

TDL-Series

**Programmable
DC Electronic Load
Operation Manual V1.1**

TESSIO TECHNOLOGY LTD.



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Use of Operation Manual

Please read through and understand this Operation Manual before operating the product. After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

Calibration notification

We notify that the instruments included in this manual are in compliance with the features and specifications as stated in this manual. Before shipment, the instrument has been calibrated in factory. The calibration procedures and standards are compliant to the national regulations and standards for electronic calibration.

Warranty

We guarantee that the instrument has been passed strict quality check. We warrant our instrument's mainframe and accessories in materials within the warranty period of one year. We guarantee the free spare parts for products which are approved defective in this period. To get repair service, please contact with your nearest sales and service office. We do not provide any other warranty items except the one being provided by this summary and the warranty statement. The warranty items include but not being subjected to the hinted guarantee items related to tradable characteristics and any particular purpose. We will not take any responsibility in cases regarding to indirect, particular and ensuing damage, such as modifications to the circuit and functions by the users, repairing or component replacement by the users, or damage during transportation.

For product improvement, the specifications are subject to change without prior notice.

Chapter1 General Introduction

This Series programmable electronic load, as a new generation product, is designed with high performance. It provides you powerful test function, user-friendly HMI, as well as RS232 interface to support SCPI and Labview. This Series is widely used in aerospace, shipbuilding, automotive electronics, solar cell, and fuel cell etc. scientific research and production field.

All “electronic load” and “load” appear in this manual refer to this Series Electronic Load if there is no special explanation.

1-1. Function Features

- 4 basic functions: CC, CV, CR and CP; 9 basic test modes: CCL, CCH, CVL, CVH, CRL, CRM, CRH, CPV, CPC;
- The 24 bit A/D and 16 bit D/A converters incorporated, provide this equipment with greatly enhanced setting and measurement resolution. 40kHz D/A conversion rate fully improves high-speed performance;
- Perfect protection assures high reliability in the most complicated of test environments;
- Innovative design of CPV and CPC modes effectively improves the practicability of CP mode;
- Circuit improvement greatly enhances the dynamic response of CR mode and widens the application scope of that mode;
- High-speed transient operation with separate high/low level time and rising/falling time control, maximum test frequency 2kHz;
- Powerful sequential test function; with a minimum step time of 10us; and a maximum step time of 10000s. Cyclic numbers can be adjusted freely and a sequence can be chained to another sequence to achieve even more complex test procedures;
- The input binding posts with their innovative design are especially suitable for large current testing;
- Provides short-circuit test, battery discharge test and other auxiliary functions;
- A high-efficiency, intelligent cooling system can effectively reduce system temperature and enhance power density;
- Automatic ON/OFF function simplifies test operation;
- Knobs and digital keypad makes the operation more convenient;
- Save/recall function can save multiple groups of general settings;
- Supports SCPI (Standard Commands for Programmable Instrumentation) and Labview, and provides necessary PC software;

1-2. Production Models

Item	Model	Rated Input			Weight kg	Dimension (W*H*D)
		Power	Voltage	Current		
1	A	150W	0~150V	1mA~30A	5.2	215x89x412mm
2	B	300W	0~150V	1mA~30A	6.7	215x89x412mm
3	C	300W	0~150V	1mA~60A	6.7	215x89x412mm
4	D	300W	0~500V	1mA~15A	6.7	215x89x412mm
5	E	600W	0~150V	1mA~60A	9	215x89x507mm
6	F	600W	0~150V	1mA~120A	9	215x89x507mm
7	G	600W	0~500V	1mA~30A	9	215x89x507mm

1-3. Front Panel

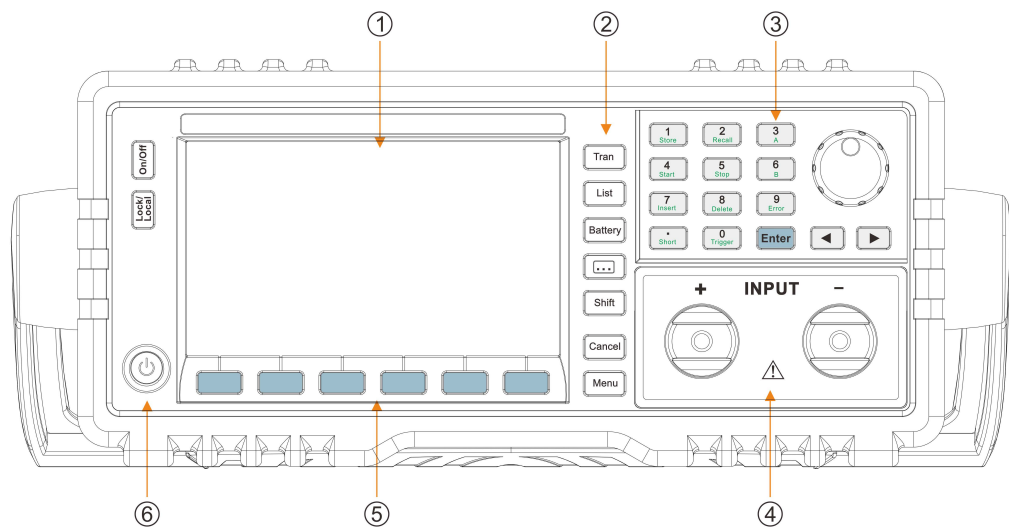


Fig.1-1 Front Panel

- | | | |
|------------------------|---------------------|---------------------|
| 1. LCD display | 2. Function buttons | 3. Parameters input |
| 4. Input binding posts | 5. Menu keys | 6. Power switch |

1-4. Message of LCD Display

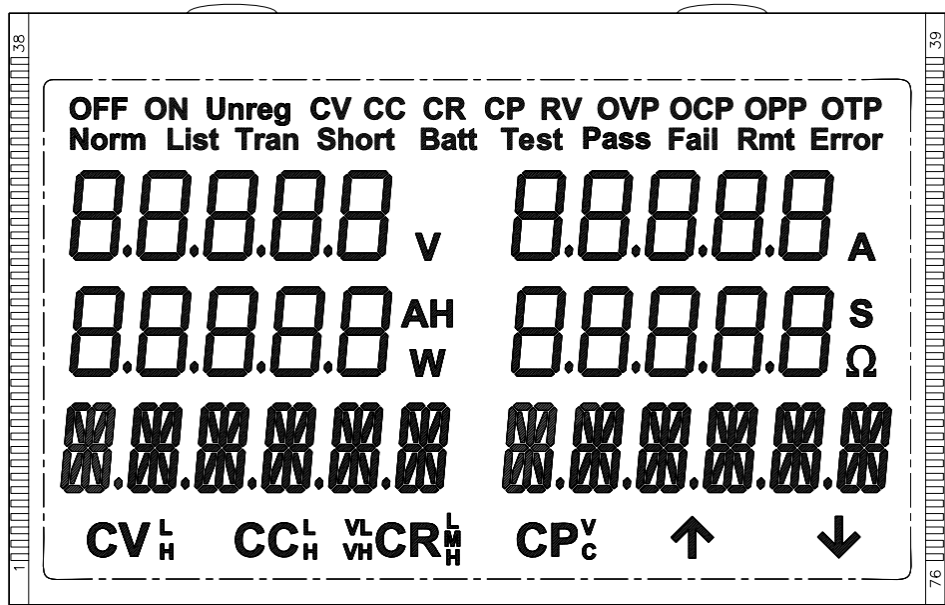


Fig.1-2 Message of LCD Display

1-5. Rear Panel

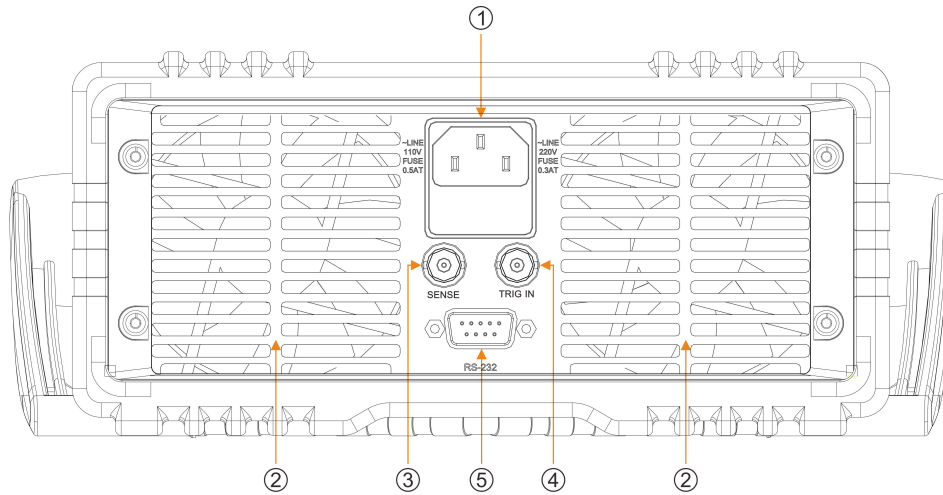


Fig.1-3 Rear Panel

- | | | |
|------------------------------------|--------------------|--------------------------|
| 1. Power cord / fuse socket | 2. Cooling fan | 3. Remote sense terminal |
| 4. External trigger input terminal | 5. RS232 interface | |

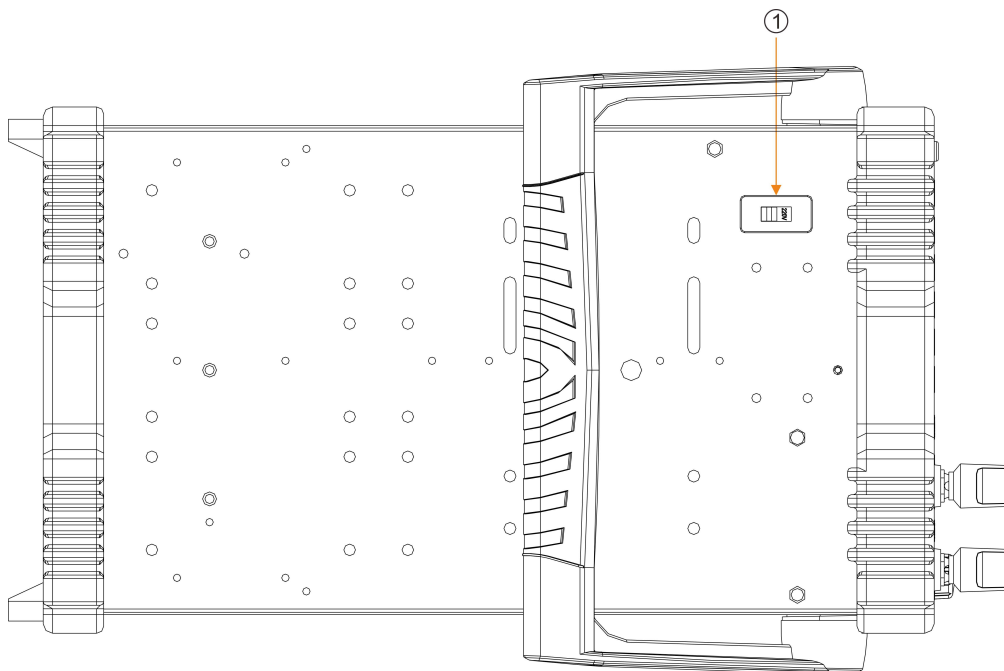


Fig.1-4 Bottom Panel

1. AC110/220V power selection switch

1-6. Keypad Function

There are three groups of keypads on the front panel: the Function Keys, the Entry Keys, which composite with secondary functions, and the Direction Keys. The first functions of the Entry Keys are printed in black. The secondary functions of the Entry Keys are printed in green. To use the secondary function, please press “Shift” key first, then press the relevant key.

List 1-1 Key discription

Key name	Main function	Secondary key name	Secondary function
0	Input digit 0	Trigger	Trigger key
1	Input digit 1	Store	Store key
2	Input digit 2	Recall	Recall key
3	Input digit 3	A	Point A setting
4	Input digit 4	Start	Sequence (list) start key
5	Input digit 5	Stop	Sequence (list) stop key
6	Input digit 6	B	Point B setting
7	Input digit 7	Insert	Insert key
8	Input digit 8	Delete	Delete key
9	Input digit 9	Error	Error code display key
.	Input decimal point	Short	Short circuit key
Enter	Confirm key		
◀	Left key		
▶	Right key		
Tran	Transient operation menu		
List	Sequence (list) operation key		
Battery	Battery discharge operation key		
...	Set up auxiliary function, auto test		
Shift	Switch key for secondary function		
Cancel	Clear or exit	Prot Clear	Clear protection
Menu	Main menu		
On/Off	Input on/off		
Lock/Local	Short-press for lock, long-press for unlock		
I-set	CC mode selection, the input current value setting		
V-set	CV mode selection, the input voltage value setting		
P-set	CP mode selection, the input power value setting		
R-set	CR mode selection, the input resistance value setting		
↑	Page up		
↓	Page down		

1-7. Menus

1-7-1. Main Menu

Press “Menu” key to enter into main menu and the LCD displays the selectable menus. Rotate knob to select menu. Press “Enter” key to enter into the function option on the cursor. Use “↑” key or “↓” key to turn over the LCD screen. At this time, press “↓” key to enter into the next level submenu. Press “Cancel” key to exit the menu setting.

List 1-2 Main Menu

System Set		
	CC SET	Set CC mode range
	CV SET	Set CV mode range
	CR SET	Set CR mode range
	CP SET	Set CP mode range
	VON Latch	Von volgate latch
	VON POint	Set Von voltage point
	VOFF Point	Set Voff voltage point
	CV CURr limit	Current limit in CV mode
	CURR Rise rate	Current rise rate in CC mode
	CURR Fall rate	Current fall rate in CC mode
	SHORT	Short circuit mode
Config		
	LOAD Default	Restore default
	INPUT recall	Set the power-on input status as last power-off status
	POWER on recall	Set the power-on relative parameters as last power-off settings
	KNOB	Enable knob function
	KEY SOund	Enable key sound
	BAUD Rate	Baud rate setting
	ADDREss	Instrument's ID or address
	CONTRAst	Contrast level of display
	LIGHT	Light level of display
	VERsion	Instrument's firmware version
Protection		
	OCP STate	Overcurrent protection On/Off
	OCP LEvel	Current pretection limit
	OCP DELay	Delay time to turn off the load in OCP
	OVP LEvel	Voltage pretection limit
	OPP LEvel	Power pretection limit
	OPP DELay	Delay time to turn off the load in OPP
Trigger Set		
	FUNCTIon	Trigger function selection
	SOURCE	Trigger source setting
	CURRENT	Trigger current
	VOLTAGe	Trigger voltage
	RESISTance	Trigger resistance

	POWER	Trigger power
Transient		
	STATE	Transient operation status
	MODE	Transient operation mode
	LEVELL	Transient low level
	LEVELH	Transient high level
	TIME L	Time for transient low level
	TIME H	Time for transient high level
	TIME R	Time for transient rising edge
	TIME F	Time for transient falling edge
List		
	STATE	Set sequence (list) test status
	NO.	Select sequence (list) number
	MEMO	Sequence memo
	DATA: <New/Edit>	Create a new or edit an existing sequence
	COUNT	Cycle times
	CHAIN	Sequence number to be chained with (0-7, off)
List data		
	NO.	Data number
	MODE	Mode Time
	LEVEL	Setting value
	DELAY	Time
Battery		
	STATE	Battery discharge operation key
	MIN VOLTage	Termination voltage value
	IOFF Piont	Termination current value
	DISCUR	Discharge current value
Auto test		
	STATE	Auto test state on/off
	GROUP	Select the saved setting of auto test
	START	Start step (0-14)
	END STep	End step (0-14)
	STEP	Step no. of setting
	MODE	Mode setting
	LEVEL	Setting value
	MIN	Parameter minimum value
	MAX	Parameter maximum value
	DELAY	Test time

Note:

- The parameters of Config, Protection, Trigger Set and Auto Test in main menu will be saved automatically after been modified. The parameter saved in location 0 will be recalled automatically every time when the load is turned on.
- The capital letters of the menu will be shown on the LCD. The numbers of shown characters should not exceed 6.

1-7-2. Mode and Parameter Setting Menu

The electronic load can be executed in the following modes.

- 1: Constant Current mode (CC)
- 2: Constant Voltage mode (CV)
- 3: Constant Resistance mode (CR)
- 4: Constant Power mode (CP)

In the basic mode, press corresponding key to enter into mode and parameter setting menu, which is shown as below:

Key name	Function and parameter	Description
I-SET	SCCL 01.000A	Constant current mode: immediate current level
V-SET	SCVL 80.00V	Constant voltage mode: immediate voltage level
R-SET	SVHCRL 02.000R	Constant resistance mode: immediate resistance level
P-SET	SCPV 10.000W	Constant power mode: immediate power level

1-7-3. Transient Operation Menu

In the basic mode, turn off the input, press “Tran” key in desired mode to enable its transient operation and enter into parameters setting menu.

Function	Description
STATE	Transient operation status and enable the function
MODE	Transient operation mode Continuous: 0 COUNT Pulsed: 1 PULSE Toggled: 2 TOGGLE
LEVELL	Transient low level
LEVELH	Transient high level
TIME L	Time for transient low level (0-99999ms), unit is ms
TIME H	Time for transient high level (0-99999ms), unit is ms
TIME R	Time for transient rising edge (0.25-99999ms) , unit is ms
TIME F	Time for transient falling edge (0.25-99999ms) , unit is ms

Note:

Transient operation may be used in CC, CV, and CR modes.

1-7-4. Sequence (List) Operation Menu

Press “List” key to enter into the list operation menu.

Function	Description
STATE	Enable the function
NO.	Select sequence (list) number 0-7
MEMO	Sequence memo (10 characters)
DATA: <New/Edit>	Create a new or edit an existing sequence
COUNT	Cycle times (1-65535), (Number 0 represents infinite loop)
CHANI: Off	Sequence number to be chained with (0-7 off)

Press “↑” and “↓” keys in sequence (list) operation menu to select “Data: <New/Edit>”, and select “New” and “edit” keys with the knob. Then press “Enter” key to enter into sequence data editing status, which is shown as below:

Function	Description
NO.	Data number (0-49)
MODE	Mode
LEVEL	Setting value
DELAY	Time, unit is s

Press “Cancel” key to store the data and exit.

1-8. Display Messages

1) CC Mode:

The LCD shows actual voltage, current, power and resistance levels. The second line shows current set level and CC mode.

2) CV Mode:

The LCD shows actual voltage, current, power and resistance levels. The second line shows voltage set level and CV mode.

3) CR Mode:

The LCD shows actual voltage, current, power and resistance levels. The second line shows resistance set level and CR mode (CRL indicates constant resistance low range; CRM indicates constant resistance medium range; CRH indicates constant resistance high range; VH indicates voltage high range; and VL indicates voltage low range).

4) CP Mode:

The LCD shows actual voltage, current, power and resistance levels. The second line shows power set level, CP mode (CPC indicates constant power-current source mode; CPV indicates constant power-voltage source mode).

5) Transient Operation:

The LCD shows actual voltage, current, power and resistance levels.

6) Sequence (List) Operation:

The LCD shows actual voltage, current, power and time. The second line shows set level and sequence operation mode.

7) Battery Discharge Operation:

The first line shows actual voltage, current, battery capacity and discharge time.

8) Short Circuit Operation:

The LCD shows actual voltage, current, power and resistance levels. The second line shows set level in short circuit mode. Please refer to Main Specifications for details.

9) Protection Status

If the protection function is active, the indicator of "Cancel" is turned on, LCD will display corresponding protection status. For example: the display of reverse voltage protection status is shown as below: Protection status includes overcurrent (OC), overvoltage (OV), overpower (OP), overtemperature (OT), load protection (PT), and reverse voltage (RV).

10) Input On/Off

When the indicator of "On/Off" is turned on, the load's input is in On status; on the contrary, the load's input is in Off status.

1-9. Remote Programming

The commands are sent to electronic load via remote interface (RS232), and will be executed after decoding by the processor. If there is any error occurs to the command, the processor can detect the wrong command and error type, and it can maintain the status register as well.

When the instrument address is set between 32 and 255, the address value should be added at the head of commands. When the instrument address is set higher than 256, the address become invalid, and the address value does not need to be added at the head of commands.

Chapter2 Functions and Features

The functions and features of electronic load will be described in this chapter, which helps you to know this series better.

2-1. Local and Remote Control

This series electronic load can be controlled via the front panel, or by remote controller via remote interface. If it is needed to control the load via the front panel, the load has to stay in local control status. Local (front panel) control is in effect immediately after power is applied. Remote control goes into effect as soon as the load receives a SYSTem:REMOte command via RS232.

Under remote control status, the REM annunciator is turned on, all operations on front panel keypad and knobs become invalid (except "Lock/Local" key). All operations on electronic load are controlled by remote controller. The electronic load will return to local control and REM remote control annunciator is turned off after receiving the return command (e.g. : SYST:LOC). Or you can return the electronic load to local control by long -pressing "Lock/Local" key.

Details of local operation are covered in Chapter Local Operation and fundamentals of remote programming are given in Chapter Remote Operation. Complete SCPI programming details are given in the "Electronic Load SCPI Programming Guide".

2-2. Main Function

Main functions (features) of electronic load:

- Constant Current Mode (CCL, CCH)
- Constant Voltage Mode (CVL, CVH)
- Constant Resistance Mode (VL CRL, VL CRM, VL CRH, VH CRL, VH CRM, VH CRH)
- Constant Power Mode (CPV, CPC)
- Transient Operation (Tran)
- Sequence (List) Operation (List)
- Battery Discharge Operation (Battery)
- Short Circuit Operation (Short)

2-3. Basic Test Function

There are four modes of operation: constant current(CC), constant voltage(CV), constant resistance(CR), constant power(CP), and nine test modes: CCL, CCH, CVL, CVH, CRL, CRM, CRH, CPV, CPC.

The test mode and the associated parameters can be set via front panel or remote command. The load will remain in that mode until the mode is changed. If the mode is changed when the load's input is in ON status, the load will be turned off automatically.

The set value for electronic load becomes effective immediately when the load is turned on. If the input set value exceeds the allowed range, it will be automatically limited at maximum value or minimum value.

2-3-1. Constant Current Mode (CC)

Constant current mode has two ranges, the high range(CCH) and the low range(CCL). The high range provides wider test range. The low range provides better resolution at low current settings. In CC mode, the load will sink a current in accordance with the programmed value regardless of the input voltage(see fig.2-1). Press “I-set” key in basic mode to enter into CC mode selection and parameter setting menu. Input the current level via the Entry keys or the knob with “◀” and “▶” keys. Use “Enter” key for confirmation. The CC mode and parameters can also be set via remote command (MODE CCL, MODE CCH, CURRent <NRf+>).

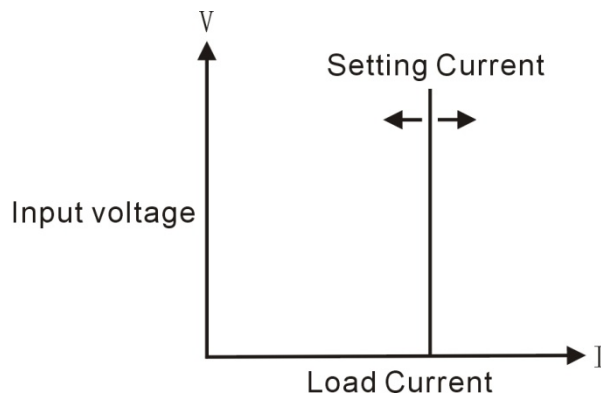


Fig. 2-1 CC Mode

2-3-1-1. Setting Ranges

In constant current low range (CCL) and in constant current high range (CCH), please refer to “Main Specifications” for the current setting range. If the range is changed in CC mode while the load’s input stays ON status, the load will be turned off automatically. For example: when the load is switched from CCL to CCH, the input will be turned off. Besides, it is noted that the current set level may have changed to fit the new range when the current range is changed. For example: the present setting is CCH 20.000A, when the load is switched from CCH to CCL, the current set level will change to the set level for CCL.

2-3-1-2. Immediate Current Level

The immediate current level refers to the current set value in CC mode, which can be set via pressing “I-set” key to enter into mode selection and parameter setting menu, or via remote command (CRRRent<NRf+>). The immediate current level can also be modified directly with left/right keys (“◀”, “▶”) and the knob.

2-3-1-3. Triggered Current Level

The triggered current level refers to the preset current value, which can become immediate current level automatically when a trigger is received. If the CC mode and the input are enabled, the input will be updated immediately when a trigger occurs. If the CC mode is not active, this current level will have no effect on the input until the CC mode becomes active.

The triggered current level can be set via entry keys or remote command (CURRent:TRIGgered <NRf+>). Once a current level is triggered, subsequent triggers will become invalid until another (CURRent:TRIGgered <NRf+>) command is received. The trigger sources available to the load will be described in later chapter. The electronic load has a status register, which can keep track of pending triggers and other operating conditions. This status register will be described in details in the “Electronic Load SCPI Programming Guide”.

2-3-1-4. Transient Current Level

The load will switch between the transient high current level (LevelH) and transient low current level (LevelL) when the transient operation is enabled. The transient current level can be set in transient operation menu from the front panel, or via remote command (CURRent:HLEV <NRf+>, CURRent:LLEV <NRf+>).

2-3-1-5. Software Current Limit

The electronic load allows the user to set a current limit via pressing corresponding key or remote command (CURRent:PROTection <NRf+>). The load will be turned off with beeping alarms if the current limit is exceeded beyond a programmable time delay (0.001-60s). Please note that the software current limit is in effect for any mode of operation.

2-3-2. Constant Voltage Mode (CV)

In CV mode, the load will attempt to sink enough current to control the source voltage to the programmed value regardless of the input current (see fig.2-2). Press “V-set” key in basic mode to enter into CV mode selection and parameter setting menu. Input the voltage value via the Entry keys or the knob with “◀” and “▶” keys. Use “Enter” key for confirmation. The CV mode and parameters can also be set via remote command (MODE CV, VOLTage <NRf+>).

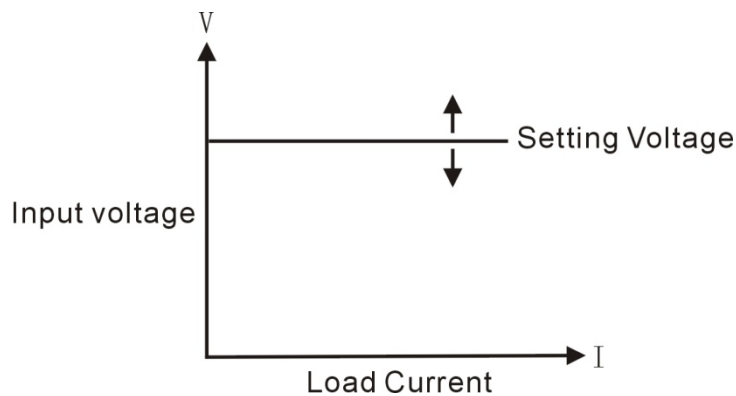


Fig. 2-2 CV Mode

2-3-2-1. Setting Ranges

Please refer to “Main Specifications” for details of the voltage setting ranges.

2-3-2-2. Immediate Voltage Level

The immediate voltage level refers to the voltage set value in CV mode, which can be set via pressing “V-set” key to enter into mode selection and parameter setting menu, or via remote command (VOLTage <NRf+>). The immediate current level can also be modified directly with left/right keys (“◀”, “▶”) and the knob.

2-3-2-3. Triggered Voltage Level

The triggered voltage level refers to the preset voltage value, which can become immediate voltage level automatically when a trigger is received. If the CV mode and the input are enabled, the input will be updated immediately when a trigger occurs. If the CV mode is not active, this voltage level will have no effect on the input until the CV mode is active.

The triggered voltage level can be set via entry keys or remote command (VOLTage:TRIGgered<NRf+>). Once a voltage level is triggered, subsequent triggers will become invalid until another (VOLTage:TRIGgered<NRf+>) command is received. The trigger sources available to the load will be described in later chapter. The electronic load has a status register, which can keep track of pending triggers and other operating conditions. This status register will be described in details in the “Electronic Load SCPI Programming Guide”.

2-3-2-4. Transient Voltage Level

The load will switch between the transient high voltage level (LevelH) and transient low voltage level (LevelL) when the transient operation is enabled. The transient voltage level can be set in transient operation menu from the front panel, or via remote command (VOLTage:HLEVel <NRf+>, VOLTage:LLEVel <NRf+>).

2-3-3. Constant Resistance Mode (CR)

Constant resistance mode has six ranges: the low level (VL CRL), medium level (VL CRM), high level (VL CRH) of the low voltage range and the low level (VH CRL), medium level (VH CRM), high level (VH CRH) of the high voltage range. In CR mode, the load will sink a current linearly proportional to the input voltage in accordance with the programmed resistance to make $I=U/R$ (see fig.2-3). Press “R-set” key in basic mode to enter into CR mode selection and parameter setting menu. Input the resistance value via the Entry keys or the knob with “◀” and “▶” keys. Use key “Enter” for confirmation. The CR mode and parameters can also be set via remote command (MODE VLCRL, MODE VLCRM, MODE VHCRH, RESistance <NRf+>).

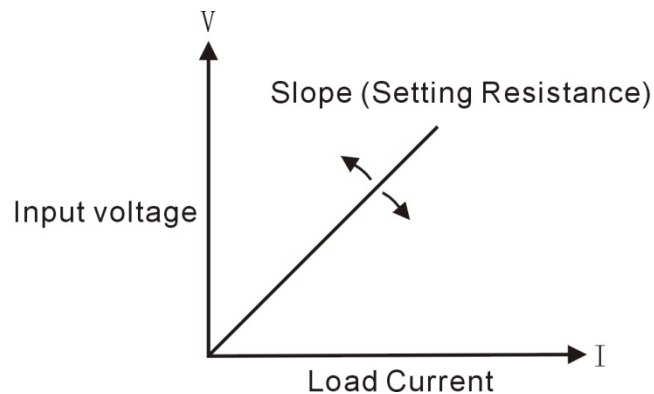


Fig. 2-3 CR Mode

2-3-3-1. Setting Ranges

In constant resistance low range (CRL), medium range (CRM), and high range (CRH), the resistance setting range is in “Main Specifications” section. If the range is changed in CR mode while the Load’s input stays ON status, the load will be turned off automatically. For example: when the load is switched from CRL to CRH, the input will be turned off. Besides, it is noted that the resistance set level may have changed to fit the new range when the resistance range is changed. For example: the present setting is CRM 10.000Ω, when the load is switched from CRM to CRL, the resistance set level will change to the maximum level 1.5000Ω for CRL.

2-3-3-2. Immediate Resistance Level

The immediate resistance level refers to the resistance set value in CR mode, which can be set via pressing “R-set” key to enter into mode selection and parameter setting menu, or via remote command (RESistance <NRf+>). The immediate resistance level can also be modified directly with left/right keys (“◀”, “▶”) and the knob.

2-3-3-3. Triggered Resistance Level

The triggered resistance level refers to the preset resistance value, which can become immediate resistance level automatically when a trigger is received. If the CR mode and the input are enabled, the input will be updated immediately when a trigger occurs. If the CR mode is not active, this resistance level will have no effect on the input until the CR mode becomes active.

The triggered resistance level can be set via entry keys or remote command (RESistance:TRIGgered <NRf+>). Once a resistance level is triggered, subsequent triggers will become invalid until another (RESistance:TRIGgered <NRf+>) command is received. The trigger sources available to the load will be described in later chapter. The electronic load has a status register, which can keep track of pending triggers and other operating conditions. This status register will be described in details in the “Electronic Load SCPI Programming Guide”.

2-3-3-4. Transient Resistance Level

The load will switch between the transient high resistance level (LevelH) and transient low resistance level (LevelL) when the transient operation is enabled. The transient resistance level can be set in transient operation menu from the front panel, or via remote command (RESistance:HLevel <NRf+>, RESistance:LLevel <NRf+>).

2-3-4. Constant Power Mode (CP)

There are two sorts of constant power modes, the Constant Power-Voltage Source mode (CPV) and the Constant Power-Current Source mode (CPC). The CPV mode is applied to voltage source test, and the CPC mode is applied to current source test. In CP mode, the load consumes the constant power in accordance with the programmed value regardless of the changes of external current and voltage (see fig.2-4). Press “P-set” key to enter into CP mode selection and parameter setting menu. Input the power value via Entry keys or the knob with “◀” and “▶” keys. Use “Enter” key for confirmation. The CP mode and parameters can also be set via remote command (MODE CPV, MODE CPC, POWER <NRf+>).

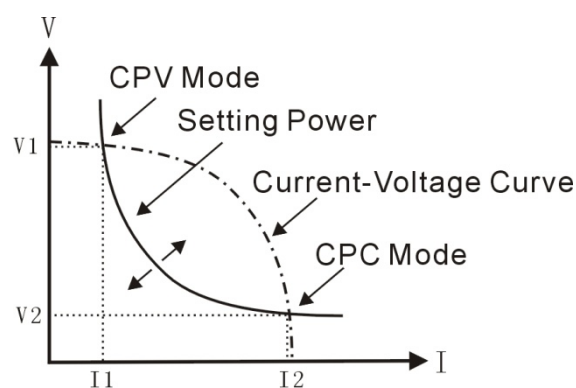


Fig. 2-4 CP Mode

Figure 2-5 are the current-voltage curves for several common power supplies. The constant power curve is a hyperbola in the first quadrant. The constant power curve usually intersects with current-voltage curve at two points (the CPV point and the CPC point) when the power of the external power supply is larger than the set power. At the CPV point, the power supply shows the feature of voltage source: the output power will be increased with increasing current; at the CPC point, the power supply shows the feature of current source: the output power will be increased with increasing voltage.

This series electronic load can be set at any one of intersection points to operate by the user.

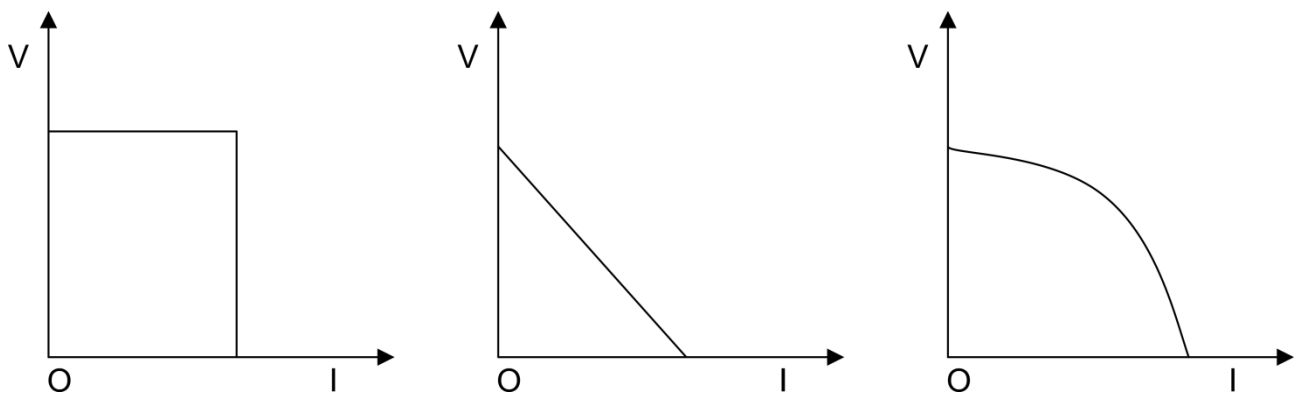


Fig. 2-5 Current-voltage Curve for Normal Power Supply

As CPV adopts advanced slope detection method, this series electronic load only has to test a part of the current-voltage curve to know whether the two curves (constant power curve and current-voltage curve) intersect. Therefore, when the set power is larger than the actual power, the external power supply will not be short-circuited by the load because the power is insufficient. When the load detects that the power of the external power supply is insufficient, the current will stop to be increased at once, and the load will try to find constant power point again till the set power is met.

In CPC mode, the load short-circuits at first to detect the constant current level of the external power supply, and calculate the maximum output power. If the output power is less than the set power, the input will be turned off immediately; If the output power is larger than the set power, the load will try to find constant power point again till the set power is met.

2-3-4-1. Setting Ranges

Please refer to “Main Specifications” section for the detailed CPV and CPC setting ranges.

2-3-4-2. Immediate Power Level

The immediate power level refers to the power set value in CP mode, which can be set via pressing “P-set” key to enter into CP mode selection and parameter setting menu, or via remote command (POWER <NRf+>). The immediate resistance level can also be modified directly with left/right keys (“◀”, “▶”) and the knob.

2-3-4-3. Triggered Power Level

The triggered power level refers to the preset power value, which can become immediate power level automatically when a trigger is received. If the CP mode and the input are enabled, the input will be updated immediately when a trigger occurs. If the CP mode is not active, this power level will have no effect on the input until the CP mode becomes active.

The triggered power level can be set via entry keys or remote command (POWER:TRIGgered <NRf+>). Once a power level is triggered, subsequent triggers will become invalid until another (POWER:TRIGgered <NRf+>) command is received. The trigger sources available to the load will be described in later chapter. The electronic load has a status register, which can keep track of pending triggers and other operating conditions. This status register will be described in details in the “Electronic Load SCPI Programming Guide”.

2-4. Transient Operation

When the transient operation is enabled, the load periodically switch between two levels (LevelH and LevelL), which can be applied to test the dynamic characteristics of the power supply. The transient operation can be executed in the CC, CV, CR modes, and has three operating statuses: Continuous, Pulsed, and Toggled. Please make sure the sequence (List) operation has been disabled before enabling transient operation.

The parameters associated with transient operation are: low level (LevelL), high level (LevelH), low level time (TimeL), high level time (TimeH), time for rising edge (TimeR), time for falling edge (TimeF), and operating mode.

Transient high/low level and corresponding CC, CV, CR modes share one setting range.

Transient test can be turned on and off via key at the front panel or via remote command (TRANSient ON/OFF). Before you turn on transient test, you should set the load to the desired mode.

Note:

In transient test, the Von point and current limit should be taken into consideration, which may cause the shut down of the input, so that the transient test is interrupted.

2-4-1. Continuous Transient Operation

In continuous operation, the load periodically switches between high/low levels. The trigger function has no effect on this continuous transient operation. The relevant (the associated) parameters such as low level (LevelL), high level (LevelH), low level time (TimeL), high level time (TimeH), time for rising edge (TimeR), time for falling edge (TimeF), and continuous transient operation can be set through transient operation menu or via remote command (CURRENT:LLEVel <NRf+>, CURRENT:HLEVel <NRf+>, VOLTage:LLEVel <NRf+>, VOLTage:HLEVel <NRf+>, RESistance:LLEVel <NRf+>, RESistance:HLEVel <NRf+>, TRANSient:LTIME <NRf+>, TRANSient:HTIME <NRf+>, TRANSient:RTIME <NRf+>, TRANSient:FTIME <NRf+>, TRANSient:MODE CONTInuous).

For example: assume that the CCH range is active, and the input is in OFF status, then the transient parameters should be set as follows:

Press “Tran” key to enter into transient operation;

Set the following parameters in transient operation menu:

State :	On
Mode :	Cont
LevelL :	5.000A
LevelH :	10.000A
TimeL :	0.50ms
TimeH :	0.50ms
TimeR :	0.25ms
TimeF :	0.25ms

Then press “Cancel” to exit transient operation, press “On/Off” key to turn on the input;

Or via remote command to set:

SCPI command	Description
MODE CCH	Sets operating mode
TRAN ON	Enables transient operation
CURR:LLEV 5	Sets transient current low level to 5A
CURR:HLEV 10	Sets transient current high level to 10A
TRAN:LTIM 0.000500	Sets transient low level time to 500us
TRAN:HTIM 0.000500	Sets transient high level time to 500us
TRAN:RTIM 0.000250	Sets the time for transient rising edge to 250us
TRAN:FTIM 0.000250	Sets the time for transient falling edge to 250us
TRAN:MODE CONT	Selects continuous operation
INPUT ON	Turns on the input

Figure 2-6 shows the current waveform of the load: the load's input current reaches the transient high level (10A) after 250us duration of rising edge, and remains at 10A for 500us. Then after 250us duration of falling edge, the input current reaches the transient low level (5A), and remains at 5A for 500us. Repeat it in cycles.

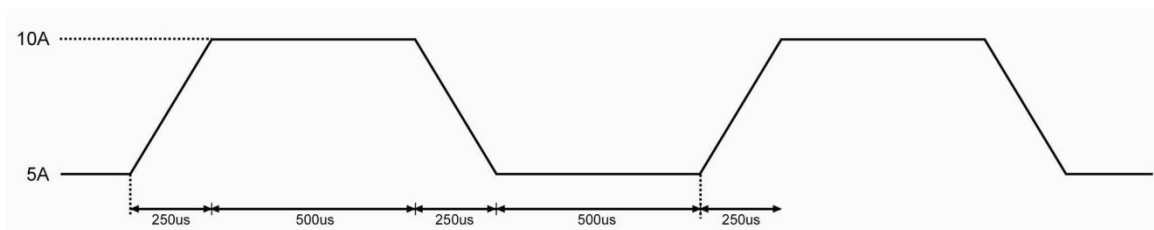


Fig. 2-6 Continuous Transient Operation

2-4-2. Pulsed Transient Operation

The trigger function is required for pulsed transient operation. When there is no trigger occurs, the load remains at the transient low level. After a trigger has been received, a pulse will be appeared with rising edge, transient high level, and falling edge three stages, then the load returns to the transient low level again at last. The associated parameters such as transient low level (LevelL), transient high level (LevelH), high level time (TimeH), time for rising edge (TimeR), time for falling edge (TimeF), and pulsed transient mode can be set through transient operation menu or via remote command (CURRent:LLEVel <NRf+>, CURRent:HLEVel <NRf+>, VOLTage:LLEVel <NRf+>, VOLTage:HLEVel <NRf+>, RESistance:LLEVel <NRf+>, RESistance:HLEVel <NRf+>, TRANSient:HTIME <NRf+>, TRANSient:RTIME <NRf+>, TRANSient:FTIME <NRf+>, TRANSient:MODE PULSe). The low level time (TimeL) has no effect on pulsed transient operation. In order to get a pulse, an explicit trigger is required. The trigger can be an external trigger signal received via the TRIG input on the rear panel, pressing the “Shift”+ “0_{Trigger}” keys, the *TRG common command, or the TRIG subsystem command. The trigger becomes effective only when the load remains at transient low level. Each trigger leads to one pulse. In the duration of rising edge, transient high level, and falling edge, any trigger will be ignored.

For example: assume that the CCH range is active, and the input is in OFF status, then the transient parameters should be set as follows:

Press “Tran” key to enter into transient operation;

Set the following parameters in transient operation menu:

State : On

Mode : Puls

LevelL : 5.000A
 LevelH : 10.000A
 TimeL : 0.50ms
 TimeH : 0.50ms
 TimeR : 0.5ms
 TimeF : 0.5ms

Then press “Cancel” to exit transient operation, press “On/Off” key to turn on the input;

Or via remote command to set:

SCPI command	Description
TRIG:SOUR EXT	Selects the external trigger input
TRAN ON	Enables transient operation
CURR:LLEV 5	Sets transient current low level to 5A
CURR:HLEV 10	Sets transient current high level to 10A
TRAN:HTIM 0.000500	Sets transient high level time to 500us
TRAN:RTIM 0.000500	Sets the time for transient rising edge to 500us
TRAN:FTIM 0.000500	Sets the time for transient falling edge to 500us
TRAN:MODE PULS	Selects pulse trigger operation
INPUT ON	Turns on the input

Get the trigger by receiving an external trigger signal. Figure 2-7 shows the current waveform of the load before it is triggered and after it has been triggered respectively: the electronic load starts operation at the transient low level (5A) when the input is turned on. For each trigger, the load current reaches the high level (10A) after 500us duration of rising edge, and remains at 10A for 500us. Then after 500us duration of falling edge, the current returns to the transient low level (5A).

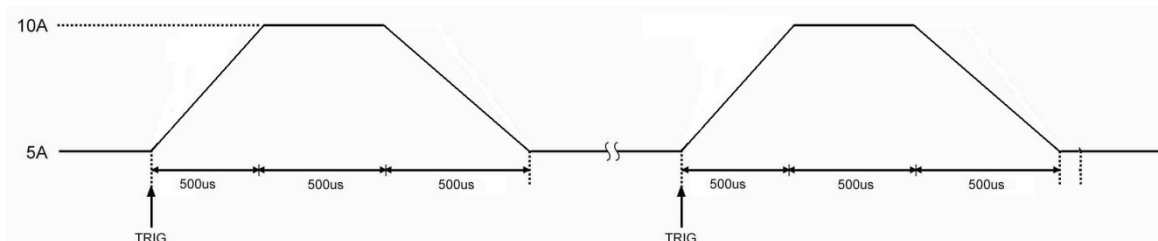


Fig. 2-7 Pulsed Transient Operation

2-4-3. Toggled Transient Mode

The trigger function is required for toggled transient operation. When there is no trigger occurs, the load remains at a transient level. After a trigger has been received, a toggle operation will be executed, and another transient level will be reached after the duration of rising edge or falling edge. The associated parameters such as transient low level (LevelL), transient high level (LevelH), time for rising edge (TimeR), time for falling edge (TimeF), and toggled transient mode can be set through transient operation menu or via remote command (CURRent:LLEVel <NRf+>, CURRent:HLEVel <NRf+>, VOLTage:LLEVel <NRf+>, VOLTage:HLEVel <NRf+>, RESistance:LLEVel <NRf+>, RESistance:HLEVel <NRf+>, TRANsient:RTIME <NRf+>, TRANsient:FTIME <NRf+>, TRANsient:MODE PULSe). The low level time (TimeL) and high level time (TimeH) have no effect on toggled transient operation.

The trigger can be an external trigger signal received via the TRIG input on the front panel, pressing the “Shift”+“0_{Trigger}” keys, the *TRG common command, or the TRIG subsystem command.

For example: assume that the CCH range is active, and the input is in OFF status, then the transient parameters should be set as follows:

Press “Tran” key to enter into transient operation;

Set the following parameters in transient operation menu:

State : On
 Mode : Togg
 LevelL : 5.000A
 LevelH : 10.000A
 TimeL : 0.50ms
 TimeH : 0.50ms
 TimeR : 0.50ms
 TimeF : 0.50ms

Then press “Cancel” to exit transient operation, press “On/Off” key to turn on the input;

Or via remote command to set:

SCPI command	Description
TRIG:SOUR EXT	Selects the external trigger input
TRAN ON	Enables transient operation
CURR:LLEV 5	Sets transient current low level to 5A
CURR:HLEV 10	Sets transient current high level to 10A
TRAN:LTIM 0.000500	Sets transient low level time to 500us
TRAN:HTIM 0.000500	Sets transient high level time to 500us
TRAN:RTIM 0.000500	Sets the time for transient rising edge to 500us
TRAN:FTIM 0.000500	Sets the time for transient falling edge to 500us
TRAN:MODE TOGG	Selects toggled operation
INPUT ON	Turns on the input

Get the trigger by receiving an external trigger signal. Figure 2-8 shows the current waveform of the load before it is triggered and after it has been triggered respectively: the electronic load starts operation at the transient low level (5A) when the input is turned on. For the first trigger, the load current reaches and remains at the high level (10A) after 500us duration of rising edge. When the second trigger is received, the load current will reach and remain at the low level (5A) after 500us duration of falling edge. Each trigger leads to one toggle operation.

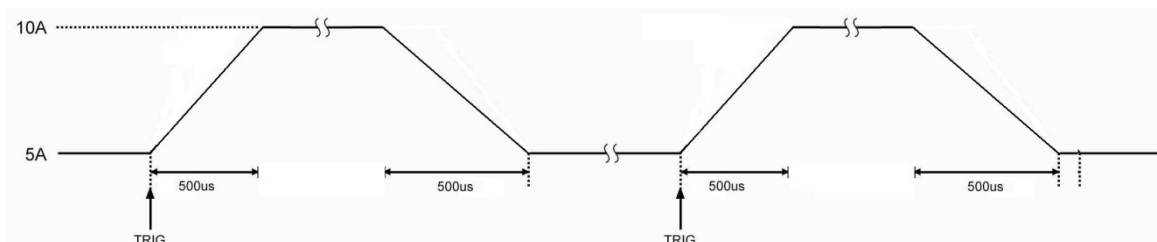


Fig. 2-8 Toggled Transient Operation

2-5. Sequence (List) Operation

Besides Transient operation, the electronic load provides more flexible list operation, which can make the load operate according to the preset sequence and synchronize with external signal.

The list operation allows you to program a series of sequence steps, and the operation mode, the load values, the duration time for each step can be set. The sequence operation can be executed in the CC, CV, and CR modes. The minimum duration for each step is 10ms (the duration to 0 indicates the current step is invalid), and the maximum one is 99999s. The list operation allows to be executed cyclically, and the cycle times can be set; the different list can be chained so that when one list has been executed, the another chained list will be enabled, which further perfects the capability of the list test to implement more complicated test task. Each list can contain 50 steps at most, and the load can store 8 lists.

The associated parameters of list operation can be edited and set through list operation menu or via remote command. The load provides convenient list editing function. When the user is operating input/edit sequence step, it is easy to check the previous and subsequent steps, and it is allowed to be edited, inserted, and deleted immediately, which simplifies the list input operation effectively.

The set value of each step will be automatically saved when exiting from step edit menu, and the other list parameters will be saved immediately after been edited.

The list operation also can be implemented via the remote command.

Please make sure the transient operation has been disabled before enabling list operation. In list operation, if the operation mode for next step is different from the present step, the load will automatically have a 5ms delay after the present step is over to avoid the probable current surge. The load's input will be turned off during this 5ms-delay.

Figure 2-9 is a list running diagram for 5 steps. See chapter 4 for detailed information about programming lists from the front panel.

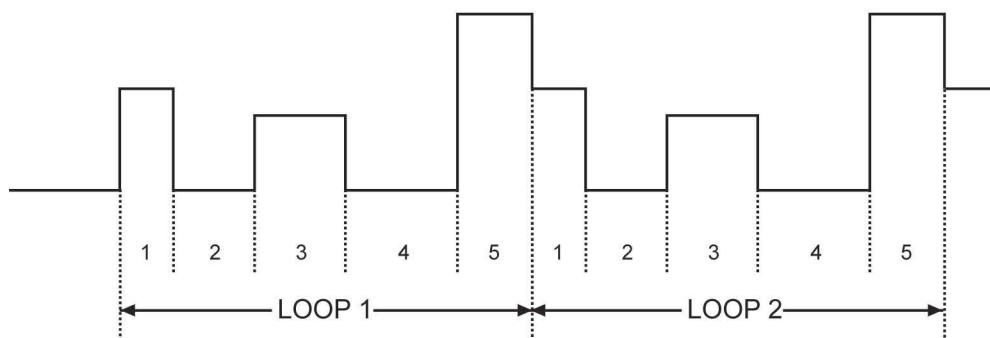


Fig. 2-9 List Operation

Note:

In list operation, the Von point and current limit level should be taken into consideration, which may cause the shut down of the input, so that the list operation is interrupted.

2-6. Battery Discharge Operation

The electronic load adopts constant current discharge to test battery capacity. The discharge current, termination voltage, and termination current can be self-defined. After the input is in ON status, constant current discharge is executed and switched to constant voltage discharge automatically when the battery voltage decreases to the termination voltage. And the battery discharge test will be stopped automatically when the discharge current is less than the termination current.

The test procedure is shown as figure 2-10. The load can real-time display battery voltage, discharge current, discharge time, and discharge capacity during the test. The maximum battery discharge time is 99hours 99minutes 99 seconds.

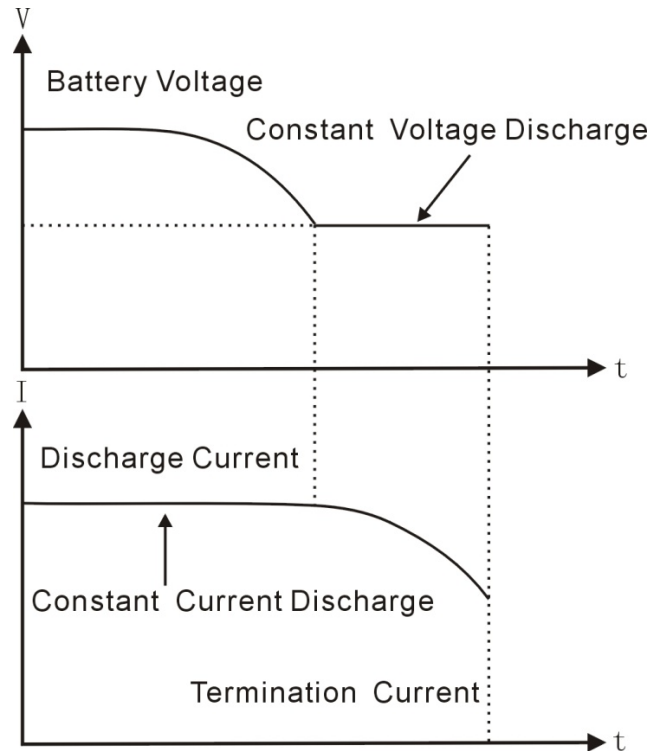


Fig. 2-10 Voltage/Current Curve Chart in Battery Discharge Operation

2-7. Short Circuit Operation

The electronic load can simulate a short circuit to test the protection performance of the tested device. The short circuit operation can be enabled and disabled by setting in the main menu, or via the remote command (INPut:SHORT ON/OFF). When the short circuit operation is enabled, the relevant short-circuit value depends on the present mode of the load. See “Main Specifications” section for details.

The other set values will not be changed when the short circuit operation is enabled.

Note:

In short circuit operation, the Von point and current limit level should be taken into consideration, which may cause the shut down of the input, so that the short circuit operation is interrupted.

2-8. Triggered Operation

The triggered operation is mainly used to make the load keep synchronized with other test equipments or events. This series electronic load provides various triggering modes, which can be applied to the following occasions:

- **Triggering a preset level**

Transfers all pending preset levels to the immediate levels. For the presently active mode, the new level will appear at the input at once if the input is turned on. For the modes which are not presently active, the preset levels will not take effect at the input until the corresponding mode becomes active.

- **Triggering a transient pulse**

Generates a transient pulse in accordance with the preset transient parameters, when pulsed transient operation is active.

- **Triggering a transient toggle**

Switches the input between the transient low level and transient high level in accordance with the preset transient parameters, when the toggled transient operation is active.

- **Triggering a list test**

Enables the present list test when the list operation is active.

Three triggering methods are available for remote control: the *TRG and TRIGger commands. The External trigger input terminal and "Shift"+"0_{Trigger}" key on the front panel of the load can be used to trigger (can generate a trigger signal to the electronic load).

The load has three triggering modes: BUS, EXTERNAL, and HOLD.

- **The BUS mode:** the trigger source is *TRG command.

- **The EXTERNAL mode:** Choose the External trigger input terminal or "Shift"+"0_{Trigger}" key on the front panel as the trigger source. The input signal at the External trigger input terminal is TTL, the falling edge (signal) is triggered (can generate a trigger signal to the electronic load).

- **The HOLD mode:** Use the command TRIGger:IMMediate as the trigger source. At this time, all other triggering methods including *TRG become invalid.

Note:

The command TRIGger:IMMediate can be used in all three triggering modes. The triggering modes can be selected via the remote command only (TRIGger:SOURce BUS; TRIGger:SOURce EXTERNAL; TRIGger:SOURce HOLD).

2-9. Input Control

2-9-1. Turn On/Off the Load

The input can be turned on/off by pressing "On/Off" key, or via the remote command (INPUT ON/OFF). When input is in Off status, press "On/Off" to turn on the input of load and the indicator of "On/Off" is turned on; When input is in On status, press "On/Off" to turn off the input of load and the indicator of "On/Off" is turned off; Turning the input on/off does not affect the programmed settings.

In local control, if the input is turned on, the load status can not be switched directly among the basic modes, transient operation, list operation and battery discharge operation etc.. The load can be switched from one operation status to another operation status only when the input is turned off.

In remote control mode, it is better to send the command "INPUT ON/OFF" in the end to turn on the load.

2-9-2. Von Point / Voff Point / Von Latch

When the rising speed or falling speed of tested power supply is slow, the load maybe protect the tested power supply. The load provides functions of Von Point and Voff Point. When the voltage of tested power supply goes up untill exceeds the Von Point, the load starts Von test. Once the voltage of tested power supply is more than the Voff Point, the voltage will drop down till less than the Voff Point, at this time, the load is in Voff status and the input is in Off status.

When the external input voltage is less than the Von Point, the load will not be enabled even though the input has been turned on. The load will be enabled till the external input voltage reaches or exceeds the Von Point. Von Latch is used to latch the active status of the load. If the Von Latch function is enabled, once the input voltage reaches Von Point, the input will be turned on, and stay in ON status regardless of the changes from the external input voltage, even though the input voltage is less than the Von point. Please see figure 2-11; if the Von Latch function is disabled, once the input voltage reaches Von Point, the input will be turned on automatically, and once the input voltage is less than the Von Point, the input will be automatically turned off. Please see figure 2-12. The automatically turning on /off of the input can be implemented via setting the Von Point and Von Latch, which simplifies test operation greatly.

The Von Voltage can be set in main menu, or via the remote command (INPut:VOLTage:ON <NRf+>).

The Voff Voltage can be set in main menu, or via the remote command (INPut:VOLTage:OFF <NRf+>).

The Von Latch can be set in main menu, or via the remote command (INPut:VOLTage:ON:LATCH ON/OFF).

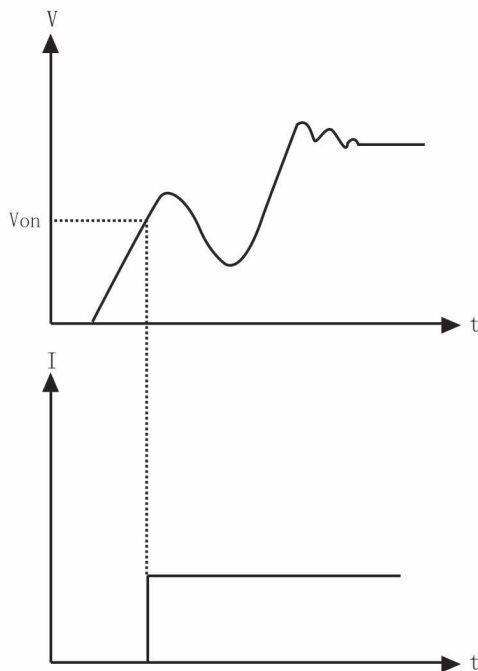


Fig. 2-11 Von Latch Is Enabled

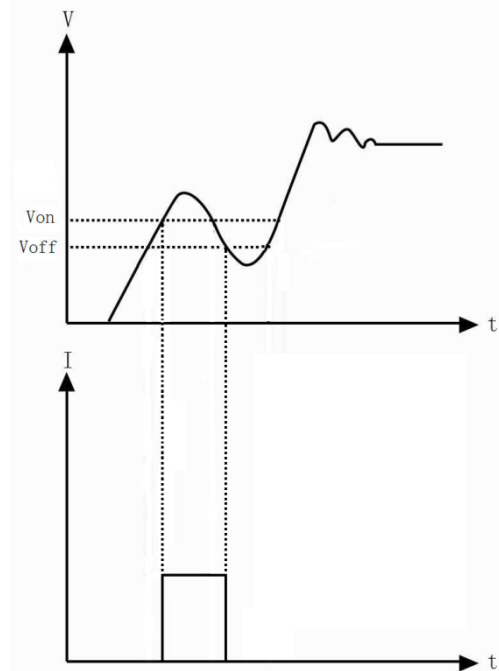


Fig. 2-12 Von Latch Is Disabled

Note:

If the load is unable to operate normally, please check the setting of Von Point and Voff Point.

2-9-3. Current Limit in CV Mode

The CV Curr Limit is used to limit the maximum input current in CV mode. If the voltage is still larger than the set level while the current limit has been reached, the load will switch to the CC mode. Please see figure 2-13. The input will not be turned off in the CV current limit, which is different from the software current limit.

The CV Curr Limit can be set in main menu, or via the remote command (CV:CURRent:LIMIt <NRf+>).

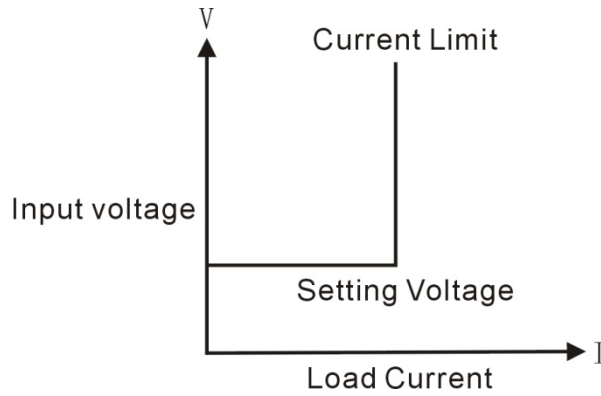


Fig.2-13 CV Curr Limit

2-9-4. Current Rise Rate

The Current Rise Rate is used to set the current rise rate in CC mode. It can be set in main menu, or via the remote command (CURRent:RISE:RATE <NRf+>).

If the current rise rate is 0.1A/us, and the current set level is 20A, then the current rise rate is shown as below when the input is turned on:

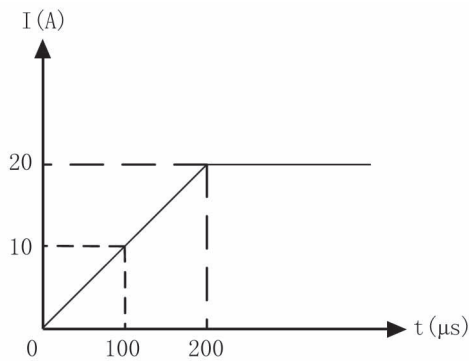


Fig.2-14 Current Rise Rate

Note:

The Current Rise Rate can be effective only in CCH and CCL, and the set level is 10 times larger than the maximum current rise rate in CCL.

2-9-5. Current Fall Rate

The Current Fall Rate is used to set the current fall rate in CC mode. It can be set in main menu, or via the remote command (CURRent:FALL:RATE <NRf+>).

If the current fall rate is 0.1A/us, and the current set level is 20A, then the current rise rate is shown as below when the input is turned off:

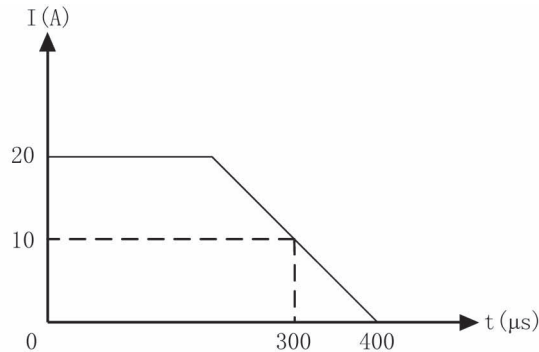


Fig.2-15 Current Fall Rate

Note:

The Curr Fall Rate can be effective only in CCH and CCL mode, and the set level is 10 times larger than the actual current fall rate in CCL.

2-10. Measurement Function

The electronic load has measurement system with high resolution. The input current level and voltage level can be measured in real time. The input power level and resistance level can be computed with the input voltage level and current level. Each measured value can be checked through LCD display or via the command (MEASure).

2-11. Saving and Recalling

The electronic load is provided with a EEPROM memory, which can save various parameters, such as modes, input status, current, voltage, resistance, transient settings, and limits etc.. This Series electronic load can save 10 groups of parameters. All parameters relevant to saving and recalling operation are listed in list 2-1. The 10 groups of parameters stored in location 0~9 can be saved and recalled by pressing “1_{Store}” and “2_{Recall}” keys, or via the remote command (*SAV < NRI > and *RCL < NRI >).

The parameter saved in location 0 will be recalled automatically every time when the load is turned on.

List 2-1

Function	Effect
Input	Input status
Mode	Operation mode
CCL Current level	CCL immediate current level
CCH Current level	CCH immediate current level
Current rise rate	Current rise rate
Current fall rate	Current fall rate
Current Hlevel	Transient current high level

Current Llevel	Transient current low level
Current protection level	Current protection limit
Current protection delay	Current protection delay
Current protection State	Enable/disable current protection
CVL Voltage level	CVL immediate voltage level
CVH Voltage level	CVH immediate voltage level
Voltage protection level	Voltage protection limit
Power protection level	Power limit
CV current limit	Current limit in CV mode
Voltage Hlevel	Transient voltage high level
Voltage Llevel	Transient voltage low level
CRL Resistance level	CRL immediate resistance level
CRM Resistance level	CRM immediate resistance level
CRH Resistance level	CRH immediate resistance level
Resistance Hlevel	Transient resistance high level
Resistance Llevel	Transient resistance low level
CPV Power level	CPV immediate power level
CPC Power level	CPC immediate power level
Transient operation	Transient test
Transient mode	Transient mode
Transient Htime	Time for transient high level
Transient Ltime	Time for transient low level
Transient Rtime	Time for transient rising edge
Transient Ftime	Time for transient falling edge
Trigger Function	Trigger function selection
Trigger source	Trigger source
Battery Mode	Battery discharge operation
Battery mini voltage	Battery discharge termination voltage
Battery discharge current	Battery discharge current
Voltage on Latch	Latch the Von point
Voltage on	Von point for the load
Voltage off	Voff point for the load

2-12. Reading Remote Programming Errors

The Err annunciator will be turned on when remote programming errors occur. The error codes are shown as followings:

- -1xx Command errors
- -2xx Execution errors
- -3xx Device-specific errors
- -4xx Query errors

The remote command (SYSTem:ERRor?) can reads back the error codes and error messages when it is in remote control.

All errors are saved in one error queue. The errors in this error queue are read in the order in which they occurred. At most 20 error messages can be saved in the error queue. If the occurred errors exceed 20, the last error in the error queue will be replaced with -350, "Queue overflow". The load will not save any additional error message, unless you clear or read errors from the queue. Once the error message is read, it will be cleared in the error queue.

2-13. Status Report

The electronic load incorporates a status reporting register. Various status conditions of the load can be reported by querying the status register. The user can make sure which event has been reported through setting the enable register (It will be introduced in details in "ElectronicLoad SCPI Programming Guide".).

2-14. Protection Function

The electronic load is equipped with the following protection functions:

- Overvoltage (OV)
- Overcurrent (OC)
- Overpower (OP)
- Overtemperature (OT)
- Reverse Voltage (RV)

Once any of the above protection functions is active, the corresponding status bit in the status will be set; the input will be turned off with beeps; the annunciator of "Cancel" will be turned on, the display will show PT to indicate protection status the detected conditions will be displayed; the load will enter into the latched protection status, and will not respond to other commands except some specific operations. For example: if an overtemperature conditions has been detected, the input will be turned off with beeps, and OT will be shown in the lower right corner of the display. The load will have no response to other operations.

2-14-1. Clearing Latched Protection

When the load enters into the latched protection status, it will have no response to other commands. The load will return to the normal operation only when the latched protection has been reset via long pressing the “Cancel” key or the remote command (INPut:PROTection:CLEar). Of course, the condition that cause the latched protection must be removed, or it will be latched again as soon as it is reset.

In addition, when the software overcurrent protection is enabled, if the overcurrent time does not exceed the specified protection time, the indicator of “Cancel” will be turned on, but the input will not be turned off. At this time, you can reset the overcurrent time via long-pressing “Cancel” key or the remote command (INPut:PROTection:CLEar).

2-14-2. Over Voltage

When the input voltage exceeds the predetermined voltage, the overvoltage protection will be enabled, and the input is turned off with OVP displayed, meanwhile, the OV and VF status register bits are set, and will remain set until they are reset and overvoltage condition is removed.

2-14-3. Over Current

The electronic load allows the user to define a current protection limit. When the defined current limit is exceeded, the overcurrent timer starts timing, and the indicator of “Cancel” will be turned on, but the input will not be turned off immediately. When the specified delay time is reached, the overcurrent protection will be enabled and the input is turned off with OCP displayed, meanwhile, the OC and PS status register bits are set, and will remain set until they are reset and overcurrent condition is removed. The current protection limit function can only be set via the entry key from the front panel and the remote command. It is turned on/off with the command (CURRent:PROTection:STATe ON/OFF). The current limit level is set with the command (CURRent:PROTection < NRf+>). The specified delay time to turn off the input can be set with the command (CURRent:PROTection:DELay < NRf+>).

2-14-4. Over Power

The electronic load provides software overpower protection function.

Once the input power exceeds the maximum rated power, the load will compute the present actual power. The overpower protection will become active as long as the overpower time exceeds the specified limit.

When the overpower protection is enabled, the input will be turned off with OPP displayed, meanwhile, the OP and PS status register bits are set, and will remain set until they are reset and overpower condition is removed.

2-14-5. Over Temperature

If the internal temperature of the load exceeds safe limits, the overtemperature protection will be enabled; the input will be turned off with OTP displayed, in the meantime, the OT and PS status register bits are set, and will remain set until they are reset and overtemperature condition is removed. You must wait until the load cools down to the normal temperature before you can reset the latched protection. The fans in the load will help to cool the load as quickly as possible.

2-14-6. Reverse Voltage

When reverse voltage is applied, the reverse voltage protection will be enabled; the input will be turned off and the indicator of “Cancel” is turned on, in the meantime, the RV and VF status register bits are set, and will remain set until they are reset and reverse voltage is removed.

2-15. Auxiliary Functions

2-15-1. Trigger Function Selection

The Trigger Function in Trigger Set menu is used to select the trigger object. Selecting “Tran” is used to trigger transient operation, and selecting “List ” is used to trigger sequence (list) operation.

2-15-2. Knob Function

The Knob in Config menu is used to enable/disable the knob function. Select On to enable the knob function, and select Off to disable.

2-15-3. Key Sound

The Key Sound in Config menu is used to enable/disable the key sound. Select On to enable the key sound, and select Off to disable.

Chapter3 Installation

3-1. Initial Check

When you receive the load, please check it for any obvious damage that may have occurred during shipment. Keep the original packing materials in case the load has to be returned to factory in the future

Please confirm that there are no broken keys or knobs, that the cabinet and panel surfaces are free of dents and scratches, and that the display is not scratched or cracked.

3-2. Environment/Installation Location

The load can operate at its full power within the temperature range of 0 °C to 40 °C, and at derated power from 40 °C to 55 °C, or the overtemperature protection will be caused.

Place the load in a location with good ventilation, and keep a distance from electromagnetic interference. Do not place the load in the flammable atmosphere.

Your load must be installed in a location that allows sufficient space at the sides and rear of the load for adequate air circulation. The fans cool the load by drawing in air through the sides and exhausting it out the back. The rubber bumpers must be removed for rack mounting.

3-3. Power-On/ Self-Test

A power-on self-test can inspect the basic operations of the load to assure you that the load is operational.

First, check AC power-line voltage to verify the power-line voltage selected by 110V/220V power selection switch on the bottom panel is in accordance with the proper voltage in your local place.

Connect the power-line cord and turn on the load. After around 20 minutes' warm-up of the load, the following test can be executed:

Connect the output of a power supply to the load's input with correct polarity to execute CCH 5A and CVH 5V operations. If the load works normally, it will draw 5A or set input voltage to 5V within the allowed tolerance.

3-4. Connections on the Rear Panel

The rear panel is shown as fig. 3-1, which mainly includes AC input part, external trigger input terminal, remote sensing terminal and communication interface part. The AC input part includes AC input socket, Fuse holder, and Line voltage switch on the bottom of panel. The interface part includes RS232 interface.

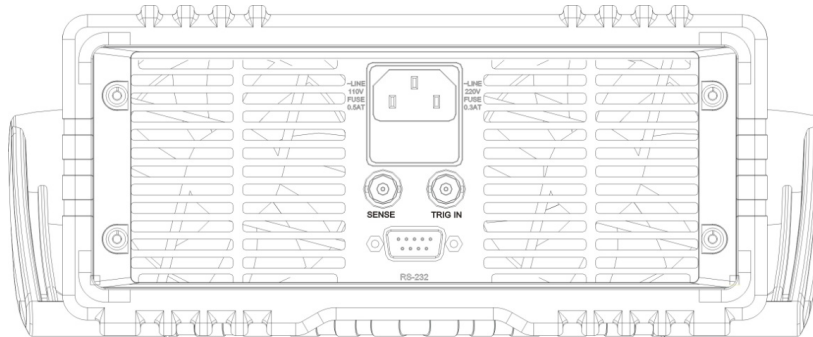


Fig. 3-1

AC Input:

AC power-line cord must be appropriate for your local standard.

The specifications of the fuse: 110V: 250V 500mA; 220V: 250V 300mA;

Line voltage switch can switch the voltage from 110V to 220V. The selected voltage should be in accordance with the proper voltage in your local place.

RS-232 Interface:

The load provides a RS-232 interface, which is a standard DB9 pin connector. The pin assignment is shown as below:

Pin	Input/Output	Description
1	-	Not used
2	Input	RXD: Receive data
3	Output	TXD: Transmit data
4	-	Not used
5	Common	GND: Ground
6	-	Not used
7	-	Not used
8	-	Not used
9	-	Not used

The interface parameters can be set in the Menu, you can use SCPI language for programming to realize the communication with the load.

TRIGGER Connections:

The external trigger input terminal on the rear panel is a BNC connector, in which the middle part is the input+, and the outer casing is the input-. It receives 5V TTL-compatible falling-edge trigger signals.

Remote Sense:

Remote sensing is a BNC connector, in which the middle part is the SENSE+, and the outer casing is the SENSE-. It compensates for the voltage drop caused by the power supply and input wire resistance to achieve greater accuracy. The load can detect voltage inputs automatically, so there is no need to modify the parameter settings or change the hardware wiring when using remote sensing.

3-5. Connections on the Front Panel

The terminals on the front panel are input terminals (INPUT+, INPUT-). See Fig. 3-2.

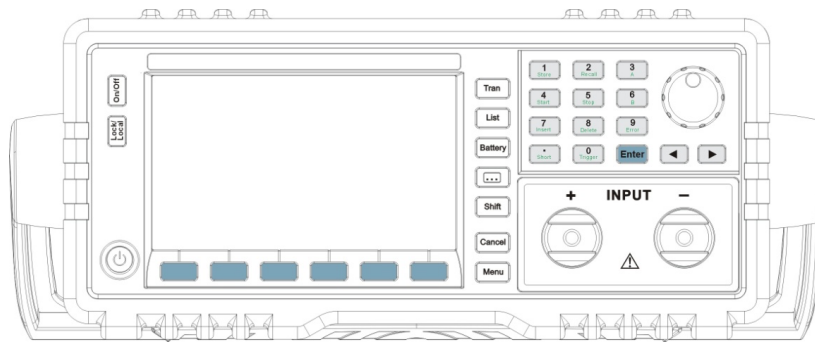


Fig. 3-2

Input Connections:

Input connections are made to two binding posts (INPUT+, INPUT-) on the front panel. The maximum wire diameter is 4mm. In order to enhance the test accuracy, and reduce the test error when executing large current test, it would be better to use thicker wire.

3-6. Wiring

Sense Connections

When greater accuracy of voltage test is needed, it is necessary to connect Sense input, and the load will switch to Sense status automatically. The relevant wiring is shown as fig.3-3.

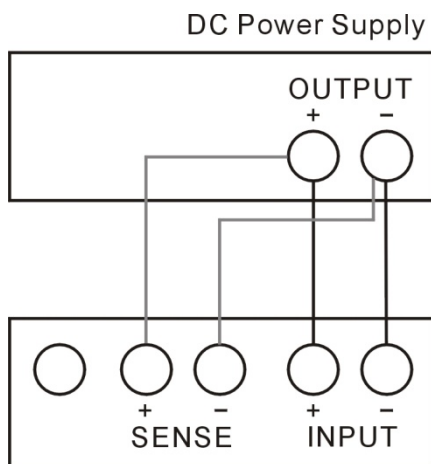


Fig. 3-3

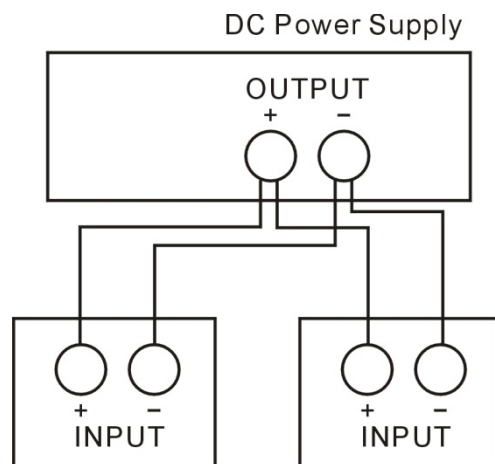


Fig. 3-4

Parallel Connections

Figure 3-4 illustrates how two or more loads can be paralleled in CC or CR mode when high power or large current is needed.

Chapter4 Local Operation

The local operation of the load has been briefly introduced in Chapter2 Functions and Features. In this chapter, it will be explained in details with examples.

4-1. Local Control

If you need to control the load via operations on the front panel, the load must stay in the local control status. The load enters into local control status once it is powered on, and preset parameters saved in EEPROM location 0 will be recalled automatically.

Under remote control status, all operations on front panel keypad and knobs become invalid (except “Lock/Local” key). When the load receives a remote command (SYST:REM) via RS232, the remote control goes into effect and Rmt annunciator is turned on. Under remote control status, all operations on electronic load are controlled by remote controller. The electronic load will return to local control after receiving the return command (e.g. : SYST:LOC). Or you can return the electronic load to local control by long-pressing “Lock/Local”key.

4-2. Main Operation on the Front Panel

- Connecting to the Power Supply
- Turning the Input On/Off
- CC Mode
- CV Mode
- CR Mode
- CP Mode
- Short Circuit Operation
- Continuous Transient Operation
- Pulsed Transient Operation
- Toggled Transient Operation
- Sequence (List) Operation
- Battery Discharge Operation
- Saving and Recalling Parameters
- Clear Protection Settings
- Error Messages
- Triggered Operation
- Main Menu

4-3. Connecting to the Power Supply

Connect the positive pole of the power supply to the INPUT + terminal, and connect the negative pole of the power supply to the INPUT - terminal. If the input is connected reversely, the RV protection status of the load will become effective, and please try to connect the power supply to the load again at this time.

After the power supply is correctly connected to the load, long-press “Cancel” key to clear the RV protection status (the relevant details will be described in “Clearing Protection Settings”).

4-4. Turning the Input On/Off

Press “On/Off” key to turn on or turn off the input.

4-5. Basic Tests

The operating procedures for basic tests are shown as below:

- 1) Press “Menu” key to enter into the mode selection and parameter setting menu.
- 2) Use Entry keys or use the knob together with “◀”, “▶” keys to input set value. Use “Cancel” key to modify the set value or exit the mode selection and parameter setting menu.
- 3) Press “Enter” key to confirm and exit the mode selection and parameter setting menu.
- 4) Press “On/Off” key to turn on the load.

4-5-1. CC Mode

CC Mode includes constant current high range (CCH) and constant current low range (CCL).

Example1: Set the load to CCH and set the current value to 5.12A in CV mode. Turn on the load, and check the present power value. The operating procedures are shown as below:

Procedures	Operation Descriptions	Display
1	Press “Menu” key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or use the knob to select “0 System Set”, press “Enter” key to confirm and enter into System Set.	CC SET 0 Low
3	Use Entry keys or use the knob to select “1 High”, press “Enter” key to confirm.	CC Set 1 High
4	Press “Cancel” key to exit and return to the basic mode.	CVH 05.000V
5	Press “I-set” key to enter into the parameter setting menu. Use Entry keys or use the knob together with “◀” and “▶” keys to input the current value to 5.12.	SCCH 05.120A
6	Press “Enter” key to confirm and exit the parameter setting menu.	CCH 05.120A
7	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

INPUT Off ; Turns off the load
MODE CCH ; Sets the mode
CURR 5.12 ; Sets the current value
INPUT ON ; Turns on the load

Example2: Set the current value to 5.8A in CCH. Turn on the load, and there are two ways to set the current value.

Solution 1:

Procedures	Operation Descriptions	Display
1	Press “I-set” key to enter into the parameter setting menu.	SCCH 05.120A
2	Use Entry keys or use the knob together with “◀” and “▶” keys to input the current value to 5.8.	SCCH 05.800A
3	Press “Enter” key to confirm and exit the parameter setting menu.	CCH 05.800A
4	Press “On/Off” key to turn on the load.	

Solution 2:

Procedures	Operation Descriptions	Display
1	Move the cursor to the hundredths with “◀” key.	CCH 05.120A
2	Rotate the knob to set the hundredths to 0. (The set value will be changed when rotating the knob. The set value will become effective at input at once when the load is turned on.).	CCH 05.100A
3	Move the cursor to the tenths with “◀” key.	CCH 05.100A
4	Rotate the knob to set the tenths to 8. (The set value will be changed when rotating the knob. The set value will become effective at input at once when the load is turned on.).	CCH 05.800A
5	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CCH ; Sets the mode
 CURR 5.8 ; Sets the current value
 INPUT ON ; Turns on the load

Note: CCH /CCL will be shown respectively in the lower right corner of the display when the load is in CCH status or CCL status.

4-5-2. CV Mode

Example1: Set the load to CCH and set the voltage value to 50V in CVH mode. Turn on the load, and check the present power value. The operating procedures are shown as below:

Procedures	Operation Descriptions	Display
1	Press “V-set” key to enter into the parameter setting menu. Use Entry keys or use the knob together with “◀” and “▶” keys to input the voltage value to 50.	SCVH 50.000V
2	Press “Enter” key to confirm and exit the parameter setting menu.	CVH 50.000V
3	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CVH ; Sets the mode
 VOLT 50 ; Sets the voltage value
 INPUT ON ; Turns on the load

Example2: Set the voltage value to 60V in CV. Turn on the load, and there are two ways to set the voltage value.

Solution 1:

Procedures	Operation Descriptions	Display
1	Press “V-set” key to enter into the parameter setting menu.	CVH 50.000V
2	Use Entry keys or use the knob together with “◀” and “▶” keys to input the voltage value to 60.	CVH 60.000V
3	Press “Enter” key to confirm and exit the parameter setting menu.	CVH 60.000V
4	Press “On/Off” key to turn on the load.	

Solution 2:

Procedures	Operation Descriptions	Display
1	Move the cursor to the tenths with “◀” key.	CVH 50.00V
2	Rotate the knob to set the tenths to 6. (The set value will be changed when rotating the knob. The set value will become effective at input at once when the load is turned on.).	CVH 60.00V
3	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CVH ; Sets the mode
VOLT 60 ; Sets the voltage value
INPUT ON ; Turns on the load

Note: CVH will be shown in the lower right corner of the display when the load is in CV mode.

4-5-3. CR Mode

CR Mode includes the low level (VL CRL), medium level (VL CRM), high level (VL CRH) of the low voltage range and the low level (VH CRL), medium level (VH CRM), high level (VH CRH) of the high voltage range.

Example1: Set the load to VHCRL and set the resistance value to 1.5Ω. Turn on the load, and check the present power value. The operating procedures are shown as below:

Procedures	Operation Descriptions	Display
1	Press “Menu” key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or use the knob to select “0 System Set”, press “Enter” key to confirm and enter into System Set.	CC Set 1 High
3	Select “Syst CR Set” with “↑” and “↓” keys.	CR Set 2 VH High
4	Use Entry keys or use the knob to select “0 Low”, press “Enter” key to confirm.	CR Set 0 VH Low
5	Press “Cancel” key to exit and return to the basic mode.	CVH 60.000V
6	Press “R-set” key to enter into the parameter setting menu. Use Entry keys or use the knob together with “◀” and “▶” keys to input the resistance value to 1.5.	SVHCRL 1.5000R
7	Press “Enter” key to confirm and exit the parameter setting menu.	VHCRL 1.5000R
8	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE VHCRL ; Sets mode
RES 1.5 ; Sets the resistance value
INPUT ON ; Turns on the load

Example2: Set the resistance value to 1.2Ω in VH CRL. Turn on the load, and there are two ways to set the resistance value.

Solution 1:

Procedures	Operation Descriptions	Display
1	Press “R-set” key to enter into the parameter setting menu.	SVHCRL 1.5000R
2	Use Entry keys or use the knob together with “◀” and “▶” keys to input the resistance value to 1.2.	SVHCRL 1.2000R
3	Press “Enter” key to confirm and exit the mode selection and parameter setting menu.	VHCRL 1.2000R
4	Press “On/Off” key to turn on the load.	

Solution 2:

Procedures	Operation Descriptions	Display
1	Move the cursor to the tenths with “◀” key.	VHCRL 1.5000R
2	Rotate the knob to set the tenths to 2. (The set value will be changed when rotating the knob. The set value will become effective at input at once when the load is turned on.).	VHCRL 1.2000R
3	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE VH CRL ; Sets mode
RES 1.2 ; Sets the resistance value
INPUT ON ; Turns on the load

Note: CRH /CRM/CRL will be shown respectively in the lower right corner of the display when the load is in CRH status, CRM status or CRL status.

4-5-4. CP Mode

CP mode includes constant power-voltage source mode (CPV) and constant power-current source mode (CPC).

Example1: Set the load to CPV and set the power value to 100W in CRL. Turn on the load, and check the present power value. The operating procedures are shown as below:

Procedures	Operation Descriptions	Display
1	Press “Menu” key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or use the knob to select “0 System Set”, press “Enter” key to confirm and enter into System Set.	CC Set 0 Low
3	Select “Syst CR Set” with “↑” and “↓” keys.	CP Set 1 CPC
4	Use Entry keys or use the knob to select “0 CPV”, press “Enter” key to confirm.	CP Set 0 CPV
5	Press “Cancel” key to exit and return to the basic mode.	VHCRL 1.200R
6	Press “P-set” key to enter into the parameter setting menu. Use Entry keys or use the knob together with “◀” and “▶” keys to input the power value to 100.	SCPV 100.00W
7	Press “Enter” key to confirm and exit the parameter setting menu.	CPV 100.00W
8	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CPV ; Sets mode
 POW 100 ; Sets the power value
 INPUT ON ; Turns on the load

Example2: Set the power value to 200W in CPV. Turn on the load, and there are two ways to set the power value.

Solution 1:

Procedures	Operation Descriptions	Display
1	Press “P-set” key to enter into the parameter setting menu.	SCPV 100.00W
2	Use Entry keys or use the knob together with “◀” and “▶” keys to input the power value to 200.	SCPV 200.00W
3	Press “Enter” key to confirm and exit the mode selection and parameter setting menu.	SCPV 200.00W
4	Press “On/Off” key to turn on the load.	

Solution 2:

Procedures	Operation Descriptions	Display
1	Move the cursor to the hundredths with “◀” key.	CPV 100.00W
2	Rotate the knob to set the hundredths to 2. (The set value will be changed when rotating the knob. The set value will become effective at input at once when the load is turned on.).	CPV 200.00W
3	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CPV ; Sets mode
 POW 200 ; Sets the power value
 INPUT ON ; Turns on the load

Note: CPV/CPC will be shown respectively in the lower right corner of the display when the load is in CPV or CPV mode.

4-6. Short Circuit Operation

The operating procedures for short circuit operation are shown as below:

- 1) Press “Menu” key to enter into the selectable menu.
- 2) Use Entry keys or use the knob to select “0 System Set”, and press “Enter” key to confirm and enter into System Set
- 3) Select Short (short circuit) item with “↓” key.
- 4) Operate all the above steps or press “Shift”+“Short” keys to select Short (short circuit) item.
- 5) Use Entry keys or knob to set On, and press “Enter” key to confirm.
- 6) Press “Cancel” key to exit the main menu. The display shows “s” to indicate in the basic test mode.
- 7) Select one basic test mode; press “Enter” key to confirm and exit the mode selection and parameter setting menu.
- 8) Press “On/Off” key to turn on the load.

Example1: The load was in CVH mode previously and it is turned off. Set the load to short circuit in CCH status. Turn on the load to execute short circuit operation.

Procedures	Operation Descriptions	Display
1	Press "Menu" key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or use the knob to select "0 System Set", press "Enter" key to confirm and enter into System Set.	CC Set 0 Low
3	Use Entry keys or use the knob to select "1 High", press "Enter" key to confirm.	CC Set 1 High
4	Select Short (short circuit) item with "↓" key.	SHORT 0Off
5	Use Entry keys or knob to set On, and press "Enter" key to confirm.	SHORT 1On
6	Press "Cancel" key to exit the main menu. The display shows "s" to indicate in CVH mode.	CVH 0.000V
7	Select CCH mode by pressing "I-set" key. press "Cancel" key to exit the mode selection and parameter setting menu.	CCH 44.000A
8	Press "On/Off" key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

INPUT:SHORT ON ; Sets the load to short circuit operation

MODE CCH ; Sets mode

INPUT ON ; Turns on the load

Example2: Based on the last example, exit the short circuit operation, and turn off the load.

Procedures	Operation Descriptions	Display
1	Press "Menu" key to enter into the selectable menu and the load is turned off automatically.	MENU 0 SYST
2	Use Entry keys or use the knob to select "0 System Set", press "Enter" key to confirm and enter into System Set.	CC Set 0 Low
3	Use Entry keys or use the knob to select "1 High", press "Enter" key to confirm.	CC Set 1 High
4	Select Short (short circuit) item with "↓" key.	SHORT 0On
5	Use Entry keys or knob to set Off, and press "Enter" key to confirm.	SHORT 1Off
6	Press "Cancel" key to exit the main menu. On the display, "s" disappears in CCH status.	CVH 0.000V

For the above operating procedures, the corresponding SCPI commands should be:

INPUT:SHORT OFF ; Sets the load to exit short circuit operation

INPUT OFF ; Turns on the load

4-7. Transient Operation

The operating procedures for transient operation are shown as below:

- 1) Select one basic test mode, press “Enter” key to confirm and exit the parameter setting menu.
- 2) Press “Tran” key to enter into transient operation.
- 3) Use “↑”, “↓” keys to select the parameter.
- 4) Use Entry keys or use the knob together with “◀”, “▶” keys to set values for LevelL, LevelH, TimeL, TimeH, TimeR, and TimeF. Use Entry keys or knob to set Mode value and set State to On.
- 5) Press “Cancel” key to exit the transient operation menu.
- 6) Press “On/Off” key to turn on the load.
- 7) If it is the pulsed transient operation or the toggled transient operation, one trigger occurs when pressing “Shift”+“0_{Trigger}” keys or the signal at the trigger input terminal (TRIG IN) is low level.

4-7-1. Continuous Transient Operation

In continuous operation, the load periodically switches between high/low levels. The relevant parameters such as low level (LevelL), high level (LevelH), low level time (TimeL), high level time (TimeH), time for rising edge (TimeR), time for falling edge (TimeF).

Example: Set the load voltage value to periodically switch between 1V and 5V; set the time for rising edge (TimeR) to 10ms; set high level time (TimeH) to 200ms; set time for falling edge (TimeF) to 20ms; set low level time (TimeL) to 400ms, and the load is in continuous transient operation. The operating procedures are shown as below:

Procedures	Operation Descriptions	Display
1	Press “V-set” key to select CVH mode, press “Cancel” key to exit the parameter setting menu.	CVH 04.000V
2	Press “Tran” key to enter into transient operation.	STATE 0OFF
3	Use Entry keys or use the knob together with “◀”, “▶” keys to set State value to “1 On”, press “Enter” key to confirm.	STATE 1ON
4	Use Entry keys or use the knob to set Mode value to “Cont”, press “Enter” key to confirm.	MODE 0Cont
5	Use Entry keys or use the knob together with “◀”, “▶” keys to set LevelL to 1, press “Enter” key to confirm.	LEVELL 01.000V
6	Use Entry keys or use the knob together with “◀”, “▶” keys to set LevelH to 5, press “Enter” key to confirm.	LEVELH 05.000V
7	Use Entry keys or use the knob together with “◀”, “▶” keys to set TimeL to 400ms, press “Enter” key to confirm.	TIMEL 400.00M
8	Use Entry keys or use the knob together with “◀”, “▶” keys to set TimeH to 200ms, press “Enter” key to confirm.	TIMEH 200.00M
9	Use Entry keys or use the knob together with “◀”, “▶” keys to set TimeR to 10ms, press “Enter” key to confirm.	TIMER 010.00ms
10	Use Entry keys or use the knob together with “◀”, “▶” keys to set TimeF to 20ms, press “Enter” key to confirm.	TIMER 020.00ms
11	Press “Cancel” key to exit the transient operation menu.	
12	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

```

MODE      CVH      ; Sets the mode
TRAN      ON       ; Enables the transient operation
VOLT:LLEV 1        ; Sets a value to low level
VOLT:HLEV 5        ; Sets a value to high level
TRAN:LTIME 0.400   ; Sets the low level time to 400ms
TRAN:HTIME 0.200   ; Sets the high level time to 200ms
TRAN:RTIME 0.025   ; Sets the time for rising edge to 25ms
TRAN:FTIME 0.025   ; Sets the time for falling edge to 25ms
TRAN:MODE  CONT    ; Selects the continuous transient operation
INPUT     ON       ; Turns on the load

```

4-7-2. Pulsed Transient Operation

Example: Assume that the load is in external triggering mode, set the load current value to periodically switch between 1A and 5A; set the time for rising edge (TimeR) to 10ms; set high level time (TimeH) to 200ms; set time for falling edge (TimeF) to 10ms; the load is in pulsed transient operation, and a trigger occurs at this time.

Procedures	Operation Descriptions	Display
1	Press “I-set” key to select CCL mode, press “Cancel” key to exit the parameter setting menu.	CCL 04.000A
2	Press “Tran” key to enter into transient operation.	STATE 1OFF
3	Use Entry keys or use the knob to set State value to “1 On”, press “Enter” key to confirm.	STATE 1ON
4	Use Entry keys or use the knob to set Mode value to “Puls”, press “Enter” key to confirm.	MODE 1PULS
5	Use Entry keys or use the knob together with “◀”, “▶” keys to set LevelL to 1, press “Enter” key to confirm.	LEVELL 01.000V
6	Use Entry keys or use the knob together with “◀”, “▶” keys to set LevelH to 5, press “Enter” key to confirm.	LEVELL 05.000V
7	Use Entry keys or use the knob together with “◀”, “▶” keys to set TimeH to 200ms, press “Enter” key to confirm.	TIMEH 200.00M
8	Use Entry keys or use the knob together with “◀”, “▶” keys to set TimeR to 10ms, press “Enter” key to confirm.	TIMER 040.00M
9	Use Entry keys or use the knob together with “◀”, “▶” keys to set TimeF to 10ms, press “Enter” key to confirm.	TIMEF 040.00M
10	Press “Cancel” key to exit the transient operation menu.	
11	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

```

MODE      CCH      ; Sets the mode
TRAN      ON       ; Enables the transient operation
CURR:LLEV 1        ; Sets a value to low level
CURR:HLEV 5        ; Sets a value to high level
TRAN:HTIME 0.200   ; Sets the high level time to 200ms
TRAN:RTIME 0.00025 ; Sets the time for rising edge to 250ms

```

TRAN:FTIME 0.00025 ; Sets the time for falling edge to 250ms
 TRAN:MODE PULS ; Selects the pulsed transient operation
 INPUT ON ; Turns on the load
 Trig ; One trigger occurs

4-7-3. Toggled Transient Operation

Example: Assume that the load is in external triggering mode, set the load resistance value to periodically switch between 200Ω and 500Ω; set the time for rising edge (TimeR) to 10ms; set time for falling edge (TimeF) to 10ms; the load is in toggled transient operation, and a trigger occurs at this time.

Procedures	Operation Descriptions	Display
1	Press “R-set” key to select CRH mode, press “Enter” key to confirm and exit the parameter setting menu.	VH CRH 100.000R
2	Press “Tran” key to enter into transient operation.	STATE 1OFF
3	Use the knob to set State value to “1 On”, press “Enter” key to confirm.	STATE 1ON
4	Use the knob to set Mode value to “Togg”, press “Enter” key to confirm.	MODE 2Togg
5	Use the knob together with “◀”, “▶” keys to set LevelL to 200, press “Enter” key to confirm.	LEVELL 200.00R
6	Use the knob together with “◀”, “▶” keys to set LevelH to 500, press “Enter” key to confirm.	LEVELH 500.00R
7	Use the knob together with “◀”, “▶” keys to set TimeR to 10ms, press “Enter” key to confirm.	TIMER 010.00M
8	Use the knob together with “◀”, “▶” keys to set TimeF to 10ms, press “Enter” key to confirm.	TIMEF 040.00M
9	Press “Cancel” key to exit the transient operation menu.	
10	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CRH ; Sets the mode
 TRAN ON ; Enables the transient operation
 RES:LLEV 200 ; Sets a value to low level
 RES:HLEV 500 ; Sets a value to high level
 TRAN:RTIME 0.010 ; Sets the time for rising edge to 10ms
 TRAN:FTIME 0.01 ; Sets the time for falling edge to 10ms
 TRAN:MODE TOGG ; Selects the toggled transient operation
 INPUT ON ; Turns on the load
 Trig ; One trigger occurs

4-8. Sequence (List) Operation

After sequence editing, the operating procedures for enabling and disabling sequence operation are shown as below:

- 1) Press “List” key to enter into sequence operation menu.
- 2) Use Entry keys or the knob to set sequence State to On, and press “Enter” key to confirm.

- 3) Use Entry keys or the knob together with “↑”, “↓” keys to set list number (No.), and press “Enter” key to confirm.
- 4) Press “Cancel” key to exit sequence operation menu.
- 5) Press “Shift”+“4_{Start}” keys to activate sequence operation.
- 6) Press “Shift”+“5_{Stop}” keys to stop sequence operation.

The operating procedures for sequence operation are shown as below:

- 1) Press “List” key to enter into sequence operation menu.
- 2) Use Entry keys or the knob to set sequence State to On, and press “Enter” key to confirm.
- 3) Use Entry keys or knob to select list number (No.). Press “Enter” key to confirm and recall the sequency in EEPROM assigned by the sequence number.
- 4) Use “↓” key to select list memo (Memo).
- 5) Use knob and “◀”, “▶” keys to edit memo (max. 10 characters).
- 6) Use “↓” key to select sequence data (Data:<New/Edit>). Use “◀”, “▶” keys keys or knob to select New or Edit operation.
- 7) Select “New” operation, and press “Enter” key to enter into data clear screen. Use the knob to select “Yes” and press “Enter” key to confirm, the data is cleared and meanwhile step edit screen appears. Use “▶” key or knob to select “No”, press “Enter” key to confirm, in the meantime the load returns to sequence (list) test menu.
- 8) Select “Edit” operation, and press “Enter” key to enter into step edit screen.
- 9) Use “↑”, “↓” keys to select parameters.
- 10) Use Entry keys or use the knob together with “◀”, “▶” keys to input set value; press “Enter” key to confirm and enter into the next step.
- 11) If it is needed to modify one step, use “↑”, “↓” keys to select this step. The setting operations for this step are the same as the operating procedure 9.
- 12) If it is needed to add one step to the last step, use “↓” key to select the new step. The setting operations for this new step are the same as the operating procedure 9.
- 13) If it is needed to insert one step above an edited step, use “↑”, “↓” keys to select this edited step. The LCD display doesn’t flash at this time, and press “Shift”+“7_{Insert}” keys to insert a new step. The setting operations for this new step are the same as the operating procedure 9.
- 14) If it is needed to delete an edited step, use “↑”, “↓” keys to select this step. The LCD display doesn’t flash at this time, and press “Shift”+ “8_{Delete}” keys to delete. If there is only one step exists, it will exit the step edit screen.
- 15) Press “Cancel” key to exit step edit screen, and save the sequence data in EEPROM assigned by the sequence number.
- 16) Use “↓” key to select the cycle times (Count); use Entry keys or the knob together with “◀”, “▶” keys to input set value. Press “Enter” key to confirm and save the cycle times (Count) in EEPROM assigned by the sequence number.
- 17) Use “↓” key to select “Chain”; use Entry keys (the “Chain” is OFF when the Entry key exceeds 7) or the knob to input the set value. Press “Enter” key to confirm and save the chain value in EEPROM assigned by the sequence number.
- 18) Press “Cancel” key to exit sequence operation menu.
- 19) Press “Shift”+“4_{Start}” keys to activate sequence operation.
- 20) Press “Shift”+“5_{Stop}” keys to stop sequence operation.

4-8-1. Sequence (List) Editing

Example: Edit a new sequence. The sequence number is 0; the sequence Memo is Test Power; the sequence steps: step1: CCL, 1A, 1s; step2: CCH, 2A, 1s; step3: CVH, 1V, 1s; step4: CRL, 1Ω, 1s; step5: CRH, 200Ω, 1s; the cycle times (Count) for sequence operation is 5; disabling the sequence chain; starting sequence operation; stopping sequence operation.

Procedures	Operation Descriptions	Display
1	Press "List" key to enter into sequence operation menu.	STATE 0 OFF
2	Use Entry keys or the knob to set sequence State to On, and press "Enter" key to confirm.	STATE 0 ON
3	Use Entry keys or knob to set list number (No.) to 0. Press "Enter" key to confirm (recall the sequence in EEPROM assigned by the sequence number).	NO. 0
4	Use "↓", "↓" keys to select list memo (Memo).	MEMO Test P
5	Rotate the knob to select the letter "T".	MEMO Test P
6	Use "▶" key to move the cursor to the right.	MEMO Test P
7	Rotate the knob to select the letter "e".	MEMO Test Power
8	Set Memo to "Test Power" according to step5 and setp6 operations. Press "Enter" key to confirm.	MEMO Test Power
9	Use "↑", "↓" keys to select Data.	DATA 0 New
10	Use the knob to select New, and "Enter" key to confirm.	DATA 0 New
11	Use the knob to select "Yes" and press "Enter" key to confirm, the data is cleared and meanwhile step edit screen appears.	CLEAR 1 YES
12	Edit the step1: CCL, 1A, 1s. Use "↑", "↓" keys to select time set value. Use Entry keys or the knob together with "◀", "▶" keys to input time to 1s, and press "Enter" key to confirm.	NO 00.
13	Use "↑", "↓" keys to select the basic mode. Use Entry keys or the knob to select operating mode to CCL, and press "Enter" key to confirm.	MODE CCL
14	Use "↑", "↓" keys to select the set value. Use Entry keys or the knob together with "◀", "▶" keys to input the current value to 1A, and press "Enter" key to confirm.	LEVEL 01.000A
15	Use "↑", "↓" keys to select the set time. Use Entry keys or the knob together with "◀", "▶" keys to input the time value to 1s, and press "Enter" key to confirm.	DELAY 01.000S
16	Repeat the procedures 12 to 14 to set the rest four steps.	
17	The five sequence steps have been edited, and there is no need to edit the step6. Press "Cancel" key to exit step edit screen and save the sequence data in EEPROM assigned by the sequence number.	
18	Use "↑", "↓" keys to select "Count". use Entry keys or the knob together with "◀", "▶" keys to input "5". Press "Enter" key to confirm and save the Count value in EEPROM assigned by the sequence number.	SAVE

19	Use “↑”, “↓” keys to select “Chain”. use Entry keys (the “Chain” is OFF when the Entry key exceeds 7) or the knob to input “Off”. Press “Enter” key to confirm and save the Chain value in EEPROM assigned by the sequence number.	COUNT 0005
20	Press “Cancel” key to exit sequence operation menu and enter into the sequence operating screen.	CHAIN 0
21	Press “Shift”+“4 _{Start} ” keys to activate sequence operation.	
22	Press “Shift”+“5 _{Stop} ” keys to stop sequence operation.	

For the above operating procedures, the corresponding SCPI commands should be:

LIST:NUMBer 0 ; Recalls the sequence of the number 0
LIST:MEMO "Test Power" ; Sequence memo is "Test Power"
LIST:ADD CCL,1,1
LIST:ADD CCH,2,1
LIST:ADD CVH,1,1
LIST:ADD CRL,1,1
LIST:ADD CRH,200,1 ; The above 5 commands are sequence steps
LIST:SAVE ; Saves the sequence
LIST:COUNT 5 ; Cycle times for this sequence
LIST:CHAIN OFF ; Disables the chained sequence
LIST ON ; Activates sequence operation
LIST OFF ; Stops sequence operation

4-8-2. Modifying, Adding, Inserting, Deleting the Sequence (List)

Example: Based on the example in 4.8.1 section, the step1: modify the time to 2s. Add “CCH, 5A, 1s” to the last step. Insert “CRL, 1Ω, 10s” at step3. Delete step2. The sequence is chained to itself to realize the continuous execution.

Procedures	Operation Descriptions	Display
1	Press “List” key to enter into sequence operation menu.	STATE 1 On
2	Use “↑”, “↓” keys to select Data:<New/Edit>.	DATA 0 New
3	Use the knob to select Edit, press “Enter” to confirm and enter into the step edit screen.	DATA 1 Edit
4	Use “▶” key to select time parameter and the time set value.	NO 00
5	Use Entry keys or the knob together with “◀”, “▶” keys to input the time to 2s, and press “Enter” key to confirm.	DELAY 02.000S
6	Use “↑”, “↓” key to select the last new step (Step6).	NO 05
7	Add a new step: CCH, 5A, 1s. Use Entry keys or the knob together with “◀”, “▶” keys to input time to 1s, and press “Enter” key to confirm.	MODE CCH
8	Use the knob to select operating mode to CCH, and press “Enter” key to confirm.	LEVEL 05.000A
9	Use Entry keys or the knob together with “◀”, “▶” keys to input the current value to 5A. Press “Enter” key to confirm and enter into the next operation.	DELAY 01.000S
10	Use “↑”, “↓” keys to select the step3.	NO 02

11	Press “Shift”+“7 _{Insert} ” keys to insert a new step at step3.	NO 02
12	Insert a new step: CRL, 1Ω, 10s at step3. The setting operations for this new step are the same as the operating procedures7 to 9.	NO 02
13	Use “↑”, “↓” keys to select the step2.	NO 01
14	Press “Shift”+“8 _{Delete} ” keys to delete the step2.	NO 01
15	Press “Cancel” keys to exit the step edit screen and save the sequence data in EEPROM assigned by the sequence number.	DATA 1 Edit
16	Use “↑”, “↓” keys to select chain.	CHAIN Off
17	Use Entry keys or the knob to input 0 (it is chained o itself to realize continuous execution). Press “Enter” key to confirm and save the Chain value in EEPROM assigned by the sequence number.	CHAIN 0
18	Press “Cancel” key to exit sequence operation menu.	

4-8-3. Starting/Stopping the Sequence (List)

Example: Start the No.0 sequence, and stop the active sequence operation.

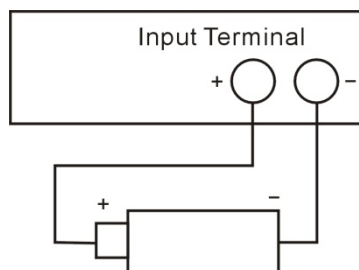
Procedures	Operation Descriptions	Display
1	Press “List” key to enter into sequence operation menu.	STATE 1 On
2	Use “↓” key to select No..Use Entry keys or knob to set the sequence number (No.) to 0, and press “Enter” key to confirm (recall the sequence in EEPROM assigned by the sequence number).	No. 0
3	Press “Cancel” key to exit sequence operation menu.	
4	Press “Shift”+“4 _{Start} ” keys to activate sequence operation. (the other operations will be active only when the sequency operation is disabled.)	
5	Press “Shift”+“5 _{Stop} ” keys to stop sequence operation.	

For the above operating procedures, the corresponding SCPI commands should be:

LIST:NUMBer 0 ; Recalls the sequence of the number 0
LIST ON ; Activates sequence operation
LIST OFF ; Stops sequence operation

4-9. Battery Discharge Operation

Battery discharge operation diagram:



The operating procedures for battery discharge operation are shown as below:

- 1) Press “On/Off” key to turn off the load, and connect the tested battery correctly.
- 2) Press “Battery” key, set the State to On and enter into battery discharge operation screen.
- 3) Use “↑”, “↓” keys to select parameters. Use Entry keys or the knob together with “◀”, “▶” keys to input State, termination voltage value, termination current value and discharge current value. Press “Enter” key to confirm.
- 4) Press “Cancel” key to exit the battery discharge parameters edit screen.
- 5) Press “On/Off” key to turn on the load, and start battery discharge operation.
- 6) Press “On/Off” key to turn off the load, and stop battery discharge operation.
- 7) Press “Cancel” key to clear the discharged time and discharged capacity of the battery.
- 8) Press the other function keys or “Cancel” key to exit the battery discharge operation.

Example: Enter into the battery discharge operation; set the termination voltage to 15V, and the discharge current to 3A; turn on the load, and start the battery discharge operation; turn off the load and stop the battery discharge operation; clear the discharged time and discharged capacity of the battery; exit the battery discharge operation.

Procedures	Operation Descriptions	Display
1	Press “On/Off” key to turn off the load, and connect the tested battery correctly.	
2	Press “Battery” key to enter into battery discharge capacity parameters edit screen.	STATE 0 Off
3	Use Entry keys or the knob to set battery State to On, and press “Enter” key to confirm.	STATE 1 On
4	Use “↑”, “↓” keys to select parameters to input termination voltage (Mini Volt). Use Entry keys or the knob together with “◀”, “▶” keys to input termination voltage to 15V, and press “Enter” key to confirm.	MIN VO 15.000V
5	Use “↑”, “↓” keys to select parameters to input termination current (Mini Curren). Use Entry keys or the knob together with “◀”, “▶” keys to input termination current to 1A, and press “Enter” key to confirm.	IOFF P 01.000A
6	Use Entry keys or the knob together with “◀”, “▶” keys to input discharge current to 3A, and press “Enter” key to confirm.	DISCUR 3.000A
7	Press “Cancel” key to exit the battery discharge parameters edit screen.	

8	Press “On/Off” key to turn on the load, and start battery discharge operation.	
9	Press “On/Off” key to turn off the load, and stop battery discharge operation.	
10	Press “Cancel” key to clear the discharged time and discharged capacity of the battery.	
11	Press mode hotkey to exit the battery discharge operation	

For the above operating procedures, the corresponding SCPI commands should be:

INPUT OFF ; Turns off the load
 BATTERY ON ; Activates the battery discharge operation screen
 BATT:VOLT:OFF 15 ; Sets termination voltage to 15V
 BATT:DISC:CURREN 3 ; Sets termination current to 3A
 INPUT ON ; Turns on the load, and start battery discharge operation
 INPUT OFF ; Turns off the load, and stop battery discharge operation
 BATTERY OFF ; Exits the battery discharge operation

4-10. Saving and Recalling

The operating procedures for saving and recalling operation are shown as below:

- 1) Press “Shift”+“1_{Store}” keys to enter into the saving menu, or press “Shift”+“2_{Recall}” keys to enter into the recalling menu.
- 2) Press Entry keys or the knob to select saving or recalling position.
- 3) Press “Enter” key to confirm and exit the saving or recalling menu. If the saving is selected, the values of List2-1 parameters will be saved in the specified location in EEPROM; if the recalling is selected, the values of List2-1 parameters should be the values saved in specified location in EEPROM.

Example1: Set the mode to CCL; set the current value to 2A; turn on the load; save the settings in location 0 in EEPROM; the next time the load is turned on, these settings will become the power-on settings.

Procedures	Operation Descriptions	Display
1	Set the mode to CCL, set the current value to 2A; turn on the load (please refer to 4.5.1 section for detailed operations).	
2	Press “Shift”+“1 _{Store} ” keys to enter into the saving menu.	SAVE 0
3	Press Entry keys or the knob to select the location 0 for saving.	SAVE 0
4	Press “Enter” key to confirm.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CCL ; Sets the load to CCL status
 CURREN 2 ; Sets the current value to 2A
 *SAV 0 ; Saves the present settings in location 0 in EEPROM

Example2: Based on the above example, set the mode to CVH; set the voltage value to 40V; recall the values saved in location0 in EEPROM. The detailed operations are shown as below:

Procedures	Operation Descriptions	Display
1	Set the mode to CVH, set the voltage value to 40V (please refer to 4.5.2 section for detailed operations).	
2	Press “Shift”+“2 _{Recall} ”keys to enter into the recalling menu.	RECALL 0
3	Press Entry keys or the knob to select the recalled location 0.	RECALL 0
4	Press “Enter” key to confirm.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CVH ; Sets the CVH mode
VOLT 40 ; Sets the voltage value to 40V
*RCL 0 ; Recalls the values saved in location 0 in EEPROM

4-11. Clear Protection Settings

The operating procedures for clear protection settings are shown as below:

- 1) Eliminate the reason that causes the protection status.
- 2) Press “Cancel” keys.

Example1: Clear RV protection of the load. The detailed operations are shown as below:

Procedures	Operation Descriptions	Display
1	Connect the power supply to the load again.	
2	Long-press “Cancel” key.	

For the above operating procedures, the corresponding SCPI commands should be:

INP:PROT:CLE ; Clears the protection status

4-12. Triggered Operation

When the triggering mode is EXTERNAL, the triggered operations are shown as below:

- 1) Set trigger object (please see 2.8 section for detailed introduction).
- 2) Press “Shift”+“0_{Trigger}” keys or trigger terminal (TRIG IN) to receive low TTL level, and a trigger occurs.

Example: Select “List” for the trigger function to trigger a sequence operation. The sequence is the one mentioned in Example in 4.8.1 section. The detailed operations are shown as below:

Procedures	Operation Descriptions
1	Select “List” in main menu for the trigger function (please see 4.14.6 section for detailed introduction).
2	Enter to List operation screen (please see 4.8 section for detailed introduction).
3	Press “Shift”+“0 _{Trigger} ” keys or trigger terminal (TRIG IN) to receive low TTL level. The load’s input will change accordingly when the sequence parameters are changed. Pressing “Shift”+“0 _{Trigger} ” keys has the same effect as pressing “Shift”+“4 _{Start} ” keys at this time.

For the above operating procedures, the corresponding SCPI commands should be:

TRIG:FUNC LIST ; Selects “List” for trigger function
TRIG ; A trigger occurs

4-13. Main Menu

The operating procedures for the main menu are shown as below:

- 1) Press “Menu” key to enter into the main menu.
- 2) Use Entry keys or the knob to select the menu item.
- 3) Use “↑”, “↓”keys to select the parameter; or use Entry keys or the knob together with “◀”, “▶” keys to input set value. Press “Cancel” key to exit modifying the parameter or exit the main menu.
- 4) Press “Enter” key to confirm.
- 5) Press “Cancel” key to exit the main menu.

4-13-1. Loading Default Values

Example: Load the default values. The detailed operations are shown as below:

Procedures	Operation Descriptions	Display
1	Press “Menu” key to enter into the selectable menu.	Menu 0 SYST
2	Use Entry keys or the knob to select “1 Config”, press “Enter” key to confirm and enter into Config.	Menu 1 CONF
3	Use “↑”, “↓” keys to select the parameter menu “Load Defa”. Use Entry key or the knob to select the parameter “Yes”.	LOAD D 1Yes
4	Press “Enter” key to confirm and return.	

4-13-2. Short Circuit Operation

Example: Short circuit operation in CVL mode. The detailed operations are shown as below:

Procedures	Operation Descriptions	Display
1	Press “Menu” key to enter into the selectable menu.	Menu 0 SYST
2	Use Entry keys or the knob to select “0 System Set”, press “Enter” key to confirm and enter into System Set.	CC Set 0 Low
3	Use “↑”, “↓”keys to select the menu item “Short”.	SHORT 0 Off
4	Use the knob to set the “Short” to On, and press “Enter” key to confirm.	SHORT 1On
5	Press “Cancel” key to exit the main menu.	
6	Press “V-set” key to select CVL mode, press “Enter” key to confirm and exit the mode selection and parameter setting menu.	
7	Press “On/Off” key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

INPUT:SHORT ON ; Sets the load to short circuit
MODE CVL ; Sets the mode
INPUT ON ; Turns on the load

4-13-3. Von Point/Von Latch

Example: Set the Von Latch to Off; set Von Point to 1V; turn on the load; This example implements the automatic on/off of the load's input, which simplifies the test operations greatly. The detailed operations are shown as below:

Procedures	Operation Descriptions	Display
1	Press "Menu" key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or the knob to select "0 System Set", press "Enter" key to confirm and enter into System Set.	CC SET 0 LOW
3	Use "↑", "↓"keys to select the menu item "Von Latch". Use the knob to select the parameter "Off", and press "Enter" key to confirm.	VON LA 0 Off
4	Use "↑", "↓"keys to select the menu item "Von Point". Use Entry keys or the knob together with "◀", "▶" keys to input the voltage value to 1V, and press "Enter" key to confirm.	VON PO 01.000V
5	Press "Cancel" key to exit the main menu.	
6	Press "On/Off" key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

INP:VOLT:ON:LATCH OFF ; Disables the Von Latch
INP:VOLT:ON 1 ; Sets the Von voltage point to 1V
INPUT ON ; Turns on the load

4-13-4. Current Limit in CV Mode

Example: Set the load to CVL mode; set the voltage value to 2V; set the current limit value in CV mode (CV Curr Limit) to 20A; turn on the load. The detailed operations are shown as below:

Procedures	Operation Descriptions	Display
1	Set the mode to CVL, set the voltage value to 2V (please refer to 4.5.2 section for detailed operations).	
2	Press "Menu" key to enter into the selectable menu.	MENU 0 SYST
3	Use Entry keys or the knob to select "0 System Set", press "Enter" key to confirm and enter into System Set.	CC SET 0 LOW
4	Use "↑", "↓"keys to select the menu item "CV Curr L".	CV CUR 120.000A
5	Use Entry keys or the knob together with "◀", "▶" keys to input the current value to 20.000A, and press "Enter" key to confirm.	CV CUR 20.000A
6	Press "Cancel" key to exit the main menu.	
7	Press "On/Off" key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CVL ; Sets the mode
VOLT 2 ; Sets the volgate value to 2V
CV:CURR:LIM 20 ; Sets the current limit value to 20A in CV mode
INPUT ON ; Turns on the load

4-13-5. Current Rise/Fall Rate in CC Mode

Example: Set the load to CCH mode, set the current value to 2A; set the current rise rate (Curr Rise Rate) in CC mode to 0.002A/us; set the current fall rate (Curr Fall Rate) in CC mode to 0.005A/us. The detailed operations are shown as below:

Procedures	Operation Descriptions	Display
1	Set the mode to CCH,; set the current value to 2A (please refer to 4.5.1 section for detailed operations).	
2	Press "Menu" key to enter into the selectable menu.	MENU 0 SYST
3	Use Entry keys or the knob to select "0 System Set", press "Enter" key to confirm and enter into System Set.	CC SET 0 LOW
4	Use "↑", "↓" keys to select the menu item "Curr Rise". Use Entry keys or the knob together with "◀", "▶" keys to input the current rise rate to 0.002A/us, and press "Enter" key to confirm.	CURR R 0.002A/us
5	Use "↑", "↓" keys to select the menu item "Curr Fall". Use Entry keys or the knob together with "◀", "▶" keys to input the current fall rate to 0.005A/us, and press "Enter" key to confirm.	CURR F 0.005A/us
6	Press "Cancel" key to exit the main menu.	
7	Press "On/Off" key to turn on the load.	

For the above operating procedures, the corresponding SCPI commands should be:

MODE CCH ; Sets the mode
CURR 2 ; Sets the current value to 2A.
CURR:RISE:RATE 0.002 ; Sets the current rise rate in CC mode to 0.002A/us
CURR:FALL:RATE 0.005 ; Sets the current fall rate in CC mode to 0.005A/us
INPUT ON ; Turns on the load
INPUT OFF ; Turns off the load

4-13-6. Trigger Function Selection

Example: Select "Tran" in trigger function selection (Trig Function).

Procedures	Operation Descriptions	Display
1	Press "Menu" key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or the knob to select "3 Trigger Set", press "Enter" key to confirm and enter into Trigger Set.	MENU 3 TRIG
3	Use "↑", "↓" keys to select the menu item "Function". Use Entry keys or the knob to select the parameter "Tran", and press "Enter" key to confirm.	Trig Func 0 Tran
4	Press "Cancel" key to exit the main menu.	

For the above operating procedures, the corresponding SCPI commands should be:

TRIG:FUNC TRAN ; Selects transient operation (TRAN) for trigger function

4-13-7. Knob Function

Example: Enable the knob function.

Procedures	Operation Descriptions	Display
1	Press “Menu” key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or the knob to select “1 Config”, press “Enter” key to confirm and enter into Config.	MENU 1 CONF
3	Use “↑”, “↓” keys to select the menu item “Knob”. Use Entry keys or the knob to select the parameter “On”, and press “Enter” key to confirm.	KNOB 1 On
4	Press “Cancel” key to exit the main menu.	

4-13-8. Key Sound

Example: Enable the key sound.

Procedures	Operation Descriptions	Display
1	Press “Menu” key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or the knob to select “1 Config”, press “Enter” key to confirm and enter into Config.	MENU 1 CONF
3	Use “↑”, “↓” keys to select the menu item “Key Sound”. Use Entry keys or the knob to select the parameter “On”, and press “Enter” key to confirm.	KEY SO 1 On
4	Press “Cancel” key to exit the main menu.	

4-13-9. Communication Interface

Example: Select RS232 interface; set the baud rate to 9600.

Procedures	Operation Descriptions	Display
1	Press “Menu” key to enter into the selectable menu.	MENU 0 SYST
2	Use Entry keys or the knob to select “1 Config”, press “Enter” key to confirm and enter into Config.	MENU 1 CONF
3	Use “↑”, “↓” keys to select the menu item “Baud Rate”. Use the knob or “◀”, “▶” keys to select the parameter “9600”, and press “Enter” key to confirm.	BAUD R 2 9600

Chapter5 Remote Programming Operation

This Series Electronic Load supports both local operation and remote control. The previous chapter has introduced how to use the front panel keys and knobs to operate on the load. This chapter will introduce you to how to use the load from the remote controller. The similarities between local and remote programming will become apparent as you read this chapter. The intent of this chapter is to help users quickly become familiar with remote programming operations. Programming examples given in this chapter use the SCPI commands in their simplest form. Please refer to the “Electronic Load SCPI Programming Guide” for detailed introduction of all SCPI commands.

5-1. Communication Interface

RS232 interface is standard. Use the cable shipped with the load to connect the load to a computer correctly. Set the baud rate, parity, data bit, and stop bit parameters. Set the same parameters in the software on the computer, and input the right SCPI command to operate the load.

5-2. Remote Control Annunciators

There is a Rmt remote control annunciator on LCD. When the load receives the remote command (SYSTem:REMOte) via RS232 interface, the Rmt remote control annunciator turns on. In remote control status, all operations on the load are controlled by the remote controller; the front panel keypad and knob has no effect (except “Lock/Local” key). The Rmt remote control annunciator turns off and the load returns to the local control after receiving the command to return to local control (e.g. :SYST:LOC). Or you can return the load to local control from remote control by long-pressing “Lock/Local” key.

5-3. Sending a Remote Command

You can use the computer to set operation mode and operation parameters remotely for the load.

5-4. Returning Data

The load can return the values of parameter settings, input voltage and current, as well as input power to computer. It can also return information relating to the internal operation and module identification. For example: the query command “MEAS:CURRE?” asks the load to return the actual input current at the Input binding posts. Please refer to “Electronic Load SCPI Programming Guide” for detailed information on using queries. The load stores the response to the query in an output buffer which will hold the information until it is read by the computer or is replaced with new information.

5-5. Remote Programming Commands

The SCPI commands have many optional key words for the programmer. Getting familiar with these key words will help you to know the programming better. Most of the commands have a query syntax which allows the present parameter settings to be returned to the controller. Please refer to “Electronic Load SCPI Programming Guide” for details. The load’s major functions can be programmed with a relatively few number of these commands. The following points are important to remember when you are remotely programming CC, CR, CV, and CP values.

5-5-1. Basic Operation Modes

The CC, CR, CV, and CP values can be programmed whether or not the associated mode is active. If the input is turned on, all of the applicable values will take effect at the input when the associated mode is selected.

5-5-2. Transient Levels

The transient CC, CV, or CR level must be set to a higher level than the respective low level, or the transient operation will be disabled.

5-5-3. Programmable Current Protection

When programmable current protection is enabled, and the programmed current limit and time delay are exceeded, the load's input will be turned off.

5-6. CC Mode Example

This example sets the current level to 0.5A, and then reads back the actual current value.

- 1) "INPUT OFF" ; Turns off the load's input
- 2) "MODE CCL" ; Selects the CCL mode
- 3) "CURR 0.5" ; Sets current value to 0.5A
- 4) "INPUT ON" ; Turns on the load's input
- 5) "MEAS:CURR?" ; Measures the actual input current

5-7. CV Mode Example

This example presets the trigger voltage to 5V, and selects the external trigger source.

- 1) "INPUT OFF" ; Turns off the load's input
- 2) "MODE CVL" ; Selects the CV mode
- 3) "VOLT:TRIG 5" ; Presets the trigger voltage value to 5V
- 4) "TRIG:SOUR EXT" ; Selects the external input as the trigger source
- 5) "INPUT ON" ; Turns on the load's input

In this example, when the external trigger signal is received, the input voltage will be set to 5V.

5-8. CR Mode Example

This example sets the current protection limit to 3A, sets the time delay to 10s, sets the resistance level to 10Ω, and reads back the computed power.

- 1) "INPUT OFF" ; Turns off the load's input
- 2) "MODE CRM" ; Selects the CRM mode
- 3) "CURR:PROT:LEV 3" ; Sets the current protection limit to 3A
- 4) "CURR:PROT:D EL 10" ; sets the time delay to 10s
- 5) "CURR:PROT:STAT ON" ; Activates the current protection
- 6) "RES 10" ; Sets the resistance level to 10Ω
- 7) "INPUT ON" ; Turns on the load's input
- 8) "MEAS:POW?" ; Measures the input power level

5-9. Continuous Transient Operation Example

This example sets CV transient high/low levels, times for transient rising/falling edge, high/low level times, and parameters for transient operation.

- 1) "INPUT OFF" ; Turns off the load's input
- 2) "MODE CVH" ; Selects the CV mode
- 3) "VOLT:LLEV 0.5" ; Sets the transient low level to 0.5V
- 4) "VOLT:HLEV 1" ; Sets the transient high level to 1V
- 5) "TRAN:LTIM 0.010" ; Sets transient low level time to 10ms
- 6) "TRAN:HTIM 0.010" ; Sets transient high level time to 10ms
- 7) "TRAN:RTIM 0.010" ; Sets the time for transient rising edge to 10ms
- 8) "TRAN:FTIM 0.010" ; Sets the time for transient falling edge to 10ms
- 9) "TRAN:MODE CONT " ; Selects the continuous transient operation
- 10) "TRAN ON" ; Activates the transient operation
- 11) "INPUT ON" ; Turns on the load's input


5-10. Pulsed Transient Operation Example

This example selects CV pulsed transient operation, selects the bus as the trigger source, and sets a pulse width of 1ms.

- 1) "INPUT OFF" ; Turns off the load's input
- 2) "MODE CVH" ; Selects the CV mode
- 3) "TRIG:FUNC TRAN" ; Selects the transient for trigger function
- 4) "TRIG:SOUR BUS" ; Selects the bus as the trigger source
- 5) "VOLT:LLEV 0.5" ; Sets the transient low level to 0.5V
- 6) "VOLT:HLEV 1" ; Sets the transient high level to 1V
- 7) "TRAN:HTIM 0.001" ; Sets transient high level time to 1ms
- 8) "TRAN:RTIM 0.000250" ; Sets the time for transient rising edge to 250us
- 9) "TRAN:FTIM 0.000250" ; Sets the time for transient falling edge to 250us
- 10) "TRAN:MODE PULSE " ; Selects the pulsed transient operation
- 11) "TRAN ON" ; Activates the transient operation
- 12) "INPUT ON" ; Turns on the load's input
- 13) "*TRG" ; *TRG command generates a 1ms high-level pulse at the load's input

Chapter6 Auto Test Operation

6-1. Main Menu

Press  key to enter into main menu of Auto Test. Rotate knob to select menu. Press “Enter” key to enter into the function option on the cursor. Use “↑” key or “↓” key to turn over the LCD screen. At this time, press “↓” key to enter into the next level submenu. Press “Cancel” key to exit the menu setting.

Please see the list below for main menu content:

Trigger set		
	Function	Trigger function 0 input input On/Off 1 Level recall trigger value 2 List enable List 3 Tran enable Tran
	Source	Trigger source selection 0 External external key trigger (“Shift”+“0 _{Trigger} ”) 1 Pluse TTL trigger on the rear panel 2 Bus the trigger source is *TRG command 3 Hold use the command “TRIGger:IMMediate” as trigger source
Auto Test		
	State	Auto test state on/off
	GROUP	Select the saved setting of auto test
	START	Start step (0-14)
	END STep	End step (0-14)
	STEP	Step no. of setting
	End Step	End step (0-14)
	Step	Step selection (0-14)
	Mode	Mode setting
	Level	Setting value
	Min	Parameter limit minimum value
	Max	Parameter limit maximum value
	Delay	Test time

6-2. LCD Display Message

The LCD shows actual voltage, current, power and resistance levels. The second line shows test state and test steps.

6-3. Function Description

The load has auto test function. Users can set the test mode, setting value, limit value range, test time and end step. There are two trigger functions: auto trigger and external TTL trigger. In auto trigger mode, when the external input voltage is more than the Von Point, the trigger will be enabled and the load starts to test; When the external input voltage is less than the Voff Point, the load will enter into waiting status. In external TTL trigger mode, short the TTL TRIG IN terminal at the rear panel and the trigger will occur. It can realize that the multi-output power supply can be tested by more than one load simultaneously. The test has 15 steps, set step parameters, turn on auto test state, input trigger signal, then start to test. It will display steps, parameters and test state. If error occurs, the input will be turned off and remain at the actual step and display the measurement value, press “Cancel” key to clear the error status.



6-4. Local Operation

6-4-1. Single Power Supply Test

For example: to test 5V2A power bank, connect the load and start auto test.

Step	Mode	Setting value	Min level	Max level	Description
0	CCL	00.000A	4.500V	5.500V	Test the range of Voff point: 4.8V-5.5V
1	CCL	02.000A	4.500V	5.500V	Test the range of Voff point with load 2A: 4.5V-5.5V
2	CVL	04.500V	01.000A	02.500A	Test the load of 4.5V output:1.0A-2.5A

Detailed steps as below:

Procedures	Operation Descriptions	Display
1	Set the external trigger as the load's trigger mode. Set the load's Von point to 2.0V. Set the load's Voff point to 1.0V.	SOURCE 0 EXTE VON PO 02 .000V VOFF P 01 .000V
2	Press  key to enter into Auto Test menu.	STATE 1 On
3	The indicator of  is turned on after entering into Auto Test menu.	STATE 1 On
4	Use Entry keys or the knob to set the State to On, and press "Enter" key to confirm.	STATE 1 On
5	Use "↑", "↓" keys to select the parameter group. Use Entry keys or the knob together with "◀", "▶" keys to input the group no., and press "Enter" key to confirm.	GROUP 000
6	Use "↑", "↓" keys to select the parameter start step. Use Entry keys or the knob together with "◀", "▶" keys to input the start step to 0, and press "Enter" key to confirm.	START 000
7	Use "↑", "↓" keys to select the parameter end step. Use Entry keys or the knob together with "◀", "▶" keys to input the end step to 2, and press "Enter" key to confirm.	END ST 2
8	Use "↑", "↓" keys to select the parameter step. Use Entry keys or the knob together with "◀", "▶" keys to input the step to 0, and press "Enter" key to confirm. (This is used for testing Voff point)	STEP 0
9	Use "↑", "↓" keys to select the parameter mode. Use Entry keys or the knob together with "◀", "▶" keys to enter into CCL, and press "Enter" key to confirm.	MODE 0 CCL
10	Use "↑", "↓" keys to select the parameter setting level. Use Entry keys or the knob together with "◀", "▶" keys to input the setting level to 0.000A, and press "Enter" key to confirm.	LEVEL 00.000A
11	Use "↑", "↓" keys to select the parameter limit minimum value. Use Entry keys or the knob together with "◀", "▶" keys to input the minimum value to 4.800V, and press "Enter" key to confirm.	MIN 04.800V
12	Use "↑", "↓" keys to select the parameter limit maximum value. Use Entry keys or the knob together with "◀", "▶" keys to input the maximum value to 5.500V, and press "Enter" key to confirm.	MAX 05.500V

13	Use “↑”, “↓” keys to select the parameter test time. Use Entry keys or the knob together with “◀”, “▶” keys to input the test time to 1s, and press “Enter” key to confirm.	DELAY 00001s
14	Use “↑”, “↓” keys to select the parameter step. Use Entry keys or the knob together with “◀”, “▶” keys to input the step to 1, and press “Enter” key to confirm. (This is used for testing the voltage with load 2A)	STEP 1
15	Use “↑”, “↓” keys to select the parameter mode. Use Entry keys or the knob together with “◀”, “▶” keys to enter into CCL, and press “Enter” key to confirm.	MODE 0 CCL
16	Use “↑”, “↓” keys to select the parameter setting level. Use Entry keys or the knob together with “◀”, “▶” keys to input the setting level to 2.000A, and press “Enter” key to confirm.	LEVEL 02.000A
17	Use “↑”, “↓” keys to select the parameter limit minimum value. Use Entry keys or the knob together with “◀”, “▶” keys to input the minimum value to 4.500V, and press “Enter” key to confirm.	MIN 04.500V
18	Use “↑”, “↓” keys to select the parameter limit maximum value. Use Entry keys or the knob together with “◀”, “▶” keys to input the maximum value to 5.500V, and press “Enter” key to confirm.	MAX 05.500V
19	Use “↑”, “↓” keys to select the parameter test time. Use Entry keys or the knob together with “◀”, “▶” keys to input the test time to 2s, and press “Enter” key to confirm.	DELAY 00002s
20	Use “↑”, “↓” keys to select the parameter step. Use Entry keys or the knob together with “◀”, “▶” keys to input the step to 2, and press “Enter” key to confirm. (This is used for testing the output current of constant voltage 4.5V)	STEP 2
21	Use “↑”, “↓” keys to select the parameter mode. Use Entry keys or the knob together with “◀”, “▶” keys to enter into CVL, and press “Enter” key to confirm.	MODE 2 CVL
22	Use “↑”, “↓” keys to select the parameter setting level. Use Entry keys or the knob together with “◀”, “▶” keys to input the setting level to 4.500V, and press “Enter” key to confirm.	LEVEL 04.500V
23	Use “↑”, “↓” keys to select the parameter limit minimum value. Use Entry keys or the knob together with “◀”, “▶” keys to input the minimum value to 1.000A, and press “Enter” key to confirm.	MIN 01.000A
24	Use “↑”, “↓” keys to select the parameter limit maximum value. Use Entry keys or the knob together with “◀”, “▶” keys to input the maximum value to 2.500A, and press “Enter” key to confirm.	MAX 02.500A
25	Use “↑”, “↓” keys to select the parameter test time. Use Entry keys or the knob together with “◀”, “▶” keys to input the test time to 2s, and press “Enter” key to confirm.	DELAY 00002s
26	Press “Cancel” key to exit auto test parameter edit interface and enter into auto test waiting interface.	

After completing all the above steps, it can enable auto test only by connecting power bank to the load's input terminal, doesn't need keys operation.

6-4-2. Multi-output Power Supply Test

For example: to test 75W, 5V/6A, +15V/2.3A, -15V/0.5A multi-output power supply, connect the power supply to load following the fig.6.1.

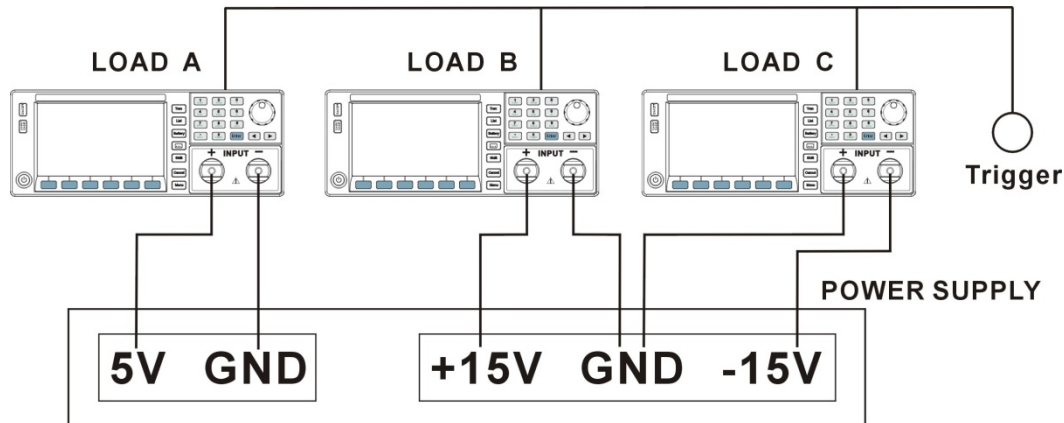


Fig. 6-1

Test step:

Step	Load number	Mode	Level	Min	Max	Delay	Description
0	A	CCL	0.000A	15.000V	16.000V	1s	Test Voff Point
	B	CCL	0.000A	15.000V	16.000V	1s	
	C	CCL	0.000A	15.000V	16.000V	1s	
1	A	CCL	2.300A	14.500V	16.000V	2s	Test Von Point in CC
	B	CCL	2.300A	14.500V	16.000V	2s	
	C	CCL	0.500A	14.200V	16.000V	2s	
2	A	CVL	5.000V	6.000A	10.000A	2s	Test Von Point in CV
	B	CVL	15.000V	2.300A	5.400A	2s	
	C	CVL	14.500V	0.400A	0.600A	2s	

Detailed operation steps as below:

1) Load A, to test 5V/6A

Procedures	Operation Descriptions	Display
1	Set the external TTL trigger as the load's trigger mode. Set the load's Von point to 2.0V. Set the load's Voff point to 1.0V.	SOURCE 1 Pulse VON PO 02 .000V VOFF P 01 .000V
2	Press ... key to enter into Auto Test menu.	STATE 1 ON
3	The indicator of ... is turned on after entering into Auto Test menu.	STATE 1 ON
4	Use Entry keys or the knob to set the State to On, and press "Enter" key to confirm.	STATE 1 ON
5	Use "↑", "↓" keys to select the parameter end step. Use Entry keys or the knob together with "◀", "▶" keys to input the end step to 2, and press "Enter" key to confirm.	END ST 2
6	Please refer to 6.4.1 operation steps, and set parameters according to table 4-A.	
7	Press "Cancel" key to exit auto test parameter edit interface and enter into auto test waiting interface.	

Table 6-A: 5V/6A parameter setting

Step	Mode	Level	Min	Max	Delay
0	CCL	0.000A	5.000V	5.500V	1s
1	CCL	6.000A	4.800V	5.500V	2s
2	CVL	5.000V	6.000A	10.000A	2s

2) Load B, to test +15V/2.3A



Procedures	Operation Descriptions	Display
1	Set the external TTL trigger as the load's trigger mode.	SOURCE 1 Pulse
2	Press  key to enter into Auto Test menu.	MENU 0 SYST
3	The indicator of  is turned on after entering into enter into Auto Test menu.	STATE 1 ON
4	Use Entry keys or the knob to set the State to On, and press "Enter" key to confirm.	STATE 1 ON
5	Use "↑", "↓" keys to select the parameter end step. Use Entry keys or the knob together with "◀", "▶" keys to input the end step to 2, and press "Enter" key to confirm.	END ST 2
6	Please refer to 6.4.1operation steps, and set parameters according to table 4-B.	
7	Press "Cancel" key to exit auto test parameter edit interface and enter into auto test waiting interface.	

Table 6-B: +15V/2.3A parameter setting

Step	Mode	Level	Min	Max	Delay
0	CCL	0.000A	15.000V	16.000V	1s
1	CCL	2.300A	14.500V	16.000V	2s
2	CVL	15.000V	2.300A	5.400A	2s

3) Load C, to test -15V/0.5A



Procedures	Operation Descriptions	Display
1	Set the external TTL trigger as the load's trigger mode.	SOURCE 1 Pulse
2	Press  key to enter into Auto Test menu.	STATE 1 ON
3	The indicator of  is turned on after entering into enter into Auto Test menu.	STATE 1 ON
4	Use Entry keys or the knob to set the State to On, and press "Enter" key to confirm.	STATE 1 ON
5	Use "↑", "↓" keys to select the parameter end step. Use Entry keys or the knob together with "◀", "▶" keys to input the end step to 2, and press "Enter" key to confirm.	END ST 2
6	Please refer to 6.4.1operation steps, and set parameters according to table 4-C.	
7	Press "Cancel" key to exit auto test parameter edit interface and enter into auto test waiting interface.	

Table 6-C: -15V/0.5A parameter setting:

Step	Mode	Level	Min	Max	Delay
0	CCL	0.000A	15.000V	16.000V	1s
1	CCL	0.500A	14.200V	16.000V	2s
2	CVL	14.500V	0.400A	0.600A	2s

After completing all the above settings, connect the power supply to the load's input terminals according to Fig.6-1. The trigger signals of the three loads should be connected on the one key. Press the key to start testing, the first step is to test the rang of Voff point, the second step is to test the rang of Von point. When the test has been finished, remove the power supply and the load will enter into the waiting status.

6-4-3. Test Signal Terminal

For example: enable the auto test by testing signal terminal. Detailed operation steps as below:

Procedures	Operation Descriptions	Display
1	Set the external trigger as the load's trigger mode.	FUNCTI 0 Input SOURCE 1 Pluse
2	Other test refers to 5.1 section.	

After completing all the above steps, connect the test signal to load's input terminal, input a trigger signal at test signal terminal, and then activate auto test. When the test is passed, the PASS signal outputs high level; When the test is failed, the FAIL signal outputs high level; in other states, the PASS signal and FAIL signal output low level.

Main Specifications

The warm-up time is 30 minutes. Specifications indicate warranted performance in the 25°C±5°C region of the total temperature range.

Model		TDL1-1530	TDL3-1530	TDL3-1560	TDL3-5015
Rated input (0°C~40°C)					
Voltage		0~150V	0~150V	0~150V	0~500V
Current		1mA~30A	1mA~30A	1mA~60A	1mA~15A
Power *1		150W	300W	300W	300W
MOV@FS current		1.5V	0.82V	1.2V	3.8V
Constant voltage mode (CV)					
Low range		0.1~30V	0.1~30V	0.1~30V	0.1~30V
Resolution		1mV	1mV	1mV	1mV
Accuracy		±(0.05%+0.02%FS)	±(0.05%+0.02%FS)	±(0.05%+0.02%FS)	±(0.05%+0.02%FS)
High range		0.10~150V	0.10~150V	0.10~150V	0.10~500V
Resolution		10mV	10mV	10mV	10mV
Accuracy		±(0.05%+0.025%FS)	±(0.05%+0.025%FS)	±(0.05%+0.025%FS)	±(0.05%+0.025%FS)
Constant current mode (CC)					
Low range		0~3A	0~3A	0~6A	0~1.5A
Resolution		1mA	1mA	1mA	1mA
Accuracy		±(0.1%+0.1%FS)	±(0.1%+0.1%FS)	±(0.1%+0.1%FS)	±(0.1%+0.1%FS)
High range		0~30A	0~30A	0~60A	0~15A
Resolution		10mA	10mA	10mA	10mA
Accuracy		±(0.1%+0.15%FS)	±(0.1%+0.15%FS)	±(0.1%+0.15%FS)	±(0.1%+0.15%FS)
Constant resistance mode (CR) (Input voltage /current 10%FS)					
Low range (VH CRL)		≈0.06~6Ω	≈0.04~6Ω	≈0.025~3Ω	≈0.3~36Ω
Resolution		100uΩ	100uΩ	50uΩ	600uΩ
Accuracy (Impedance)		±(0.5%+0.5%FS)	±(0.5%+0.5%FS)	±(0.5%+0.5%FS)	±(0.5%+0.5%FS)
Middle range (VH CRM)		≈6~600Ω	≈6~600Ω	≈3~300Ω	≈36~3600Ω
Resolution		2.7us	2.7us	5.4us	0.45us
Accuracy (Conductance)		±(1%+1%FS)	±(1%+1%FS)	±(1%+1%FS)	±(1%+1%FS)
High range (VH CRH)		≈60~4000Ω	≈60~4000Ω	≈30~4000Ω	≈360~4000Ω
Resolution *2		0.30us	0.30us	0.20us	0.051us
Accuracy (Conductance)		±(1.5%+1.5%FS)	±(1.5%+1.5%FS)	±(1.5%+1.5%FS)	±(1.5%+1.5%FS)
Low range (VL CRL)		≈0.06~1.12Ω	≈0.04~1.12Ω	≈0.025~0.6Ω	≈0.3~2.4Ω
Resolution		18uΩ	18uΩ	9.6uΩ	38uΩ
Accuracy (Impedance)		±(0.5%+0.5%FS)	±(0.5%+0.5%FS)	±(0.5%+0.5%FS)	±(0.5%+0.5%FS)
Medium range (VL CRM)		≈1.12~112Ω	≈1.12~112Ω	≈0.6~60Ω	≈2.4~240Ω
Resolution		15us	15us	27us	6.8us
Accuracy (Conductance)		±(1%+1%FS)	±(1%+1%FS)	±(1%+1%FS)	±(1%+1%FS)
High range (VL CRH)		≈11.2~2000Ω	≈11.2~2000Ω	≈6.0~2000Ω	≈24~2000Ω
Resolution		1.6us	1.6us	3.0us	0.78us
Accuracy (Conductance)		±(1.5%+1.5%FS)	±(1.5%+1.5%FS)	±(1.5%+1.5%FS)	±(1.5%+1.5%FS)
Constant power mode (CP) (Input voltage /current 10%FS)					
Range		0~150W	0~300W	0~300W	0~300W
Resolution	P<100W	1mW	1mW	1mW	1mW
	P≥100W	10mW	10mW	10mW	10mW
Accuracy		±(1%+0.1%FS)	±(1%+0.1%FS)	±(1%+0.1%FS)	±(1%+0.1%FS)

Model		TDL1-1530	TDL3-1530	TDL3-1560	TDL3-5015
Voltage measurement					
Low range		0~30V	0~30V	0~30V	0~30V
Resolution		1mV	1mV	1mV	1mV
Accuracy		$\pm(0.05\%+0.02\%FS)$	$\pm(0.05\%+0.02\%FS)$	$\pm(0.05\%+0.02\%FS)$	$\pm(0.05\%+0.02\%FS)$
High range		0~150V	0~150V	0~150V	0~500V
Resolution		10mV	10mV	10mV	10mV
Accuracy		$\pm(0.05\%+0.025\%FS)$	$\pm(0.05\%+0.025\%FS)$	$\pm(0.05\%+0.025\%FS)$	$\pm(0.05\%+0.025\%FS)$
Current measurement					
Low range		0~3A	0~3A	0~6A	0~1.5A
Resolution		1mA	1mA	1mA	1mA
Accuracy		$\pm(0.1\%+0.1\%FS)$	$\pm(0.1\%+0.1\%FS)$	$\pm(0.1\%+0.1\%FS)$	$\pm(0.1\%+0.1\%FS)$
High range		0~30A	0~30A	0~60A	0~15A
Resolution		1mA	1mA	1mA	1mA
Accuracy		$\pm(0.1\%+0.15\%FS)$	$\pm(0.1\%+0.15\%FS)$	$\pm(0.1\%+0.15\%FS)$	$\pm(0.1\%+0.15\%FS)$
Power measurement (Input voltage /current 10%FS)					
Range		0~150W	0~300W	0~300W	0~300W
Resolution	P<100W	1mW	1mW	1mW	1mW
	P≥100W	10mW	10mW	10mW	10mW
Accuracy		1%+0.1%FS	1%+0.1%FS	1%+0.1%FS	1%+0.1%FS
Current slew rate					
Range	CCH (/us)	0.1mA ~1.5A	0.1mA ~1.5A	0.1mA ~3A	0.1mA ~0.75A
	CCL (/us) *3	0.1mA ~0.15A	0.1mA ~0.15A	0.1mA ~0.33A	0.1mA ~0.075A
Resolution		0.1mA/us	0.1mA/us	0.1mA/us	0.1mA/us
Accuracy *4		3%+10us	3%+10us	3%+10us	3%+10us
Battery discharge					
Discharge time		1s~100h	1s~100h	1s~100h	1s~100h
Resolution		1s	1s	1s	1s
Accuracy		0.2%+1s	0.2%+1s	0.2%+1s	0.2%+1s
Battery capacity		3000Ah	3000Ah	6000Ah	1500Ah
Resolution		1mAh	1mAh	1mAh	1mAh
Accuracy		0.3%+0.01Ah	0.3%+0.01Ah	0.3%+0.01Ah	0.3%+0.01Ah
Discharge voltage range		0.1V~150V	0.1V~150V	0.1V~150V	0.1V~150V
Discharge current resolution		10mA	10mA	10mA	10mA
Short circuit					
CCL		3.6A	3.6A	7.2A	1.8A
CCH		33A	33A	66A	16.5A
CV		0V	0V	0V	0V
VH CRL		0.044Ω	0.027Ω	0.022Ω	0.24Ω
VH CRM		5.6Ω	5.6Ω	2.8Ω	31Ω
VH CRH		58Ω	58Ω	29Ω	310Ω
VL CRL		0.044Ω	0.027Ω	0.022Ω	0.24Ω
VL CRM		1.1Ω	1.1Ω	0.53Ω	2Ω
VL CRH		10Ω	10Ω	5.3Ω	20Ω
CPV		165W	315W	315W	315W
CPC		0W	0W	0W	0W

Model	TDL1-1530	TDL3-1530	TDL3-1560	TDL3-5015
Max. slew rate				
Current	1.5A /us	1.5A /us	3A /us	0.75A /us
Voltage	0.2V /us	0.2V /us	0.2V /us	0.02V /us
Open circuit	≥20kΩ	≥20kΩ	≥20kΩ	≥20kΩ
Max. input level				
Current	33A	33A	66A	16.5A
Voltage	175V	175V	175V	550V
Ripple & Noise				
Current (rms/p-p)	3mA/30mA	3mA/30mA	6mA/60mA	5mA/50mA
Voltage (rms)	5mV	5mV	5mV	5mV
Transient operation				
Transient mode	Continuous, Pulse, Toggled			
Frequency range *5	0.01Hz~2kHz			
High/Low time	0~99999ms			
Resolution	250us			
Accuracy	0.2%+10us			
Rising/Falling time	250us~99999ms			
Resolution	250us			
Accuracy	0.2%+10us			
List Mode				
Step time	10ms~99999s			
Resolution	10ms			
Accuracy	0.2%+10us			
No. of steps	1~50			
No. of cycles	0~65535			
Storage	8 Lists			
Expanded function	Chain			
Trigger input				
Trigger level	TTL falling edge			
Trigger pulse width	≥20us			
General				
Protection	Over current, over voltage, over power, over temperature and reverse voltage protections			
Interface	RS-232 interface, support SCPI commands, support Labview			
	Optional RS-232 to USB cable			
Operating environment	0°C~40°C, ≤85%RH			
Storage environment	-10°C~70°C, ≤70%RH			
Power source	AC110V/220V±10% selectable, 50/60Hz			
Accessories	Power cord x1, Operation manual x1, RS-232 cable x1			
Dimension (WxHxD)	215x89x412mm	215x89x412mm		
Weight	5.2kg	6.7kg		

Model		TDL6-1560	TDL6-1512	TDL6-5030	
Rated input (0°C~40°C)					
Voltage		0~150V	0~150V	0~500V	
Current		1mA~60A	1mA~120A	1mA~30A	
Power *1		600W	600W	600W	
MOV@FS current		0.9V	1.6V	4.2V	
Constant voltage mode (CV)					
Low range		0.1~30V	0.1~30V	0.1~30V	
Resolution		1mV	1mV	1mV	
Accuracy		±(0.05%+0.02%FS)	±(0.05%+0.02%FS)	±(0.05%+0.02%FS)	
High range		0.10~150V	0.10~150V	0.10~500V	
Resolution		10mV	10mV	10mV	
Accuracy		±(0.05%+0.025%FS)	±(0.05%+0.025%FS)	±(0.05%+0.025%FS)	
Constant current mode (CC)					
Low range		0~6A	0~12A	0~3A	
Resolution		1mA	1mA	1mA	
Accuracy		±(0.1%+0.1%FS)	±(0.1%+0.1%FS)	±(0.1%+0.1%FS)	
High range		0~60A	0~120A	0~30A	
Resolution		10mA	10mA	10mA	
Accuracy		±(0.1%+0.15%FS)	±(0.1%+0.15%FS)	±(0.1%+0.15%FS)	
Constant resistance mode (CR) (Input voltage /current 10%FS)					
Low range (VH CRL)		≈0.02~3Ω	≈0.15~15Ω	≈0.15~18Ω	
Resolution		50uΩ	25uΩ	300uΩ	
Accuracy (Impedance)		±(0.5%+0.5%FS)	±(0.5%+0.5%FS)	±(0.5%+0.5%FS)	
Middle range (VH CRM)		≈3~300Ω	≈1.5~150Ω	≈18~1800Ω	
Resolution		5.4us	10us	0.90us	
Accuracy (Conductance)		±(1%+1%FS)	±(1%+1%FS)	±(1%+1%FS)	
High range (VH CRH)		≈30~4000Ω	≈150~4000Ω	≈180~4000Ω	
Resolution *2		0.20us	1.2us	0.10us	
Accuracy (Conductance)		±(1.5%+1.5%FS)	±(1.5%+1.5%FS)	±(1.5%+1.5%FS)	
Low range (VL CRL)		≈0.02~0.6Ω	≈0.015~0.3Ω	≈0.15~1.2Ω	
Resolution		9.6uΩ	4.8uΩ	19uΩ	
Accuracy (Impedance)		±(0.5%+0.5%FS)	±(0.5%+0.5%FS)	±(0.5%+0.5%FS)	
Medium range (VL CRM)		≈0.6~60Ω	≈0.3~30Ω	≈1.2~120Ω	
Resolution		27us	54us	14us	
Accuracy (Conductance)		±(1%+1%FS)	±(1%+1%FS)	±(1%+1%FS)	
High range (VL CRH)		≈6.0~2000Ω	≈3.0~2000Ω	≈12~2000Ω	
Resolution		3.0us	6.1us	1.5us	
Accuracy (Conductance)		±(1.5%+1.5%FS)	±(1.5%+1.5%FS)	±(1.5%+1.5%FS)	
Constant power mode (CP) (Input voltage /current 10%FS)					
Range		0~600W	0~600W	0~600W	
Resolution	P<100W	1mW	1mW	1mW	
	P≥100W	10mW	10mW	10mW	
Accuracy		±(1%+0.1%FS)	±(1%+0.1%FS)	±(1%+0.1%FS)	

Model		TDL6-1560	TDL6-1512	TDL6-5030	
Voltage measurement					
Low range		0~30V	0~30V	0~30V	
Resolution		1mV	1mV	1mV	
Accuracy		$\pm(0.05\%+0.02\%FS)$	$\pm(0.05\%+0.02\%FS)$	$\pm(0.05\%+0.02\%FS)$	
High range		0~150V	0~150V	0~500V	
Resolution		10mV	10mV	10mV	
Accuracy		$\pm(0.05\%+0.025\%FS)$	$\pm(0.05\%+0.025\%FS)$	$\pm(0.05\%+0.025\%FS)$	
Current measurement					
Low range		0~6A	0~12A	0~3A	
Resolution		1mA	1mA	1mA	
Accuracy		$\pm(0.1\%+0.1\%FS)$	$\pm(0.1\%+0.1\%FS)$	$\pm(0.1\%+0.1\%FS)$	
High range		0~60A	0~120A	0~30A	
Resolution		1mA	1mA	1mA	
Accuracy		$\pm(0.1\%+0.15\%FS)$	$\pm(0.1\%+0.15\%FS)$	$\pm(0.1\%+0.15\%FS)$	
Power measurement (Input voltage /current 10%FS)					
Range		0~600W	0~600W	0~600W	
Resolution	P<100W	1mW	1mW	1mW	
	P≥100W	100mW	100mW	100mW	
Accuracy		1%+0.1%FS	1%+0.1%FS	1%+0.1%FS	
Current slew rate					
Range	CCH (/us)	0.1mA ~3A	0.1mA ~6A	0.1mA ~1.5A	
	CCL (/us) *3	0.1mA ~0.33A	0.1mA ~0.6A	0.1mA ~0.15A	
Resolution		0.1mA/us	0.1mA/us	0.1mA/us	
Accuracy *4		3%+10us	3%+10us	3%+10us	
Battery discharge					
Discharge time		1s~100h	1s~100h	1s~100h	
Resolution		1s	1s	1s	
Accuracy		0.2%+1s	0.2%+1s	0.2%+1s	
Battery capacity		6000Ah	12000Ah	3000Ah	
Resolution		1mAh	1mAh	1mAh	
Accuracy		0.3%+0.01Ah	0.3%+0.01Ah	0.3%+0.01Ah	
Discharge voltage range		0.1V~150V	0.1V~150V	0.1V~150V	
Discharge current resolution		10mA	10mA	10mA	
Short circuit					
CCL		7.2A	14.6A	3.6A	
CCH		66A	132A	33A	
CV		0V	0V	0V	
VH CRL		0.015Ω	0.013Ω	0.13Ω	
VH CRM		2.8Ω	1.4Ω	16Ω	
VH CRH		29Ω	15Ω	160Ω	
VL CRL		0.015Ω	0.013Ω	0.13Ω	
VL CRM		0.53Ω	0.26Ω	1.0Ω	
VL CRH		5.3Ω	2.4Ω	10Ω	
CPV		630W	630W	630W	
CPC		0W	0W	0W	

Model	TDL6-1560	TDL6-1512	TDL6-5030	
Max. slew rate				
Current	3A /us	6A /us	1.5A /us	
Voltage	0.2V /us	0.2V /us	0.02V /us	
Open circuit	≥20kΩ	≥20kΩ	≥20kΩ	
Max. input level				
Current	66A	132A	33A	
Voltage	175V	175V	550V	
Ripple & Noise				
Current (rms/p-p)	6mA/60mA	12mA/120mA	5mA/50mA	
Voltage (rms)	5mV	5mV	5mV	
Transient operation				
Transient mode	Continuous, Pulse, Toggled			
Frequency range *5	0.01Hz~2kHz			
High/Low time	0~99999ms			
Resolution	250us			
Accuracy	0.2%+10us			
Rising/Falling time	250us~99999ms			
Resolution	250us			
Accuracy	0.2%+10us			
List Mode				
Step time	10ms~99999s			
Resolution	10ms			
Accuracy	0.2%+10us			
No. of steps	1~50			
No. of cycles	0~65535			
Storage	8 Lists			
Expanded function	Chain			
Trigger input				
Trigger level	TTL falling edge			
Trigger pulse width	≥20us			
General				
Protection	Over current, over voltage, over power, over temperature and reverse voltage protections			
Interface	RS-232 interface, support SCPI commands, support Labview			
	Optional RS-232 to USB cable			
Operating environment	0°C~40°C, ≤85%RH			
Storage environment	-10°C~70°C, ≤70%RH			
Power source	AC110V/220V±10% selectable, 50/60Hz			
Accessories	Power cord x1, Operation manual x1, RS-232 cable x1			
Dimension (WxHxD)	215x89x507mm			
Weight	9kg			

Specifications are subject to change without prior notice.

*1. Maximum continuous power available is derated linearly from 100% of maximum at 40°C, to 75% of maximum at 50°C.

*2. Conductance (S) = 1 / Resistance (Ω).

*3. The set level is 10 times larger than the slew rate in CCL mode.

*4. The actual transition time is defined as the time required for the input to change from 10% to 90% or from 90% to 10% of the programmed excursion.

*5. Transient frequency depends on the time for high/low level and rising/falling edge.

