit

LIMit:VOLTage <NRF>

Set the limit voltage (v) to <NRF>

LIMit:CURRent <NRF>

Set the limit current (a) to <NRF>

LIMit:POWer <NRF>

Set the limit power (w) to <NRF>

# 12. MAINTENANCE

The Manufacturers or their agents overseas will provide a repair service for any unit developing a fault. Where owners wish to undertake their own maintenance work, this should only be done by skilled personnel in conjunction with the Service Guide, which may be requested directly from the Manufacturers or their agents overseas.

## Cleaning

If the instrument requires cleaning use a cloth that is only lightly dampened with water or a mild detergent, to avoid damage to the case never clean with solvents.

**WARNING**



**To avoid electric shock, or damage to the instrument, never allow water to get inside the case.**

## Internal AC Power Fuse

The correct fuse type is:

1A 250V HRC time-lag (T), 5 x 20mm

Make sure that only fuses of the required rated current and specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse-holders is prohibited.

To replace the fuse, first disconnect the instrument from the AC supply. Remove the 5 rear panel securing screws and the top two screws on the front panel. Slide back and lift off the cover. Replace the fuse with one of the correct type and refit the cover and screws.

**NOTE**



The main function of the fuse is to make the instrument safe and limit damage in the event of failure of one of the switching devices. If a fuse fails it is therefore very likely that the replacement will also blow, because the instrument has developed a fault; in such circumstances the instrument will need to be returned to the manufacturer for service.

## Calibration

To ensure that the accuracy of the instrument remains within specification the calibration must be checked (and if necessary adjusted) annually. The procedure is detailed in the Service Guide, which also lists the calibrated test equipment required.

## Firmware Update

The firmware of the instrument can be updated through the USB port using a PC software utility available from the manufacturer. This uses a HID (human interface device) USB class driver which will already be installed on any PC with a USB port.

Before the firmware can be updated the instrument must be placed in a special mode that enables it to accept the update. Unless the instrument is placed in this mode it cannot be updated.

- Ensure that the USB interface is connected and the instrument is powered on. The instrument should be connected to the PC with a USB cable.
- Press and hold the 'USB UPDATE' button on the rear panel. If this has been done correctly then 'Firmware Update' will be displayed on the ALD display.
- The instrument will now wait for an update from the PC via the USB connection and the Windows based update utility can now be run.
- The latest Firmware update, together with file transfer utility can be downloaded from https://www.aimtti.com/
- Once downloaded, unzip the file, and run the File Transfer Utility application.
- Within the File Transfer Utility application, select File and Open.
- Open the ALD1120.hex file.
- Select Start Update.
- The instrument will power cycle and be ready to use once the update is complete.

**NOTE**



After a Firmware update, the settings will automatically be reset to default.

# 13. SPECIFICATION

Accuracies apply for 1 year 19°C to 25°C after 30 minutes warm-up.

General specifications apply for the temperature range 5°C to 40°C.

Typical specifications are determined by design and are not guaranteed.

## Maximum Input Ratings

### Maximum Input Ratings

| | |
|---|---|
| Current | 24A |
| Voltage | 120V |
| Power | 120W |
| Min operating voltage | <= 700mV @ 24A |
| Min effective resistance | 30mΩ (typical) |
| Off state leakage | <60µA (typical) |
| Reverse Polarity | 24A (diode will conduct) |
| Isolation Voltage | ±300Vdc to chassis ground |

## Operating Modes

### CC Mode

| | |
|---|---|
| Ranges | 0 to 2A (limited to 40W). 0 to 24A |
| Accuracy | ±(0.1% + 0.05% Range) |
| Resolution | 2A range: 100uA. 24A range: 1mA |
| Regulation | Same as accuracy specification (auto-compensating) |
| Minimum Transition time at full current | 2A range: 4µs. 24A range: 12µs |

### CP Mode

| | |
|---|---|
| Range | 0 to 40W (limited to 2A). 0 to 120W |
| Accuracy | ± (0.2% + 2mW + 0.05% I Range) |
| Resolution | 1mW |
| Regulation | Same as accuracy specification (auto-compensating) |
| Minimum Transition time at full current | 40W range: 4µs. 120W range: 12µs |

### CR Mode

| | |
|---|---|
| Range | 100mΩ to 10kΩ |
| Accuracy | ± (0.2% + 2mΩ + 0.05% I Range) |
| Resolution | 4 digits (minimum 1mΩ) |
| Regulation | Same as accuracy specification (auto-compensating) |
| Minimum Transition time at full current | 2A range: 4µs. 24A range: 12µs |

### CV Mode

| | |
|---|---|
| Range | 0 to 120V |
| Accuracy | ±(0.05% + 0.01% FS) |
| Resolution | 1mV |
| Regulation | Same as accuracy specification (auto-compensating) |

# Functions

## Pulse

| | |
|---|---|
| Available Modes | CC, CP, CR, CV |
| Pulse Level 0/1 | Same as range for each mode |
| Pulse Width 0/1 | 100µs to 1000s. 100ms to 1000s (CV) |
| Pulse Width Resolution | 100µs |

## Battery Discharge

| | |
|---|---|
| Available Modes | CC, CP, CR |
| Capacity Reading | Watt Hours and Amp hours. Updated each second |
| Stop Time | 1 min to 99.99 Hours (1 min resolution) |
| Voltage Dropout | 0 to 120V (1mV resolution) |

## Sweep

| | |
|---|---|
| Available Modes | CC, CP, CR, CV |
| Start / Stop levels | Same as range for each mode |
| Time per Step | 1ms to 1000s (1ms resolution). 100ms to 1000s (CV) |
| Slope | Single / Dual |
| Type | Linear / Logarithmic |
| Number of Steps | 2 to 1000 |

## Slew Rate

| | |
|---|---|
| Fast | No slew rate limiting, fastest possible response. |
| Medium | Slew rate limiting applied to help reduce risk of overshoot or ringing. |
| Slow | Significant slew rate limiting applied to help overcome potential instability in unstable source/load combinations or setups. |

# Protection

| | |
|---|---|
| OPP | The input is disabled if the power exceeds a user set limit of 0 to 125W |
| OCP | The input is disabled if the current exceeds a user set limit of 0 to 25A |
| OVP | The input is disabled if the voltage exceeds a user set limit of 0 to 125V |
| Excess Voltage | Surge suppressors will start to conduct above 140V. |
| Temperature | The input will trip if the heatsink temperature exceeds safe levels. |
| Reverse Polarity | The unit will trip if a reverse current is detected. The unit will continue to show a popup until the reverse polarity is removed. |
| External Sense | The unit will trip if the input voltage exceeds that of the external sense voltage by more than 4.5V. (External sense enabled). |

## Meter Specifications

| | |
|---|---|
| Volts and Amps | Measured values of current through and voltage across the load |
| Watt & Ohms | Power and equivalent load resistance, calculated from Volts and Amps. |
| Voltage Accuracy | ±(0.05% + 0.01% FS) |
| Voltage Resolution | 1mV |
| Current Accuracy | ±(0.1% + 0.05% Range) |
| Current Resolution | 2A range: 100µA. 24A range: 1mA |

## External Voltage Sense

| | |
|---|---|
| Terminals | 4mm Banana sockets on 19mm spacing. |
| Input Impedance | Nominally 2.2MΩ each input to load negative |
| Maximum sense offset | 4V (allowance for backing-off supply for zero-volt operation) |

## Interfaces

| | |
|---|---|
| USB | Full digital remote control facilities are available through the USB interface. Standard USB 2.0 hardware connection. Implemented as virtual-COM port. SCPI compatible |
| Remote Command Processing Time | Typically < 100ms |

## General

| | |
|---|---|
| Terminals | 4mm Banana sockets on 19mm spacing. |
| Display | 2.8” IPS TFT (320x240) Backlit, 4-wire resistive touch. |
| Data Entry | Menu navigation via touchscreen or rotary knob, value entry direct by numeric keys or by rotary control. |
| Stored Settings | Up to 6 complete instrument set-ups may be stored in non-volatile memory. |
| Size and Weight | 213 x 228 x 98 mm (WxDxH) . 1.7kg |
| Power | 100-240VAC ±10% 50/60Hz; 30VA max. Installation Category II. |
| Operating Range | +5°C to 40°C, 20-80% RH. |
| Storage Range | -20°C to + 60°C. |
| Cooling | Variable Speed fan. Air exit at rear. |
| Environmental | Indoor use at altitudes up to 2000m, Pollution Degree 2. |
| Safety & EMC | Complies with EN61010-1 & EN61326-1.. All inputs 300Vpk max to ground. |
| Security | Kensington Lock |

*Thurlby Thandar Instruments Ltd. operates a policy of continuous development and reserves the right to alter specifications without prior notice.*

# 14. DEFAULT VALUES

When supplied from the factory the electronic load is set as follows:

| | | | | |
|---|---|---|---|---|
| Mode | CC | | | |
| Slew | Medium | | | |
| Battery Stop Voltage | 0V | | | |
| Battery Stop Time | 60 Mins | | | |
| OVP | 125V | | | |
| OCP | 25A | | | |
| OPP | 125W | | | |
| External Sense | Off | | | |
| Range | 24A / 120W | | | |
| Input | Off | | | |
| Mode Specific Settings | | | | |
| | CC | CV | CP | CR |
| Level | 0A | 0V | 0W | 10kΩ |
| Function | Continuous (None) | Continuous (None) | Continuous (None) | Continuous (None) |
| Sweep Start | 0A | 0V | 0W | 10kΩ |
| Sweep Stop | 0A | 0V | 0W | 1kΩ |
| Sweep Time | 1s | 1s | 1s | 1s |
| Sweep Number Steps | 20 | 20 | 20 | 20 |
| Sweep Slope | Single | Single | Single | Single |
| Sweep Type | Linear | Linear | Linear | Linear |
| Pulse Level 0 | 0A | 0V | 0W | 10kΩ |
| Pulse Level 1 | 0A | 0V | 0W | 1kΩ |
| Pulse Time 0 | 1s | 1s | 1s | 1s |
| Pulse Time 1 | 1s | 1s | 1s | 1s |

### System Level Settings

| | |
|---|---|
| Power-On state | Defaults |
| Buzzer | Off |
| Brightness | 80% |
| Trigger | Continuous |
| Theme | Blue |

The default values can be restored from the “Reset Defaults” function – see ‘*Reset Defaults’*.

# 15. SCPI COMMANDS INDEX


| Command | Page |
|---|---|
| [INPut:]PROTection:CLEar | 47 |
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48511-1990 Issue 1