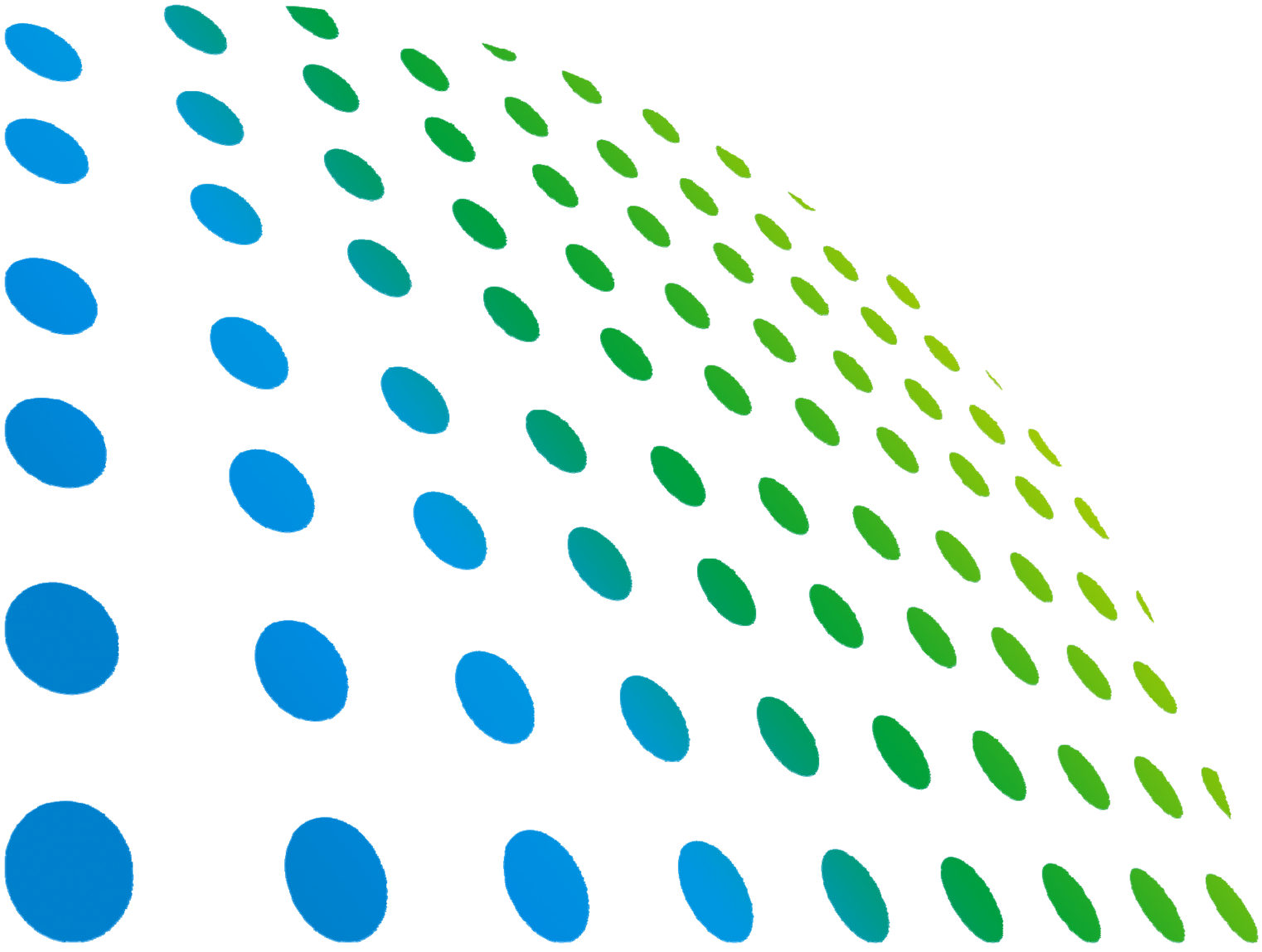
Chroma

High Speed DC Electronic Load

6330A Series

Operation & Programming Manual



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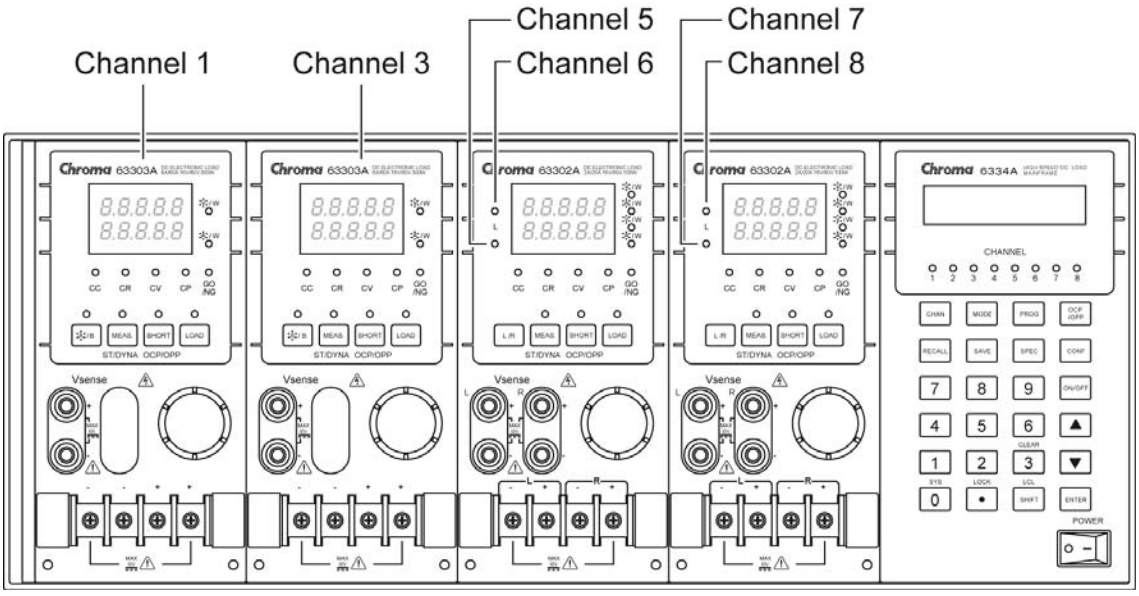

Version 1.4
August 2013

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CHROMA ATE INC.
66 Hwaya 1st Rd., Kueishan Hwaya Technology Park, Taoyuan County 33383, Taiwan

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Material Contents Declaration

The recycling label shown on the product indicates the Hazardous Substances contained in the product as the table listed below.


: See **<Table 1>**.


: See **<Table 2>**.

<Table 1>

Part Name	Hazardous Substances					
	Lead	Mercury	Cadmium	Hexavalent Chromium	Polybrominated Biphenyls	Polybromodiphenyl Ethers
	Pb	Hg	Cd	Cr^{6+}	PBB	PBDE
PCBA	O	O	O	O	O	O
CHASSIS	O	O	O	O	O	O
ACCESSORY	O	O	O	O	O	O
PACKAGE	O	O	O	O	O	O

“O” indicates that the level of the specified chemical substance is less than the threshold level specified in the standards of SJ/T-11363-2006 and EU 2005/618/EC.

“×” indicates that the level of the specified chemical substance exceeds the threshold level specified in the standards of SJ/T-11363-2006 and EU 2005/618/EC.

Disposal

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal at least for free of charge.

<Table 2>

Part Name	Hazardous Substances					
	Lead	Mercury	Cadmium	Hexavalent Chromium	Polybrominated Biphenyls	Polybromodiphenyl Ethers
	Pb	Hg	Cd	Cr^{6+}	PBB	PBDE
PCBA	×	O	O	O	O	O
CHASSIS	×	O	O	O	O	O
ACCESSORY	×	O	O	O	O	O
PACKAGE	O	O	O	O	O	O

"O" indicates that the level of the specified chemical substance is less than the threshold level specified in the standards of SJ/T-11363-2006 and EU 2005/618/EC.

"×" indicates that the level of the specified chemical substance exceeds the threshold level specified in the standards of SJ/T-11363-2006 and EU 2005/618/EC.

1. Chroma is not fully transitioned to lead-free solder assembly at this moment; however, most of the components used are RoHS compliant.
2. The environment-friendly usage period of the product is assumed under the operating environment specified in each product's specification.

Disposal

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal at least for free of charge.

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CE

Declaration of Conformity

For the following equipment :

DC Electronic Load

(Product Name/ Trade Name)

6310A Series:

6312A, 6314A, 63101A, 63102A, 63103A, 63105A, 63106A, 63107A, 63108A, 63112A

6330A Series:

6332A, 6334A, 63301A, 63302A, 63303A, 63305A, 63306A, 63307A, 63308A, 63312A

(Model Designation)

CHROMA ATE INC.

(Manufacturer Name)

66, Hwaya 1st Rd., Kueishan Hwaya Technology Park, Taoyuan County 33383, Taiwan

(Manufacturer Address)

Is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States relating to Electromagnetic Compatibility (2004/108/EC) and Low Voltage Directive (2006/95/EC). For the evaluation regarding the Directives, the following standards were applied :

EN 61326-1:2006,Table 2

CISPR 11:2003+A1:2004+A2:2006(Class A), IEC 61000-4-2:1995+A1:1998+A2:2000,

IEC 61000-4-3:2002+A1:2002, IEC 61000-4-4:2004, IEC 61000-4-5:1995+A1:2000,

IEC 61000-4-6:1996+A1:2000, IEC 61000-4-8:1993+A1:2000, IEC 61000-4-11:2004

EN 61000-3-2:2000+A2:2005, EN 61000-3-3:1995+A1:2001+A2:2005

EN 61010-1:2010

The following importer/manufacturer or authorized representative established within the EUT is responsible for this declaration :

CHROMA ATE INC.

(Company Name)

66, Hwaya 1st Rd., Kueishan Hwaya Technology Park, Taoyuan County 33383, Taiwan

(Company Address)

Person responsible for this declaration:

Mr. Benjamin Huang

(Name, Surname)

Division Vice President

(Position/Title)

Taiwan	**2013.03.05**	Benjamin Huang
(Place)	(Date)	(Legal Signature)

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Declaration of Conformity

For the following equipment :

LED Load Simulator

(Product Name/ Trade Name)

63110A, 63310A Load Module

(Model Designation)

CHROMA ATE INC.

(Manufacturer Name)

66, Hwaya 1st Rd., Kueishan Hwaya Technology Park, Taoyuan County 33383, Taiwan

(Manufacturer Address)

Is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States relating to Electromagnetic Compatibility (2004/108/EC) and Low Voltage Directive (2006/95/EC). For the evaluation regarding the Directives, the following standards were applied :

EN 61326-1:2006 Class A

EN61000-3-2:2006, EN61000-3-3:1995+A1:2001+A2:2005

EN61326-1:2006 (industrial locations)

IEC 61000-4-2:1995+A1:1998+A2:2000, IEC 61000-4-3:2006, IEC 61000-4-4:2004,

IEC 61000-4-5:2005, IEC 61000-4-6:2006, IEC 61000-4-8:2001, IEC 61000-4-11:2004

EN 61010-1:2010

The following importer/manufacturer or authorized representative established within the EUT is responsible for this declaration :

CHROMA ATE INC.

(Company Name)

66, Hwaya 1st Rd., Kueishan Hwaya Technology Park, Taoyuan County 33383, Taiwan

(Company Address)

Person responsible for this declaration:

Mr. Benjamin Huang

(Name, Surname)

Division Vice President

(Position/Title)

Taiwan	**2013.03.05**	Benjamin Huang
(Place)	(Date)	(Legal Signature)

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Declaration of Conformity

For the following equipment :

DC Electronic Load

(Product Name/ Trade Name)

63123A, 63323A Load Module

(Model Designation)

Chroma ATE Inc.

(Manufacturer Name)

66 Hwa-Ya 1st Rd., Hwa-Ya Technical Park, Kuei-Shan Hsiang, Taoyuan Hsien, Taiwan.

(Manufacturer Address)

Is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States relating to Electromagnetic Compatibility (2004/108/EC), Low-voltage Directive (2006/95/EC). For the evaluation regarding the Directives, the following standards were applied :

EN 61010-1:2001

EN 61326-1: 2006, Table 2

EN 61000-3-2:2006,Class A; EN 61000-3-3:1995+A1:2001+A2:2005

CISPR 11:2003+A1:2004+A2:2006,(Class A); IEC 61000-4-2:1995+A1:1998+A2:2000;

IEC 61000-4-3:2006; IEC 61000-4-4:2004; IEC 61000-4-5:2005; IEC 61000-4-6:2007

IEC 61000-4-8:1993+A1:2000;IEC 61000-4-11:2004

The following importer/manufacturer or authorized representative established within the EUT is responsible for this declaration :

Chroma ATE Inc.

(Company Name)

66 Hwa-Ya 1st Rd., Hwa-Ya Technical Park, Kuei-Shan Hsiang, Taoyuan Hsien, Taiwan.

(Company Address)

Person responsible for this declaration:

Mr. Benjamin Huang

(Name, Surname)

T & M BU Director

(Position/Title)

Taiwan	**2010.07.08**	Benjamin Huang
(Place)	(Date)	(Legal Signature)

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Declaration of Conformity

For the following equipment :

Programmable DC Electronic Load

(Product Name/ Trade Name)

63113A, 63313A

(Model Designation)

Chroma ATE Inc.

(Manufacturer Name)

66, Hwa-Ya 1st Rd., Hwa-Ya Technology Park, Kuei-Shan Hsiang, Taoyuan County 33383, Taiwan

(Manufacturer Address)

Is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States relating to Electromagnetic Compatibility (2004/108/EC), Low-voltage Directive (2006/95/EC). For the evaluation regarding the Directives, the following standards were applied :

EN 61326-1: 2006

EN 55011:2007 Class A; EN 61000-3-2:2006/A2:2009; EN 61000-3-3:2008;

IEC 61000-4-2:2008; IEC 61000-4-3:2006/A1:2007/A2:2010;

IEC 61000-4-4:2004; IEC 61000-4-5:2005; IEC 61000-4-6:2008;

IEC 61000-4-8:2009; IEC 61000-4-11:2004

EN 61010-1: 2010(Edition 3.0) and EN 61010-2-030: 2010(Edition 1.0)

The following importer/manufacturer or authorized representative established within the EUT is responsible for this declaration :

Chroma ATE Inc.

(Company Name)

66, Hwa-Ya 1st Rd., Hwa-Ya Technology Park, Kuei-Shan Hsiang, Taoyuan County 33383, Taiwan

(Company Address)

Person responsible for this declaration:

Mr. Benjamin Huang

(Name, Surname)

T&M BU Division Vice President

(Position/Title)

Taiwan	**2011.11.28**	Benjamin Huang
(Place)	(Date)	(Legal Signature)

⚠WARNING

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Safety Summary

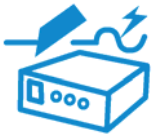
The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or specific WARNINGS given elsewhere in this manual will violate safety standards of design, manufacture, and intended use of the instrument. *Chroma* assumes no liability for the customer's failure to comply with these requirements.

BEFORE APPLYING POWER

Verify that the power is set to match the rated input of this power supply.

PROTECTIVE GROUNDING

Make sure to connect the protective grounding to prevent an electric shock before turning on the power.



NECESSITY OF PROTECTIVE GROUNDING

Never cut off the internal or external protective grounding wire, or disconnect the wiring of protective grounding terminal. Doing so will cause a potential shock hazard that may bring injury to a person.

FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuse holders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. The instrument should be used in an environment of good ventilation.

DO NOT REMOVE THE COVER OF THE INSTRUMENT

Operating personnel must not remove the cover of the instrument. Component replacement and internal adjustment can be done only by qualified service personnel.

Safety Symbols

	**DANGER –** High voltage.
	**Explanation:** To avoid injury, death of personnel, or damage to the instrument, the operator must refer to an explanation in the instruction manual.
	**High temperature:** This symbol indicates the temperature is now higher than the acceptable range of human. Do not touch it to avoid any personal injury.
	**Protective grounding terminal:** To protect against electrical shock in case of a fault. This symbol indicates that the terminal must be connected to ground before operation of equipment.
	The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.
	The **CAUTION** sign denotes a hazard. It may result in personal injury or death if not noticed timely. It calls attention to procedures, practices and conditions.
	The **Notice** sign denotes important information in procedures, applications or the areas that require special attention. Be sure to read it carefully.

Revision History

The following lists the additions, deletions and modifications in this manual at each revision.

Date	Version	Revised Sections
Dec. 2009	1.0	Complete this manual.
Aug. 2010	1.1	Modify the description in the following sections: – "*Installation*" , "*Local Operation*" and "*Language Dictionary*" Add 63323A and 63310A specification in the chapter of "*General Information*." Add the following in the chapter of "*Operation Overview*": – LED Mode in the section of "Modes of Operation" Add the following in the chapter of "*Local Operation*": – LED Mode in the section of "*Setting the Operation Mode*" – CR Irange Select Notice, Set all channels at one time, Change the setting of Rd, Rd Coefficient or VF, Set the load internal impedance Rr and Electronic Load response speed adjustment in the section of "*Setting the Configuration*."
Feb. 2011	1.2	Update the following sections: – "*Specifications*" in the chapter of "*Overview*." – "*Setting the OCP/OPP Mode of Operation*" in the chapter of "*Local Operation*." – "*Protection Features*" in the chapter of "*Operation Overview*." Add "VOLTage:SLOWTYPE" in the section of "*VOLTAGE Subsystem.*" Add the chapter of "*Verification*."
Feb. 2012	1.3	Update the following sections: – Specification tables in the chapter of "*General Information*". – "*Inspection & Standard Accessories*" in the chapter of "*Installation*" – "*Setting the Operation Mode*" and "*Setting the Configuration*" in the chapter of "*Local Operation*" – "*CHANNEL Subsystem*" and "*LED Subsystem*" in the chapter of "*Language Dictionary*" Add a new model 63313A and its detail descriptions in the manual.
Aug. 2013	1.4	Replace the CE Declaration of Conformity with the new one. Modify the following sections: – "*Specifications*" in the chapter of "*General Information*" – "*Inspection & Standard Accessories*" in the chapter of "*Installation*" – "*Setting the Operation Mode*", "*Setting the OCP/OPP Mode of Operation*" & "*Recalling Files/OCP Files/OPP Files*" in chapter of "*Local Operation*" – "*MODE Subsystem*" & "*SHOW Subsystem*" in the chapter of "*Language Dictionary*" – "*Performance Tests*" in the chapter of "*Verification*"

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PART 1

Operation

1. General Information

1.1 Introduction

This manual contains specifications, installation, operation, and programming instructions for the 6334A, 6332A electronic load mainframes as well as 63301A, 63302A, 63303A, 63305A, 63306A, 63307A, 63308A, 63310A, 63312A, 63313A and 63323A electronic load modules. Here “Load” means the electronic load modules of the Chroma 6330A Series while “Mainframe” means the 6334A, 6332A electronic load mainframes.

1.2 Description

The functions of the 6334A (4 Slots) and the 6332A (2 Slots) mainframes are the same. The functions of the 63301A, 63302A, 63303A, 63305A, 63306A, 63307A, 63308A, 63310A, 63312A, 63313A and 63323A are all the same. The differences are in input voltage ratings, load current ratings, and power rating. An individual module may have one or two channels depending on the model. Each channel has its own channel number, load & measurement connectors, and operates independently in constant current (CC) mode, constant resistance (CR) mode, constant voltage (CV) mode, or constant power (CP) mode.

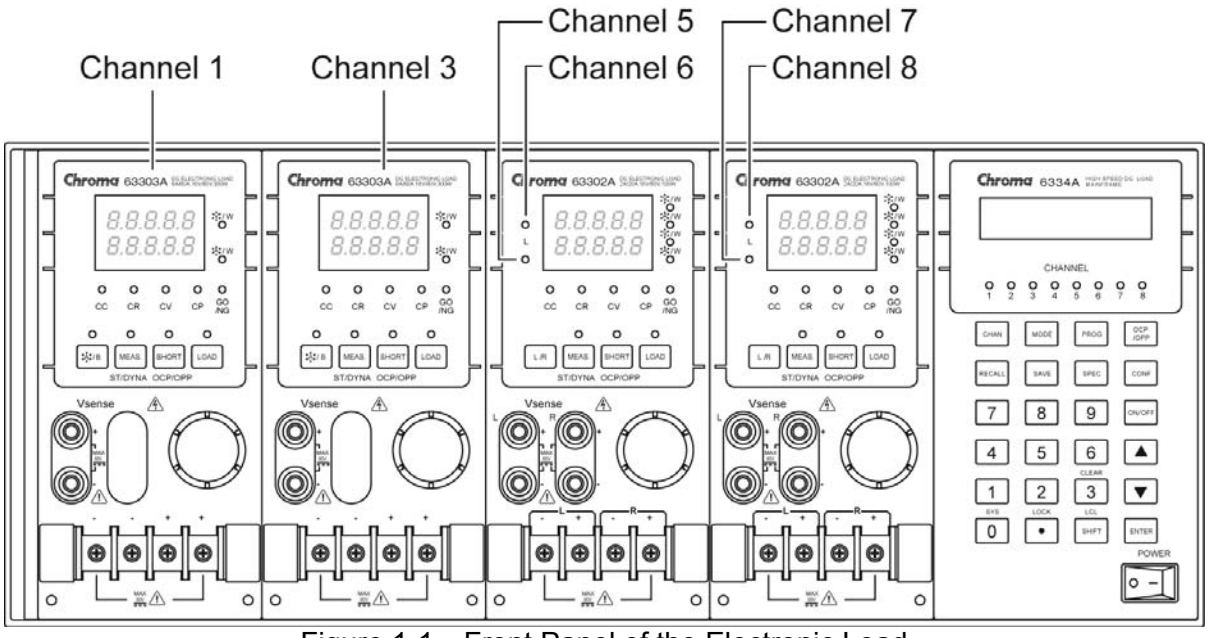


Figure 1-1 Front Panel of the Electronic Load

Press **MODE** on the frame as Figure 1-1 shows can switch to various modes (CC, CR, CV, CP) for operation.

1.3 Overview of Key Features

A. Configuration

- Flexible configuration with plug-in electronic load modules in mainframes.
- Local operation via front panel keypad.
- Remote control via RS-232C, GPIB or USB interface.
- Photocoupler isolation offers true floating Load.
- Automatic fan speed control to reduce noise.
- Up to 8 channels in one Mainframe.

B. Load

- Constant current (CC), constant resistance (CR), constant voltage (CV), and constant power (CP) operation modes.
- Programmable slew rate, load levels, load periods and conduct voltage (Von).
- Programmable dynamic loading with speeds up to 20KHz.
- Minimum input resistance allows load to sink high current even with low input voltage (1 V).
- Selective voltage and current ranges.
- Remote sensing capability.
- 100 sets of memories to save/recall user-definable setups.
- 10 sets of OCP memories to save/recall user-definable setups.
- 10 sets of OPP memories to save/recall user-definable setups.
- 10 sets of programs to link files for automatic test.
- 16-bit A/D converter offers precision measurements.
- Short circuit simulation.
- Automatic GO/NG inspection to confirm UUT is within spec.
- Independent GO/NG signals for each channel.

1.4 Specifications

Mainframe	:	6334A/6332A
AC input	:	115/230 switchable or 100/200 switchable Vac line
Fuse	:	2.5A, 250V/2A, 250V
Amplitude	:	±10%
Frequency	:	47 to 63 Hz
Maximum VA	:	300VA/200VA
Trigger output	:	Vlo = 0.8V maximum at Ilo = 1 mA Vhi = 3.2V minimum at Ihi = –40μA
Weight	:	24kg (48.5lbs) / 15kg (33.1lbs)
Dimension	:	
Width	:	440mm/275mm
Height	:	177.4 mm (excluding feet) 186mm (including feet)
Depth	:	560mm (including Load module)

∗ The specifications of Load are listed below.

Notice

1. The equipment is for indoor use only.
2. The altitude up to 2000 meters is allowed to use the equipment.
3. All specifications are tested under 20°C ~ 30°C except otherwise stated.
4. The range of operation temperature is 0°C ~ 40°C.
5. The range of storage temperature is -5°C ~ 60°C.
6. The operating relative humidity is 30% to 90%.
7. The storage relative humidity is 10% to 95%.
8. The specifications of DC current accuracy are tested after the input is applied for 30 seconds.
9. The power of the load module of 6330A series is supplied from 6334A/6332A mainframe.
10. The typical temperature coefficient is 100ppm.
11. The accuracy specification for CR mode: S (Siemens) means 1/Ω.
12. The transient overvoltage at Mains supply is 2500 V.
13. Pollution Degree: 2.

CAUTION

This equipment is not intended for performing measurements on CAT I, II, III or IV.

* CAT IV – is for measurements performed at the source of the low-voltage installation.
* CAT III – is for measurements performed in the building installation.
* CAT II – is for measurements performed on circuits directly connected to the low-voltage installation.
* CAT I – is for measurements performed on circuits directly connected to mains.

MODEL	**63301A**		**63305A**	
POWER	20W	200W	30W	300W
CURRENT	0~4A	0~40A	0~1A	0~10A
VOLTAGE	0~80V		0~500V	
MIN. OPERATING VOLTAGE (DC)*[1](Typical)	0.4V@2A	0.4V@20A	1V@0.5A	1V@5A
	0.8V@4A	0.8V@40A	2V@1A	2V@10A
CONSTANT CURRENT MODE Range	0~4A	0~40A	0~1A	0~10A
Resolution	1mA	10mA	0.25mA	2.5mA
Accuracy	0.1%+0.1%F.S.	0.1%+0.2%F.S.	0.1%+0.1%F.S.	0.1%+0.2%F.S.
CONSTANT RESISTANCE MODE Range	0.0375Ω~150Ω (200W/16V) 1.875Ω~7.5kΩ (200W/80V)		1.25Ω~5kΩ (300W/125V) 50Ω~200kΩ (300W/500V)	
Resolution	6.667mS (200W/16V) 133μS (200W/80V)		200μS (300W/125V) 5μS (300W/500V)	
Accuracy	150Ω : 0.1S +0.2% 7.5kΩ : 0.01S +0.1%		5kΩ : 20mS +0.2% 200kΩ : 5mS +0.1%	
CONSTANT VOLTAGE MODE Range	0~80V		0~500V	
Resolution	20mV		125mV	
Accuracy	0.05%±0.1%F.S.		0.05%±0.1%F.S.	
CONSTANT POWER MODE Range*[13]	0 ~ 20W	0 ~ 200W	0 ~ 30W	0 ~ 300W
Resolution	5mW	50mW	7.5mW	75mW
Accuracy	0.5%±0.5%F.S.		0.5%±0.5%F.S.	
DYNAMIC MODE				
DYNAMIC MODE	C.C. MODE		C.C. MODE	
T1 & T2	0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms		0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms	
Accuracy	1μs /1ms+100ppm		1μs /1ms+100ppm	
Slew Rate	0.64~160mA/μs	6.4~1600mA/μs	0.16~40mA/μs	1.6~400mA/μs
Resolution	0.64mA/μs	6.4mA/μs	0.16mA/μs	1.6mA/μs
Accuracy*[9]	10%±20μs		10%±20μs	
Minimum Rise Time	10μs(Typical)		24μs(Typical)	
Current	0~4A	0~40A	0~1A	0~10A
Resolution	1mA	10mA	0.25mA	2.5mA
Accuracy	0.4% F.S.		0.4% F.S.	
Minimum Transient Voltage	2.5V	2.5V	2V	2V
MEASUREMENT SECTION				
VOLTAGE READ BACK				
Range	0~16V	0~80V	0~125V	0~500V
Resolution	0.25mV	1.25mV	2mV	8mV
Accuracy	0.025%+0.025% F.S.		0.025%+0.025% F.S.	
CURRENT READ BACK				
Range	0~4A	0~40A	0~1A	0~10A
Resolution	0.0625mA	0.625mA	0.016mA	0.16mA
Accuracy	0.05%+0.05% F.S.		0.05%+0.05% F.S.	
POWER READ BACK				
Range	0 ~ 20W	0 ~ 200W	0 ~ 30W	0 ~ 300W
Accuracy*[2]	0.1%+0.1% F.S		0.1%+0.1% F.S	
PROTECTIVE SECTION				
Over Power Protection	YES		YES	
Over Current Protection	YES		YES	
Over Temperature Protection	YES		YES	
Over Voltage Alarm*[3]	YES		YES	

GENERAL				
SHORT CIRCUIT				
Current (CC)	–	YES	–	YES
Voltage (CV)	–	YES	–	YES
Resistance (CR)	–	YES	–	YES
Power (CP)	–	YES	–	YES
INPUT RESISTANCE (LOAD OFF)	R≧100kΩ (Typical)		R≧100kΩ (Typical)	
Temperature Coefficient	100ppm/°C (Typical)		100ppm/°C (Typical)	
Power	Supply from 6334A Mainframe		Supply from 6334A Mainframe	
Dimension (H×W×D)	172×82×489.5mm / 6.77×3.23×19.27inch		172×82×489.5mm / 6.77×3.23×19.27inch	
Weight (Approx.)	4.2kg/9.25 lbs		4.2kg/9.25 lbs	
Operating Range	0~40°C		0~40°C	
EMC & SAFETY	CE		CE	

MODEL	**63302A(100W*2)**		**63303A**	
POWER	20W	100W	30W	300W
CURRENT	0~2A	0~20A	0~6A	0~60A
VOLTAGE	0~80V		0~80V	
MIN. OPERATING VOLTAGE (DC)[*1](Typical)	0.4V@1A 0.8V@2A	0.4V@10A 0.8V@20A	0.4V@3A 0.8V@6A	0.4V@30A 0.8V@60A
CONSTANT CURRENT MODE Range	0~2A	0~20A	0~6A	0~60A
Resolution	0.5mA	5mA	1.5mA	15mA
Accuracy	0.1%+0.1%F.S.	0.1%+0.2%F.S.	0.1%+0.1%F.S.	0.1%+0.2%F.S.
CONSTANT RESISTANCE MODE Range	0.075Ω~300Ω (100W/16V) 3.75Ω~15kΩ (100W/80V)		0.025Ω~100Ω (300W/16V) 1.25Ω~5kΩ (300W/80V)	
Resolution	3.333mS (100W/16V) 66.667μS (100W/80V)		10mS (300W/16V) 200μS (300W/80V)	
Accuracy	300Ω : 0.1S +0.2% 15kΩ : 0.01S +0.1%		100Ω : 0.1S +0.2% 5kΩ : 0.01S +0.1%	
CONSTANT VOLTAGE MODE Range	0~80V		0~80V	
Resolution	20mV		20mV	
Accuracy	0.05%±0.1%F.S.		0.05%±0.1%F.S.	
CONSTANT POWER MODE Range[*13]	0 ~ 20W	0 ~ 100W	0 ~ 30W	0 ~ 300W
Resolution	5mW	25mW	7.5mW	75mW
Accuracy	0.5%±0.5%F.S.		0.5%±0.5%F.S.	
DYNAMIC MODE				
DYNAMIC MODE	C.C. MODE		C.C. MODE	
T1 & T2	0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms		0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms	
Accuracy	1μs /1ms+100ppm		1μs /1ms+100ppm	
Slew Rate	0.32~80mA/μs	3.2~800mA/μs	0.001~0.25A/μs	0.01~2.5A/μs
Resolution	0.32mA/μs	3.2mA/μs	0.001A/μs	0.01A/μs
Accuracy[*9]	10%±20μs		10%±20μs	
Minimum Rise Time	10μs(Typical)		10μs(Typical)	
Current	0~2A	0~20A	0~6A	0~60A
Resolution	0.5mA	5mA	1.5mA	15mA
Accuracy	0.4% F.S.		0.4% F.S.	
Minimum Transient Voltage	2V	2V	2.5V	2.5V
MEASUREMENT SECTION				
VOLTAGE READ BACK				
Range	0~16V	0~80V	0~16V	0~80V
Resolution	0.25mV	1.25mV	0.25mV	1.25mV
Accuracy	0.025%+0.025% F.S.		0.025%+0.025% F.S.	
CURRENT READ BACK				
Range	0~2A	0~20A	0~6A	0~60A
Resolution	0.03125mA	0.3125mA	0.09375mA	0.9375mA
Accuracy	0.05%+0.05% F.S.		0.05%+0.05% F.S.	
POWER READ BACK				
Range	0 ~ 20W	0 ~ 100W	0 ~ 30W	0 ~ 300W
Accuracy[*2]	0.1%+0.1% F.S		0.1%+0.1% F.S	
PROTECTIVE SECTION				
Over Power Protection	YES		YES	
Over Current Protection	YES		YES	
Over Temperature Protection	YES		YES	
Over Voltage Alarm[*3]	YES		YES	

GENERAL				
SHORT CIRCUIT				
Current (CC)	–	YES	–	YES
Voltage (CV)	–	YES	–	YES
Resistance (CR)	–	YES	–	YES
Power (CP)	–	YES	–	YES
INPUT RESISTANCE (LOAD OFF)	R≧100kΩ (Typical)		R≧100kΩ (Typical)	
Temperature Coefficient	100ppm/°C (Typical)		100ppm/°C (Typical)	
Power	Supply from 6334A Mainframe		Supply from 6334A Mainframe	
Dimension (H×W×D)	172×82×489.5mm / 6.77×3.23×19.27inch		172×82×489.5mm / 6.77×3.23×19.27inch	
Weight (Approx.)	4.2kg/9.25 lbs		4.2kg/9.25 lbs	
Operating Range	0~40°C		0~40°C	
EMC & SAFETY	CE		CE	

MODEL	**63307A(30W,250W)**			**63306A**	
POWER	30W	30W	250W	60W	600W
CURRENT	0~5A	0~4A	0~40A	0~12A	0~120A
VOLTAGE	0~80V			0~80V	
MIN. OPERATING VOLTAGE (DC)[*1](Typical)	0.4V@2.5A	0.4V@2A	0.4V@20A	0.4V@6A	0.4V@60A
	0.8V@5A	0.8V@4A	0.8V@40A	0.8V@12A	0.8V@120A
CC MODE Range	0~5A	0~4A	0~40A	0~12A	0~120A
Resolution	1.25mA	1mA	10mA	3mA	30mA
Accuracy	0.1%+0.1%F.S.	0.1%+0.1%F.S.	0.1%+0.2%F.S.	0.1%+0.1%F.S.	0.1%+0.2%F.S.
CR MODE Range	0.3Ω~1.2kΩ (30W/16V) 15Ω~60kΩ (30W/80V)	0.0375Ω~150Ω (250W/16V) 1.875Ω~7.5kΩ (250W/80V)		12.5mΩ~50Ω (600W/16V) 0.625Ω~2.5kΩ (600W/80V)	
Resolution	833μS (30W/16V) 16.67μS (30W/80V)	6.667mS (250W/16V) 133μS (250W/80V)		20mS (600W/16V) 400μS (600W/80V)	
Accuracy	12kΩ: 0.1S +0.2% 60kΩ: 0.01S +0.1%	150Ω: 0.1S +0.2% 7.5kΩ: 0.01S +0.1%		50Ω: 0.4S +0.5% 2.5kΩ: 0.04S +0.2%	
CV MODE Range	0~80V			0~80V	
Resolution	20mV			20mV	
Accuracy	0.05%±0.1%F.S.			0.05%±0.1%F.S.	
CP MODE Range[*13]	0 ~ 30W	0 ~ 30W	0 ~ 250W	0 ~ 60W	0 ~ 600W
Resolution	7.5mW	7.5mW	62.5mW	15mW	150mW
Accuracy	0.5%±0.5%F.S.			0.5%±0.5%F.S.	
DYNAMIC MODE					
DYNAMIC MODE	C.C. MODE			C.C. MODE	
T1 & T2	0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms			0.025ms ~ 50ms / Res:5μs 0.1ms ~ 500ms / Res:25μs 10ms ~ 50s / Res: 2.5ms	
Accuracy	1μs /1ms+100ppm			1μs /1ms+100ppm	
Slew Rate	0.8~200mA/μs	0.64~160mA/μs	6.4~1600mA/μs	0.002~0.5A/μs	0.02~5A/μs
Resolution	0.8mA/μs	0.64mA/μs	6.4mA/μs	0.002A/μs	0.02A/μs
Accuracy[*9]	10%±20μs			10%±20μs	
Minimum Rise Time	10μs(Typical)			10μs(Typical)	
Current	0~5A	0~4A	0~40A	0~12A	0~120A
Resolution	1.25mA	1mA	10mA	3mA	30mA
Accuracy	0.4% F.S.			0.4% F.S.	
Min. Transient Voltage	2.5V	2.5V	2.5V	4V	4V
MEASUREMENT SECTION					
VOLTAGE READ BACK					
Range	0~16V	0~80V	0~16V	0~80V	0~16V	0~80V
Resolution	0.25mV	1.25mV	0.25mV	1.25mV	0.25mV	1.25mV
Accuracy	0.025%+0.025% F.S.			0.025%+0.025% F.S.	
CURRENT READ BACK					
Range	0~5A	0~4A	0~40A	0~12A	0~120A
Resolution	0.078125mA	0.0625mA	0.625mA	0.1875mA	1.875mA
Accuracy	0.05%+0.05% F.S.			0.05%+0.05% F.S.	
POWER READ BACK					
Range	0 ~ 30W	0 ~ 30W	0 ~ 250W	0 ~ 60W	0 ~ 600W
Accuracy[*2]	0.1%+0.1% F.S			0.1%+0.1% F.S	
PROTECTIVE SECTION					
Over Power Protection	YES			YES	
Over Current Protection	YES			YES	
Over Temperature Protection	YES			YES	
Over Voltage Alarm[*3]	YES			YES	

GENERAL					
SHORT CIRCUIT					
Current (CC)	–	–	YES	–	YES
Voltage (CV)	–	–	YES	–	YES
Resistance (CR)	–	–	YES	–	–
Power (CP)	–	–	YES	–	YES
INPUT RESISTANCE (LOAD OFF)	R≧100kΩ (Typical)			R≧100kΩ (Typical)	
Temperature Coefficient	100ppm/°C (Typical)			100ppm/°C (Typical)	
Power	Supply from 6334A Mainframe			Supply from 6334A Mainframe	
Dimension (H×W×D)	172×82×489.5mm / 6.77×3.23×19.27inch			172×164.2×489.5mm / 6.77×6.46×19.27inch	
Weight (Approx.)	4.5kg/9.91 lbs			7.3kg/16.08 lbs	
Operating Range	0~40°C			0~40°C	
EMC & SAFETY	CE			CE	

MODEL	**63308A**		**63312A**	
POWER	60W	600W	120W	1200W
CURRENT	0~2A	0~20A	0~24A	0~240A
VOLTAGE	0~500V		0~80V	
MIN. OPERATING VOLTAGE (DC)[*1]	1V@1A	1V@10A	0.4V@12A	0.4V@120A
	2V@2A	2V@20A	0.8V@24A	0.8V@240A
CONSTANT CURRENT MODE Range	0~2A	0~20A	0~24A	0~240A
Resolution	0.5mA	5mA	6mA	60mA
Accuracy	0.1%+0.1%F.S.	0.1%+0.2%F.S.	0.1%+0.1%F.S.	0.1%+0.2%F.S.
CONSTANT RESISTANCE MODE Range	0.625Ω~2.5kΩ (600W/125V) 25Ω~100kΩ (600W/500V)		6.25mΩ~25Ω (1200W/16V) 0.3125Ω~1.25kΩ (1200W/80V)	
Resolution	400μS (600W/125V) 10μS (600W/500V)		40mS (1200W/16V) 800μS (1200W/80V)	
Accuracy	2.5kΩ : 50mS +0.2% 100kΩ : 5mS +0.1%		25Ω : 0.8S +0.8% 1.25kΩ : 0.08S +0.2%	
CONSTANT VOLTAGE MODE Range	0~500V		0~80V	
Resolution	125mV		20mV	
Accuracy	0.05%±0.1%F.S.		0.05%±0.1%F.S.	
CONSTANT POWER MODE Range[*13]	0 ~ 60W	0 ~ 600W	0 ~ 120W	0 ~ 1200W
Resolution	15mW	150mW	30mW	300mW
Accuracy	0.5%±0.5%F.S.		0.5%±0.5%F.S.	
DYNAMIC MODE				
DYNAMIC MODE	C.C. MODE		C.C. MODE	
T1 & T2	0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms		0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms	
Accuracy	1μs /1ms+100ppm		1μs /1ms+100ppm	
Slew Rate	0.32~80mA/μs	3.2~800mA/μs	0.004~1A/μs	0.04~10A/μs
Resolution	0.32mA/μs	3.2mA/μs	0.004A/μs	0.04A/μs
Accuracy[*9]	10%±20μs		10%±20μs	
Minimum Rise Time	24μs(Typical)		10μs(Typical)	
Current	0~2A	0~20A	0~24A	0~240A
Resolution	0.5mA	5mA	6mA	60mA
Accuracy	0.4% F.S.		0.4% F.S.	
Minimum Transient Voltage	2V	2V	5V	5V
MEASUREMENT SECTION				
VOLTAGE READ BACK				
Range	0~125V	0~500V	0~16V	0~80V
Resolution	2mV	8mV	0.25mV	1.25mV
Accuracy	0.025%+0.025% F.S.		0.025%+0.025% F.S.	
CURRENT READ BACK				
Range	0~2A	0~20A	0~24A	0~240A
Resolution	0.03125mA	0.3125mA	0.375mA	3.75mA
Accuracy	0.05%+0.05% F.S.		0.075%+0.075% F.S.	
POWER READ BACK				
Range	0 ~ 60W	0 ~ 600W	0 ~ 120W	0 ~ 1200W
Accuracy[*2]	0.1%+0.1% F.S		0.1%+0.1% F.S	
PROTECTIVE SECTION				
Over Power Protection	YES		YES	
Over Current Protection	YES		YES	
Over Temperature Protection	YES		YES	
Over Voltage Alarm[*3]	YES		YES	

GENERAL				
SHORT CIRCUIT				
Current (CC)	–	YES	–	YES
Voltage (CV)	–	YES	–	YES
Resistance (CR)	–	YES	–	YES
Power (CP)	–	YES	–	YES
INPUT RESISTANCE (LOAD OFF)	R≧100kΩ (Typical)		R≧100kΩ (Typical)	
Temperature Coefficient	100ppm/°C (Typical)		100ppm/°C (Typical)	
Power	Supply from 6334A Mainframe		Supply from 6334A Mainframe	
Dimension(H×W×D)	172×164.2×489.5mm / 6.77×6.46×19.27inch		172×328.6×495mm / 6.77×12.94×19.49inch	
Weight (Approx.)	7.3kg/16.08 lbs		14kg/30.84 lbs	
Operating Range	0~40°C		0~40°C	
EMC & SAFETY	CE		CE	

MODEL	**63323A**	
POWER	350W	
CURRENT	0~7A	0~70A
VOLTAGE	0~120V	
MIN. OPERATING VOLTAGE (DC)	0.05V@3.5A	0.3V@35A
	0.1V@7A	0.6V@70A
CONSTANT CURRENT MODE Range	0~7A	0~70A
Resolution	0.125mA	1.25mA
Accuracy	0.04%+0.04%F.S.	0.04%+0.04%F.S.
CONSTANT RESISTANCE MODE Range	CRL @ CH: 0.015Ω~15Ω (350W/24V) CRL @ CL: 0.15Ω~150Ω (350W/80V) CRH @ CH: 2Ω~2kΩ (112W/16V) CRH @ CL: 11.5Ω~11.5kΩ (350W/80V)	
Resolution	CRL @ CH: 1.33mS CRL @ CL: 0.13mS CRH @ CH: 10uS CRH @ CL: 1.74μS	
Accuracy[*12]	CRL @ CH: 0.1%+0.667S CRL @ CL: 0.1%+66.7mS CRH @ CH: 0.2%+5mS CRH @ CL: 0.2%+0.87mS	
CONSTANT VOLTAGE MODE Range	0~120V	
Resolution	2mV	
Accuracy	0.05%±0.1%F.S.	
CONSTANT POWER MODE Range[*13]	0 ~ 35W	0 ~ 350W
Resolution	2.5mW	25mW
Accuracy	0.5%±0.5%F.S.	
DYNAMIC MODE		
DYNAMIC MODE	C.C. MODE	
T1 & T2	0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms	
Accuracy	1μs /1ms+100ppm	
Slew Rate[*7]	0.1~25mA/μs 1m~250mA/μs	1m~250mA/μs 10m~2.5A/μs
Resolution[*8]	0.1mA/μs 1mA/μs	1mA/μs 10mA/μs
Accuracy[*9]	10%±20μs	
Minimum Rise Time	25μs(Typical) @ > 0.35A	
Current	0~7A	0~70A
Resolution	0.125mA	1.25mA
Current Accuracy	0.1% F.S.	
Minimum Transient Voltage	1.5V	1.5V
MEASUREMENT SECTION		
VOLTAGE READ BACK		
Range	0~24V	0~120V
Resolution	0.4mV	2mV
Accuracy	0.025%+0.015% F.S.	
CURRENT READ BACK		
Range	0~7A	0~70A
Resolution	0.125mA	1.25mA
Accuracy	0.04%+0.04% F.S.	

POWER READ BACK		
Range	0~35W	0~350W
Accuracy[*2]	0.1%+0.1% F.S	
PROTECTIVE SECTION		
Over Power Protection	YES	
Over Current Protection	YES	
Over Temperature Protection	YES	
Over Voltage Alarm[*3]	YES	
GENERAL		
SHORT CIRCUIT		
Current (CC)	–	YES
Voltage (CV)	–	YES
Resistance (CR)	–	YES
Power (CP)	–	YES
INPUT RESISTANCE (LOAD OFF)	R≧800kΩ (Typical)	
Temperature Coefficient	100ppm/°C (Typical)	
Power	Supply from 6334A Mainframe	
Dimension(H×W×D)	172×82×489.5mm / 6.77×3.23×19.27inch	
Weight (Approx.)	4.5kg/9.91 lbs	
Operating Range	0~40°C	
EMC & SAFETY	CE	

MODEL[*6]	**63310A (100W[*2])**	
POWER	100W	
CURRENT	0~0.6A	0~2A
VOLTAGE	0~500V	
MIN. OPERATING VOLTAGE (DC)[*1][*4]	0.9V@0.6A	3V@1A
	1.8V@0.6A	6V@2A
CONSTANT CURRENT MODE		
Range	0~0.6A	0~2A
Resolution	12μA	40μA
Accuracy	0.1%±0.1%F.S.	
CONSTANT RESISTANCE MODE		
Range	CRL: 3Ω~1kΩ (100W/100V) CRH: 10Ω~10kΩ (100W/500V)	
Resolution	0.0625mS/0.00625mS	
Accuracy[*5]	CRL : 0.004S+0.2% CRH : 0.001S+0.1%	
CONSTANT VOLTAGE MODE		
Range	0~500V	
Resolution	20mV	
Accuracy	0.05%±0.1%F.S.	
LED MODE		
Range	Operating Voltage : 0~100V/0~500V Current : 0~2A R_d Coefficient : 0.001~1 (Default: 0.15) R_d : 1Ω~1kΩ/10Ω~10kΩ V_F : 0~100V/0~500V	
Resolution	V_o : 4mV/ 20mV I_o : 0.04mA R_d Coefficient : 0.001 R_d : 0.0625mS/0.00625mS V_F : 4mV/ 20mV	
RIPPLE DYNAMIC RESISTANCE		
RIPPLE DYNAMIC RESISTANCE Range	5Ω~125Ω	
Resolution	0.5Ω	
Accuracy	5%+1%F.S.	
MEASUREMENT SECTION		
VOLTAGE READ BACK		
Range	0~100V	0~500V
Resolution	2mV	10mV
Accuracy	0.025%+0.025% F.S.	
CURRENT READ BACK		
Range	0~0.6A	0~2A
Resolution	12μA	40μA
Accuracy	0.05%+0.05% F.S.	
PROTECTIVE SECTION		
Over Power Protection	YES	
Over Current Protection	YES	
Over Temperature Protection	YES	
Over Voltage Alarm[*3]	YES	

GENERAL	
SHORT CIRCUIT Resistance	< 1Ω
Response Speed	5 sections
INPUT RESISTANCE (LOAD OFF)	R≧700kΩ (Typical)
Temperature Coefficient	100PPM/◦C (Typical)
Dimension(H×W×D)	172×82×489.5mm / 6.77×3.23×19.27inch
Weight (Approx.)	4.2kg
Operating Range	0 ~ 40◦C
EMC & SAFETY	CE

MODEL	**63313A**	
POWER	300W	
CURRENT	0~5A	0~20A
VOLTAGE	0~300V	
MIN. OPERATING VOLTAGE (DC)[*1]	0.5V@2.5A	2V@10A
	1V@5A	4V@20A
CONSTANT CURRENT MODE Range	0~5A	0~20A
Resolution	100μA	400μA
Accuracy	0.1%±0.1%F.S.	0.1%±0.2%F.S.
CONSTANT RESISTANCE MODE Range	CRL @ CH: 0.2Ω~200Ω (300W/60V) CRL @ CL: 0.8Ω~800Ω (300W/60V) CRH @ CL: 4Ω~4kΩ (300W/300V)	
Resolution	CRL @ CH: 100μS CRL @ CL: 25μS CRH @ CL: 5μS	
Accuracy*[10]	CRL @ CH : 10mS+0.2% CRL @ CL : 2.5mS+0.2% CRH @ CL : 0.5mS+0.2%	
CONSTANT VOLTAGE MODE Range	0~300V	
Resolution	6mV	
Accuracy	0.05%±0.1%F.S.	
LED MODE Range	Operating Voltage : 0~60V / 0~300V R_d Coefficient : 0.001~1 (Default: 0.15) V_F : 0~60V/0~300V LEDL@CH : 0~60V / 0~20A (R_d : 0.05Ω~50Ω) LEDL@CL : 0~60V / 0~5A (R_d : 0.8Ω~800Ω) LEDH@CL : 0~300V / 0~5A (R_d : 4Ω~4kΩ)	
Resolution	V_o : 1.2mV / 6mV I_o : 100μA / 400μA R_d Coefficient : 0.001 R_d : 400μS / 25μS / 5μS V_F : 6mV / 30mV	
DYNAMIC MODE		
DYNAMIC MODE	CC Mode	
T1 & T2	0.025ms ~ 50ms / Res: 5μs 0.1ms ~ 500ms / Res: 25μs 10ms ~ 50s / Res: 2.5ms	
Accuracy	1μs /1ms+100ppm	
Slew Rate	0.8~200mA/μs	3.2~800mA/μs
Resolution	0.8mA/μs	3.2mA/μs
Accuracy*[9]	10%±20μs	
Minimum Rise Time	25us(Typical)	
Current	0~5A	0~20A
Resolution	100μA	400μA
Accuracy	0.4% F.S.	
Transient Min. Voltage	1V	4V
MEASUREMENT SECTION		
VOLTAGE READ BACK		
Range	0~60V	0~300V
Resolution	1.2mV	6mV
Accuracy	0.025%+0.025% F.S.	

CURRENT READ BACK		
Range	0~5A	0~20A
Resolution	100μA	400μA
Accuracy	0.05%+0.05% F.S.	
PROTECTIVE SECTION		
Over Power Protection	YES	
Over Current Protection	YES	
Over Temperature Protection	YES	
Over Voltage Alarm*3	YES	
GENERAL		
SHORT CIRCUIT		
Current (CC)	–	YES
Voltage (CV)	–	YES
Resistance (CR)	–	YES
Power (CP)	–	YES
RESPONSE Level	5 Sec.	
INPUT RESISTANCE (LOAD OFF)	R≧800kΩ(Typical)	
Temperature Coefficient	100PPM/°C (Typical)	
Dimension(H×W×D)	172×82×489.5mm / 6.77×3.23×19.27inch	
Weight (Approx.)	4.2kg	
Operating Temperature Range	0 ~ 40°C	
EMC & SAFETY	CE	

* Before using CCL mode on model 63305A & 63308A, it needs to set **CC Vrange Select** in Configuration to "2. LOW" for access permission.

Note

***1:** For 80V models, the operating voltage of load modules 63301A, 63302A, 63303A, 63306A, 63307A, 63312A is 0.8 volt or above and of 63323A is 0.6 volt. For 500V models, the operating voltage for 63305A, and 63308A load modules is 2 volt or above; while 6 volt or above for the 63310A load module. For 300V model, the operating voltage of 63313A is 4 volt or above. The operating temperature range is 0ºC to 40ºC. All specifications apply for 25ºC±5ºC, except as noted.

***2:** Power F.S. = V_{range} F.S. × I_{range} F.S.

***3:** When the operating voltage exceeds the rated voltage for 1.1 times, it would cause permanent damage to the device. For instance, the rated voltage of 63303A is 80V, the device would be damaged if the input voltage exceeds 88V.

***4:** 6V@2A 100V voltage range
8V@2A 500V voltage range

***5:** CRH @Viin<2% F.S. : 0.01S/Vin+0.5%

***6:** The module 63310A does not have program function.

***7:** Each of the high and low range has two levels for the slew rate setting. The 1st level of low range is 0.1~25mA/μs and the 2nd level is 1m~250mA/μs. The 1st level of high range is 1m~250mA/μs and the 2nd level is 10m~2.5A/μs.

***8:** The resolution is different by level. The 1st level of low range is 0.1mA/μs and the 2nd level is 1m/μs. The 1st level of high range is 1mA/μs and the 2nd level is 10m/μs.

***9:** It is the slew rate accuracy specification for dynamic load simulation that the minimum loading current needs to be larger than 1% of full current.

***10:** CRL at CH:
When loading current > 10% of F.S. current, 0.2% (setting+range)
When loading current < 10% of F.S. current, the loading error is 0.2%×Vin/Rsetting±8mA
CRL at CL:
When loading current > 20% of F.S. current, 0.2% (setting+range)
When loading current < 20% of F.S. current, the loading error is 0.2%×Vin/Rsetting±4mA
CRH at CL:
When loading current > 20% of F.S. current, 0.2% (setting+range)
When loading current < 20% of F.S. current, the loading error is 0.2%×Vin/Rsetting±4mA

***11:**CCL
When the loading current is <70mA：0.04%+0.12% F.S.

***12:** CRL at CH:
When the loading current is >10% F.S. current, 0.1%+0.667S
When the loading current is <10% F.S. current, 0.1%+0.667S +70mA/Vin
CRL at CL:
When the loading current is >10% F.S. current, 0.1%+66.7mS
When the loading current is <10% F.S. current, 0.1%+66.7mS +7mA/Vin
CRH at CH:
When the loading current is >10% F.S. current, 0.2%+5mS
When the loading current is <10% F.S. current, 0.2%+5mS +70mA/Vin
CRH at CL:
When the loading current is >10% F.S. current, 0.2%+0.87mS
When the loading current is <10% F.S. current, 0.2%+0.87mS +7mA/Vin

***13:** In CP mode, the 80V models: the minimum operating voltage is 0.2 volt or above for 63301A, 63302A, 63303A, 63306A, 63307A and 63312A load modules. For 120V models: the minimum operating voltage is 0.32 volt or above for 63323A load module. For 500V models: the minimum operating voltage is 1.2 volt or above for 63305A and 63308A load modules.

Mainframe MODEL	**6332A**	**6334A**
Dimension(H×W×D)	193.7×274.8×550mm / 7.63×10.82×21.65inch	193.7×439×550mm / 7.63×17.28×21.65inch
Weight (Approx.)	15kg/33.04 lbs	21.5kg/47.36 lbs

2. Installation

2.1 Introduction

This chapter describes how to install the Load module into the Mainframe and make connections to the Loads. It also discusses the turn-on check out procedure and application considerations.

2.2 Inspection

As soon as the device is unpacked, inspect any damage that might have occurred during shipment. Keep all packing materials in case the Load or the Mainframe has to be returned. If any damage is found, please file a claim with the carrier immediately. Do not return the instrument to Chroma without prior approval.

Please ensure that the following items are received along with the Mainframe and Load.

6330A Series Standard Accessories:

Power cord – U.S. Standard
W39 000002

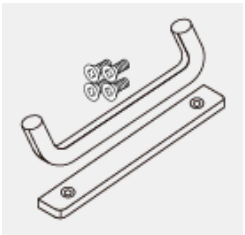
6332A/6334A e-Manual CD
F30 000017

Quick Start Guide
A11 001308

Measurement Cable
W32 831003

Load Cable
W39 000038

M3x12L Screw
H61 301251



63112 Handlebar
G28 003500

Load Frame: 6332A, 6334A Standard Accessory

Item	Qty	Remark
6332A/6334A E-file CD	1	Chinese/English
Quick Start Guide	1	Chinese/English
US Standard Power Cord	1	Length 1.8 meter

Load Module: 63301A, 63303A, 63305A, 63313A, 63323A Standard Accessory

Item	Qty	Remark
Measurement Cable	1	Red and black in a set
Load Cable	2	Length 75 cm
M3x12L Screw	2	Round black zinc plated -Nylok

Load Module: 63302A, 63307A, 63310A Standard Accessory

Item	Qty	Remark
Measurement Cable	2	Red and black in a set
Load Cable	2	Length 75 cm
M3x12L Screw	2	Round black zinc plated -Nylok

Load Module: 63306A, 63308A Standard Accessory

Item	Qty	Remark
Measurement Cable	1	Red and black in a set
Load Cable	6	Length 75 cm
M3x12L Screw	2	Round black zinc plated -Nylok

Load Module: 63312A Standard Accessory

Item	Qty	Remark
Measurement Cable	1	Red and black in a set
Load Cable	2	Length 80 cm
M3x12L Screw	2	Round black zinc plated -Nylok
63112 Handlebar Assembly Kit	1	

2.3 Installing the Modules

CAUTION The load module can be damaged by electronic discharge (static electricity). Use standard anti-static work practices when handling and installing the modules. Avoid touching the connectors and the circuit board.

The Chroma 6334A Mainframe has room for four single-width Loads (Ex: 63302A, 63303A), or two double-width Loads (Ex: 63306A). The Loads can be combined in the Mainframe in any order. The Chroma 6332A mainframe has room for only two single-width Loads or one double-width Load. The procedures for the module installation in both Mainframes are the same. Only a screwdriver is required to install the Load to the Mainframe. The LED simulation load 63310A can only be placed in the frame of 6332A and 6334A for use. The frame of 6332 and 6334 is invalid. The LED mode only appears when the 6332A and 6334A frame detects the LED simulation load.

Notice 6330A Series load module can be installed in the frame of 6330 Series; however, the operation modes and functions are limited to 6330 Series. The frame of 6330 Series does not support new module 63310A, 63313A and 63323A of 6330A Series. The 6330 Series module is unable to use the frame of 6334A & 6332A.

Notice If the firmware version of the mainframe (6312A/6314A, 6332A/6334A) is old, it may not able to support the new modules such as 63110A/ 63310A, 63113A/63313A, 63123A/63323A (80V already phased out) and 63123A/63323A (120V). Please contact the technical personnel listed on Chroma's web page below under the global sales and service locations for the latest firmware upgrade.

http://www.chromaate.com/english/contact/default.asp

Be sure to check the firmware version in use currently before contacting the technical personnel. The table below lists the firmware version of the mainframe for the supported new modules.

Mainframe Firmware Version	Supported Module
Version 1.25 or later	63110A
Version 1.00 or later	63310A
Version 2.31 or later	63113A/63313A
Version 2.00 or later	63123A/63323A (80V already phased out)
Version 3.00 or later	63123A/63323A (120V)

Procedures:

1. Disconnect the power cord with the Mainframe power off.
2. Remove any packing materials from the Mainframe.
3. Start installing the modules in the slot (see Figure 2-1).
4. Insert the load module into the slot of the Mainframe along the rail.
5. Lock the module in place with a screwdriver (see Figure 2-1).
6. Install each additional module in the slot next to the previous one, likewise if applicable.

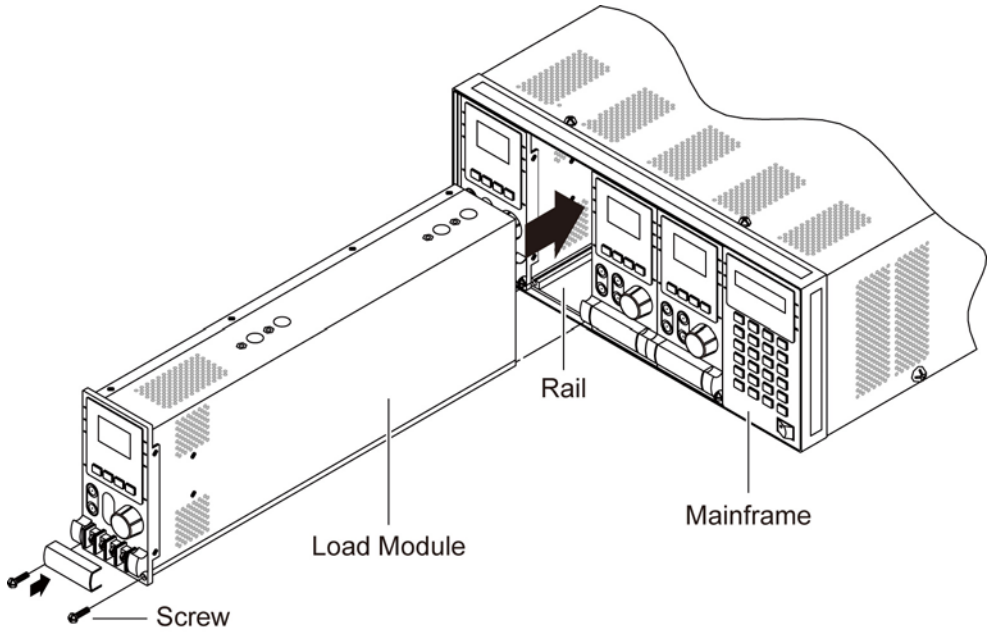


Figure 2-1 Installing Modules in the Electronic Load

⚠WARNING If the Mainframe is not installed with all modules, the empty one must be covered with the panel cover (Chroma part No: L00 002255) for safety and airflow.

2.3.1 Channel Number

The channel number of a specific Load is determined by the location of that module in relation to the leftmost position in the Mainframe. As some Loads (63302A) have two channels in one module, channel 1 and 2 are always on the leftmost slot of the Mainframe,

and channel 7 and 8 on the rightmost. The channel number is fixed for the Mainframe even if the Load module is empty. Figure 2-2 shows the channel assignments for a Chroma 6334A Mainframe containing two Loads, 63303A single channel/module, and two Loads 63302A double channel/module. Channel number is automatically assigned to each channel: 1, 3, 5, 6, 7, 8. In this example channels 2 and 4 are not used because they are reserved for multiple channel modules and a single channel module is in that slot. The 6332A Mainframe has only four channels (1, 2, 3, 4).

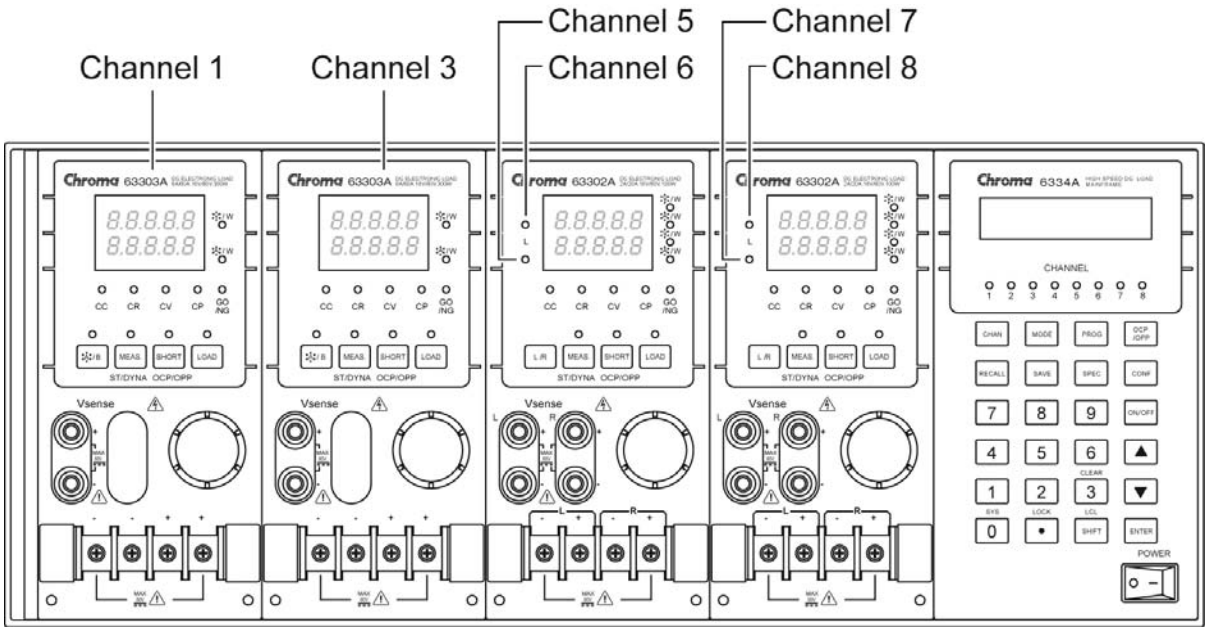


Figure 2-2 Channel Number Example

2.4 Installing the Mainframe

The electronic load can operate well within the temperature range of 0 to 40 degree C. However, the electronic load must be installed in a location that has enough space at the top, around the sides, and the rear of the unit for adequate air flow. At least 15 cm (5 inch) space above the unit is required for adequate air circulation. Note that the unit must have enough vertical space for air circulation when it is stacked. The feet of the Mainframe can be removed for rack mounting.

If equipment is installed on top of the electronic load in a cabinet, the user must install a filter panel above the unit to ensure adequate air circulation. A 1U (EIA standard) panel is sufficient.

2.4.1 Changing Line Voltage

The electronic load can operate with a 115/230 Vac input as indicated on the rear LINE label. The 100/200 line voltage input model is used only in Japan. If the factory set switch on this label does not correspond to the local nominal line voltage, turn off the Mainframe power and disconnect the power cord. Set switch to the correct line voltage as shown in Figure 2-3.

Notice Line fuses do not need to be changed when the line voltage is changed. The line fuses will protect the electronic load voltage input settings.

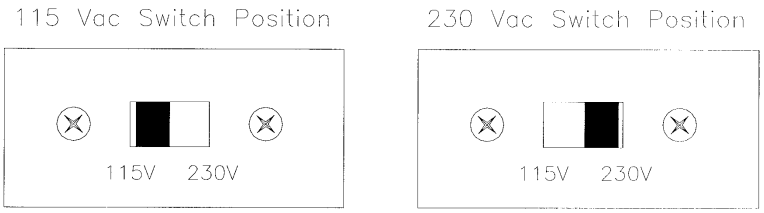


Figure 2-3 Line Voltage Switch

2.4.2 Turn-On Self-Test

Check the following things before turning on the Load.

1. The unit has been set to the correct line voltage. Refer to the line voltage on the rear panel.
2. The power cord is connected to the AC input socket.

⚠WARNING The power provides a chassis ground through a third connector. Be sure that the outlet is a three-conductor type with the correct pin connected to earth ground.

Turn on the Load's power switch on the front panel of the Mainframe and observe the display. Immediately after turning on, the electronic load executes a self-test, which checks the GPIB interface board and the input circuitry of the installed modules. All of the LED segments on the front panel are momentarily activated. The Mainframe displays

GPIB ADDRESS 1

and then

LOAD MODULE CHANNEL SCANing

The LCD displays the GPIB address for power-on condition. The GPIB address switch is on the rear panel if the GPIB card is installed. If the GPIB card is not installed, the LCD will show `LOAD MODULE CHANNEL SCANing` and checks the existing channels. The LED

segments on the front panel are momentarily activated. If the Mainframe fails any portion of the self-test, the LED will blink and the LCD will have no display. When the self-test completes, the Mainframe will display the active channel.

The Load module also executes a self-test that checks firmware and communicates with the Mainframe. All of the LEDs on the front panel are momentarily activated, and the 7-segment LED displays the model number as well as the firmware version. If any error is found in self-test, the display will stop here. Check the Load and Mainframe connections if an error occurs. When the self-test completes, the 7-segment will display V & I measurements. The double channel/module goes to the L channel.

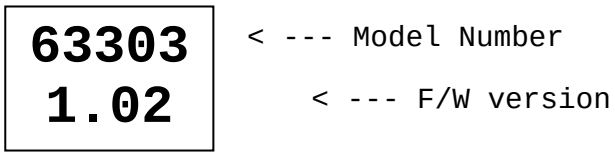


Figure 2-4 Module Panel Self-test Display

In case of failure, return the Mainframe or Load module to Chroma sales or service office for repair services.

2.5 Application Connection

2.5.1 Load Connections

⚠WARNING To meet the safety requirements, load wires must be thick enough not to overheat while carrying the short-circuit output current of the device connected to the electronic load.

Before connecting the load wires to the Load module, remove the terminal cover from the Load. Re-install the cover after the load wires are connected. Input connections are made to the + and – terminal block on the front of each Load module. The major considerations in making the input connections are the wire size, length and polarity. The minimum wire size required to prevent the overheating may not be enough to maintain good regulation, so ensure that the wires are thick enough to limit the voltage drop to no more than 0.5V per lead. The wires should be as short as possible and bundled or tied together to minimize inductance and noise picked up by them. Connect the wire from the PLUS (+) terminal on the module to the HIGH potential output terminal of the power supply (UUT). Connect the wire from the MINUS (–) terminal on the module to the LOW potential output terminal of the power supply (UUT). Figure 2-5 illustrates the typical setup for the Load module to the UUT.

⚠WARNING To prevent accidental contact with hazardous voltage, the terminal cover must be installed correctly. Each terminal can carry 40 Amps at most. If the input current of Load is over 40 Amps, multiple terminals for connection should be used. To avoid the surge current damaging the load module due to sudden collision, the UUT needs to be uninstalled when connecting the terminal.

Recommended safety precautions:

Ensure wiring, external circuit elements, etc are sized to the maximum rating of the LOAD even if intended UUTs are smaller. This provides protection in the event that users inadvertently apply full rated voltage, current or power or larger UUTs are tested in the future.

User should take into account the power dissipated in the output cable under worse case conditions to ensure the wire the gauge and cooling is adequate.

Ensure the load always receives adequate ambient cooling air at all times and air filters, ducks, etc are maintained regularly. If loads are used with a cabinet, precautions should be taken to minimize heating within the cabinet.

If the UUT may be damaged or an unsafe condition may occur in the event of a load short circuit (e.g. certain types of batteries), or if there is no means of de-energizing the UUT in the event of a load failure, user may consider including a suitably rated circuit breaker, fuse or other means of disconnecting the load from the UUT under emergency conditions.

* If there are any questions regarding safe operation of the equipment or adding external protection circuits, please contact Chroma's service personnel.

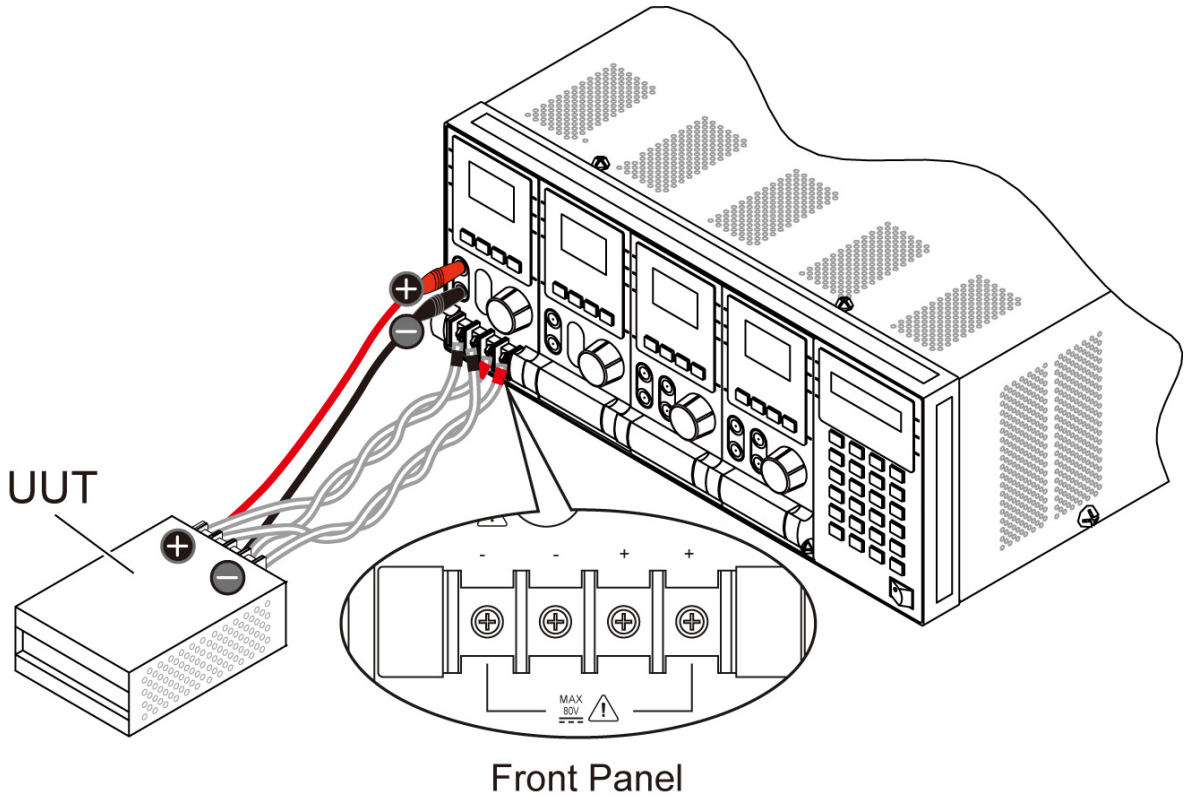


Figure 2-5 Load & Remote Sensing Connection

⚠WARNING When connecting the load cable to the load module, do not use a load cable to connect a load module and short circuit other load modules, or it may cause the load cable to burn out when loading larger current.

2.5.2 Remote Sensing Connections

There are two sensing points on the electronic load module. One is the measurement at Load, terminal, and the other is the measurement at Vsense. The Load module will automatically switch to Vsense when the Vsense terminals are connected to the UUT, otherwise it will measure at the Load terminals. Remote sensing compensates for voltage drops in applications that require long lead lengths. It is useful when a module is operating in CV, CR or CP mode, or when it needs precise measurement. Figure 2-5 also illustrates a typical setup for remote sensing operation.

Notice The potential of Vsense red connector must be higher than that of Vsense black connector.

2.5.3 Parallel Connections

Figure 2-6 illustrates how modules can be paralleled for increased power dissipation. Modules can be directly paralleled in CC, CR, CP and LED modes for static operation, but cannot be paralleled in CV mode. Each module will dissipate the power that has been programmed. For example, if two modules are connected in parallel, one is programmed to 10A, and another is 15A, the total current drawn from the source is 25A.

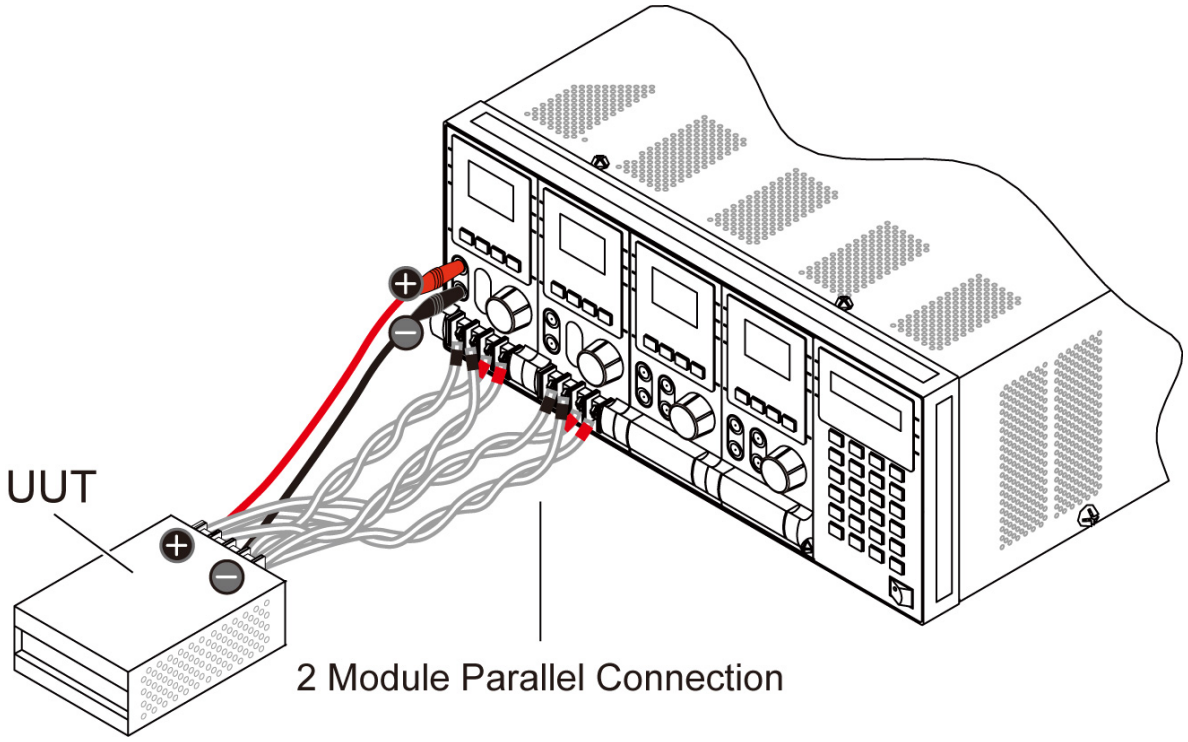


Figure 2-6 Parallel Connection

2.6 Remote Control Connection

The remote operation of the Load can be accomplished through GPIB, USB or RS-232C. The interface connectors on the rear panel connect the Load to the controller or a computer. The GPIB or USB interface of the electronic load is optional. The 6330A Series Remote

Controller can control the load through RS-232C port standard. Connect the Remote Controller to the electronic load before powering on. If this is not done, the Load will shut down, or the fuse for the remote controller in the Mainframe will be broken.

3. Operation Overview

3.1 Introduction

The Chroma 6334A and 6332A multiple electronic load mainframes are used for design, manufacturing, testing and quality assurance. The Mainframe contains four (6334A) or two (6332A) slots for load modules. Load modules occupy either one or two slots depending on the power rating of the module. The Mainframe can dissipate up to 1200 watts when it is full loaded. It contains a processor, GPIB or USB and RS-232C connectors, front panel keypad and display, and PASS/FAIL signals. Built-in remote control function allows you to control and read back current, voltage and status. The SYNC function of the Mainframe synchronizes each module when module current/voltage level changes. Save/Recall feature allows you to save up to 100 files, 10 OCP files, 10 OPP files, 10 programs, and one default setting. All of them can be saved in Mainframe EEPROM for future use.

The Mainframe contains three (6334A) or one (6332A) cooling fans, and the module consists of one cooling fan. The fan speed automatically increases or decreases when the module's power dissipation rises or falls. This feature reduces overall noise level because the fans do not always run at the maximum speed.

Each module can operate independently in constant current (CC), constant resistance (CR), constant voltage (CV), and constant power (CP) modes. An individual module may have one or two channels. Each of them has its own channel number, contains its own input connectors, and can be turned on/off or short-circuited independently. If your application requires a greater power or current capacity than one module can provide, you can connect the load modules in parallel in CC, CR or CP mode.

Each load module can be independently controlled either remotely via GPIB/USB/RS-232C or locally via the front panel. Once a channel is selected or addressed, all subsequent commands go to that channel until another channel is selected or addressed. Operation of all modules in the Mainframe is similar regardless of power ratings. The module has a keypad to control itself independently also.

3.2 Front Panel Description

The front panel of the mainframe includes a 16 × 2 character LCD display, 8 (4) channel indicators, and a keypad. All parameters of the load are set through mainframe. The LCD display also shows which function is being performed when you use the keypad. Three of the keys perform two functions. The alternative function is labeled in blue above the key. It is selected by pressing the blue **SHIFT** key and the function key simultaneously. Figure 3-1 shows the front panel of the mainframe 6332A.

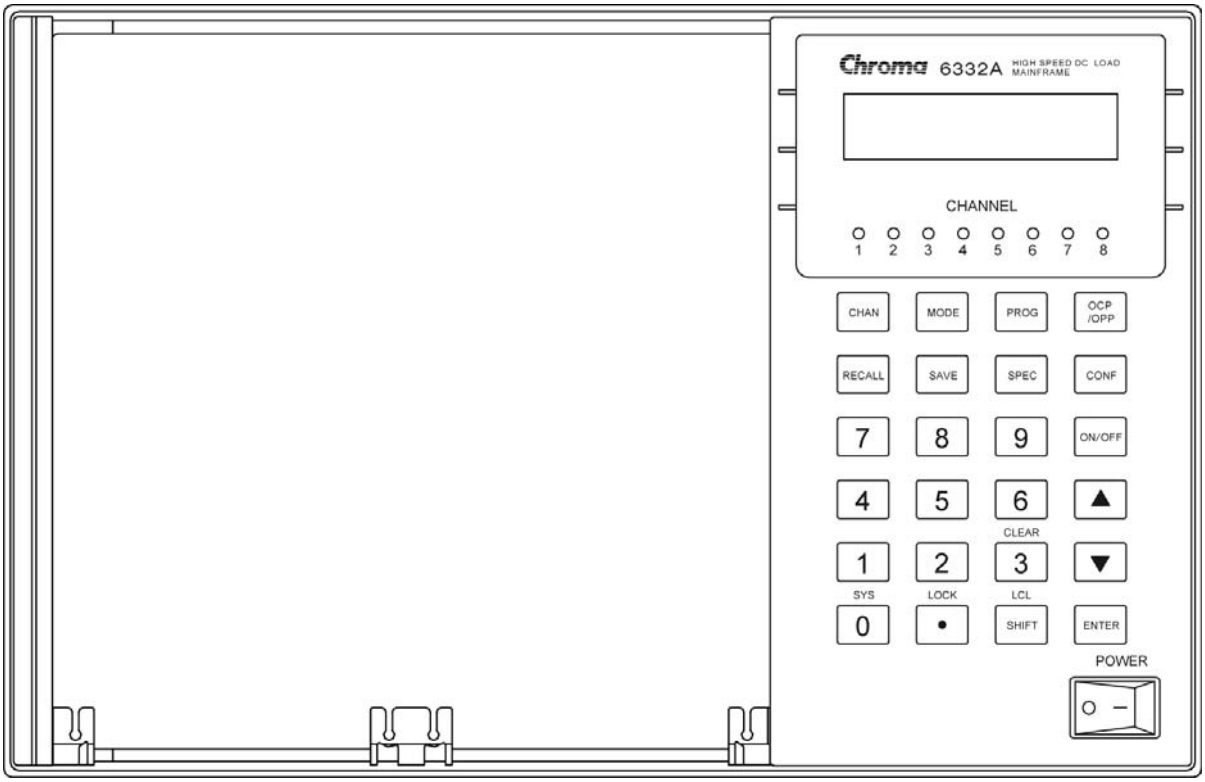


Figure 3-1 Front Panel of the Mainframe 6332A

3.3 Rear Panel Description

The rear panel of the mainframe includes an RS-232C connector, a GO/NG output port, a DIGTAL I/O port, an AC LINE socket, a fuse holder, an optional GPIB or USB connector, and three cooling fans. Figure 3-2 shows the rear panel of the mainframe 6334A.

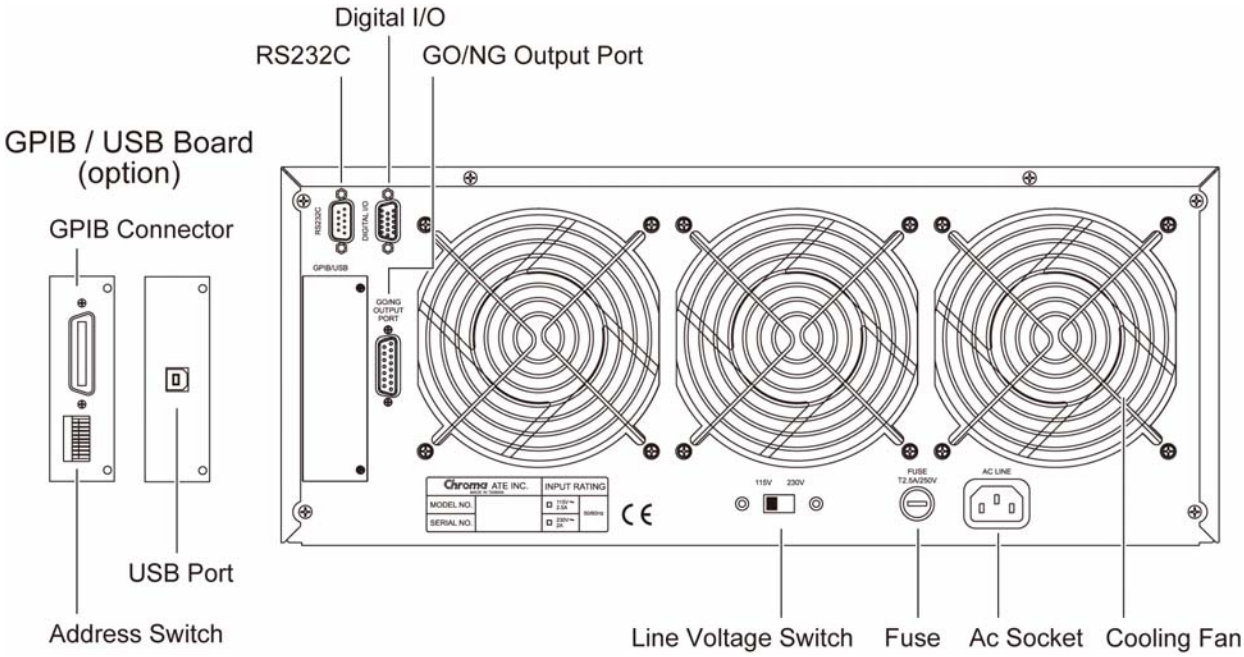


Figure 3-2 Rear Panel of the Mainframe 6334A

3.4 Local/Remote Control

Local (front panel) control is in effect immediately after the power is applied. The front panel keypad and display allow manual control of individual modules when the load is used in bench test applications. Remote control goes into effect as soon as the mainframe receives a command via GPIB or USB or RS-232C. With remote control in effect, only the computer can control the load. The front panel keypad has no effect with the exception of the **LCL** key. You can return the load to local control from remote control by pressing the **LCL** key. The **SHIFT** key acts as the **LCL** when the load is in the remote state.

Most of the functions can be controlled both remotely and locally. The keypads on the module can control basic functions like short, load on/off, static /dynamic, and load A/B or display selection R/L.

Details of local operation are given in *Chapter 4 Local Operation*. Fundamentals of remote programming are described in the second part of this manual, Chroma 6330A Programming Manual.

3.5 Modes of Operation

There are four modes of operation: Constant Current (CC), Constant Resistance (CR), Constant Voltage (CV), and Constant Power (CP).

When you press the **ENTER** key to program to a mode, the module will change to a new mode. When changing modes, the module's input is momentarily disabled before the new mode is enabled. This ensures that there will be minimum overshoots when changing modes. It is easier to change the parameters of a given mode if that mode is presently selected.

All data set in CC/CR/CV/CP mode will be rescaled to fit the set resolution of current/voltage levels or slew rate. In local mode any value can be set to any module from the keypad. The mainframe automatically selects data, which are rescaled from the programmed value, truncates and checks high, low boundary before implementing. When programmed data are over the boundary, the mainframe will set the maximum or minimum level for the Load module. In remote mode the programmed value cannot be over boundary. An error will occur when data are over the maximum or under the minimum value.

3.5.1 Constant Current Mode

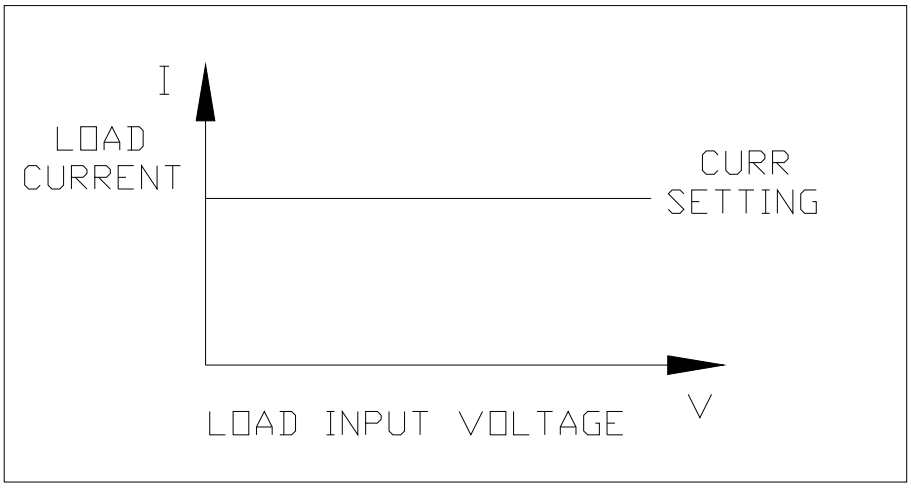


Figure 3-3 Constant Current Mode

In CC mode, the Load will sink a current in accordance with the programmed value regardless of input voltage. The CC mode can be set with the front panel key **MODE**. When `MODE SELECT` is displayed, the user must select static low range `CCL` or static high range `CCH`.

Current Ranges (Low, High)

Current can be programmed in one of the two ranges, low range and high range. The low range provides better resolution at low current settings. If any value is over the maximum of low range, you must select the high range. Press the **MODE** key first, and then use ▲or ▼ keys to select the current range.

MODE SELECT CCL	Select Static Constant Current low range
MODE SELECT CCH	Select Static Constant Current high range
MODE SELECT CCDL	Select Dynamic Constant Current low range
MODE SELECT CCDH	Select Dynamic Constant Current high range

Select range by pressing **ENTER** key.

The change of modes will affect the module, so will the change of range. Both cause the input to go through an off state. If the CC mode of the Load module is active, the new setting will immediately change the input at a rate determined by the slew rate setting.

STATic/DYNAmic Functions

In CC mode two operation functions (STATic, DYNAmic) may be selected. The STATic function checks the stability of the output voltage from a power supply. In some modules (single channel/module) there are two current levels (A or B) for the static function. Both states A and B use the same range. The user can select A (CCL1 or CCH1) or B (CCL2 or CCH2) through the **A/B** key on the module's keypad or the mainframe keypad when level1 (A) or level2 (B) changes. Slew rate determines the rate at which the load level changes from one level to the other. Figure 3-3 shows the current level of the load module after pressing of **A/B** key.

CCL1:4A, CCL2:2A, CCL↗: 0.2A/μs, CCL↘: 0.08A/μs

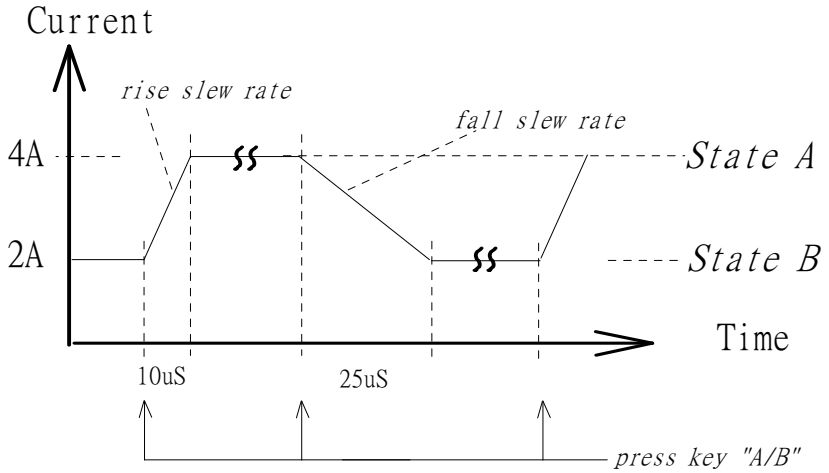


Figure 3-4 Load Level after Pressing A/B Key

Dynamic load operation enables you to program two load levels (CCDL1, CCDL2), load duration (CCDLT1, CCDLT2), and slew rate (CCDL↗, CCDL↘). During operation the load level is switched between those two load levels according to the user's specific settings. The dynamic load operation is commonly used in the testing of a UUT's performance under transient loading condition. Figure 3-4 shows the current waveform of the dynamic function.

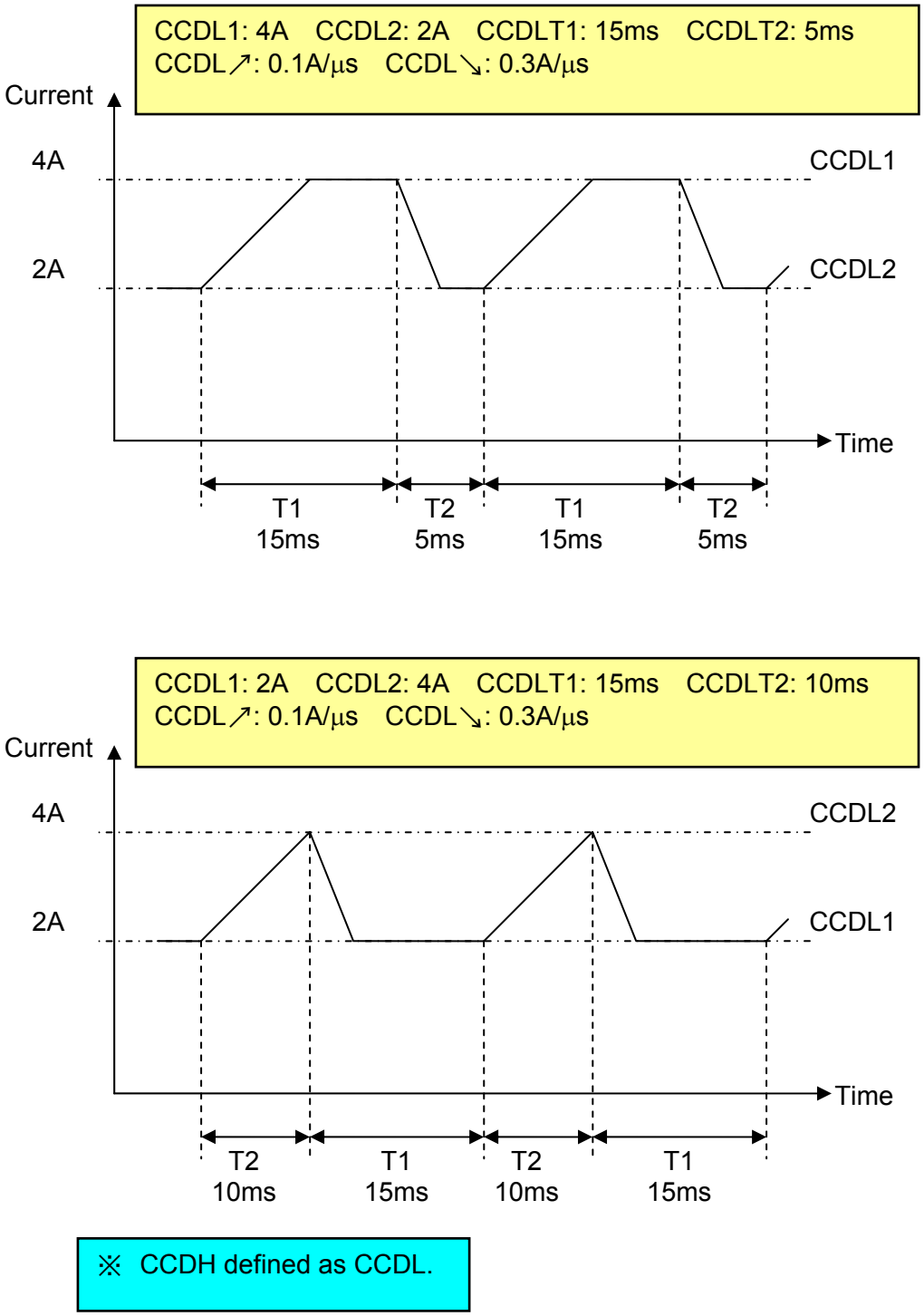


Figure 3-5 Dynamic Current Waveform

The STATic/DYNAmic functions can also be selected through the **MEAS.** key on the load module.

Slew Rate (Rise, Fall A/μs or mA/μs)

Slew rate determines the rate at which the current input of a module changes to a newly programmed value. There are two slew rate values. One is for rise rate, and another for fall rate.

Voltage Ranges (Low, High)

There are two voltage ranges for voltage measurement and Von voltage setting. The low range provides better resolution for low voltage measurements. If any value is over the maximum of low range, you must select the high range. The voltage range selection of the CC mode is in the configuration setting.

3.5.2 Constant Resistance Mode

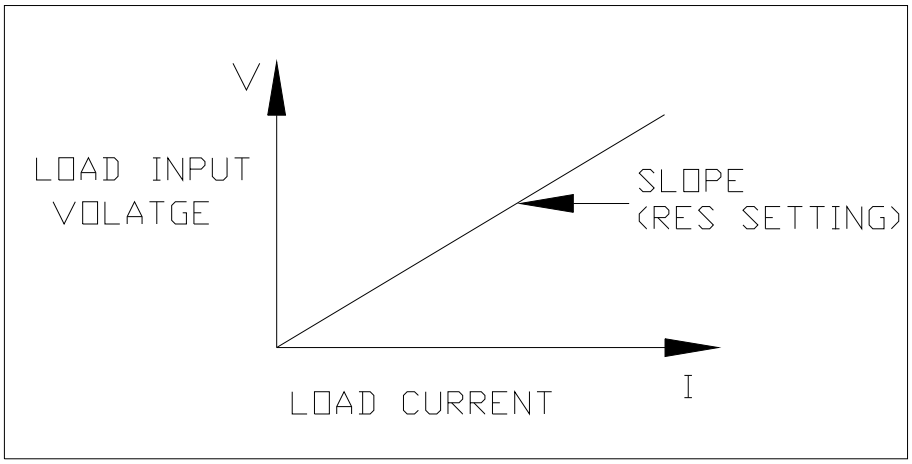


Figure 3-6 Constant Resistance Mode

In CR mode, the load will sink a current linearly proportional to the input voltage in accordance with the programmed resistance. When the input has high frequency noise voltage in the Load, the internal Active-filter will filter out the high frequency noise. The time constant of the low pass filter is about 47 μs. The load sink current in CR mode is proportional to the input voltage through a double pole RC filter. To prevent the load current change caused by the input voltage variation, the power source impedance should be as low as possible and the remote sensing cable must be used to sense the load input voltage when a high sink current (low setting resistance) is programmed.

Voltage Ranges (Low, High)

Resistance can be programmed in either of the two ranges, low range or high range. The low range is used for input voltages within the low voltage range parameters, while the high range is used for input voltages over low voltage range. The current range of CR mode is the high range.

MODE SELECT CRL	Select Constant Resistance low voltage range
MODE SELECT CRH	Select Constant Resistance high voltage range

Select the range by pressing the **ENTER** key.

If the input voltage is over the maximum of the low range, you must select the high range. Press the **MODE** key first, and then use ▲ or ▼ keys to select the voltage range. In some modules (single channel/module) there are two resistance levels (A or B) for the CR function. Both states A/B use the same range. You can select A (CRL1 or CRH1) or B (CRL2 or CRH2) through the **A/B** key on the module's keypad. Slew rate determines the rate at which load level changes from one load level state to another.

Slew Rate (Rise, Fall A/μs)

Slew rate in constant resistance mode is programmed in amps/second.

3.5.3 Constant Voltage Mode

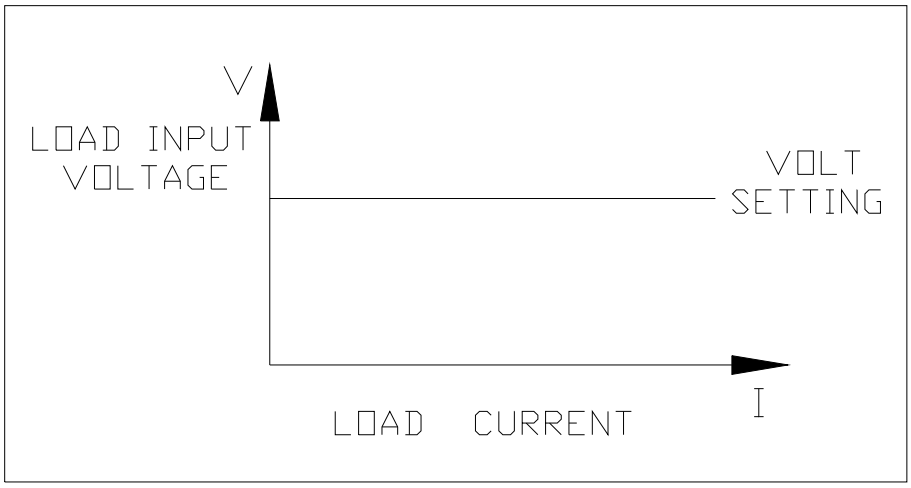


Figure 3-7 Constant Voltage Mode

In CV mode the load will sink current to control the voltage of the source to the programmed value. In some modules (single channel/module) there are two voltage levels (A or B) for the CV function. You can select A (CV1) or B (CV2) through the **A/B** key on the module's keypad. There are two response speeds of the CV mode, fast and slow. The fast/slow response speed means the slew rate of the current change.

Voltage & Current Range (High)

MODE SELECT CV	Select Constant Voltage high voltage range

Select the range by pressing the **ENTER** key.

The voltage and current range in the CV mode is the high range.

3.5.4 Constant Power Mode

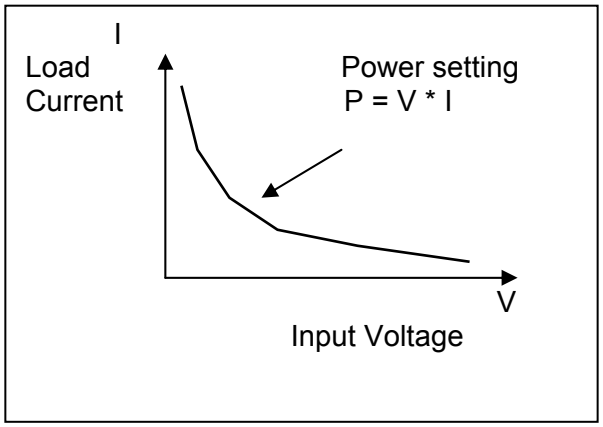


Figure 3-8 Constant Power Mode

In CP mode, the Load will sink a current according to the programmed power. This mode is operated under the F/W calculation. That is, take the measured V data, divide the Power setting, which results in the I set value. High frequency parts will be removed as there is a lower pass filter for measuring the data.

Power can be programmed in either the low range or the high range by the **RANGE** key. The low power range is operated under low current range mode while the high power range is under high current range mode.

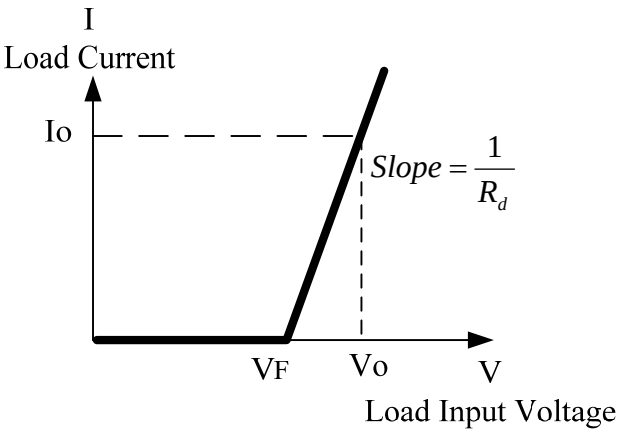
MODE SELECT CPL	Select Constant Power low voltage range
MODE SELECT CPH	Select Constant Power high voltage range

Select the range by pressing the **ENTER** key.

There are two power levels (A or B) for the CP function as in other modes. Both A and B states use the same range. You can select CPL1 or CPL2 using the **A/B** key. Slew rate determines the rate that the load level changes from one state to another.

The voltage RISE bandwidth has to be <200Hz to prevent the OPP from happening.

3.5.5 LED Mode



$$\begin{cases} if \quad V_O < V_F, I_O = 0 \\ if \quad V_O \geq V_F, I_O = \dfrac{V_O - V_F}{R_d} \end{cases}$$

In the LED mode, the load simulation is similar to the fragment based on the programmed LED working point to sink current by input voltage.

Press MODE to select LEDH (High range) or LEDL (Low range).

MODE SELECT LEDL	Select low voltage range of the LED mode
MODE SELECT LEDH	Select high voltage range of the LED mode

Select the range by pressing the **ENTER** key.

3.6 OCP/OPP Mode of Operation

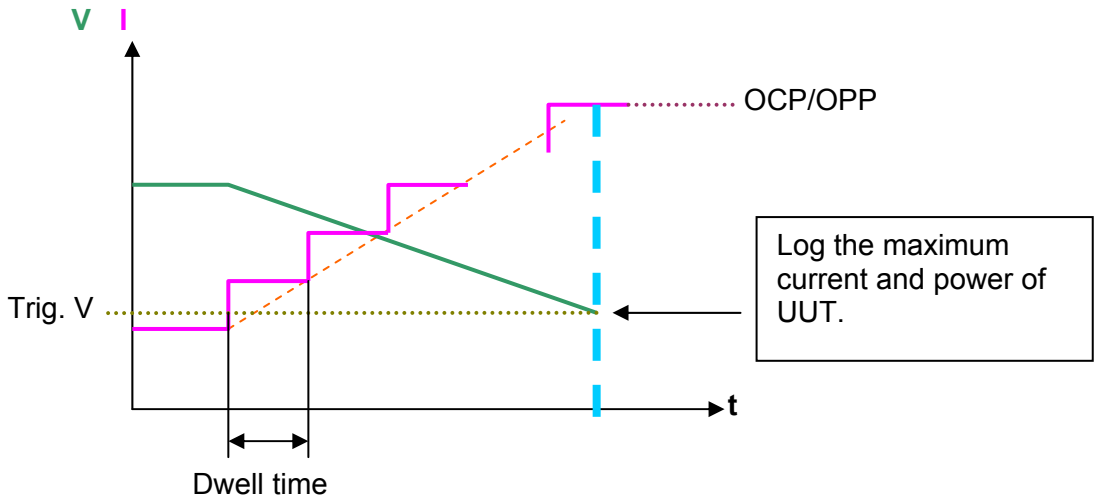


Figure 3-9 OCP/OPP Mode

In this mode the load provides a ramped up current or power to test if the UUT voltage

reaches a trigger voltage level and the OCP or OPP protection is operating normally. Press the **OCP/OPP** key to select the OCP mode or OPP mode.

Press the **OCP/OPP** key to enter into the OCP mode of operation

CURRENT RANGE 1.CCH 2.CCL	Select OCP mode of the current range

Select the range by pressing the **ENTER** key.

Press and hold the **OCP/OPP** key to enter into the OPP mode of operation

POWER RANGE 1.CPH 2.CPL	Select the OPP mode of the power range

Select the range by pressing the **ENTER** key.

3.7 Load Synchronization

The Chroma 6334A/6332A multiple electronic load mainframes contain eight and four load channels respectively. The channel on/off or change of load timing is important. You can set the module to change synchronously through SYNC RUN in the configuration setting. If a channel is set to SYNC RUN ON, it means that the channel on/off or change of load level is synchronized with the other load modules. In other cases the channel on/off can be controlled only by the module's **LOAD** key.

3.8 Measurements

Each module measures the current and voltage of the UUT. The sampling rate in fast mode is about 5 ms. Voltage and current measurements are performed with a 16-bit resolution of full-scale ratings. The user can also enter into **CONF** to do the VI MEASURE setting, see section 4.2.6.

3.9 Slew Rate & Minimum Transient Time

Slew rate is defined as the change in current over time. A programmable slew rate allows a controlled transition from one load setting to another to minimize induced voltage drops on inductive power wiring or control induced transients on a test device. If the transient from one setting to another is large, the actual transient time can be calculated by dividing the current transition by the slew rate. The actual transition time is defined as the time required for the change of input from 10% to 90% or from 90% to 10% of the programmed excursion. If the transition from one setting to another is small, the small signal bandwidth of the load will limit the minimum transition time for all programmable slew rates. Because of the limit, the actual transition time is longer than the expected time based on the slew rate. Therefore, both minimum transition time and slew rate must be considered in the

determination of actual transition time. The minimum transition time is from 24 μs to 6 ms, which depends on the slew rate setting.

3.10 Start/Stop Sink Current

In the simulation of transient characteristics of load to UUT, the critical problems are when and how the load starts sinking current. You may set the conducting voltage Von to solve these problems. The Load will start or stop sinking current when the output voltage of the UUT reaches the Von voltage. You can start sinking current when the setting is “load ON”, and the input voltage of the module is over Von voltage, but stop sinking when in “load OFF”, or the input voltage is below the Von voltage. For start and stop sinking current refer to Figure 3-10 and Figure 3-11 separately.

There are two operation modes for Von control. One is latch, and the other is non-latch. Latch means that when voltage is over the Von voltage, the load will start sinking current continuously even though the input voltage drop is below the Von voltage. Non-latch means that when the input voltage is below the Von voltage, the load will stop sinking current. The Von voltage and operation mode of Von is set in configuration.

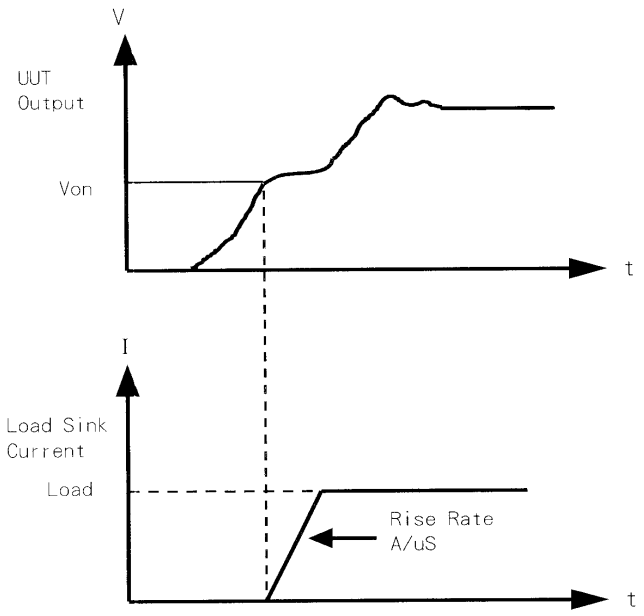


Figure 3-10 Start Sinking Current (Von Non-Latch)

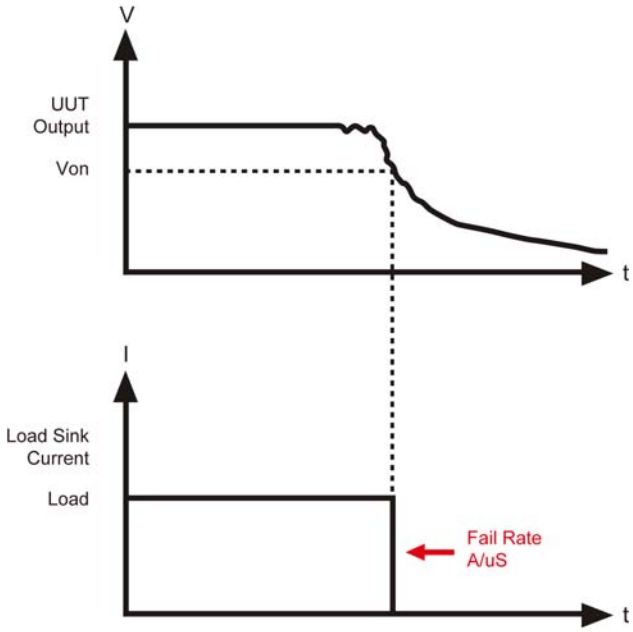


Figure 3-11 Stop Sinking Current (Von Non-Latch)

3.11 Short On/Off

A load module can simulate a short circuit at its input by setting the load on with full-scale current. The short circuit can be set on or off at the front panel or via remote control. There are two operations for the **SHORT** key on the front panel. One is "toggled on/off", and the other is "Control by Key". They are selected in configuration. The **SHORT** key will be enabled only when the load is ON.

"Toggled on/off" means pressing the **SHORT** once to enable short circuit, and again to disable. "Control by Key" means pressing **SHORT** and holding it to enable short circuit, and releasing it to return to normal operation.

The actual value of the electronic short is dependent on the mode and range that are active when the short is enabled. In CC mode, based on the maximum rated power of device and the current programmed by the input voltage of UUT, it is equivalent to the programmed value of the maximum current as long as it is under the maximum power limit. In CR mode it is equivalent to the programmed value of the minimum resistance provided to the present resistance range. In CV mode it is the same as programming the load to zero volts. In CP mode it is equivalent to the programming of the maximum power for the selected range. Turning on the short circuit does not affect the programmed setting, and the load input will return to the previously programmed values when the short circuit is turned off.

When executing SHORT in OCP mode or OPP mode, the load will follow the setting made in OCP mode or OPP mode and perform current or power loading step by step until the trigger voltage stops.

Note Turning on the short circuit may cause the load to sink high current to trigger the protection circuitry, and that will turn off the load. In addition, the short circuit will not function when operating in the low range of the CC mode.

3.12 Load On/Off

A module's input can be toggled on/off through the **ON/OFF** key on the front panel of Mainframe, the **LOAD** key on the module, or the remote control. The on/off change of input is done in accordance with the slew rate.

Turning off the load does not affect the programmed setting. The load will return to the previously programmed values when the Load is turned on again.

3.13 Protection Features

Each load module includes the following protection features: Over Voltage, Over Current, Over Power, Over Temperature, and Reverse Voltage.

The appropriate bits in the Mainframe's status registers are set when any of the protection features mentioned above are active. In addition, the Load's buzzer will produce a beep sound to inform you until the protection status is reset. When any protection is triggered, it will cause the load's input to be turned off.

- Over Voltage
  The overvoltage protection circuit is set at a level slightly above the selected voltage range. The overvoltage (OV) and voltage fault (VF) status register bits are set when an OV condition occurs. They will remain set until they are reset. The load module will display OVP when the overvoltage protection is triggered.

- Over Current
  When the load is operating in CR or CV mode, it is possible for a module to attempt to sink a current more than it is rated for. The limit level of the current is set at a level slightly above the current of the load. The over current (OC) and current error (CE) status register bits are set when an OC condition occurs, and will remain set until they are reset. The Load module will display OCP when over current protection is triggered.

- Over Power
  The overpower protection circuit is set at a level slightly above the full scale power range specified. The overpower (OP) and power error (PE) status register bits are set when an OP condition is triggered, and will remain set until they are reset. The Load module will display OPP when overpower protection is triggered.

⚠WARNING If the Electronic Load is Load ON and then transmit power to UUT under the following two conditions, it may damage the hardware as the over power protection was not activated.

1. V_{ON} is set to 0V.
2. Latch on is set to ON.

- Over Temperature
  Each Load has an over temperature protection circuit, which will turn off the load if the internal temperature exceeds the safe limit. The over temperature (OT) and temperature error (TE) status register bits are set when the OT protection is triggered, and will remain set until they are reset. The Load module will display OTP when over temperature protection is triggered.

- Reverse Voltage
  The Load conducts a reverse current when the polarity of UUT connection is not correct. The maximum safe reverse current is the same as the rated current of the load. If the reverse current of the UUT is over the rated current of load, the load may be damaged. If a reverse voltage condition is detected, you must turn off power to the UUT immediately, and make a correct connection. The reverse voltage (RV) and voltage fault (VF) status register bits are set when the RV condition occurs, and will remain set until they are reset. The Load module will display REV when reverse voltage protection is triggered.

All of the protection features will latch when they are tripped. When any protection is triggered the module will turn off the load input, and produce beep sound until you remove the condition and reset protection by pressing the **LOAD** key on the module.

CAUTION To protect the electronic load from possible damage, the input voltage must not exceed the maximum input voltage rating specification. Besides, Load + terminal potential must be more than – terminal potential.

3.14 Save/Recall Setting

The settings of the electronic load for all channels can be saved and recalled for use in various test setups. This simplifies the repetitive programming of multiple setups. The present setting of mode parameters (CC, CR, CV, CP), programs, OCP, OPP and power on status (DEFAULT) can be saved in the EEPROM using the **SAVE** key. Later you can recall the settings from the specified file using the **RECALL** key. The **SAVE** and **RECALL** keys affect all channels simultaneously.

3.15 Program

The program feature is very powerful. It allows you to simulate various test conditions. There are ten programs in the electronic load each with 10 sequences. The setting mapping of program sequence to file is one to one. It means that program 1, sequence 1 maps to file 1, and program 3, sequence 4 maps to file 24. For setting and running the programs please refer to 4.2.4.

3.16 Synchronizing Dynamic and Static

Dynamic and Static loading in synchronization is provided for one FRAME and multiple FRAMES (maximum 5 in parallel.)

New options and GPIB command:
(1) Add << SYNC PARALLEL >> ON/OFF selection in CONF for sync parallel. The mapping GPIB command is SYNC: FRAME ON/OFF [1/0].
(2) Add <<MASTER/SLAVE SEL>> in CONF to set the FRAME to be MASTER or SLAVE. The mapping GPIB command is SYNC: TYPE MASTER/SLAVE [1/0].

(3) Add <<SYNC. PARALLEL >> CHANNEL selection in CONF. It sets the T1 & T2 parameters of CCDL or CCDH for the set CHANNEL to be the DYNAMIC T1 & T2 value. The mapping GPIB command is SYNC: CHANnel x [1/8].

Procedure for manual setting:
(1) Connect the parallel cable.
(2) Set all modules to the same work mode.
(3) Set the relative parameters in CONF.
(4) Execute LOAD ON/OFF.

Procedure for remote setting:
(1) Connect the parallel cable.
(2) Set all modules to the same work mode.
(3) Set the relative parameters in CONF.
(4) Execute SYNC ON/OFF.

Specification: The sync loading time error is ±5μs.

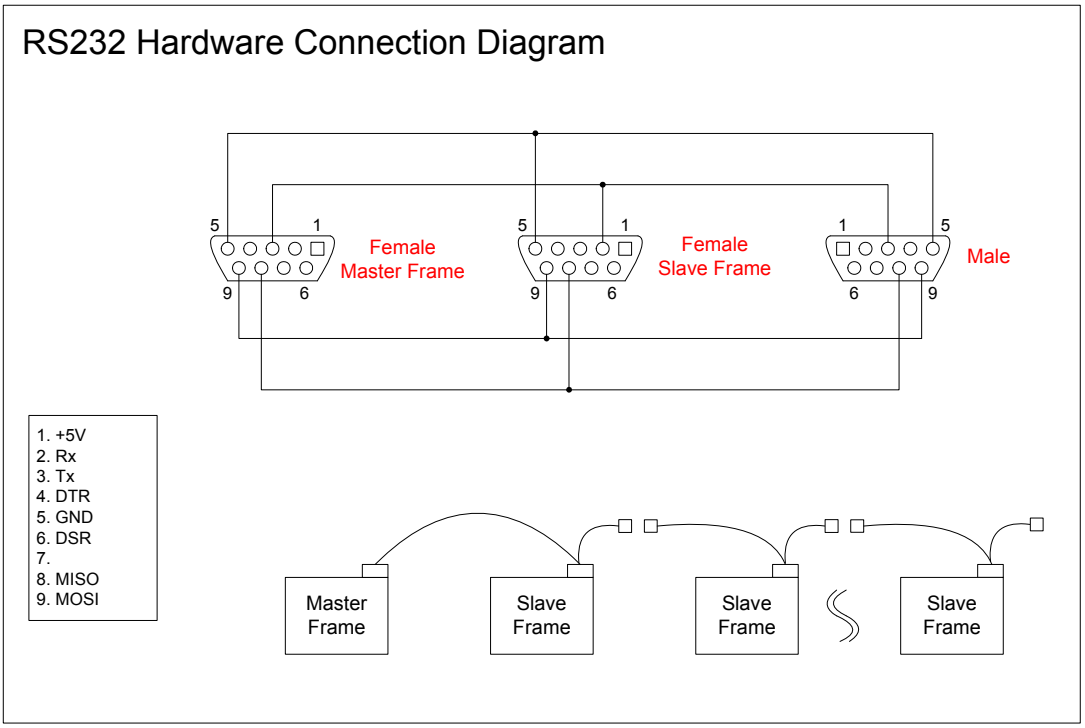


Figure 3-12 RS232 Hardware Connection Diagram

Test: 6334A mainframe x2 + 63303A load module x2
Condition: Set 12 V parallel two 63303A loads sync loading

63303A Load no.1: CC mode A: 2A ,B:14A ;T1:100μs; T2:100μs ; Slew rate sets to 0.5A/μs.
63303A Load no.2: CC mode A: 2A, B:14A ;T1:100μs; T2:100μs ; Slew rate sets to 0.5A/μs.

Current Probe ration: 5A/10mV
Ch1: Load no.1
Ch3: Load no.2
ChM: Sum of Load no.1 and Load no.2

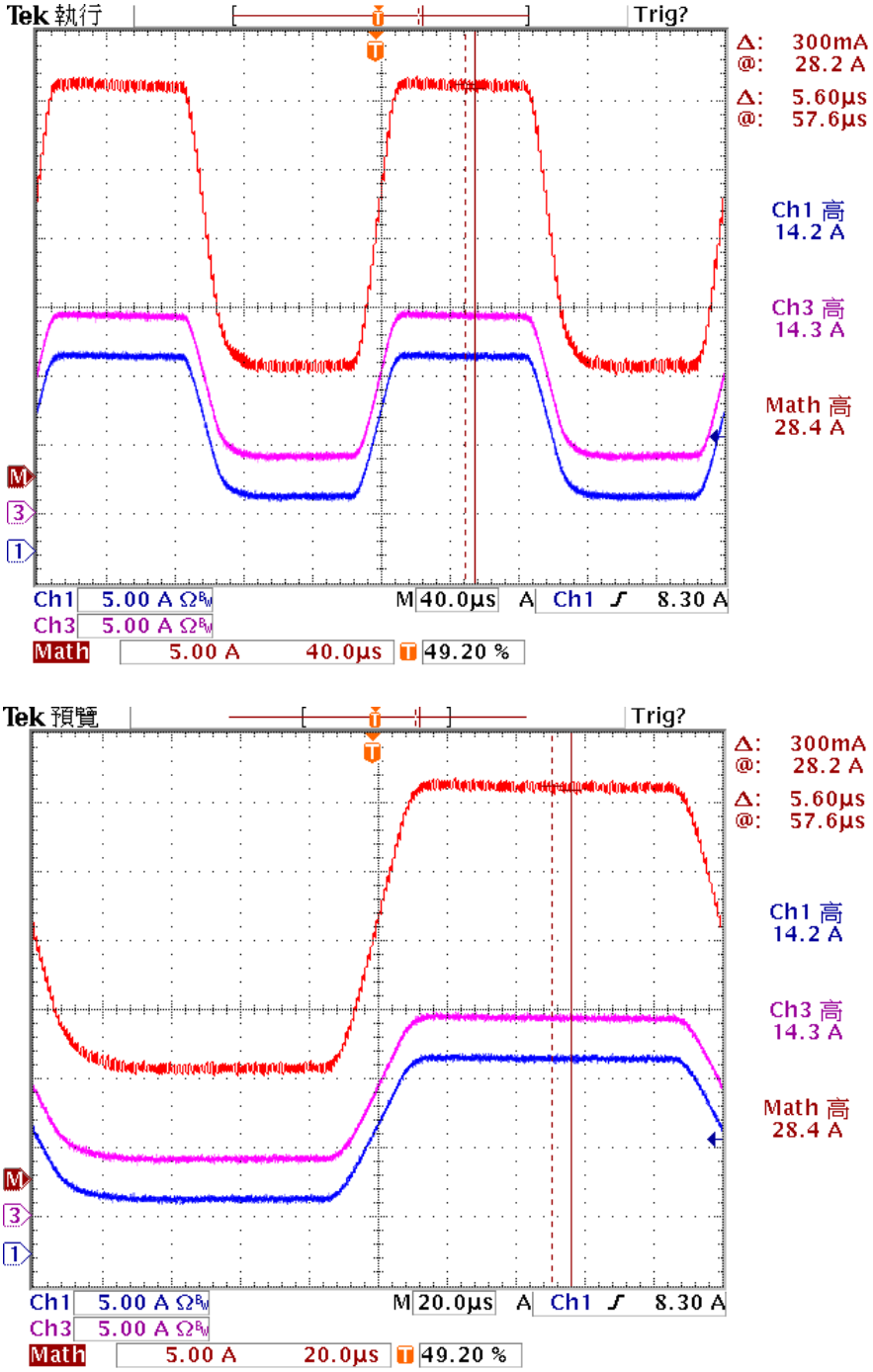


Figure 3-13 Synchronizing the Measurement Signal

4. Local Operation

4.1 Introduction

This chapter describes how to operate the electronic load from the local panel in detail. The descriptions include: Mainframe panel control, Module panel control and indicators.

4.2 Local Operation of Load Mainframe

In order to use the front panel keys to control the electronic load, local operation must be in effect. Immediately after power is applied, local operation will be in effect. When local operation is in effect, you can select a channel, and use the display as well as keypad on the front panel to control the Load. The display of the mainframe can be used to view the programmed setting of a selected channel. The input voltage/current is displayed on the module's display. The mainframe will scan module type at power-on, and memorize it for channel setting.

Notice

When you edit the setting, the display will blink setting, and let you know that the active setting is to be edited or selected.

In the remote state, the keys on the front panel will have no effect. Only the remote controller can program the Load. The display of the module will show the present input voltage and current readings or the last display while the local state is in effect. The display of the mainframe will display REMOTE.

Notice

In the setting of the load modules level, the resolution of current, voltage, resistance and slew rate setting will be different from the entered values. The displayed or stored value of the setting will be the actual value of the D/A programmed in the load module. The current, voltage and slew rate settings will be degraded as low values are entered. The resistance setting will be degraded as higher values are entered.

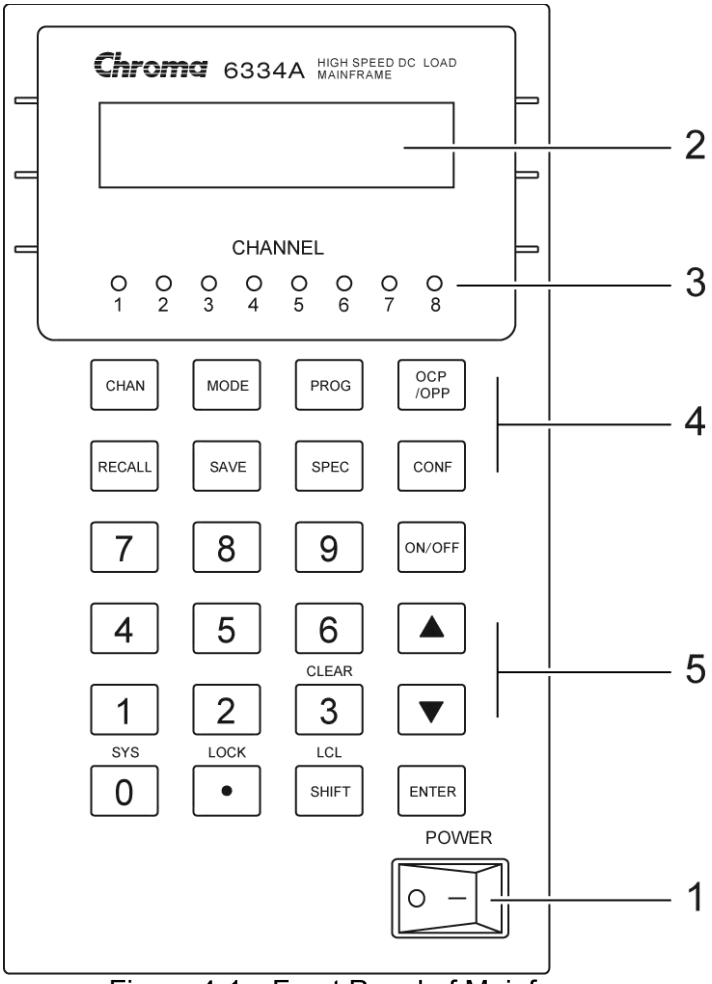


Figure 4-1 Front Panel of Mainframe

1. Line switch — Turn the ac power on/off.
2. LCD display — Display channel information normally.
3. Channel indicator — Indicate the active channel settings.
4. Function keys

CHAN — To select a channel for settings.

MODE — To select a mode for settings.

PROG — To select a program for settings or running.

OCP/OPP — To select OCP or OPP mode.

RECALL — To recall the saved settings from EEPROM, and all channel's settings from specified files (1 to 101), OCP files (1 to 10) and OPP files (1 to 10). Recalling file 101 recalls the factory default settings. Recalling program is from **PROG**, number 1 to 10.

SAVE — To save all of the present mode settings of all channels in the specified files (1 to 100). To save OCP mode settings of all channels in the OCP files (1 to 10). To save OPP mode settings of all channels in the OPP files (1 to 10). Saving

program is from 1 to 10. Saving DEFAULT saves the status of all channels for the next time the electronic load is turned on. All saved settings are stored in EEPROM, and will not be lost when the ac power is cycled.

SPEC — To select specification data for editing, or to enable SPEC function.

CONF — To select configuration data for editing.

5. Entry keys

▲ ▼ — They let you scroll through choices in a parameter list that is applied to a specific command. Parameter lists are circular. You can return to the starting position by pressing either of the keys continuously.

ON/OFF — It toggles the output of the electronic load between on and off states if channel SYNC. RUN is set at on.

ENTER — It executes the entered value or the parameter of the presently accessed command. The parameters you have entered with other keys are displayed but not entered into the load until you press this key. Before pressing **ENTER** you can change or abort anything previously entered into the display.

SHIFT — It enables a shifted key to function (LOCK, SYS).
When in remote control state, this key acts as the local key.

SHIFT + **3** — The “CLEAR” key lets you correct wrong digits before they are entered.

0 – **9** — They are used for entering numeric values.

. — It is a decimal point.

4.2.1 Selecting the Channel

The **CHAN** key is used to select one of the channels for local control. See channel number in 2.3.1. To edit channel settings, you must select a channel first. If the channel does not exist, it cannot be selected. If no module is installed in the mainframe, the display will show a DUMMY CHANNEL. When you press **CHAN**, the channel number you want to select will automatically increase to the next existing channel. The mainframe will scan the module types at power-on, and memorize them for channel editing.

4.2.2 Setting the Operation Mode

The **MODE** key and ▲ , ▼ keys are used to select the modes of channels for local control. Press **MODE** to display the selected channel's active mode. The active mode can be changed by use of the ▲ or ▼ key followed by the **ENTER** key. The sequence of mode selection after pressing ▼ key is as follows:

Selection sequence of common Electronic Load mode:
CCL -> CCH -> CCDL -> CCDH -> CRL -> CRH -> CV->CPL->CPH go back to CCL.

Selection sequence of LED simulation mode:
LEDH -> LEDL -> CRH -> CRL -> CV -> CCH -> CCL go back to LEDH.

Press **ENTER** key to select mode and confirm setting.

Notice

The eight operation modes of load module settings stored in the mainframe are independent. Changing any mode setting won't affect others. Storing the settings to EEPROM (1-100) will store only one mode setting.

The load levels and slew rate are common to CC, CR , CP modes. CV mode sets voltage level and response speed. There are two level settings for single channel/modules in the CC, CR, CV and CP modes. They can be switched by the module's **A/B** key.

Setting CC Values

There are four modes of CC operation: CCL, CCH, CCDL and CCDH. The current levels are programmed in Amps and the slew rate levels are programmed in milliamps/μs at low range and in Amps/μs at high range. The timings are programmed in milliseconds, while the buffer settings of four CC modes are independent. Changing the operation range doesn't affect the settings of other ranges. The following examples show how to set the CC values of load modules for model number 63303A. Before observing the examples, select the channel.

1. Select Range/Function
   Press **MODE**, and use the ▲ or ▼ key to select CCL followed by the **ENTER** key.
   CCL: static low range CCH: static high range
   CCDL: dynamic low range CCDH: dynamic high range

MODE SELECT CCL

2. Set Current Level
   There are 4000 discrete steps from 0 to full scale in each range. Set level1 (A) current level to 2 amps by pressing **2**, **ENTER** . Set level2 (B) current level to 1 amp by pressing **1**, **ENTER**.

CCL1: 1.9995A CCL2: 0.9990A

3. Set Slew Rate
   There are 250 discrete steps in each range. Set the rise 50 mA/μs and fall slew rates to 50 mA/μs by pressing **5**, **0**, **ENTER** for rise and **6**, **0**, **ENTER** for fall slew rate. LED simulation load does not have Set Slew Rate function.

CCL↗ : 50mA/μs CCL↘ : 60mA/μs

4. Set DYNAmic Function Periods
   Dynamic function has period T1 and T2 to be set. Set dynamic period 1 to 0.1 ms, period 2 to 0.2 ms by pressing **0**, **.**, **1**, **ENTER** and **0**, **.**, **2**, **ENTER**. The range of Dynamic period is from 0.025 μS to 30 Sec.

CCDLT1: 0.100ms CCDLT2: 0.200ms

Notice If you press the **ENTER** key, and the blinking data does not go to next, change configuration setting Enter Data Next to YES.

Setting CR Values

The CR values for the selected channel are programmed by pressing the **MODE**, ▲ and **ENTER** keys. The resistance values can be programmed in low voltage (CRL) or high voltage (CRH) range. The current is always in high range. ALL resistance levels are programmed in ohms. The slew rate is in A/μs. 63323A is able to set 4 types of resistances using the high and low current provided as "*Set the current range of CR mode*" described in section 4.2.7.

The following examples illustrate how to set CR values for load module model number 63303A.

1. Select Range
   Press **MODE** and use ▲ or ▼ key to select CRL followed by **ENTER** key.

MODE SELECT CRL

2. Set Resistor Level
   There are 4000 discrete steps from 0 to full scale in each range. Set the main resistor level1 (A) to 2 ohms by pressing **2**, **ENTER**. Set the level2 (B) resistor level to 1 ohm by pressing **1**, **ENTER**.

CRL1: 2.000Ω CRL2: 1.000Ω

3. Set Slew Rate
   There are 250 discrete steps in each range. Set the rise and fall slew rates to 0.1 A/μs by pressing **.**, **1**, **ENTER** for rise slew rate and **.**, **2**, **ENTER** for fall slew rate.

CRL↗ : 0.10A/μs CRL↘ : 0.20A/μs

The LED simulation load does not have Set Slew Rate function.

Setting CV Values

The CV values for the selected channel are programmed by pressing the **MODE**, ▲ and **ENTER** keys. The voltage values can be programmed in one range. The voltage levels are programmed in volts and the response speed is programmed in fast/slow operations.

The following examples illustrate how to set CV values of the load module for model number 63303A. Before observing the examples, select the channel.

1. Select Range
   Press **MODE** and use ▲ or ▼ key to select CV followed by **ENTER** key.

MODE SELECT CV

2. Set Voltage Level
   There are 4000 discrete steps from 0 to full scale in each range. Set the main voltage level1 (A) to 5 volts by pressing **5**, **ENTER**. Set the level2 (B) voltage level to 6 volts by pressing **6**, **ENTER**.

CV 1: 5.00V CV 2: 6.00V

3. Set Response Speed
   There are two response speeds for CV mode for different UUT tests, fast and slow.

CV RESPONSE 1:FAST 2:SLOW

Setting CP Values

The CP values for the selected channel are programmed by pressing the **MODE**, ▲ and **ENTER** keys. The resistance values can be programmed in the low voltage (CPL) range or the high voltage (CPH) range. The current is always in the high range. ALL resistance levels are programmed in ohms. The slew rate is in W/μs.

The following examples illustrate how to set the CP values of load module for model number 63303A.

1. Select Range
   Press **MODE** and use ▲ or ▼ key to select CPL followed by the **ENTER** key.

MODE SELECT CPL

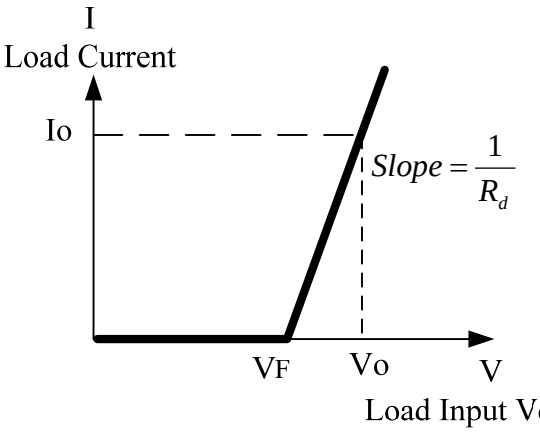
2. Set Resistor Level
There are 4000 discrete steps from 0 to full scale in each range. Set the main resistance level1 (A) to 20 watts by pressing **2**, **ENTER**. Set the level2 (B) resistance level to 10 watts by pressing **1**, **ENTER**.

CPL1: 20.000W CPL2: 10.000W

3. Set Slew Rate
There are 250 discrete steps in each range. Set the rise and fall slew rates to 0.1 W/μs by pressing **.**, **1**, **ENTER** for the rise slew rate and **.**, **2**, **ENTER** for the fall slew rate.

CPL↗ : 0.10W/μs CPL↘ : 0.20W/μs

Setting LED Mode Values



$$\begin{cases} if \quad V_O < V_F, I_O = 0 \\ if \quad V_O \geq V_F, I_O = \dfrac{V_O - V_F}{R_d} \end{cases}$$

The V-I Fragments Similar to Curve of LED

From the V-I curve of LED, the similar fragments can get the following formula:

$$\frac{V_O - V_F}{R_d} = I_O \Leftrightarrow \frac{V_O - V_F}{I_O} = R_d \Leftrightarrow \frac{V_O\left(1 - \dfrac{V_F}{V_O}\right)}{I_O} = R_d \Leftrightarrow \left(1 - \frac{V_F}{V_O}\right) = \frac{R_d}{\left(\dfrac{V_O}{I_O}\right)} = \frac{R_d}{R_{DC}}$$

$$Define \quad R_{d\_Coeff} = \frac{R_d}{R_{DC}}$$

$$R_d = \frac{V_O}{I_O} \times R_{d\_Coeff} \qquad V_F = V_O \times \left(1 - R_{d\_Coeff}\right)$$

Definition:
V_o: The output voltage of LED power.
I_o: The output current of LED power.
R_d Coefficient: The ratio of dynamic LED working point and DC impedance.
R_d: The dynamic impedance of LED operating point.
V_F: The forward bias of LED.
LED N: The number of LED in series.

1. Select the range
   Press **MODE** and use ▲ or ▼ to select LEDL and then press **ENTER**.

   ```
   MODE SELECT
   LEDL
   ```

2. Set the output voltage and current of LED power
   There are 25,000 non-sequential steps from 0 to full scale in each range. Pressing **1**, **0**, **0**, **ENTER** can set the voltage level to 100 volt and pressing **0**, **.**, **5**, **ENTER** can set the current level to 0.5 amp.

   ```
   LEDLVo:    100.000V
   LEDLIo:    0.50000A
   ```

3. Set Rd or Rd Coefficient or V_F
   There are 1,000 non-sequential steps from 0.001 to 1 full scale in RdCoeff and pressing **0**, **.**, **1**, **ENTER** can set the impedance ratio to 0.1.
   There are 16,000 non-sequential steps under full scale in RdOHM and pressing **1**, **0**, **.**, **0**, **ENTER** can set the impedance to 10.1 ohm.
   There are 25,000 non-sequential steps under full scale in Vf and pressing **9**, **0**, **ENTER** to set the forward bias to 90 volts.

   ```
   Rd = Default
   ```
   or
   ```
   RdCoeff:        0.100
   ```
   or
   ```
   RdOHM:          10.0Ω
   ```
   or
   ```
   Vf:             90.000V
   ```

   The settings can be changed by the configuration.
4. Set Rd, V_F and number in series
   Select LED Series setting mode in Configuration.
   In LED Rd, press **1**, **.**, **0**, **ENTER** to set the resistance to 1.0Ω. In LED Vf, press **3**, **.**, **0**, **ENTER** to set the forward bias 3.0 volt.

   ```
   LEDL Rd:    1.0000Ω
   LEDL Vf:    3.0000V
   ```

   In LED N, there are 2000 non-continuous steps under full scale and press **1**, **0**, **ENTER** to set the number in series to 10pcs.

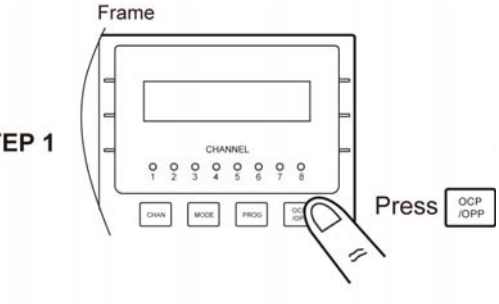
   ```
   LEDL N:          10PCS
   ```

4.2.3 Setting the OCP/OPP Mode of Operation

The **OCP/OPP** key has OCP and OPP modes for users to test the UUT voltage to ensure that it reaches the trigger voltage level and determine if the OCP or OPP protection is acting normally.

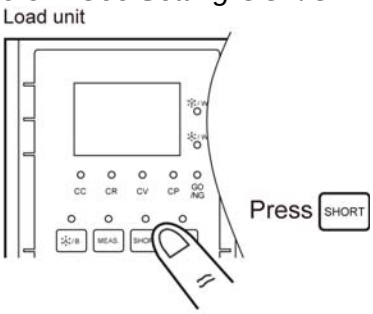
※Note: Follow the steps below for OCP/OPP mode operation.

STEP 1



First select the channel to be tested and press **OCP/OPP** key to set the related parameters. See *Setting OCP/OPP Values* for detail information.

STEP 2

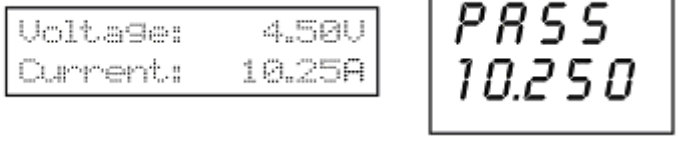


Once STEP 1 is done, go to the Channel and press the **SHORT** key to execute OCP or OPP. If operating the R channel of the 63302A and the 63307A models, first press the **L/R** key of the module and switch to the R channel, then press the **SHORT** key to execute OCP or OPP.

STEP 3

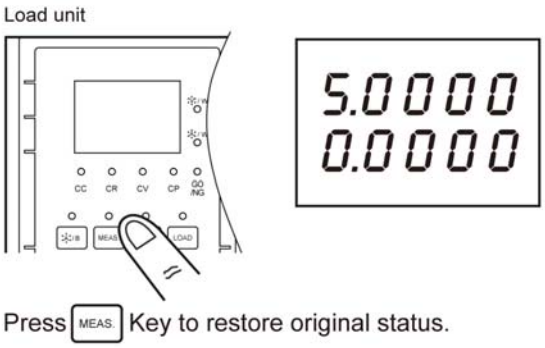
Once STEP 2 is executed, the LCD on the mainframe and the 7-segment display on the module will show the OCP/OPP execution status in real time so the user receives the current information.

STEP 4



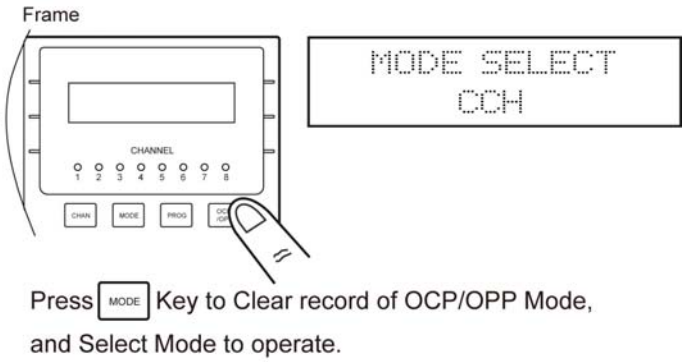
When the OCP/OPP execution is done, a message of Pass or Fail and OCP or OPP point will show on the module.

STEP 5



When the OCP/OPP execution is done, to clear the 7-segment display of the module, press the **MEAS.** key to clear it and restore the display of voltage, current or power.

STEP 6



When the OCP/OPP execution is done, to clear the OCP/OPP loading message on the LCD of the mainframe, press the **MODE** key to clear the screen and select a new mode for operation.

Setting OCP Values

OCP mode can be executed in any mode. Press the **OCP/OPP** key to set the Current Range (CCH, CCL) of the OCP mode and follow the options to the related values, including start current (Istart), end current (Iend), step no. (No. step), dwell time (DwellT), trigger voltage setting (SET Trig. Voltage), OCP low limit (SPEC_L) and OCP high limit (SPEC_H).

Notice

Set the start current (Istart) and end current (Iend): Set based on the option of CCH or CCL selected for each mode. The OCP mode only acts when Istart < Iend.
Range of the step no. (No. step): 1 ~ 1000
Range of the dwell time (DwellT): 1 ~ 1000 ms
Trigger voltage (SET Trig. Voltage): Set based on the user's request, but only acts when the trigger voltage is lower than the UUT voltage.
OCP current low limit (SPEC_L) and high limit (SPEC_H): Set based on the user's request.

$$OCP\ Accuracy\ (Typical) = \frac{Iend - Istart}{no.\ Step}$$

The following examples illustrate how to set OCP values of the load module for model number 63303A.

1. Enter into OCP mode and select CURRENT Range
   Press the **OCP/OPP** key to enter into CURRENT mode and select the current range.
   Press **2**, **ENTER** keys to select the CCL Range for operation.

CURRENT RANGE 1.CCH 2.CCL

2. Set the start and end current
   Press **1**,**.**,**5**,**ENTER** keys to set the start current (Istart) and press **6**,**ENTER** keys to set the end current (Iend).

Istart： 1.500 A Iend： 6.000 A

3. Set the number of step and dwell time
   Press **1**,**0**,**0**,**ENTER** keys to set the number of steps (No. step) and press **2**,**0**, **0**,**ENTER** keys to set the dwell time (DwellT).

No. step： 100 DwellT： 200 mS

4. Set the trigger voltage
   Press **3**,**.**,**6**,**ENTER** keys to set the trigger voltage (SET Trig Voltage).

SET Trig Voltage： 3.60 V

5. Set the low and high limit for OCP specification
   Press **4**,**.**,**5**,**ENTER** keys to set the current low limit (SPEC_L) and press **6**,**ENTER** keys to set current high limit (SPEC_H).

SPEC_L： 4.500 A SPEC_H： 6.000 A

Setting OPP Values

OPP mode can be executed in any mode. Press the **OCP/OPP** key to set the Power Range (CPH, CPL) of the OPP mode and follow the related option values including start power (Pstart), end power (Pend), step no. (No. step), dwell time (DwellT), trigger voltage setting (SET Trig. Voltage), OPP low limit (SPEC_L) and OPP high limit (SPEC_H).

Notice

- Set the start power (Istart) and the end power (Iend): Set based on range selected CPH or CPL for each mode. The OPP mode only acts when Pstart < Pend.
- Range of the step no. (No. step): 1 ~ 1000
- Range of the dwell time (DwellT): 1 ~ 1000 ms
- Trigger voltage (SET Trig. Voltage): Set based on the user's request, but only acts when the trigger voltage is lower than UUT voltage.
- OPP current low limit (SPEC_L) and high limit (SPEC_H): Set based on the user's request.

$$OPP\ Accuracy\ (Typical) = \frac{Pend - Pstart}{no.\ Step}$$

The following examples illustrate how to set the OPP values of the load module for 63303A.

1. Enter into the OPP mode and Select POWER Range
   Press the **OCP/OPP** key to enter into the Power mode and select the power range.
   Press **2**,**ENTER** keys to select the CPL Range for operation.

POWER RANGE 1.CPH 2.CPL

2. Set the start and end power
   Press **5**,**ENTER** keys to set the start power (Pstart) and press **3**,**0**,**ENTER** keys to set the end power (Pend).

Pstart： 5.00 W Pend： 30.00 W

3. Set the number of steps and dwell time
   Press **2**,**0**,**ENTER** keys to set the number of steps (No. step) and press **5**,**0**, **0**,**ENTER** keys to set the dwell time (DwellT).

No. step： 20 DwellT： 500 mS

4. Set the trigger voltage
   Press **4**,**.**,**5**,**ENTER** keys to set the trigger voltage (SET Trig Voltage).

SET Trig Voltage： 4.50 V

5. Set the low and high limit for OPP.
   Press **1**,**5**,**ENTER** keys to set the power low limit (SPEC_L) and press **3**,**0**,**ENTER** keys to set the power high limit (SPEC_H).

SPEC_L： 15.00 W SPEC_H： 30.00 W

4.2.4 Setting the Program

The electronic load provides the ability to select customized basic tests, and link them into a program test for automatic execution.

The **PROG** key is used to select a program, or recall a program for local control. There are ten programs (1-10). Each program has ten sequences to map files from 1 to 100. The program 1 maps files from 1 to 10. Table 4-1 shows the relationship between the program sequence and the corresponding file.

Table 4-1 The Relationship of the Program Sequence and the Corresponding File

Program 1 Sequence No.	1	2	3	4	5	6	7	8	9	10
Corresponding File No.	1	2	3	4	5	6	7	8	9	10
Program 2 Sequence No.	1	2	3	4	5	6	7	8	9	10
Corresponding File No.	11	12	13	14	15	16	17	18	19	20
:										
:										
Program 10 Sequence No.	1	2	3	4	5	6	7	8	9	10
Corresponding File No.	91	92	93	94	95	96	97	98	99	100

In running a program you must set its corresponding file parameters first. If one program sequence is not enough for you to test the UUT, you can use the program chain function to get more sequences.

Press the **PROG** key, and the LCD will display as below. Press number 1 -10 followed by **ENTER** to recall the program from the EEPROM, or use ▲ , ▼ keys to edit program.

```
PROGRAM SELECT
No:    1
```

1. Setting the Active Channels

   The LCD displays the active channels for the program to control. The LED channel indicators will be active if the channel is active. The channel can be active only when it exists and the mode of SYNC. RUN is ON. When the channel is not selected or does not exist, the channel number will not be displayed. Press number 1 to 8 to enable or disable the active channel.

```
ACTIVE CHANNEL
 1   3   5 6 7 8
```

2. Setting the Program Chain

   The chain function of programming enables you to chain programs to get more sequences for testing. Setting the program chain number to 0 results in no program chain. The program chain function can chain itself for a loop test, or chain with other programs. Press **1**, **ENTER** keys to set chain for loop test. The default setting is 0.

```
PROGRAM CHAIN
No:    1
```

3. Setting the Sequence P/F Delay Time

The sequence Pass/Failure delay time let you set the delay time for P/F checking when the load condition changes. The failure status of the sequence will latch when a program is executed. It means that any failure will be logged even when the UUT becomes stable within specification. The range of the P/F delay time is from 0 to 60 seconds. Press **1**, **ENTER** keys to set the sequence P/F delay time to 1 second. The default setting is 0 second.

```
SEQ. P/F DELAY
TIME:      1.0Sec
```

4. Setting the Sequence ON/OFF Time

The sequence ON/OFF time controls the Load input ON/OFF when the program sequence is executed. The range of ON/OFF time is from 0 to 60 seconds.

```
SEQ. ON TIME
TIME:    1.0Sec
```

Press **0**, **ENTER** keys to set the OFF time to 0 second. The default setting is 0 second for OFF time.

```
SEQ. OFF TIME
TIME:      0.0Sec
```

5. Setting the Sequence Mode

There are three modes to control the method of sequence execution.

SKIP (**0** Key):	Skip the sequence. Load will not change input status.
AUTO (**1** Key):	Use ON/OFF time to control Load input on/off. When ON/OFF time passes, the Load will get to the next sequence automatically.
MANUAL (**2** Key) :	Use **▲** or **▼** or number **0** to **9** to control the execution sequence.
EXT (**3** Key):	The Trig. signal from External Trig. by Pin15 of DIGITAL I/O PORT to control the execution sequence.

Pressing the number key lets you select a random sequence number to execute. Pressing **0** instructs the load to go to sequence 10.

Press the **2**, **ENTER** keys to set sequence 1 manual mode. You must set ten sequence settings for one program. The default setting is SKIP.

```
SEQ    1:    SKIP=0
AUTO=1   MANUAL=2
```

To set the external control, press the **▼** key and select EXT to key in **3**.

```
EXT=3
```

6. Setting the Short Channel

   When the sequence mode is not SKIP, you must set the short channel & time. The short channel is selected as the active channel. For selection of the short channel press number 1 to 8 to enable or disable the corresponding module's short function.

```
SEQ. 1 SHORT   CH.
  1    3    5 6 7 8
```

7. Setting the Short Time

   The range of the short time is from 0 to 30 Sec. The short time must be ≤ the SEQuence ON time. If the short channel is not selected or the short time is set to 0 Sec., the selected channel will not short. The default setting is channel 0 and 0 Sec.

```
SEQ. 1
 SHORT TIME= 0.0S
```

4.2.5 Running the Program

Press the **ON/OFF** key to run programs when program function is selected. The LED channel indicators will be active if channel is active. The display shows as follows.

```
PROG. 1 SEQ. 1
[ON][KEY][PASS]
```

The upper line displays the executed program and sequence number while the lower line displays load status, key and test result status.

ON/OFF : It shows load input status.
KEY (EXT) : It shows when MANUAL mode is active and waiting for key input. If external control is selected, the name will change to EXT. Please use the External Trig. signal of pin15 from DIGITAL I/O PORT for control.
PASS/FAIL : It shows the test results compared with SPEC setting.

When a program is executed, the setting of the sequence will recall files from EEPROM, and the SPEC function is always ON. All function keys are disabled until the **ON/OFF** key is pressed to stop the program's execution, or program's run finishes. When the program run stops or finishes, the LCD will display the following:

PROGRAM OFF RESULT :PASS

This means that all of the sequences in the program have passed. If the test fails, the LCD will show the following:

PROG. XX : 1 2 3 4 5 6 7 8 9 10

PROG. XX stands for the file number of the program that failed, 1 to 10. Also, 1, 2, 3...10 shown by LCD stands for the failed sequence. The failed sequences are the results of all failed channels. The LED of the channel will show the failed channel. In the test by program chain, if the failed program files are more than one set, you can use the ▲ ▼ to read the contents of the failed programs.

4.2.6 Setting the Specification

The **SPEC** key is to enable/disable the SPEC function or select the settings of specifications. The load will compare measurement data with the set specifications for HIGH and LOW limits when the SPEC TEST is ON, and the LED, GO/NG, is lighted on the module panel. To set specifications for the module, you must go to mode editing by pressing the **MODE**, **ENTER** keys, and then the **SPEC** key. In other operating modes, pressing the **SPEC** key is to enable/disable the SPEC TEST function. The SPEC TEST ON/OFF function is global. This means that all modules installed on the Mainframe will do a GO/NG comparison. There are two ranges, Value and Per cent for setting the SPEC, see 4.2.7 for detail description. The CENTER level must be set by the value of the channel input reference level. The HIGH and LOW levels can be set by value or percentage selected in the configuration SPEC. ENTRY MODE. The HIGH/LOW percentage range is from 0 to 100%.

Press **MODE**, **ENTER**, **SPEC** keys to set the specifications of the CC mode. Press **5**, **ENTER** to set CENTER level 5V.

VOLTAGE SPEC. CENTER: 5.0000V

Press **5**, **ENTER** to set HIGH level 5%.

VOLTAGE SPEC. HIGH PCet: 5.0%

Press **5**, **ENTER** to set LOW level 5%.

VOLTAGE SPEC. LOW PCet: 5.0%

The default setting of HIGH and LOW is 100%. The CENTER value is half of the range. For selection of the specifications set by Value or Percentage please refer to "*Set the*

specifications of entry mode" in 4.2.7.

4.2.7 Setting the Configuration

The electronic load provides useful features such as Von point, Current limit, Sync run, etc. To use these powerful features, you must set relevant parameters in accordance with application needs by the use of the configuration setup. This procedure is only needed for the initial setup of a test operation. The configuration of each channel is stored independently in the EEPROM of Mainframe. To set configuration you must press **CONF**.

Set the voltage range of CC mode. There are two voltage ranges for CC mode. High range is for high voltage and low range for low voltage so as to get better voltage resolution. The default setting of Vrange is HIGH.

CC Vrange Select 1:HIGH 2=LOW

Set the current range of CR mode. There are two current ranges for CR mode. High range is for CR mode at Current High (CH) and low range for CR mode at Current Low (CL). The default setting of Irange is HIGH. This item is valid for 63323A only.

CR Irange Select 1:HIGH 2:LOW

Set the current range of CRL and LEDL mode. CRL and LEDL mode has two current ranges. High current range is for CRL and LEDL mode when Current High (CH) is in use and low current range is CRL and LEDL mode when Current Low (CL) is in use. The default setting of I range is HIGH. This item is valid for 63313A only.

CRL&LEDL I Range 1:HIGH 2:LOW

Set the current measurement range. It is able to set the current measurement range to make the measurement of small current more precise.

CURR MEAS. RANGE 1:HIGH 2:LOW

⚠WARNING This function supports LED simulation load only. When the current measurement range is set to Low and the loading current exceeds, the Module panel will prompt an error message ERR01 to warn the user. Press ENTER to cancel the warning.

Set Von point. Von is the conduction voltage level when the electronic load starts to sink current and the UUT output reaches the Von voltage. The default setting is 1V.

Von POINT VOLTAGE: 3.50V

Set Von latch. There are two operating modes for Von control. Von latch ON means that Load will sink current continuously when Von voltage is reached. Von latch OFF means that the load will stop sinking current when the UUT voltage is under the Von voltage. The default setting of Von latch is OFF. Figure 4-2 and Figure 4-3 show Von LATCH ON and OFF current waveform separately.

Von LATCH 1:ON 2:OFF

CAUTION If Von is set to 0V, the load circuit will be ON in spite of the absence of a UUT. This will get overshoot spike. If a UUT is applied, the overshoot may damage the UUT in spite of a small setting of the load current. So, do not set Von to 0V.

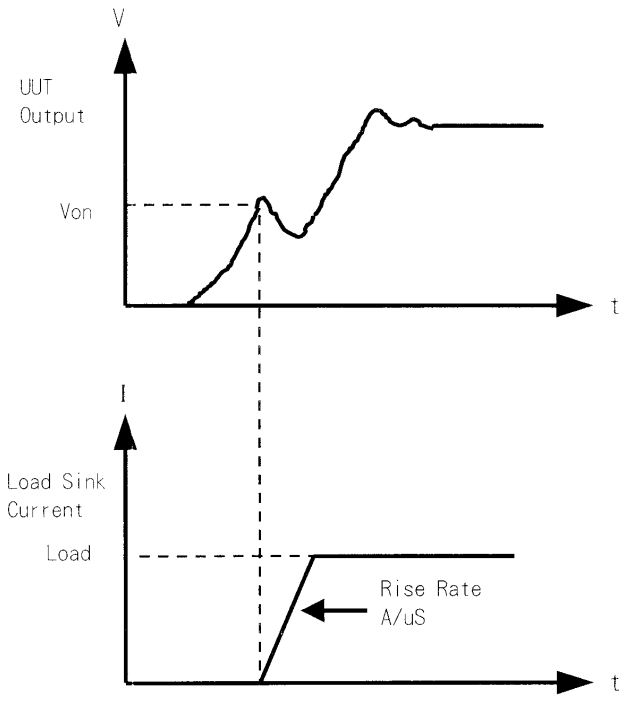


Figure 4-2 Von LATCH ON Current Waveform

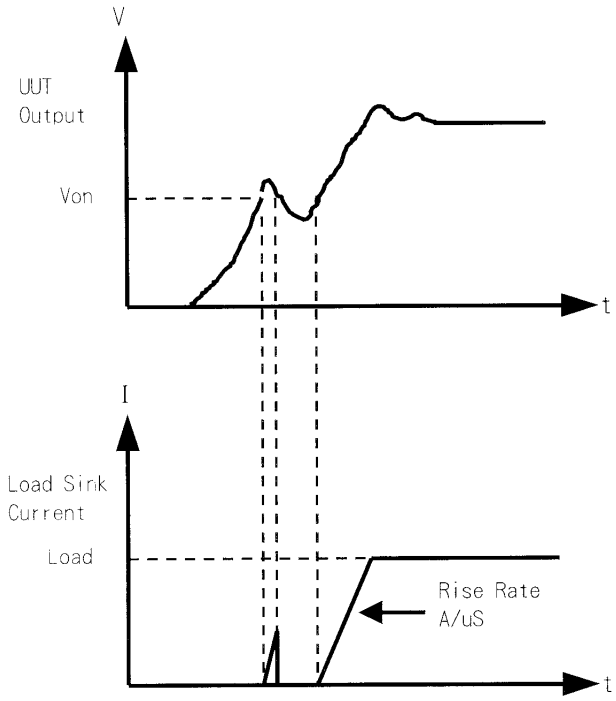


Figure 4-3 Von LATCH OFF Current Waveform

Set VOFF.

The VOFF is set for the user to stop the current loading when the voltage is under the low limit. The default setting of VOFF is OFF.

VOFF 1:ON 2:OFF

Set VOFF FINAL.

Sets the final loading voltage for VOFF. When VOFF is **ON**, the Von Point and Von Latch must be set in advance. Von Point must be larger than the VOFF Final Voltage and the Von Latch has to be **ON** for VOFF to execute. Figure 4-4 shows the Von and VOFF Loading Current Waveform separately.

VOFF FANAL VOLTAGE: 1.00V

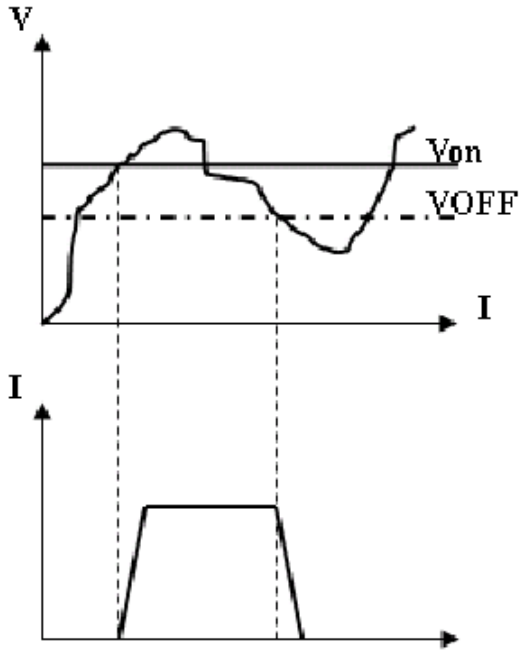


Figure 4-4 Von and VOFF Loading Current Waveform

Set CV mode CURR_LIMIT. Limits the current sinking of the load to protect the UUT in CV mode. The default setting of current limit is the maximum Load current.

CV CURR_LIMIT CURRENT: 20.000A

Set CV SLOW TYPE.
Sets the type of SLOW RESPONSE for 6330A.

CV SLOW TYPE 1: MOST 2: MORE

If slower RESPONSE is desired, select **MOST**. The default setting of CV SLOW TYPE is MORE.

CAUTION If **MOST** is set for CV SLOW TYPE, it won't be able to use the CV RESPONSE (1. FAST, 2. SLOW) set by **MORE** in default for 6330A. The operation will be kept to the slowest CV RESPONSE.

Set the sign of voltage for display. The electronic load will show minus sign of the voltage if you select MINUS. It will not show any sign if you select PLUS. The default setting is PLUS. Selecting MINUS of SIGN OF VOLT. will occupy one digit. Four digits will be displayed.

SIGN OF VOLT. 1:PLUS 2:MINUS

Set the specifications of entry mode. The specifications of the load can be set by VALUE or Percentage for HIGH and LOW data. The percentage values refer to the CENTER value of specification. The default setting of the SPEC entry mode is percentage.

SPEC. ENTRY MODE 1:VALUE 2:PCet

Set SYNChronous run mode. When SYNC run is set to ON, the Load on/off is controlled by the **ON/OFF** key on the Mainframe. Under other circumstances the Load on/off is simply controlled by **LOAD** key on the module. The default setting of SYNC run is ON.

SYNC. RUN 1:ON 2:OFF

Select the data entry mode by **ENTER**. If ON is selected for data entry, the setting will go to the next one after pressing **ENTER**. If OFF is selected for data entry, the setting will remain on the same line for you to change it again and again. The default setting is ON.

Enter Data Next 1:ON 2:OFF

Select the module SOUND on/off. When you press the key on the module, it will produce a sound if sound = ON. The default setting for the sound is ON.

SOUND 1:ON 2:OFF

Select Load module input status when it is powered ON. If ON is selected, the module will be active according to the AUTO LOADON mode setting. The default setting of AUTO LOADON is OFF.

AUTO LOADON 1:ON 2:OFF

Select the load on mode of module if AUTO LOADON is ON. If LOAD is selected, the Load module will be active as DEFAULT. If PROG is selected, the module will be active as the program values saved last time. The default setting of AUTO LOADON MODE is LOAD.

AUTO LOADON MODE 1: LOAD 2: PROG.

Select Load module rotary knob type. There are two modes for you to change the load module data with the rotary knob.

UPDATED means that the data changed by the rotary knob will be updated on the load module. When you press the **LOAD** key to set the load module ON, new data will be executed.

OLD means that the data changed by the rotary knob will be invalid and the load module data remains the same if the load module is ON again. For the operation of rotary knob

please refer to 4.3.1 and 4.3.2.

LOADON KNOB TYPE 1=UPDATED 2=OLD

Select short key mode. It sets the **SHORT** key mode for the load module. The default setting of the SHORT mode is TOGGLE.

SHORT 1:TOGGLE 2:HOLD

Notice

The short circuit of 63310A is to load the full power in CR mode and then use a relay to short to 1Ω. The current reading showed on the Electronic Load is not the actual output current of UUT. If actual output current is required, please add other instrument such as multi-meter to conduct the measurement. The UUT output current cannot exceed 2A after short circuit. It would damage the 63310A if exceeds 2A.

Select sync. parallel mode. Set the mainframe if to synchronize in parallel run. The 6330A series have a master/slave paralleling control mode that allows synchronous load control in static and dynamic loading mode.

SYNC. PARALLEL 1 : ON 2 : OFF

Select Master / Slave mode. Set the specified mainframe to master or slave for sync. in parallel run.

MASTER / SLAVE SEL 1 : MASTER 2 : SLAVE

Select sync. parallel channel mode. Set the specified channel to T1 & T2 in sync dynamic mode for parallel loading.

SYNC. PARALLEL CHANNEL SEL: 1 TO 8

Set Voltage & Current MEASURE.
It sets the average times for voltage and current measurement. The range is 1~64 and the default setting of VI MEASURE is 10.

VI MEASURE AVERAGE: 10

Set Timing Function mode

The 6330A Series Loads have a unique timing & measurement function that is able to conduct precision time settings and measurements in the range of 00:00:00.000s to 24:00:00.000s. This feature allows users to set a trigger voltage & timeout value for battery discharge testing and similar applications.

For example, the Figure 4-5 below shows the 6330A's internal timer that can be initiated automatically when the battery voltage falls under the preset value. The timer will continue counting until the next preset voltage value is reached. The default setting of the TIMING FUNCTION is OFF.

Press **1**, **ENTER** to set the timing function.

TIMING FUNCTION 1:ON 2:OFF

Press **2**, **ENTER** to set Vtrg Voltage for timing function.

TIMING FUNCTION Vtrg: 2.000V

Press **0**,**0**,**1**, **ENTER** to set the timeout.

TIMEOUT(24hr) 00:10:00.000 s

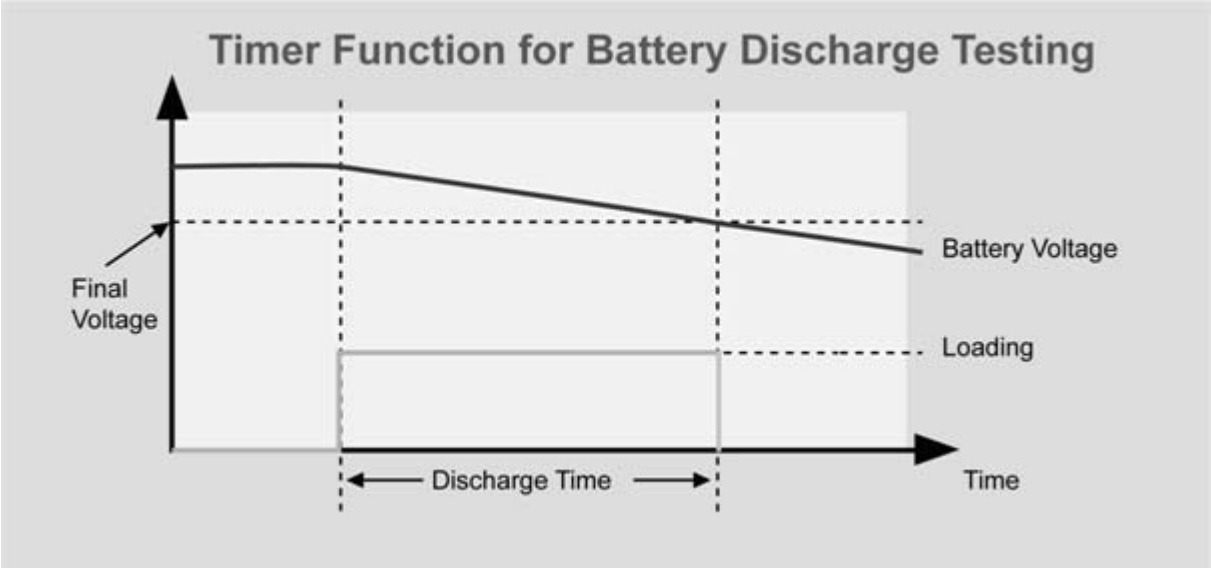


Figure 4-5 Battery Discharge Testing

CAUTION Timing function cannot be operated under CV mode but only valid in CC, CR and CP mode.

Set DIGITAL IO

It sets the external signal (High > 4.3V, Low < 0.7V) to control the mainframe and module through the Digital I/O Port as well as gain the related information. See 4.2.13 for detail description of the Port function. The default setting of DIGITAL IO is OFF.

Press **1**, **ENTER** keys to control the mainframe and module for the Digital I/O Port.

DIGITAL IO 1:ON 2:OFF

CAUTION DIGITAL IO and TIMING FUNCTION cannot be used at the same time. To control the mainframe and module via an external I/O, be sure to set the TIMING FUNCTION to OFF. When DIGITAL IO is set to ON, all the settings on the module won't be unable to execute Load ON loading until the DIGITAL IO is set to OFF.

Set ST/DYNA KEY.

It sets the key on the module to the Static/DYNAmic function when required. It can change the MEAS. hot key to ST/DYNA for users to switch CC mode and CC Dynamic mod on the module directly. The default setting of ST/DYNA KEY is OFF. Press **1**, **ENTER** to change the MEAS. function to the ST/DYNA function.

ST／DYNA KEY 1: ON 2: OFF

Select ECHO MODELNAME.

It gives users the ID for PC by changing the 6334A mainframe ID to 6334 mainframe so that the 6334 GPIB commands edited previously can be used to operate the PC. The default setting of ECHO MODELNAME is NEW.

ECHO MODELNAME 1: OLD 2: NEW

Set all channels at once.

In the LED mode, all LED mode settings can be set at once for the module under LED mode. Press **CONF** and ▲ ▼ to select CHANNEL SETTING and then press the numeric key (1, 2) to select ALL or SINGLE and **ENTER** to complete the setting. The setting can be done in any channel with LED mode and other channels with LED mode will change as well.

CHANNEL SETTING 1: ALL 2: SINGLE

WARNING This function supports LED simulation load only.

Change the setting Rd, Rd Coefficient or V_F.

Besides setting the Vo & Io, the setting of the 3rd primary parameter value for Rd, Rd Coefficient and VF can be changed too. Press **CONF** and ▲ ▼ to select Rd/Vf SELECT and then press the numeric keys (0~3) to select the desired value.

0：DEF., it selects the Rd Coefficient as the default and 0.15 is the default value.
1：COEFF, it sets the operating point Rd Coefficient value.
2：Ω, it sets the Ohm of operating point impedance Rd.
3：Vf, it sets the forward bias VF value.
4：Rd/Vf, it sets V_F and R_d.

Rd/Vf SELECT 1/3
0: DEF. 2: COEFF

Rd/Vf SELECT 2/3
2: Ω 3: Vf

Rd/Vf SELECT 3/3
4: Vf Rd

⚠WARNING This function supports LED simulation load only.

Set the load internal impedance R_r.
R_r is used to adjust the internal impedance for ripple current. It is suggested to set to OFF when the LED driver is on and is doing PWM dimming to avoid causing damage to the Electronic Load due to over transient current. Thus the default of R_r is OFF. The user can set the R_r to ON when the ripple current of LED driver needs to be tested.

Under the fixed operating point (V_o / I_o), the ripple current (I_{ripple}) is the V_{ripple} of LED driver divided by the equivalent impedance R_d of LED that is V_{ripple} / R_d = I_{ripple}. The LED driver output voltage using the switch power technology often has ripple voltage (V_{ripple}) and the frequency is the switch frequency that can up to 100kHz. However, since the LED simulation load is an active load, the internal control circuit has bandwidth limitation and it causes the R_d unable to cope with high frequency range (>100kHz).

The setting of high-frequency resistance R_r can be the same as R_d. However, considering the actual condition of ripple current, it is suggested to use an oscilloscope to check the actual LED load. Then, fine tune the R_r setting after comparison to get a more accurate ripple current simulation result.

Setting the R_r：
It enables the R_r function by changing the R_r in system configuration to ON. Press **1** and **ENTER** to change the R_r to ON.

Rr
1: ON 2: OFF

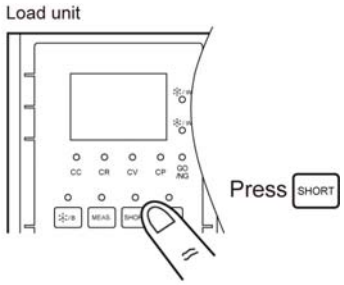
Press **Config** and ▲, ▼ to select R_r and press **ENTER** for setting. R_r has two setting as shown below. The user can change the setting as desired.

Rr
1. Default 2. Set

1: Default, it sets the R_r Ohm same as the Rd value in LED mode. When selecting 2. Set, the user has to set the R_r value within the range of 5Ω~125Ω. For instance, press **1**, **0**, **0**, **ENTER** to set the impedance to 100Ω if R_r=100Ω.

Rr:	100.00Ω

When R_r is ON, the **SHORT** key on the LED simulation load panel will switch to R_r function. The internal impedance R_r will paralleled with R_d when the **SHORT** key is pressed to see the ripple current of high frequency.



Note When the R_r is set to ON, the **SHORT** key will switch to R_r ON/OFF and the R_r is valid only when the **SHORT** key is pressed. Once the **SHORT** key is released, the R_r function will be disabled. Only 63310A is able to set R_r. It is not valid for 63313A.

CAUTION It is suggested to set to OFF when the LED driver is on and is doing PWM dimming to avoid causing damage to the Electronic Load due to over transient current.

Adjust the response speed of Electronic Load.

The response speed of Electronic Load can be adjusted based on the UUT status. Press **CONF** and ▲ ▼ to select RESPONSE SET and then the numeric keys 1, 2 to select 1: Default or 2: Set.

RESPONSE SET
1. Default 2.Set

When 2: Set is selected, press the numeric keys (1~5) to select the Electronic Load response speed and then press **ENTER** to complete the setting. The setting of response speed is 1(lowest) ~ 5(fastest) and the default is 2.

RESPONSE
PRESS1-5: 2

WARNING This function supports LED simulation load only.

Select LVP
It is low voltage protection function.

LVP
1: ON 2: OFF

⚠WARNING In 633xxA Series models, if the PCB version is C or above and FPGA version is 2.10 or above support this function, while 63310A does not support this function.

Select RC
It is Dampping RC on/off function. Turning off this function can increase the dynamic resistance.

RC
1: ON 2: OFF

⚠WARNING This function supports 63313A only. Turning off this function may affect the system stability. Once there is a problem with system stability, it is suggested to restart this function.

Display the versions of load module & mainframe.

INFORMATION
1. ON 2. OFF

When ON is selected, all firmware versions are shown as below and the following messages are closed when OFF is selected.

LOAD MODEL
Version: 1.00

Press ▼ key.

FRAME BOOT PROG.
Version: 1.00

Press ▼ key.

FRAME DOWN PROG.
Version: 1.00

Press ▼ key.

FRAME EXEC PROG.
Version: 1.00

4.2.8 Recalling Files/OCP Files/OPP Files

Press **RECALL** to recall files from 1 to 101. Files 1 to 100 are user data. File 101 is factory default settings. After a file is recalled, the display will go to mode editor for you to edit or view the file. By pressing **RECALL** the display will show the file No. last recalled. The default file No. is 2 when the mainframe is powered on.

Press **RECALL** , **3**, **ENTER** to recall the number 3.

RECALL FILE FILE NO: 3

The data of all channels will be recalled when you execute file recall.

Press **RECALL** , **2**,**ENTER** to recall OCP files from 1 to 10.

OCP FILE FILE NO: 2

Press **RECALL** , **3**,**ENTER** to recall OPP files from 1 to 10.

OPP FILE FILE NO: 3

4.2.9 Saving File/OCP File/OPP File/Default/Program

There are 100 file locations (1 to 100) for you to save files. Press **SAVE**, **2**, **0**, **ENTER** to save a file to location 20.

SAVE FILE FILE NO: 20

There are OCP file locations (1 to 10) for you to save files. Press **SAVE**, **2**, **ENTER** to save a file to location 2.

OCP FILE FILE NO: 2

There are OPP file locations (1 to 10) for you to save files. Press **SAVE**, **5**, **ENTER** to save a file to location 5.

OPP FILE FILE NO: 5

Press **SAVE**, **▼** until the display shows as follows. The DEFAULT states are used for the

electronic load after power-on. Press [1] to save DEFAULT to EEPROM.

SAVE DEFAULT 1: YES 2: NO

Press [SAVE], [▼] until the display shows as follows. Press [1] to save program.

SAVE PROGRAM 1: YES 2: NO

4.2.10 Going To Local

The [SHIFT] key operates as the local key, [LCL] when the electronic load is in remote mode. You can press [LCL] key to go to local operation when the load is in remote state. In local operation the [SHIFT] key operates as shift key.

4.2.11 Lock Operation

The lock operation disables the ability to change settings. When the data are locked, all settings cannot be changed. The operation of the [ON/OFF] and [SPEC] keys will not be affected by the lock function. Press [SHIFT] and [.] simultaneously to enable/disable lock function. This is a toggle key to enable/disable lock function.

4.2.12 Setting System and RS-232C Connection

The parameters of the RS-232C interface are set in the system. There are three parameters for you to set: Baud Rate, Parity Check and Data Bit number. Press [SHIFT] and [0] simultaneously to set system data.

Baud Rate : 0:600, 1:1200, 2:2400, 3:4800, 4:9600 bits/second.
Parity Check : 0:EVEN, 1:ODD, 2:NONE.
Data Bit : 0:7 bits, 1:8 bits.

The RS-232C connector on the rear panel of Mainframe is a 9-pin connector (DB-9, male connector). The RS-232C connector bus signal is defined as follows.

RS-232C Connector

Pin Number	Input/Output	Description
1	Output	+5V
2	Input	R×D
3	Output	T×D
4	Output	DTR
5	Output	GND
6	Input	DSR
7	NC	

8	NC	
9	NC	

Note Pin 1 (+5V) is for 6330A series Remote Controller only.

4.2.13 Connecting the GO/NG Output Port

The GO/NG output port on the rear panel of Mainframe is a 15-pin connector (DB-15, female connector). The GO/NG signals are TTL active low to indicate NG. They are defined as follows, see *Figure 4-6 Pin Assignment of DIGITAL I/O Port and GO/NG OUTPUT Port*.

GO/NG Output Port Connector

Pin Number	Channel No.	Description
1	1	H:PASS or SPEC. OFF, L:FAIL
3	2	H:PASS or SPEC. OFF, L:FAIL
5	3	H:PASS or SPEC. OFF, L:FAIL
7	4	H:PASS or SPEC. OFF, L:FAIL
9	5	H:PASS or SPEC. OFF, L:FAIL
11	6	H:PASS or SPEC. OFF, L:FAIL
13	7	H:PASS or SPEC. OFF, L:FAIL
15	8	H:PASS or SPEC. OFF, L:FAIL
8	Enable	H:SPEC. ON, L:SPEC. OFF

Note Pin 2, 4, 6, 10, 12, 14 are connected to GND.

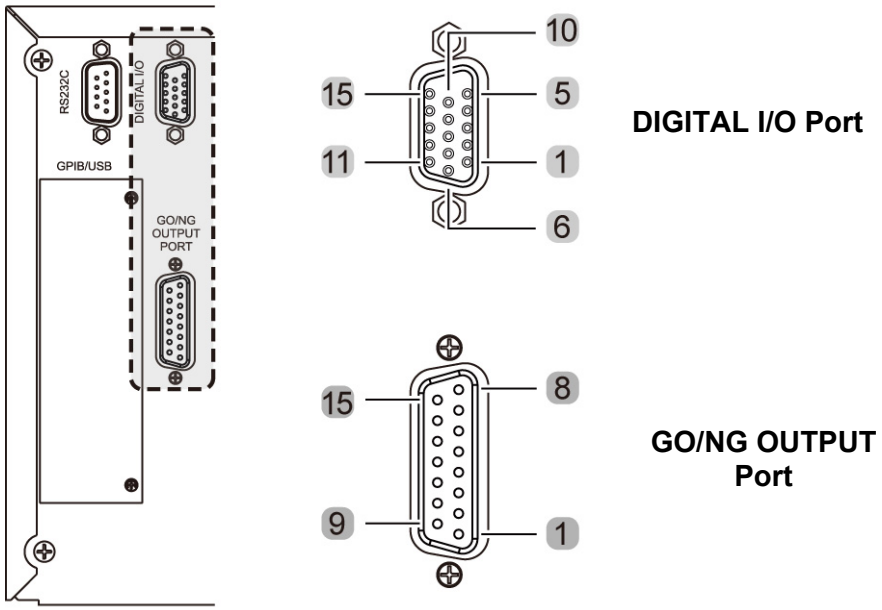


Figure 4-6 Pin Assignment of DIGITAL I/O Port and GO/NG OUTPUT Port

4.2.14 Connecting the DIGITAL IO Port

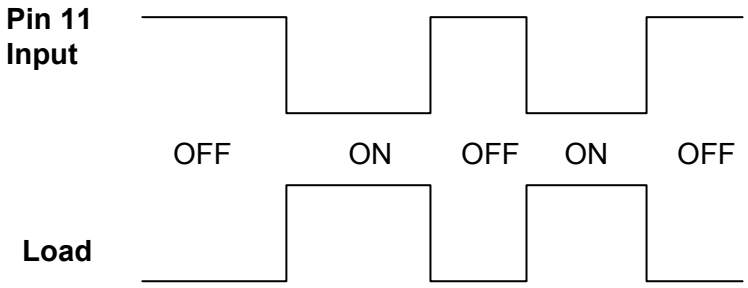
The Digital I/O is a 15 Pin Connector (DR3-15ST, Female) interface controlled by a TTL signal (sink current 10mA max.) The external TTL signal input controls contain External ON/OFF, External Trig., For Sequences Run and the Pass/Fail messages received through this interface including Load ON/OFF, Total Pass, Total Fail, Short Signal and Protection Signal. Please see *Figure 4-6 Pin Assignment of DIGITAL I/O Port and GO/NG OUTPUT Port* for detail information.

DIGITAL IO Port Connector

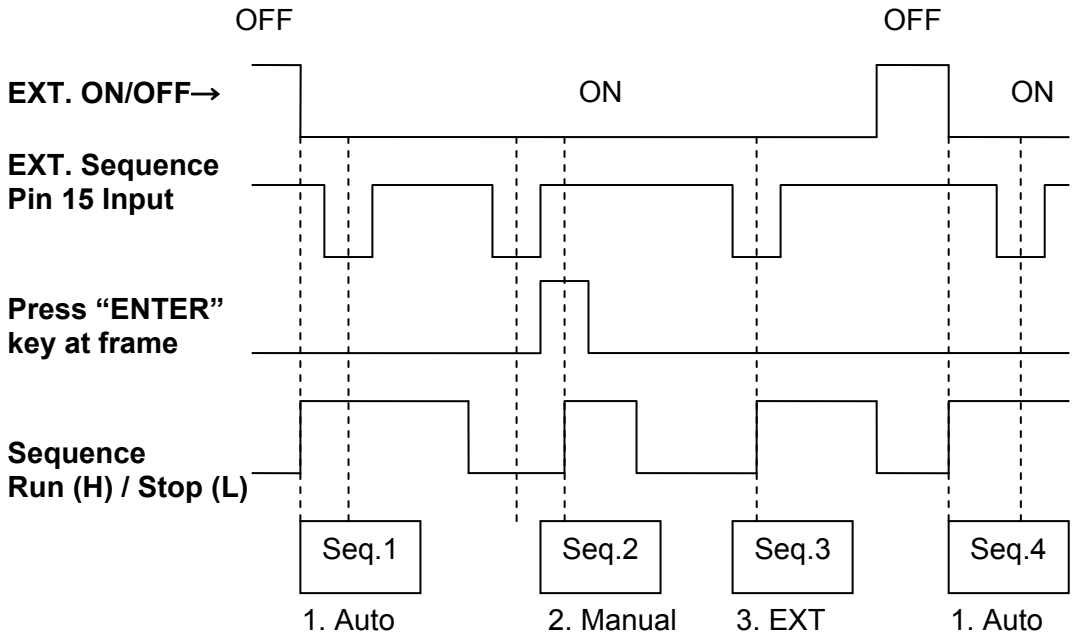
DR3-15ST Definition	
Pin Number	**Definition**
1	—
6	Load ON/OFF (O/P)
7	Total Pass (O/P)
8	Total Fail (O/P)
9	Short Signal (O/P)
10	Protection Signal (O/P)
11	External Load ON/OFF (I/P)
12	—
13	—
15	External Trig. For Sequences Run (I/P)

Note Pin 2, 3, 4, 5, 14 are connected to GND.

External ON/OFF (I/P): <50ms (Level)
Uses the TTL input signal (High > 4.3V, Low < 0.7V) to control the mainframe **ON/OFF** key to perform Sync. Run loading on the load module.

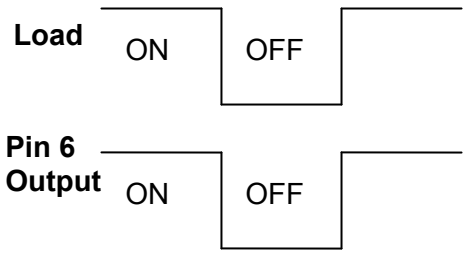


External Trig. For Sequences Run (I/P) <100ms (Pulse)
This signal is for external control program use only. It can only work when External ON/OFF input is ON. To execute the program loading test, select [3.EXT] in the control items (0.Skip, 1.Auto, 2.Manual, 3.EXT) for program selection. When the sequence is executed to the one requires [EXT] key in, the Port will input a pulse for execution. See section 4.2.4 and 4.2.5 for detail operation.



CAUTION When executing the program with the DIGITAL IO set to ON, the SQENCE can be controlled via remote signal if it is set to [EXT] control. Also press **ENTER** on the FRAME is able to control the SQENCE for SHORT.

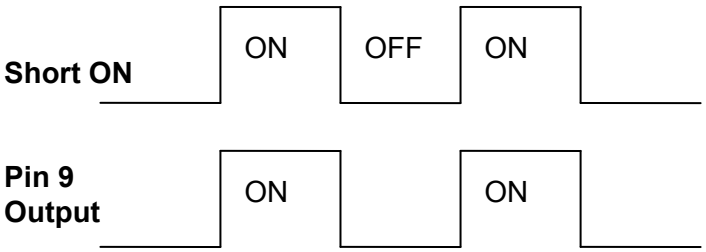
Load ON/OFF (O/P) : <50ms (Level)
This signal is the ON/OFF High/Low Level for actual loading. When the mainframe is ON, it outputs a High Level and outputs a Low Level when OFF.



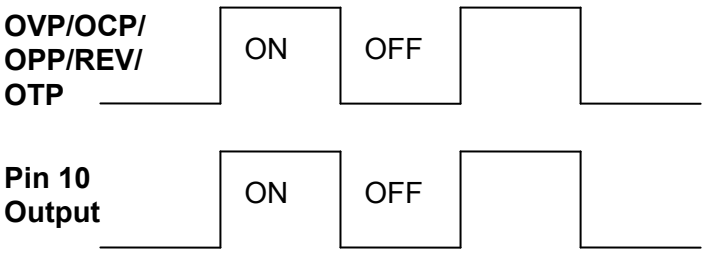
Total Pass (O/P): <100ms (Pulse)
This signal is for Program Seq. only. If all channel test items are Pass, the Pin7 on the Connector will output a High pulse signal to notify that all tests are Pass.

Total Fail (O/P): <100ms (Pulse)
This signal is for Program Seq. only. If one or more of all the channel test items are Fail, the Pin 8 on the Connector will output a High pulse to notify the tests are Fail.

Short Signal (O/P): <100ms (Level)
When executing the Short command, Short ON will output High Level and Short OFF will output Low Level.

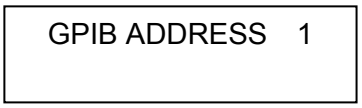


Protection Signal (O/P) : <100ms (Level)
When any of the channels is having protection, Protection ON will output High Level and Protection OFF will output Low Level.



4.2.15 Setting the GPIB Address

Please refer to the second part of this manual, Chroma 6330A Programming Manual. GPIB address displays after RS-232C parameters in the system. You can use this feature to check the GPIB address.



4.2.16 Using the Synchronous Cable

6330A Series supports up to 5 sets of mainframe synchronous load control, see 4.2.7 for the configuration setting. The connection between mainframe is via the RS-232C connector on the rear panel. Figure 4-7 shows the internal wiring of synchronous cable and MASTER/ SLAVE connection of mainframe. It requires another synchronous cable if one more SLAVE is desired. Be sure to connect the MASTER port to the EXTENDED port of previous cable and plug in the SLAVE port to mainframe, and so forth.

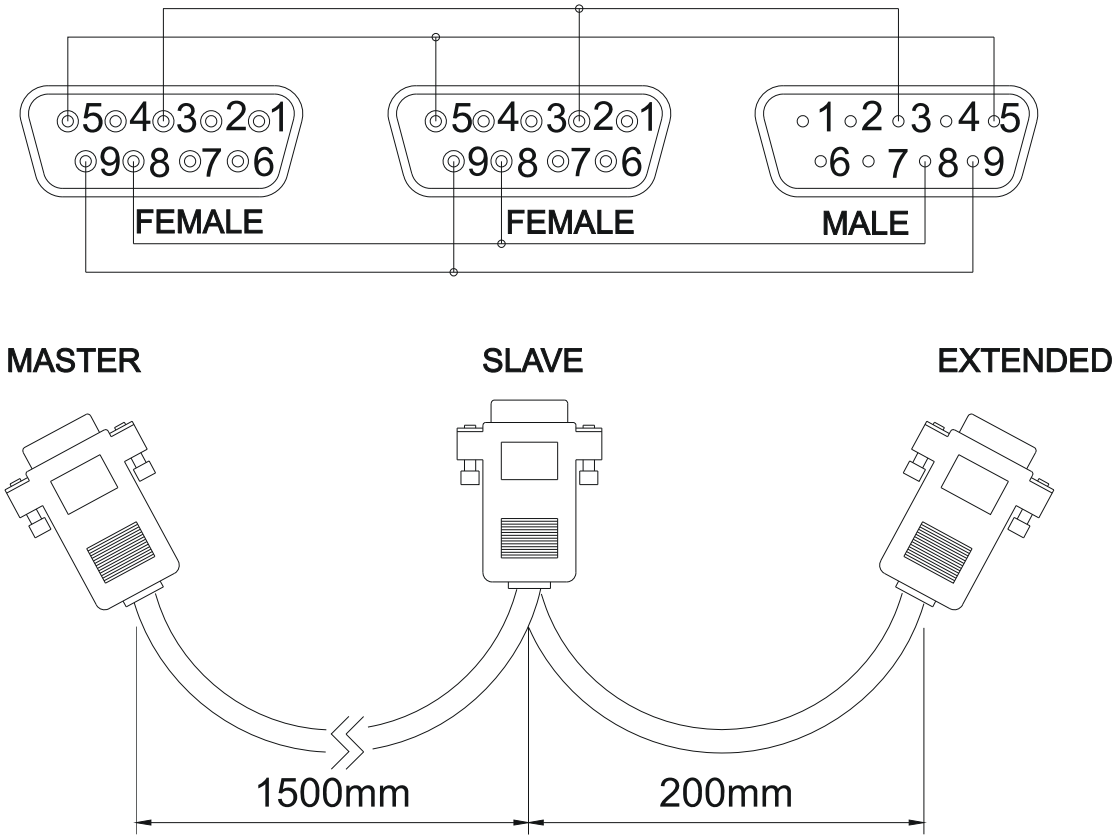


Figure 4-7 Synchronous Cable Connections

4.3 Local Operation of Load Module

There are two kinds of panels in the load module. One is a single channel/module panel. The other is a dual channel/module panel. There are four keys for each of the module panels. Only one key is different from these keypads. Figure 4-8 shows the single channel/module front panel.

4.3.1 Local Operation of Single Channel/Module (Panel A)

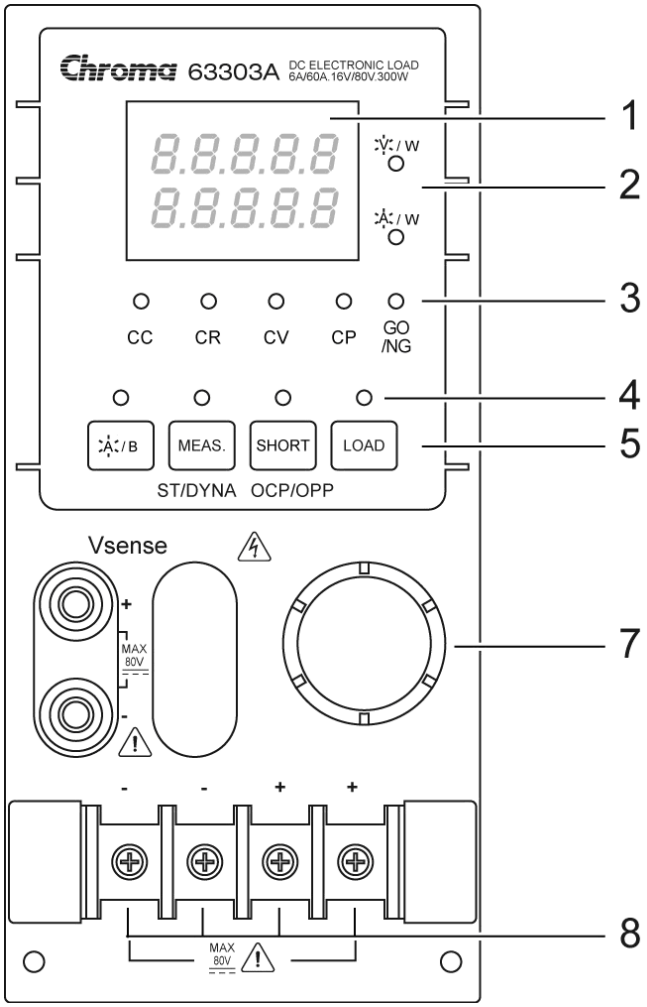


Figure 4-8 Single Channel/Module (Panel A)

1. 7-segment LED Display
   It displays the measurement Voltage, Current and Power. Each display has five digits.

2. 7-segment Display Unit Indicators
   They indicate the 7-segment display measurement unit V, I and P.

3. Operation Mode and GO/NG indicators
   They indicate the operation modes of CC, CR, CV, CP and GO/NG in the Load module. GO/NG LED indicator has two colors. The green LED is on for GO (pass) while the red for NG (fail). The GO/NG LED is off when SPEC test is OFF.

4. Keypad Indicators
   The four LEDs indicate the keypad status. Each LED shows the key status under the LED. Refer to the next paragraph for LED on/off status.

5. Keypad
   There are four keys for you to select/control the operation of load module. The **A/B** key is used to select static load level. Its LED will be on when the load is in level1 (A) state and off when in level2 (B) state or others. The **A/B** key can be used to select Fix mode for rotary knob setting too. Please refer to 4.3.4.

MEAS. key can select the measurement voltage (V), current (A) and power (W) using the 7-segment display. See section 4.3.4 for detail operation. The other function of this key is Static/DYNAmic mode, see 4.2.7 for detail description. Set ST/DYNA KEY to on in **CONF** can switch the **MEAS.** to **ST/DYNA**. The LED will be on when the Load is in DYNAmic mode. DYNAmic operation is only effective in CC mode. This key has no response in other modes.

The **SHORT** key enables the load to simulate the short function. Its LED will be on when the short function of the load is enabled. It operates only when the load input is enabled. It will not respond if the load input is not enabled.

The **LOAD** key controls the on/off of the load module input. Its LED will be on when the load input is enabled.

6. Vsense Connectors
   These two connectors are the Vsense measurement input. Refer to 2.5.2 for remote sense connections.

7. Rotary Knob
   This knob changes the level when the Load input is enabled. Rotating the knob clockwise will increase the level and counterclockwise will decrease the level. When you change the load level with the knob, the setting of Mainframe will not change. The changed load level will remain unless the same setting is changed on Mainframe.

8. Load Terminals
   These are the input connectors of the Load for connecting to the UUT. Each of them can carry 40 Amps maximum. If the current is over 40 Amps, you must connect two or more terminals for load connection. The PLUS (+) must be connected to the high potential of UUT. Refer to 2.5.1 for load input connection.

Examples

The following examples illustrate how to operate the module in CC mode.

1. Select Level1 (A) and Level2 (B)
   There are two levels of each mode for you to select in static function. The level1 (A) and level2 (B) can be selected through **A/B** key. Press **A/B** key to select current level1 or level2. When level1 (A) is selected, the LED of **A/B** key will be active. Press this key again to select level2 (B), and the LED will be inactive.

2. Select Dynamic Function
   Set the ST/DYNA KEY in **CONF** to ON to change the function of **MEAS.** to **ST/DYNA**. There are two functions for CC mode: STATIC and DYNAmic. These two functions can be selected by **ST/DYNA** key. Press **ST/DYNA** key to select Dynamic function. Press this key again to select the static function. When Dynamic function is selected, the LED of DYNA will be active.

3. Short the Load Input
   The load can simulate a short circuit across the input. The short circuit will be enabled when **SHORT** is pressed, and Load input is active (on). If the input is shorted, the short LED will be active. The **SHORT** key can be set in the configuration of toggled on/off mode or by pressing mode. If the **SHORT** key mainframe is pressed when the

mainframe is in OCP/OPP mode, it will perform the OCP/OPP test. See 4.2.3 for the detail operation.

4. Load Input On/Off
   The input can be toggled on or off by pressing **LOAD**. When the input is turned on, the LED of the load will be active.

4.3.2 Local Operation of Dual Channel/Module (Panel B)

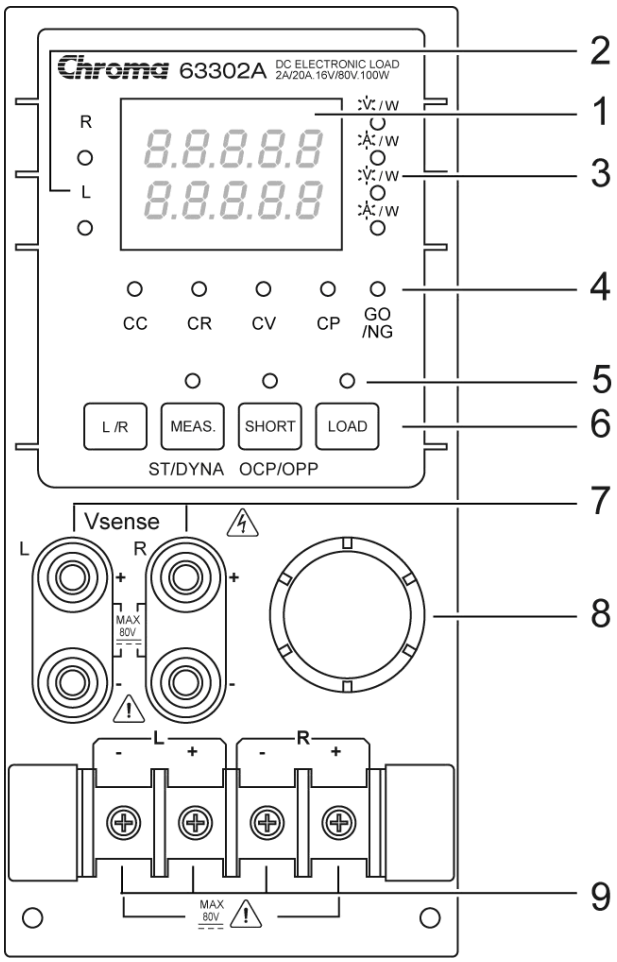


Figure 4-9 Dual Channel/Module (Panel B)

The dual channel/module means that there are two channels for one module. Each channel of module is isolated from the other. One set of display/keypad for the module can control both channels. The left channel is called channel L while the right one channel R. The 7-segment LED displays one or two channel status. The keypad and rotary knob can control both channels through the **L/R** key.

1. 7-segment LED Display
   The 7-segment LED displays measurement Voltage, Current and Power of single or dual channel. Each display has five digits.

2. The Channel LED Indicators
   There are two LEDs indicating the active right and/or left channel(s) of Load module. When the LED of channel R is on, the 7-segment display, mode, GO/NG indicators, and keypad are active on channel R. Channel L has the same function as channel R when its LED indicator is on.

   When the indicators of channel R and L are on, the 7-segment display selectively shows both channels' V or I or P. The indicators and keys, **SHORT**, **LOAD** in operation mode will be disabled when both channels are selected.

3. 7-segment Display Unit Indicators
   They indicate the 7-segment display measurement unit V, I and P.

4. Operation Mode and GO/NG Indicators
   When the LED of channel R or L is on, the operation and GO/NG LED has the same function as single channel/module. When the LEDs of channel R and L are on, the LED of operation mode indicators will be disabled (off). The GO/NG LED will be red when the check of any channel SPEC fails. It will be green when the check of both channels SPEC is all right.

5. Keypad Indicators
   There are three LEDs indicating the keypad status. Each LED shows the key status. It has the same function as single channel/module. The LED of the load will be active when any input of channel L or R is on.

6. Keypad
   There are four keys for you to select /control the operation of the load module. The **L/R** key is used to select the display of 7-segment LED, and the indicators of channel R and/or L. The **L/R** key can be used to select Fix mode for rotary knob setting too. Please refer to 4.3.4.

7. Vsense Connectors
   These four connectors are for Vsense measurement input. The two connectors on the right are for right channel while those on the left for left channel. Refer to 2.5.2 for remote sensing connections.

8. Rotary Knob
   The knob has the same function as the single channel/module when channel R or L is selected. If the indicators of channel R and L are on, the knob will be disabled.

9. Load Terminals
   They are input connectors of the Load for connecting to the UUT. The two terminals on the left are for input of the left channel while those on the right for that of the right channel. The PLUS (+) sign of the input of each channel must be connected to the high potential. Refer to 2.5.1 for load input connections.

Examples

The following examples illustrate how to select the dual channel/module in CC mode.

There are two channels/modules, so you have to select the right or left channel for display & keypad. When channel R and L are selected, only **L/R** key is enabled. Other keys are disabled. During power-on, the pre-selected channel is channel L. It means that the 7-segment display, indicators and keypad are active at channel L. The dual channel/module

has the same function as single channel/module. But it cannot select level 2(B).

1. The display sequence of **L/R** key is channel L -> channel R -> channels L+R display V -> channels L+R display I -> channels L+R display P back to channel L.

2. Select Dynamic Function
   Set the ST/DYNA KEY in **CONF** to ON to change the function of **MEAS.** to **ST/DYNA**. The static and dynamic functions can be selected through the **ST/DYNA** key. Press this key to select the Dynamic function, and press again to select the static function. When Dynamic function is selected, the LED of DYNAmic will be active.

3. Short the Load Input
   The Load can simulate a short circuit across the input. The short circuit can be enabled when **SHORT** is pressed, and the load's input is active. When the input is shorted, the LED of short will be active. The **SHORT** key can be set in the configuration of toggled on/off mode or active by pressing mode. If the **SHORT** key frame is pressed when the frame is in OCP/OPP mode, it will conduct the OCP/OPP test. See 4.2.3 for the detail operation.

4. Load Input On/Off
   The input can be toggled on or off by pressing **LOAD**. When the input is turned on, the LED of **LOAD** will be active.

4.3.3 Switching of MEAS. Voltage, Current & Power on Module

Pressing the **MEAS.** key can switch the measurement modes via the 7-segment display. There are 3 types of measure modes - Mode 1: Voltage (V) and Current (A); Mode 2: Power (W) and Current (A); Mode 3: Voltage (V) and Power (W), see Figure 4-10.

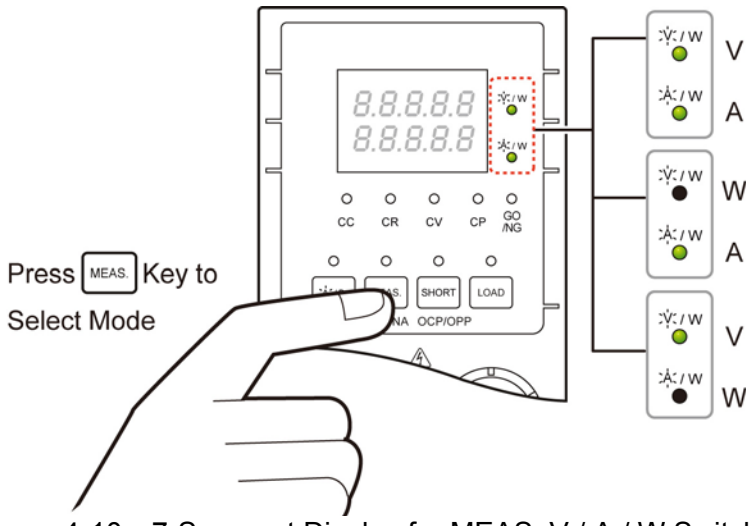


Figure 4-10 7-Segment Display for MEAS. V / A / W Switch

4.3.4 Online Change Level

The load module provides the user with two ways to change level. They make it convenient to change the load directly with the rotary knob in LOADON. These two operation modes are described below.

Ratio Mode: In LOADON change load with the rotary knob.
When the rotary knob rotates clockwise, it operates as follows.
CC mode: raise the current value.
CR mode: raise the resistance value.
CV mode: raise the voltage value.
CP mode: raise the power value.

When the rotary knob rotates counterclockwise, it operates as follows.
CC mode: lower the current value.
CR mode: lower the resistance value.
CV mode: lower the voltage value.
CP mode: raise the power value.

The modulation is dependent on the rotating speed of the rotary knob.

Fixed Mode: In LOAD ON press **A/B** key (single channel/module) or **L/R** key (double channel/module) for over 2.5 seconds to enter this operation mode. Now V, I will be displayed in the fixed positions. Press **A/B** /**L/R** or **STATIC/DYNA** key to shift a digit left or right. The resolution nearest to that digit will begin to change. The changed digit will be displayed boldly, and modulated by the rotary knob. To exit from this mode press the **A/B** or **L/R** key for more than 2.5 seconds.

Notice

The value of the mainframe setting will not be changed if the setting is changed by the rotary knob. Therefore, when you change the value of a setting with the rotary knob, the value of the load module setting and that of mainframe setting will not be the same.

PART 2

Programming

5. General Information for Programming

5.1 Introduction

This section describes how to program the 6330A series electronic load remotely from a GPIB controller, or USB controller or RS232C. The command set introduced here can be applied to all electronic loads of 6330A series, including 63301A, 63302A, 63303A, etc. equipped with optional GPIB cards or USB cards or standard equipment, RS232C.

Either GPIB or USB or RS232C can be used at one time. They cannot be used simultaneously. If GPIB is used first in remote control, USB & RS232C will be disabled unless the machine is reset, and vice versa.

5.2 DIP Switches on the GPIB Card

5.2.1 GPIB Address

Before programming the electronic load remotely via a GPIB computer, you need to know the GPIB address. Each device connected to the GPIB interface has a unique address assigned to it. Such address allows the system controller to communicate with individual devices. Setting GPIB address of an individual mainframe, the Chroma 6332A or 6334A, is done with an 8-bit DIP switch on a GPIB card at its rear panel. Five bits, from A1 to A5, are GPIB address bits, which offer addressing space from 0 to 30. For details please refer to the following illustration and table.

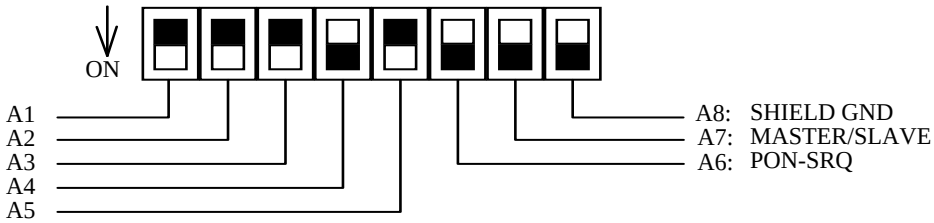


Table 5-1 GPIB address

Address	A5	A4	A3	A2	A1	Address	A5	A4	A3	A2	A1
0	0	0	0	0	0	16	1	0	0	0	0
1	0	0	0	0	1	17	1	0	0	0	1
2	0	0	0	1	0	18	1	0	0	1	0
3	0	0	0	1	1	19	1	0	0	1	1
4	0	0	1	0	0	20	1	0	1	0	0
5	0	0	1	0	1	21	1	0	1	0	1
6	0	0	1	1	0	22	1	0	1	1	0
7	0	0	1	1	1	23	1	0	1	1	1
8	0	1	0	0	0	24	1	1	0	0	0
9	0	1	0	0	1	25	1	1	0	0	1
10	0	1	0	1	0	26	1	1	0	1	0
11	0	1	0	1	1	27	1	1	0	1	1
12	0	1	1	0	0	28	1	1	1	0	0

13	0	1	1	0	1	29	1	1	1	0	1
14	0	1	1	1	0	30	1	1	1	1	0
15	0	1	1	1	1						

5.2.2 Other DIP Switches

The remaining bits on the DIP switch, A6-A8, preset the electronic load mainframe 6332A or 6334A to the following functions:

Bit	Meaning	Preset	Description
A6	Frame LOAD ON Link	OFF	When ON is set, two frames can act as LOAD Key ON/OFF through RS232C port.
A7		OFF	It must be “OFF”.
A8	SHIELD GND	OFF	It is the selection for enabling shield ground.

5.3 GPIB Capability of the Electronic Load

GPIB Capability	Response	Interface Functions
Talker/Listener	All electronic load functions except for setting the GPIB address are programmable over the GPIB. The electronic load can send and receive messages over the GPIB. Status information is sent using a serial poll.	AH1, SH1, T6, L4
Service Request	The electronic load will set the SRQ line true if there is an enabled service request condition.	SR1
Remote/Local	In local mode, the electronic load is controlled from the front panel but will also execute commands sent over the GPIB. The electronic load powers up in local mode and remains there until it receives a command over the GPIB. Once the electronic load is in remote mode, *REMOTE* will be shown on the front panel LCD, all front panel keys except LCL are disabled, and the load module display is in normal metering mode. Pressing LCL key on the front panel returns the electronic load to local mode. Local can be disabled using local lockout, so only the controller or the power switch can return the electronic load to local mode.	RL1
Device Clear	The electronic load responds to the Device Clear (DCL) and Selected Device Clear (SDC) interface commands. These cause the electronic load to clear any activity that may prevent it from receiving and executing a new command. DCL and SDC do not change any programmed settings.	DCL, SDC

5.4 RS232C in Remote Control

When you use RS232C in remote control, you have to send the remote command of CONFigure:REMote ON first in order to let control procedure enter into remote state, and then do other command set. When control comes to an end, you have to send the command of CONFigure:REMote OFF so as to let control procedure return to the mode of local operation.

The control commands of RS232C are the same as those of GPIB. When the string comes to an end in the command sending of RS232C, <nl> must be added. Its ASCII code is 0A hexadecimal (or 10 decimal).

6. Introduction to Programming

6.1 Basic Definition

GPIB statement includes instrument control and query commands. A command statement sends an instruction to the electronic load, and a query command requests information from the electronic load.

Simple Command
The simplest command statement consists of a command or keyword usually followed by a parameter or data:

LOAD ON
or TRIG

Compound Command
When two or more keywords are connected by colons (:), it creates a compound command statement. The last keyword usually is followed by a parameter or data:

CURRent : STATic : L1 3
or CONFigure : VOLTage : RANGe H

Query Command
A simple query command consists of a keyword followed by a question mark:

MEASure : VOLTage?
MEASure : CURRent?
or CHAN?

Forms of Keywords
Every keyword has two forms:
Long-Form The word is spelled out completely to identify its function. For instance, CURRENT, VOLTAGE, and MEASURE are long-form keywords.
Short-Form The word contains only the first three or four letters of the long-form. For instance, CURR, VOLT, and MEAS are short-form keywords.

In keyword definitions and diagrams, the short-form part of each keyword is emphasized in UPPER-CASE letters to help you remember it. However, the electronic load will accept Volt, volt, voltage, VOLTAGE, volTAGE, etc. without regard to which form you apply. If the keyword is incomplete, for example, “VOL” or “curre”, it will not be recognized.

6.2 Numerical Data Formats

The Chroma 6330A electronic load accepts the numerical data type listed in Table 6-1. Numeric data may be followed by a suffix that dimensions the data. A suffix may be preceded by a multiplier. The Chroma 6330A makes use of the suffixes listed in Table 6-2 and multipliers listed in Table 6-3.

Table 6-1 Numerical Data Type

Symbol	Description	Example
NR1	Digits with no decimal point. The decimal point is assumed to be to the right of the least-significant digit.	123, 0123
NR2	Digits with a decimal point.	123., 12.3, 0.123, .123
NR3	Digit with a decimal point and an exponent.	1.23E+3, 1.23E-3
NRf	Flexible decimal form that includes NR1 or NR2 or NR3.	123, 12.3, 1.23E+3
NRf+	Expanded decimal form that includes NRf and MIN, MAX. MIN and MAX are the minimum and maximum limit values for the parameter.	123, 12.3, 1.23E+3, MIN, MAX

Table 6-2 Suffix Elements

Mode	Class	Preferred Suffix	Secondary Suffix	Referenced Unit
CC	Current	A		Ampere
CR	Resistance	OHM		Ohm
CV	Amplitude	V		Volt
All	Time	S		Second
			MS	Millisecond
All	Slew Rate	A/μS		Amperes/micro Second

Table 6-3 Suffix Multipliers

Multiplier	Mnemonic	Definition
1E6	MA	mega
1E3	K	kilo
1E-3	M	milli
1E-6	U	micro
1E-9	N	nano

6.3 Character Data Formats

For command statements, the <NRf+> data format permits entry of required characters. For query statements, character strings may be returned in either of the forms shown in the following table. It depends on the length of the returned string.

Symbol	Character Form
crd	Character Response Data. They permit the return up to 12 characters.
aard	Arbitrary ASCII Response Data. They permit the return of undelimited 7-bit ASCII. This data type is an implied message terminator (refer to “Separators and Terminators”).

6.4 Separators and Terminators

In addition to keywords and parameters, GPIB program statements require the following:

Data Separators:
Data must be separated from the previous command keyword by a space. This is shown in examples as a space (CURR 3) and on diagrams by the letters *SP* inside a circle.

Keyword Separators:
Keywords (or headers) are separated by a colon (:), a semicolon (;), or both. For example:

- **LOAD:SHOR ON**
- **MEAS:CURR?;VOLT?**
- **CURR:STAT:L1 3;:VOLT:L1 5**

Program Line Separators:
A terminator informs GPIB that it has reached the end of a statement. Normally, this is sent automatically by your GPIB programming statements. The termination also occurs with other terminator codes, such as EOI. In this manual, the terminator is assumed at the end of each example line of code. If it needs to be indicated, it is shown by the symbol <nl>, which stands for "new line" and represents the ASCII coded byte 0A hexadecimal (or 10 decimal).

Traversing the Command Tree:

- The colon ":" separates keywords from each other which represent changes in branch level to the next lower one. For example:

  CONF:VOLT:ON 5
  CONF is a root-level command, *VOLT* is the first branch, and *ON* is the second branch. Each ":" moves down command interpretation to the next branch.

- The semicolon ";" allows you to combine command statements into one line. It returns the command interpretation to the previous colon.

  For example: Combine the following two command statements:
  RES:RISE 100 <nl> and
  RES:L1 400 <nl>
  which can be formed into one command line as follows:
  RES:RISE 100;L1 400 <nl>

- To return to the root-level form you can
  1. Enter a new-line character. This is symbolized by "<nl>" and can be linefeed "LF" or/and end-of-line "EOL". Or else,
  2. Enter a semicolon followed by a colon ";:".

  Please refer to the following.

1. (root):VOLT:L1: 30<nl>
   Starting a New Line returns to the Root.

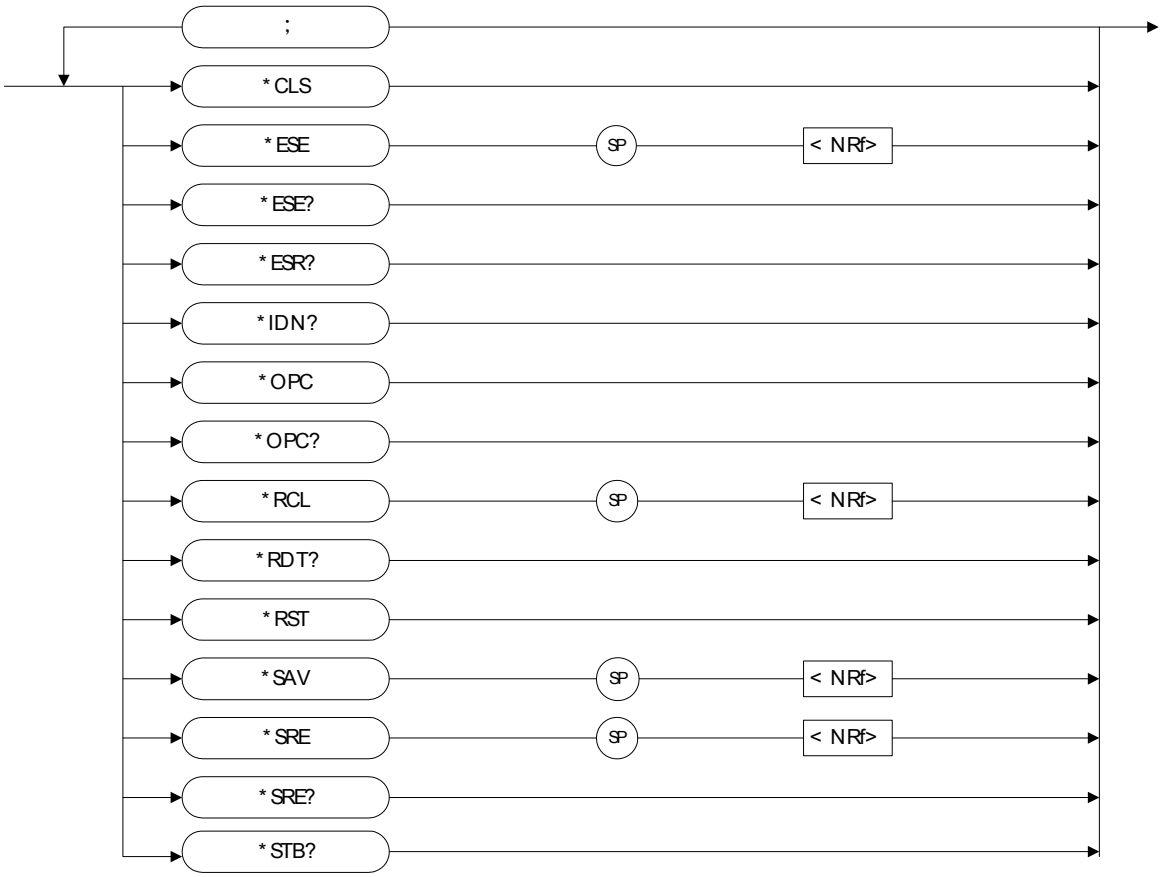
2. (root):SPEC:VOLT:H 30;
   :L 5;:
   (root):RES:L1 400;
   :RISE 1000;:

7. Language Dictionary

Commands for operating the 6330A Electronic Load remotely are grouped into subsystems. Each command belonging to the same subsystem is arranged in alphabetic order. A syntax chart of the subsystem, which includes the commands belonging to the same group, is given. Sub-systems are then ordered alphabetically according to their names in the following sections.

7.1 Common Commands

Common commands defined by the IEEE488.2 standard are generic commands and queries. The first part of the language dictionary covers these commands. Each of them has a leading "*".



CLS** **Clear Status Command

Type : Device Status

Description : The *CLS command executes the following actions:

1. Clear these registers
   - <1> Channel Status Event registers for all channels
   - <2> Channel Summary Event register
   - <3> Questionable Status Event register
   - <4> Standard Event Status Event register
   - <5> Operation Status Event register

2. Clear the Error Queue
3. If “Clear Status Command” immediately follows a program message terminator (<nl>), the “Output Queue” and the MAV bit are also cleared.

Syntax : *CLS
Parameters : nil

**ESE Standard Event Status Enable Command/Query*

Type : Device Status
Description : This command sets the condition of the Standard Event Status Enable register, which determines which events of the Standard Event Status Event register (see *ESR?) are allowed to set the ESB (Event Summary Bit) of the Status Byte register. A "1" in the bit position enables the corresponding event. All of the enable events of the Standard Event Status Event register are logically ORed to cause the ESB (bit 5) of the Status Byte register to be set. See description of all three registers in *Chapter 8 Status Reporting*.
Syntax : *ESE <NRf>
Parameters : 0 to 255
Example : *ESE 48 This command enables the CME and EXE events of the Standard Event Status Event register.
Query Syntax : *ESE?
Return Parameters : <NR1>
Query Example : *ESE? This query returns current setting of "Standard Event Status Enable".

**ESR? Standard Event Status Register Query*

Type : Device Status
Description : This query reads the Standard Event Status register. Reading the register clears it. See detailed explanation of this register in *Chapter 8 Status Reporting*.

Standard Event Status Event register

Bit Position	7	6	5	4	3	2	1	0
Condition	0	0	CME	EXE	DDE	QYE	0	0
Bit Weight	128	64	32	16	8	4	2	1

Query Syntax : *ESR?
Return Parameters : <NR1>
Query Example : *ESR? It returns the status readings of Standard Event Status register.
Return Example : 48

**IDN? Identification Query*

Type : System Interface
Description : This query requests the Electronic Frame (6334A) to identify itself.
Query Syntax : *IDN?
Return Parameters : <aard>
Query Example : *IDN?
String Information

	CHROMA	Manufacture
	6334A	Model
	0	Always return zero
	01.00	Revision level of the primary interference firmware
	0	Customer's version

Return Example : CHROMA 6334A,0,01.00,0

****OPC Operation Complete Command***

Type : Device Status
Description : This command causes the interface to set the OPC bit (bit 0) of the Standard Event Status register when the Electronic Frame (6334A) has completed all pending operations.
Syntax : *OPC
Parameters : nil

****OPC? Operation Complete Query***

Type : Device Status
Description : This query returns an ASCII "1" when all pending operations are completed.
Query Syntax : *OPC?
Return Parameters : <NR1>
Query Example : 1

****RCL Recall Instrument State Command***

Type : Device Status
Description : This command restores the electronic load to a state that was previously stored in memory with the *SAV command to the specified location (see *SAV).
Syntax : *RCL <NRf>
Parameters : 1 to 101
Example : *RCL 50

****RDT? Resource Description Transfer Query***

Type : System Interface
Description : This command returns the types of Electronic Frame (6334A). If channel does not exist, it returns 0. If channel exists, it returns the types like 63303A, 63302A, 63307R, 63307L...
Query Syntax : *RDT?
Return Parameters : <aard>
Query Example : 63307L, 63307R, 63303A, 0, 63302A, 63302A, 0, 0.

****RST Reset Command***

Type : Device State
Description : This command forces an ABORt, *CLS, LOAD=PROT=CLE command.
Syntax : *RST
Parameters : nil

**SAV Save Command*

Type : Device Status
Description : This command stores the present state of the single electronic load and the states of all channels of the multiple loads in a specified location in memory.
Syntax : *SAV <NRf>
Parameters : 1 to 100
Example : *SAV 50

**SRE Service Request Enable Command/Query*

Type : Device Status
Description : This command sets the condition of the Service Request Enable register, which determines which events of the Status Byte register (see *STB) are allowed to set the MSS(Master Status Summary) bit. A "1" in the bit position enable bits are logically ORed to cause Bit 6(the Master Summary Status Bit) of the Status Byte register to be set. See details concerning the Status Byte register in *Chapter 8 Status Reporting*.
Syntax : *SRE <NRf>
Parameters : 0 to 255
Example : *SRE 20 It enables the CSUM and MAV bit of the Service Request Enable.
Query Syntax : *SRE?
Return Parameters : <NR1>
Query Example : *SRE? It returns the setting for "Service Request Enable".

**STB? Read Status Byte Query*

Type : Device Status
Description : This query reads the Status Byte register. Note that the MSS (Master Summary Status) bit instead of RQS bit is returned in Bit 6. This bit indicates if the electronic load has at least one reason for requesting service. *STB? does not clear the Status Byte register, which is cleared only when subsequent action has cleared all its set bits. Refer to *Chapter 8 Status Reporting* for more information about this register.

Status Byte Register

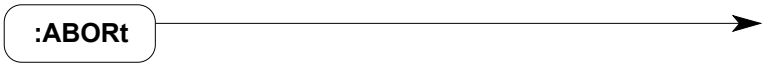
Bit Position	7	6	5	4	3	2	1	0
Condition	0	MSS	ESB	MAV	QUES	CSUM	0	0
Bit Weight	128	64	32	16	8	4	2	1

Query Syntax : *STB?
Return Parameters : <NR1>
Query Example : *STB? It returns the contents of "Status Byte".
Return Example : 20

7.2 Specific Commands

The 6330A series products are equipped with the following specific GPIB commands.

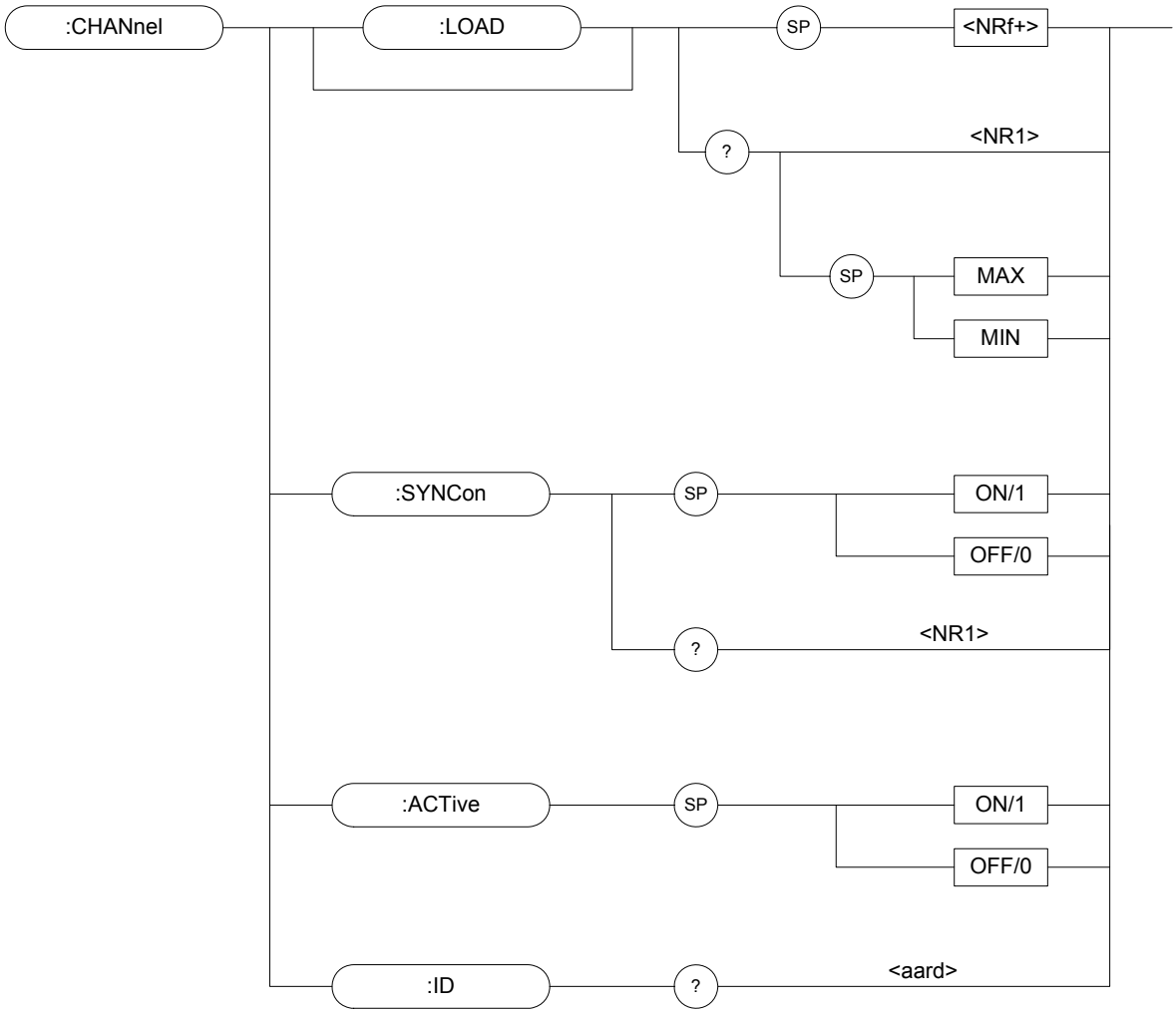
7.2.1 ABORT Subsystem



ABORt

Type : All Channels
Description : It sets all electronic loads to "OFF".
Syntax : ABORt

7.2.2 CHANNEL Subsystem



CHANnel:[LOAD]

Type : Channel Specific
Description : It selects a specific channel by which the coming channel-specific command will be received and executed.
Syntax : CHANnel <NRf+>
Parameters : 1 ~ 8
Example : CHAN 1 It sets the specific channel as "1".
CHAN MAX It sets the specific channel as "8".
CHAN MIN It sets the specific channel as "1".
Query Syntax : CHAN?
CHAN? MAX
CHAN? MIN
Return Parameters : <NR1>
Query Example : CHAN? It returns the current specific channel.
Return Example : 1

CHANnel:ACTive

Type : Channel Specific
Description : It enables or disables the load module.
Syntax : CHANnel:ACTive ON. It enables the load module. The front panel displays the measurement of voltage and current.
CHANnel:ACTive OFF. It disables the load module. LCD on the front panel displays OFF.
Parameter : ON/1, OFF/0
Example : CHAN : ACT ON

CHANnel:SYNCon

Type : Channel Specific
Description : It sets the load module to receive synchronized command action of RUN ABORT or not.
Syntax : CHANnel:SYNCon ON
CHANnel:SYNCon OFF
Parameters : ON/1, OFF/0
Example : CHAN:SYNC ON. It sets the load module to receive synchronized command action.
CHAN:SYNC OFF. It sets the load module not to receive synchronized command action.
Query Syntax : CHAN:SYNC?
Return Parameters : <NR1>
Query Example : CHAN:SYNC? It returns to the load module and makes it receive synchronized command status.
Return Example : 0 The load module does not receive synchronized command status.
: 1 The load module receives synchronized command status.

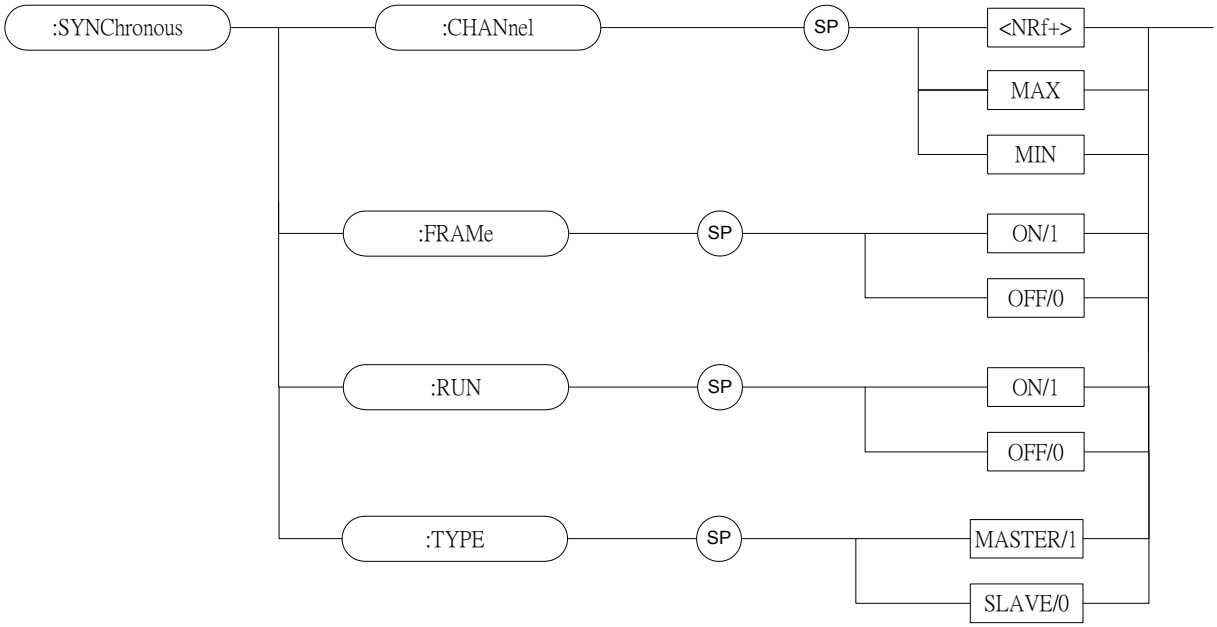
CHAN:ID?

Type : Channel-Specific
Description : This query requests the module to identify itself.
Query Syntax : CHAN:ID?
Return Parameters : <aard>
Query Example : CHAN:ID?

String	Information
CHROMA	Manufacturer
6330XA	Model
0	Serial No.
xx.xx	Revision of the primary interface firmware
0	PCB version no.

Return Example : CHROMA,63302A,0,01.00,0

7.2.3 SYNCHRONOUS Subsystem



SYNChronous:CHANnel

Type: All Channels
Description: Set the specified channel to T1 & T2 in sync dynamic mode for parallel loading.
Syntax: SYNChronous:CHANnel <NRf+>
Parameters: 1 ~ 8
Example: SYNC:CHAN 1 It sets the specified channel to "1".
SYNC:CHAN MAX It sets the specified channel to "8".

	SYNC:CHAN MIN	It sets the specified channel to "1".

SYNChronous:FRAMe

Type:	All Channels	
Description:	Set the mainframe if to sync. in parallel run. The 6330 series have a master/slave paralleling control mode that allows synchronous load control in static and dynamic loading mode.	
Syntax:	SYNChronous: FRAMe ON.	It enables the mainframe to sync. in parallel run.
	SYNChronous: FRAMe OFF.	It disables the mainframe to sync. in parallel run.
Parameter:	ON/1, OFF/0	
Example:	SYNC: FRAM ON	

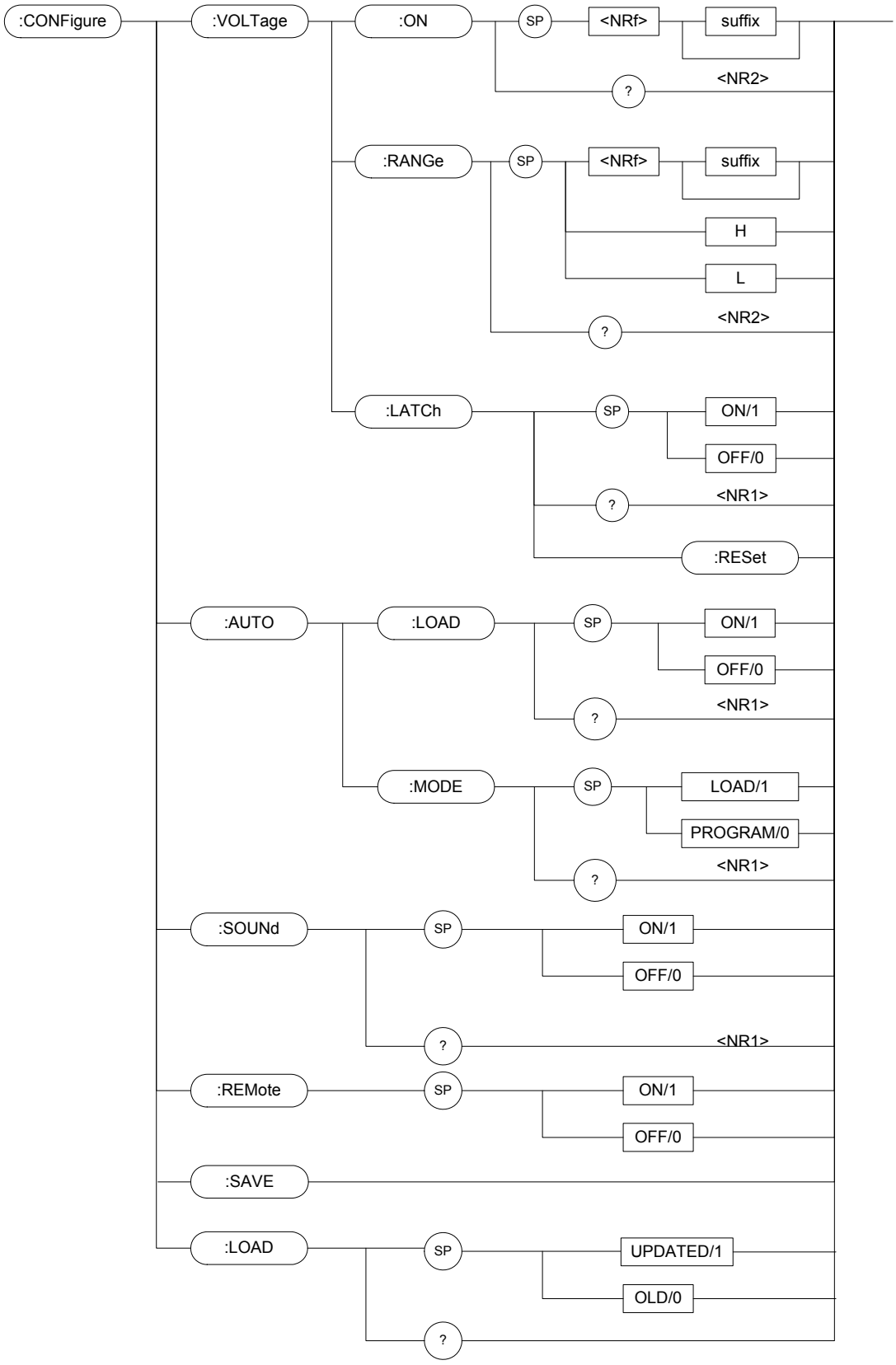
SYNChronous:RUN

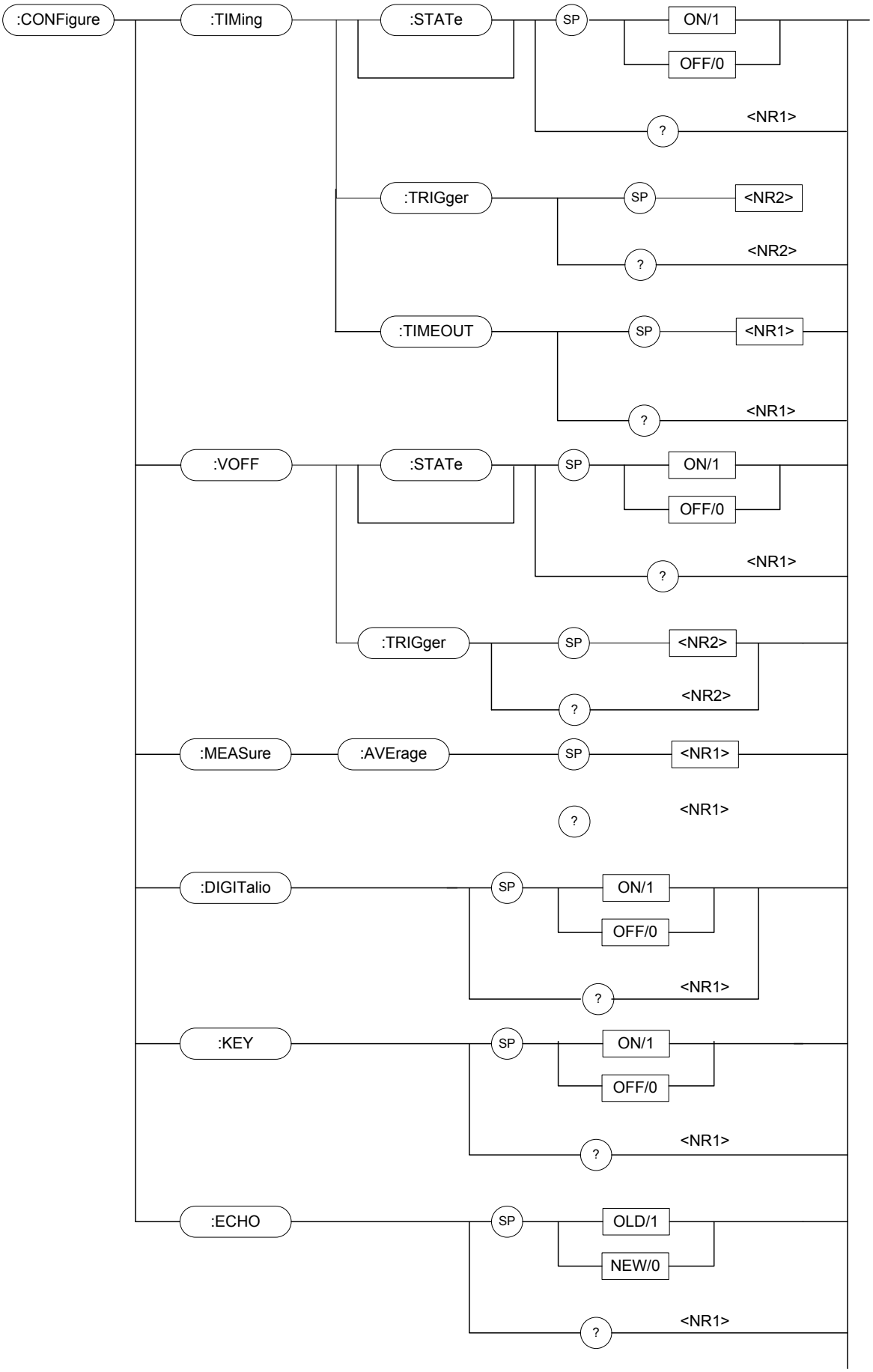
Type:	All Channels	
Description:	Set all electronic loads to “ON” in sync. parallel run.	
Syntax:	SYNChronous: RUN ON	
	SYNChronous: RUN OFF	
Parameters:	ON/1, OFF/0	
Example:	SYNC: RUN ON	It sets the load to “ON” on sync. parallel.
	SYNC: RUN OFF	It sets the load to “OFF” on sync. parallel.

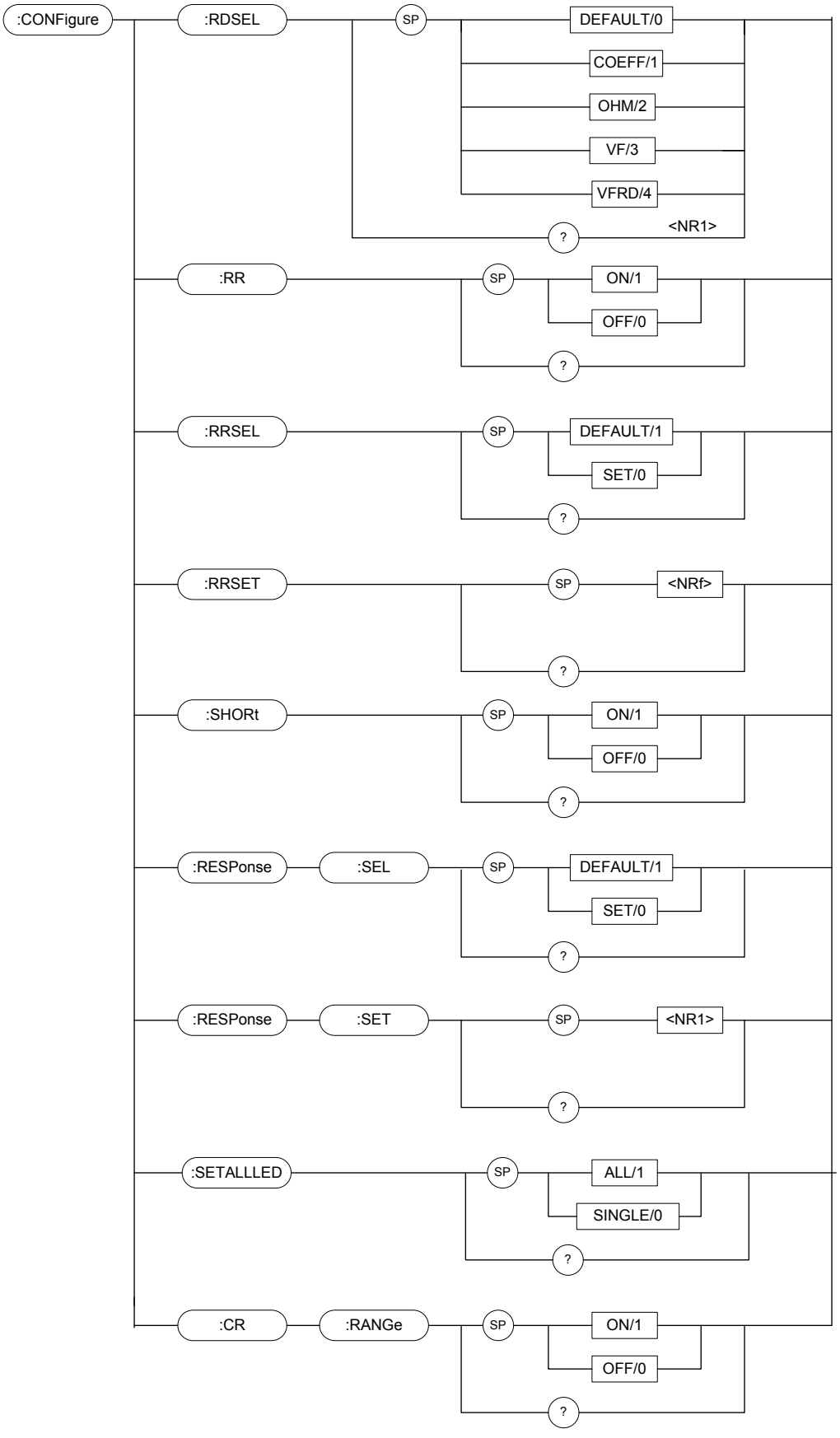
SYNChronous:TYPE

Type:	All Channels	
Description:	Set the specified mainframe to master or slave for sync. in parallel run.	
Syntax:	SYNChronous: TYPE MASTER	
	SYNChronous: TYPE SLAVE	
Parameters:	MASTER /1, SLAVE /0	
Example:	SYNC: TYPE MASTER	It sets the mainframe to master for sync. in parallel run.
	SYNC: TYPE SLAVE	It sets the mainframe to slave for sync. in parallel run.

7.2.4 CONFIGURE Subsystem




:CONFigure
:TIMing
:STATe
SP
ON/1
OFF/0
?
<NR1>
:TRIGger
SP
<NR2>
?
<NR2>
:TIMEOUT
SP
<NR1>
?
<NR1>
:VOFF
:STATe
SP
ON/1
OFF/0
?
<NR1>
:TRIGger
SP
<NR2>
?
<NR2>
:MEASure
:AVErage
SP
<NR1>
?
<NR1>
:DIGITalio
SP
ON/1
OFF/0
?
<NR1>
:KEY
SP
ON/1
OFF/0
?
<NR1>
:ECHO
SP
OLD/1
NEW/0
?
<NR1>


:CONFigure
:RDSEL
SP
DEFAULT/0
COEFF/1
OHM/2
VF/3
VFRD/4
<NR1>
?
:RR
SP
ON/1
OFF/0
?
:RRSEL
SP
DEFAULT/1
SET/0
?
:RRSET
SP
<NRf>
?
:SHORt
SP
ON/1
OFF/0
?
:RESPonse
:SEL
SP
DEFAULT/1
SET/0
?
:RESPonse
:SET
SP
<NR1>
?
:SETALLLED
SP
ALL/1
SINGLE/0
?
:CR
:RANGe
SP
ON/1
OFF/0
?

CONFigure:VOLTage:ON

Type : Channel-Specific
Description : It sets the voltage of sink current on.
Syntax : CONFigure:VOLTage:ON <NRf> [suffix]
Parameters : For valid voltage range refer to respective specification.
Example : CONF:VOLT:ON 1 It sets Von=1V.
CONF:VOLT:ON 300mV It sets Von=300mV.
Query Syntax : CONFigure:VOLTage:ON?
Return Parameters : <NR2> [Unit=Voltage]
Query Example : CONF:VOLT:ON? It returns the setting Von value.
Return Example : 3.5

CONFigure:VOLTage:RANGe

Type : Channel-Specific
Description : It sets the voltage measurement range in CC mode.
Syntax : CONFigure:VOLTage:RANGEe <NRf> [suffix]
Parameters : Value ranges depend on Load Module. For details refer to specification.
Example : CONF:VOLT:RANG 16 It sets the full-range as Low, for example, in 63303A.
CONF:VOLT:RANG 80V It sets the full-range as High, for example, in 63303A.
CONF:VOLT:RANG H It sets full-range as High.
CONF:VOLT:RANG L Set full-range as Low.
Query Syntax : CONFigure:VOLTage:RANGe?
Return Parameters : <NR2> [Unit = Voltage]
Query Example : CONF:VOLT:RANG? It returns the Voltage range.
Return Example : 16

CONFigure:VOLTage:LATCh

Type : Channel-Specific
Description : It sets the action type of Von.
Syntax : CONFigure:VOLTage:LATCh ON
CONFigure:VOLTage:LATCh OFF
Parameters : ON/1, OFF/0
Example : CONF:VOLT:LATC ON It sets the action type of Von as Latch.
CONF:VOLT:LATC OFF It sets the action type of Von as Non Latch (For detailed action refer to the user's manual).
Query Syntax : CONFigure:VOLTage:LATCh?
Return Parameters : <NR1>
Query Example : CONF:VOLT:LATC?
Return Example : 0 (non latch), 1 (latch) It returns the action type of Von.

CONFigure:VOLTage:LATCh:RESet

Type : channel-specific
Description : It resets the Von signal.
Syntax : CONFigure:VOLTage:LATCh:RESet
Example : CONF:VOLT:LATC:RES It resets the Von signal.

CONFigure:AUTO:LOAD

Type	: All Channels	
Description	: It sets if the load module will do Auto Load On during power-on.	
Syntax	: CONFigure:AUTO:LOAD ON CONFigure:AUTO:LOAD OFF	
Parameters	: ON/1, OFF/0	
Example	: CONF:AUTO:LOAD ON	It starts Auto Load On during power-on.
	CONF:AUTO:LOAD OFF	It closes Auto Load On during power-on.
Query Syntax	: CONFigure:AUTO:LOAD?	
Return Parameters	: <NR1>	
Query Example	: CONF:AUTO:LOAD?	
Return Example	: 0 or 1	It returns the status of Auto Load On.

CONFigure:AUTO:MODE

Type	: All Channels	
Description	: It sets the Auto Load On to LOAD ON or PROGRAM z.	
Syntax	: CONFigure:AUTO:MODE LOAD CONFigure:AUTO:MODE PROGRAM	
Parameters	: LOAD/1, PROGRAM/0	
Example	: CONF:AUTO:MODE LOAD	It sets Auto Load On as general LOAD ON.
	CONF:AUTO:MODE PROGRAM	It sets Auto Load On as PROGRAM RUN.
Query Syntax	: CONFigure:AUTO:MODE?	
Return Parameters	: <NR1>	
Query Example	: CONF:AUTO:MODE?	It returns the execution
Return Example	: 0 or 1	type of Auto Load On.

CONFigure:SOUND

Type	: All Channels	
Description	: It sets the buffer sound of load module to ON or OFF.	
Syntax	: CONFigure:SOUND ON CONFigure:SOUND OFF	
Parameters	: ON/1, OFF/0	
Example	: CONF:SOUND ON CONF:SOUND OFF	
Query Syntax	: CONFigure:SOUND?	
Return Parameters	: <NR1>	
Query Example	: CONF:SOUND?	It returns the control status of the load module's buzzer sound.
Return Example	: 0 or 1	

CONFigure:REMote

Type	: All Channels	
Description	: It sets the status of remote control (only effective in RS232C).	
Syntax	: CONFigure:REMote ON CONFigure:REMote OFF	
Parameters	: ON/1, OFF/0	
Example	: CONF:REM ON	Set to remote control.

CONFigure:SAVe

Type : All Channels
Description : It stores the data of CONFigure into EEPROM.
Syntax : CONFigure:SAV
Parameters : none
Example : CONF:SAV

CONFigure:LOAD

Type : All Channels
Description : The value at the setting of load module as LOADON is the one changed by the rotary knob (UPDATED/1) or the original set value (OLD/0).
Syntax : CONFigure:LOAD UPDATED
CONFigure:LOAD OLD
Parameters : UPDATED/1, OLD/0
Example : CONF:LOAD UPDATED It sets the value of LOADON as that changed by the rotary knob.
CONF:LOAD OLD It sets the value of LOADON as the original set value.
Query Syntax : CONFigure:LOAD?
Return Parameters : <NR1>
Query Example : CONF:LOAD?
Return Example : 1 (UPDATED) or 0 (OLD)

CONFigure:TIMing:STATe

Type : Channel-Specific
Description : It sets the timing function to ON or OFF
Syntax : CONFigure:TIMing <NRf>
Parameters : ON/1, OFF/0.
Example : CONFigure:TIMing ON It sets the timing function to ON.
Query Syntax : CONFigure:TIMing?
Return Parameters : <NR2>
Query Example : CONFigure:TIMing? It returns the timing function setting to be ON or OFF.
Return Example : 1

CONFigure:TIMing:TRIG

Type : Channel-Specific
Description : It sets the voltage for Timing function at time out.
Syntax : CONFigure:TIMing :TRIG <NRf>
Parameters : Value ranges depend on Load Module. For details refer to specification.
Example : CONFigure:TIMing:TRIG 3 It sets the voltage to 3V at timeout.
Query Syntax : CONFigure:TIMing:TRIG?
Return Parameters : <NR2>[Unit=Voltage]
Query Example : CONFigure:TIMing:TRIG? It returns the voltage set at timeout.
Return Example : 3

CONFigure:TIMing:TIMEOUT

Type : Channel-Specific
Description : It sets timeout for Timing function from 1ms to 24 hr.
Syntax : CONFigure:TIMing :TIMEOUT <NR1>

Parameters : 0-86400000
Example : CONFigure:TIMing : TIMEOUT 1000 It sets the timeout.
Query Syntax : CONFigure:TIMing: TIMEOUT?
Return Parameters : <NR2>[Unit=ms]
Query Example : CONFigure:TIMing:TRIG? It returns the timeout set.
Return Example : 1000

CONFigure:VOFF:STATe

Type : Channel-Specific
Description : It sets VOFF function ON or OFF
Syntax : CONFigure:VOFF :STATe <NR1>
Parameters : ON/1, OFF/0
Example : CONFigure:VOFF:STATe ON It sets VOFF function to ON.
Query Syntax : CONFigure:VOFF:STATe?
Return Parameters : <NR1>
Query Example : CONFigure:VOFF:STATe? It returns the VOFF function setting to be ON or OFF.
Return Example : 1

CONFigure:VOFF:FINALVOLTage

Type : Channel-Specific
Description : It sets the final loading voltage.
Syntax : CONFigure:VOFF:FINALVOLTage <NRf>
Parameters : Value ranges depend on Load Module. For details refer to specification.
Example : CONFigure:VOFF:FINALVOLTage 1.8 It sets the final loading voltage to 1.8V
Query Syntax : CONFigure:VOFF:FINALVOLTage?
Return Parameters : <NR2>[Unit=Voltage]
Query Example : CONFigure:VOFF:FINALVOLTage It returns the final loading voltage set.
Return Example : 1.8

CONFigure:MEASure:AVErage

Type : Channel-Specific
Description : It sets the average number of times for measurement.
Syntax : CONFigure:MEASure:AVErage <NR1>
Parameters : 1~64
Example : CONFigure:MEASure:AVErage 24 It sets the average to 24 times for measurement.
Query Syntax : CONFigure:MEASure:AVErage?
Return Parameters : <NR1>
Query Example : CONFigure:TIMing:AVE? It returns the average times set.
Return Example : 24

CONFigure:DIGITalio

Type : All Channels
Description : It sets the Digital IO to ON or OFF
Syntax : CONFigure:DIGITalio <NR1>
Parameters : ON/1, OFF/0
Example : CONFigure:DIGITalio ON It sets the Digital IO to ON.

Query Syntax : CONFigure:DIGITalio?
Return Parameters : <NR1>
Query Example : CONFigure:VOFF:STATe? It returns the Digital IO setting to be ON or OFF
Return Example : 1

CONFigure:KEY

Type : Channel-Specific
Description : It sets if change the MEAS key on the Module to Static/Dynamic.
Syntax : CONFigure:KEY <NR1>
Parameters : ON/1, OFF/0
Example : CONFigure:KEY ON It changes the function of MEAS key to Static/Dynamic.
Query Syntax : CONFigure:KEY?
Return Parameters : <NR1>
Query Example : CONFigure:VOFF:STATe? It returns the key setting.
Return Example : 1

CONFigure:ECHO

Type : All Channels
Description : It sets to reply new or old Model Name when querying the device's model name.
Syntax : CONFigure:ECHO <NR1>
Parameters : OLD/1, NEW/0
Example : CONFigure:ECHO NEW It sets to reply the new Model Name.
Query Syntax : CONFigure:ECHO?
Return Parameters : <NR1>
Query Example : CONFigure:ECHO? It returns the ECHO setting to be NEW or OLD.
Return Example : 0

CONFigure:RDSEL

Type : Channel-Specific
Description : It selects the parameters to be set for LED Mode.
Syntax : CONFigure:RDSEL DEFAULT
CONFigure:RDSEL COEFF
CONFigure:RDSEL OHM
CONFigure:RDSEL VF
Parameters : DEFAULT /0, COEFF/1, OHM/2, VF/3, VFRD/4
Example : CONF:RDSEL COEFF It sets the parameter COEFF.

Query Syntax : CONFigure:RDSEL?
Return Parameters : <NR1>
Query Example : CONF:RDSEL?
Return Example : 1 It returns the parameter set.

CONFigure:RR

Type : Channel-Specific
Description : It sets the Rr function to on or off.
Syntax : CONFigure:RR ON
CONFigure:RR OFF
Parameters : ON/1, OFF/0
Example : CONF:RR ON It sets the Rr function to on.

CONF:RR OFF It sets the Rr function to off.

Query Syntax : CONFigure:RR?
Return Parameters : <NR1>
Query Example : CONF:RR?
Return Example : 1 It returns if the Rr function is on.

CONFigure:RRSEL

Type : Channel-Specific
Description : It sets the Rr to default or user-defined.
Syntax : CONFigure:RRSEL DEFAULT
CONFigure:RRSEL SET
Parameters : DEFAULT /1, SET /0
Example : CONF:RRSEL DEFAULT It sets the Rr to default.
CONF:RRSEL SET It sets the Rr to user-defined value.
Query Syntax : CONFigure:RRSEL?
Return Parameters : <NR1>
Query Example : CONF:RRSEL?
Return Example : 1 It returns the Rr value set.

CONFigure:RRSET

Type : Channel-Specific
Description : It sets the ripple resistance Rr to default or user-defined.
Syntax : CONFigure:RRSET <NRf>
Parameters : 5~125
Example : CONF:RRSEL 10 It sets the Rr to 10 Ohm.
Query Syntax : CONFigure:RRSEL?
Return Parameters : <NRf>
Query Example : CONF:RRSEL?
Return Example : 10 It returns the Rr set value.

CONFigure:SHORt

Type : Channel-Specific
Description : It sets if enable Short function when pressing the SHORT key on Module.
Syntax : CONFigure:SHORt ON
CONFigure:SHORt OFF
Parameters : ON/1, OFF/0
Example : CONF:SHOR ON It enables the SHORT key.
CONF:SHOR OFF It disables the SHORT key.
Query Syntax : CONFigure:SHORt?
Return Parameters : <NR1>
Query Example : CONF:SHOR?
Return Example : 0 It returns if the SHORT key is enabled.

CONFigure:RESPonse:SEL

Type : Channel-Specific
Description : It sets the response speed of Electronic Load to default or user-defined.
Syntax : CONFigure:RESPonse:SEL DEFAULT
CONFigure:RESPonse:SEL SET
Parameters : DEFAULT/1, SET/0
Example : CONF:RESP:SEL DEFAULT It sets response speed of

Electronic Load to default.

Query Syntax : CONFigure:RESPonse:SEL?
Return Parameters : <NR1>
Query Example : CONF:RESP:SEL?
Return Example : 1 It returns the response speed the Electronic Load uses.

CONFigure:RESPonse:SET

Type : Channel-Specific
Description : It sets the response speed of Electronic Load.
Syntax : CONFigure:RESPonse:SET <NR1>
Parameters : 1~5
Example : CONF:RESP:SET 2 It sets the response speed of Electronic Load to 2.
Query Syntax : CONFigure:RESPonse:SET?
Return Parameters : <NR1>
Query Example : CONF:RESP:SET?
Return Example : 2 It returns the response speed of Electronic Load.

CONFigure:SETALLLED

Type : Channel-Specific
Description : It sets the LED mode setting for one single channel or all channels.
Syntax : CONFigure:SETALLLED SINGLE
CONFigure:SETALLLED ALL
Parameters : ALL/1, SINGLE/0
Example : CONFigure:SETALLLED ALL
Query Syntax : CONFigure: SETALLLED?
Return Parameters : <NR1>
Query Example : CONF: SETALLLED?
Return Example : 1 It returns the channel set.

CONFigure:CR:RANGe

Type : Channel-Specific
Description : It sets the current range of CR mode.
Syntax : CONFigure:CR:RANGe HIGH
CONFigure:CR:RANGe LOW
Parameters : HIGH/1, LOW/0
Example : CONFigure:CR:RANG HIGH It sets the current range of CR mode to High.
Query Syntax : CONFigure:CR:RANG?
Return Parameters : <NR1>
Query Example : CONF: CR:RANG?
Return Example : 1 It returns the current range set for CR mode.

CONFigure:LVP

Type	: Channel-Specific	
Description	: It enables or disables the LVP function.	
Syntax	: CONFigure:LVP ON CONFigure:LVP OFF	
Parameters	: ON/1, OFF/0	
Example	: CONFigure:LVP ON	It sets the LVP function to on.
Query Syntax	: CONFigure: LVP?	
Return Parameters	: <NR1>	
Query Example	: CONF: LVP?	
Return Example	: 1	It returns the LVP function has been enabled.

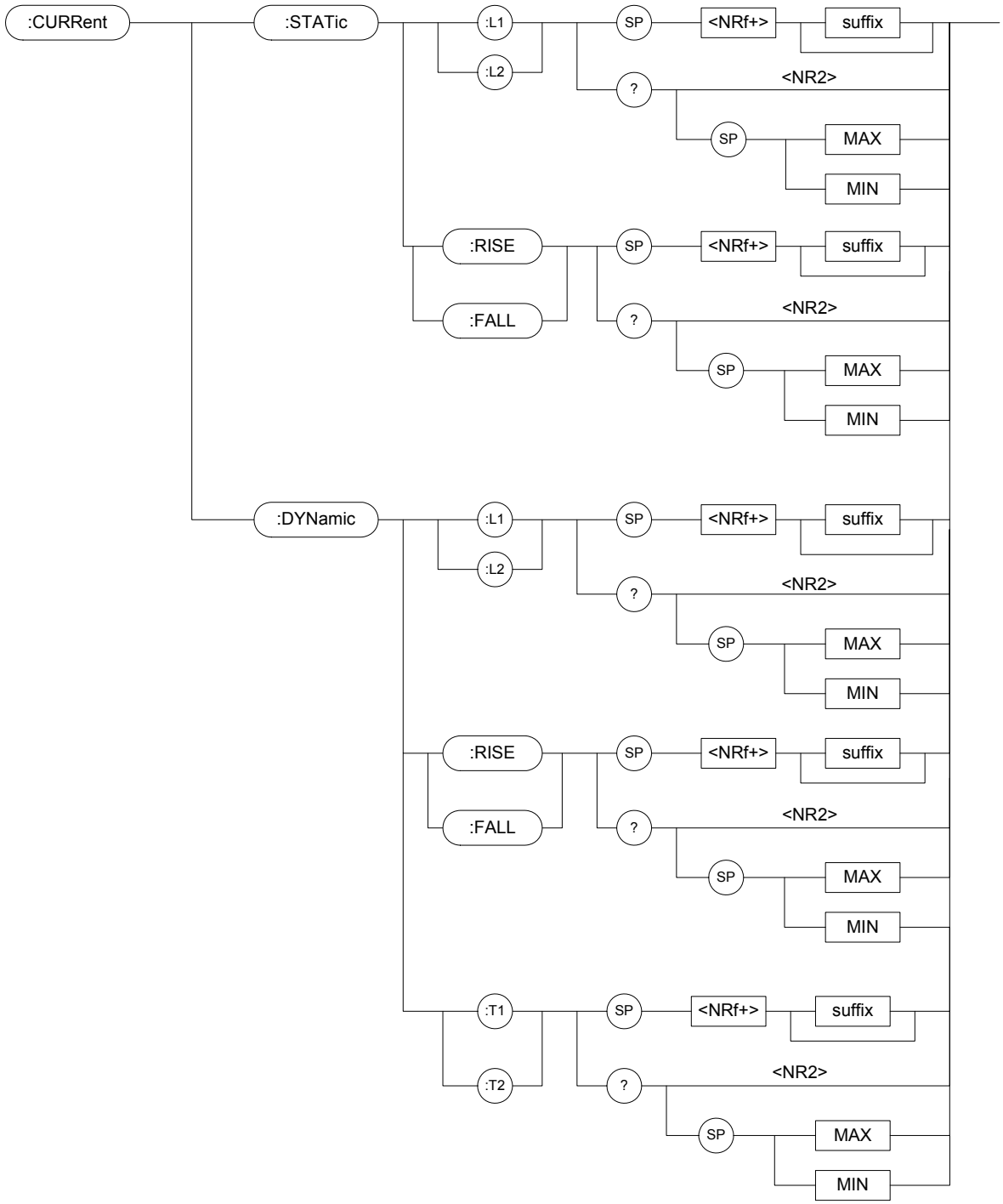
CONFigure:LEDLCRL:RANGe

Type	: Channel-Specific	
Description	: It sets the CRL and LEDL Mode current range..	
Syntax	: CONFigure:LEDLCRL:RANG HIGH CONFigure:LEDLCRL:RANG LOW	
Parameters	: HIGH/1, LOW/0	
Example	: CONF:LEDLCRL:RANG HIGH	It sets the CRL, LEDL Mode current range to High.
Query Syntax	: CONF:LEDLCRL:RANG?	
Return Parameters	: <NR1>	
Query Example	: CONF:LEDLCRL:RANG?	
Return Example	: 1	It returns the CRL, LEDL Mode current range.

CONFigure:RC

Type	: Channel-Specific	
Description	: It enables or disables the RC function.	
Syntax	: CONFigure: RC ON CONFigure: RC OFF	
Parameters	: ON/1, OFF/0	
Example	: CONFigure: RC ON	It enables the RC function.
Query Syntax	: CONFigure: RC?	
Return Parameters	: <NR1>	
Query Example	: CONF: RC?	
Return Example	: 1	It returns the RC function has been enabled.

7.2.5 CURRENT Subsystem



CURRent:STATic:L1/L2

Type : Channel-Specific
Description : It sets the Static Load Current of constant current mode.
Syntax : CURRent:STATic:L1 <NRf+> [suffix]
CURRent:STATic:L2 <NRf+> [suffix]
Parameters : For valid value range refer to respective specification.
Example : CURR:STAT:L1 20 It sets the Constant Current = 20A for Static Load L1.
CURR:STAT:L2 10 It sets the Constant Current = 10A for

Static Load L2.

CURR:STAT:L1 MAX — It sets the Constant Current = maximum value for Static Load L1.

CURR:STAT:L2 MIN — It sets the Constant Current = minimum value for Static Load L2.

Query Syntax : CURRent:STATic:L1?
CURRent:STATic:L2?
CURRent:STATic:L1? MAX
CURRent:STATic:L2? MIN

Return Parameters : <NR2> [Unit=Ampere]

Query Example : CURR:STAT:L1? — It returns the set current value of Static Load L1.

Return Example : 3.12

CURRent:STATic:RISE/FALL

Type : Channel-Specific

Description : It sets the current slew rate of constant current static mode.

Syntax : CURRent:STATic:RISE <NRf+> [suffix]
CURRent:STATic:FALL <NRf+> [suffix]

Parameters : For valid value range refer to respective specification.

Example : CURR:STAT:RISE 2.5 — It sets the rise slew rate to 2.5A/μS for static load.

CURR:STAT:FALL 1A/μS — It sets the fall slew rate to 1A/μS for static load.

Query Syntax : CURRent:STATic:RISE?
CURRent:STATic:FALL?
CURRent:STATic:RISE? MAX
CURRent:STATic:FALL? MIN

Return Parameters : <NR2> [Unit=A/μS]

Query Example : CURR:STAT:RISE? — It returns the rise slew rate of static load.

Return Example : 2.5

CURRent:DYNamic:L1/L2

Type : Channel-Specific

Description : It sets the Dynamic Load Current during constant current mode.

Syntax : CURRent:DYNamic:L1 <NRf+> [suffix]
CURRent:DYNamic:L2 <NRf+> [suffix]

Parameters : For valid value range refer to respective specification.

Example : CURR:DYN:L1 20 — It sets the dynamic load parameter L1 = 20A.

CURR:DYN:L2 10 — It sets the dynamic load parameter L2 = 10A.

CURR:DYN:L1 MAX — It sets the dynamic load parameter L1 = maximum value.

CURR:DYN:L2 MIN — It sets the dynamic load parameter L2 = minimum value.

Query Syntax : CURRent:DYNamic:L1?
CURRent:DYNamic:L2?
CURRent:DYNamic:L1? MAX
CURRent:DYNamic:L2? MIN

Return Parameters : <NR2> [Unit=Ampere]

Query Example : CURR:DYN:L1? — It returns the setting current in dynamic load L1.

Return Example : 35.6

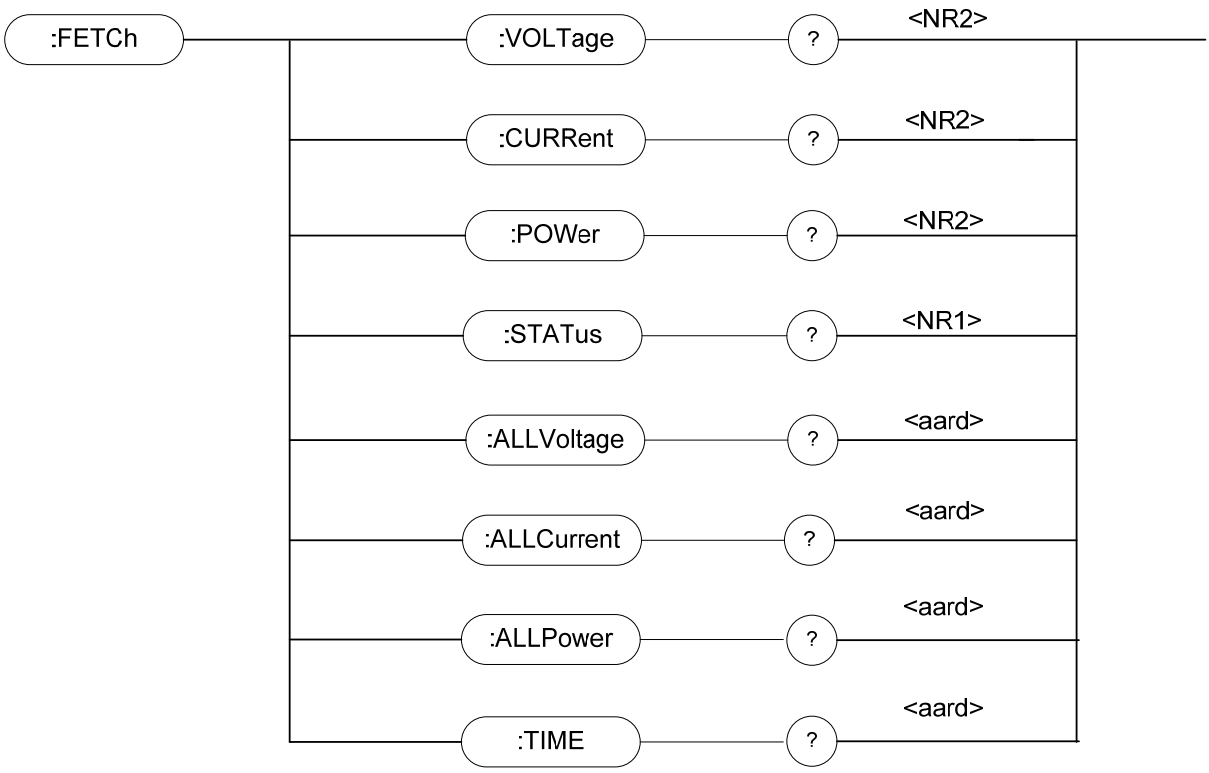
CURRent:DYNamic:RISE/FALL

Type : Channel-Specific
Description : It sets the current slew rate of constant current dynamic mode.
Syntax : CURRent:DYNamic:RISE <NRf+> [suffix]
CURRent:DYNamic:FALL <NRf+> [suffix]
Parameters : For valid value range refer to respective specification.
Example : CURR:DYN:RISE 2.5 It sets the rise slew rate to 2.5A/μS.
CURR:DYN:FALL 1A/μS It sets the fall slew rate to 1A/μS.
CURR:DYN:RISE MAX It sets the rise slew rate as maximum value of dynamic load.
CURR:DYN:FALL MIN It sets the fall slew rate as minimum value of dynamic load.
Query Syntax : CURRent:DYNamic:RISE?
CURRent:DYNamic:FALL?
CURRent:DYNamic:RISE? MAX
CURRent:DYNamic:FALL? MIN
Return Parameters : <NR2> [Unit=A/μS]
Query Example : CURR:DYN:RISE? It returns the rise slew rate of dynamic load.
Return Example : 2.5

CURRent:DYNamic:T1/T2

Type : Channel-Specific
Description : It sets the duration parameter T1 or T2 of dynamic load.
Syntax : CURRent:DYNamic:T1 <NRf+> [suffix]
CURRent:DYNamic:T2 <NRf+> [suffix]
Parameters : For valid value range refer to respective specification.
Example : CURR:DYN:T1 10ms It sets the dynamic duration T1 = 10ms.
CURR:DYN:T2 2S It sets the dynamic duration T2 = 2S.
CURR:DYN:T1 MAX It sets the dynamic duration T1 as maximum value.
CURR:DYN:T2 MIN It sets the dynamic duration T2 as minimum value.
Query Syntax : CURRent:DYNamic:T1?
CURRent:DYNamic:T2?
CURRent:DYNamic:T1? MAX
CURRent:DYNamic:T2? MIN
Return Parameters : <NR2> [Unit=Sec]
Query Example : CURR:DYN:T1? It returns the dynamic duration parameter T1.
Return Example : 0.15

7.2.6 FETCH Subsystem



FETCh:VOLTage?

Type : Channel-Specific
Description : It returns the real time voltage measured at the input of the load module.
Query Syntax : FETCh:VOLTage?
Return Parameters : <NR2> [Unit=Voltage]
Query Example : FETC:VOLT?
Return Example : 8.12

FETCh:CURRent?

Type : Channel-Specific
Description : It returns the real time current measured at the input of the load module.
Query Syntax : FETCh:CURRent?
Return Parameters : <NR2> [Unit=Ampere]
Query Example : FETC:CURR?
Return Example : 3.15

FETCh:POWer?

Type : Channel-Specific
Description : It returns the real time power measured at the input of the load module.
Query Syntax : FETCh:POWer?
Return Parameters : <NR2> [Unit=Watt]
Query Example : FETC:POW?
Return Example : 5.28

FETCh:STATus?

Type : Channel-Specific
Description : It returns the real time status of the load module.
Query Syntax : FETCh:STATus?
Return Parameters : <NR1>

FETCh:ALLVoltage?

Type : Channel-Independent
Description : It returns the real time voltage measured at the input of the all load module.
Query Syntax : FETCh:ALLVoltage?
Return Parameters : <aard> [Unit=Voltage]
Query Example : FETC:ALLV?
Return Example : 1.2, 2, 0, 0, 10.2, 0, 0, 0

FETCh:ALLCurrent?

Type : Channel-Independent
Description : It returns the real time current measured at the input of the all load module.
Query Syntax : FETCh:ALLCurrent?
Return Parameters : <aard> [Unit=Ampere]
Query Example : FETC:ALLC?
Return Example : 0, 0, 0, 0, 5.12, 0, 12, 0

Bit Position	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Condition												OT	RV	OP	OV	OC
Bit Weight												16	8	4	2	1

Query Example : FETC:STAT? It reads back the present status of load module.
Return Example : 4

FETCh:ALLPower?

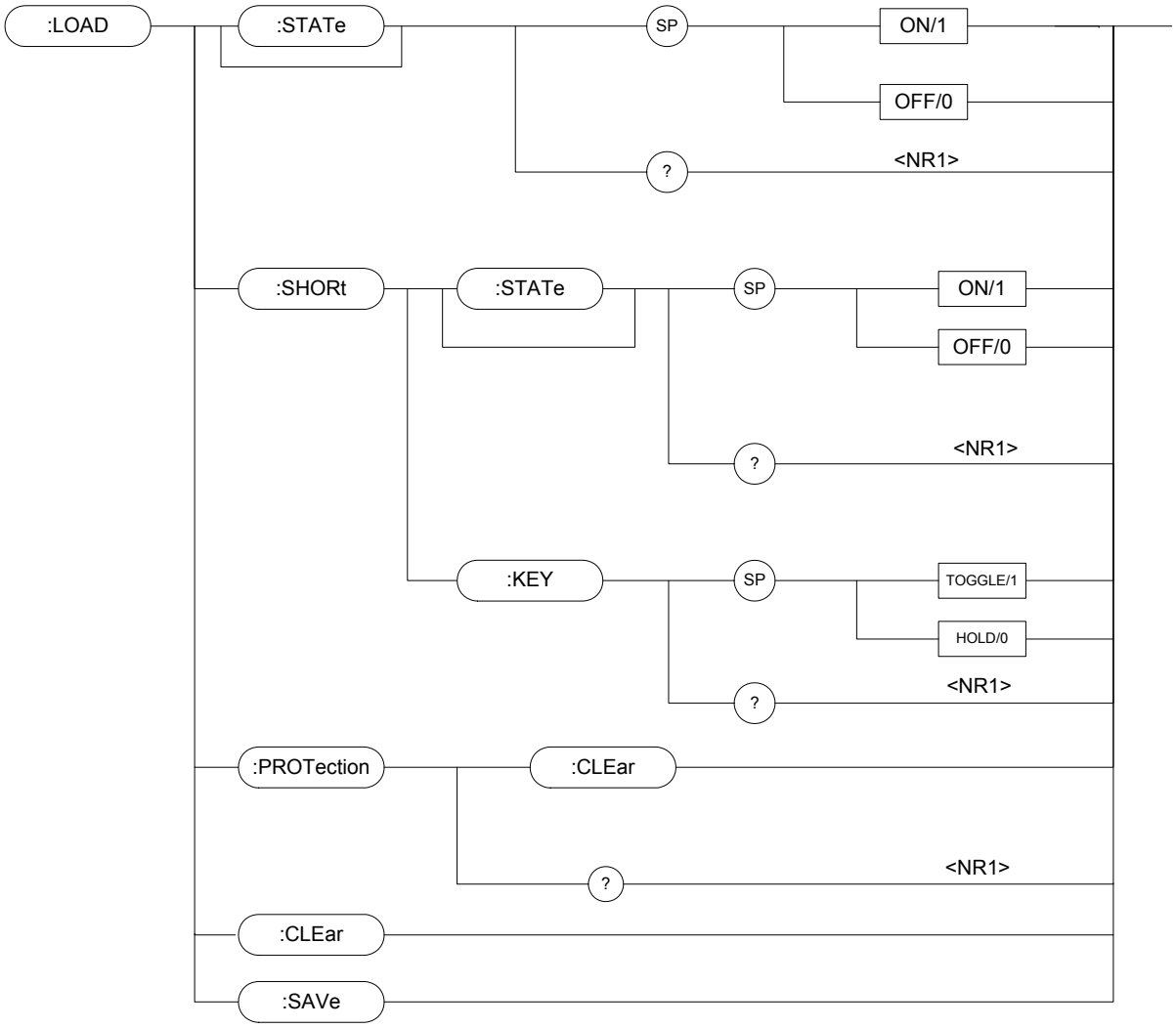
Type : Channel-Independent
Description : It returns the real time power measured at the input of the all load module.
Query Syntax : FETCh:ALLPower?
Return Parameters : <aard> [Unit=Watt]
Query Example : FETC:ALLP?
Return Example : 5.28, 2, 0, 0, 10.2, 0, 0, 0

FETCh:TIME?

Type : Channel-Independent
Description : Return the time measured in timing mode.
Query Syntax : FETCh:TIME?
Query Example : FETC:TIME?
Return Parameters : It returns the parameter composed of <arg1>,<arg2>
<arg1>
-1 denotes the Timing Function test is stop.
-2 denotes the Timing Function test is ready to execute what wait for Von or other condition.
-3 denotes the Timing Function test is execute.
-4 denotes the Timeout.
-5 denotes the input voltage is lower than TRIGer voltage.

<arg2>
The time count in the format of hr：min：sec . ms
If the parameter of arg1 is -1 or -2, it does not return arg2.

7.2.7 LOAD Subsystem



LOAD:[STATe]

Type : Channel-Specific
Description : The LOAD command makes the electronic load active/on or inactive/off.
Syntax : LOAD:[STATe] ON
LOAD:[STATe] OFF
Parameters : ON/1, OFF/0
Example : LOAD ON — Activate the electronic load.
LOAD OFF — Inactivate the electronic load.
Query Syntax : LOAD:[STATe]?
Return Parameters : <NR1>
Query Example : LOAD? — It returns if the electronic load is active.
Return Example : 1

LOAD:SHORt:[STATe]

Type : Channel-Specific
Description : It activates or inactivates the short-circuited simulation.

Syntax : LOAD:SHORt:[STATe]
Example : LOAD:SHOR ON — It activate the short-circuited simulation.
LOAD:SHOR OFF — It inactivates the short-circuited simulation.
Parameters : ON/1, OFF/0
Query Syntax : LOAD:SHORt:[STATe]?
Return Parameters : <NR1>
Query Example : LOAD:SHOR? — It returns the short-circuit simulation state.
Return Example : 1

LOAD:SHORt:KEY

Type : All Channels
Description : It sets the mode of short key in the electronic load.
Syntax : LOAD:SHORt:KEY TOGGLE
Parameters : TOGGLE/1, HOLD/0
Example : LOAD:SHOR:KEY TOGGLE — It sets the short key mode to Toggle.
LOAD:SHOR:KEY HOLD — It sets the short key mode to Hold.
Query Syntax : LOAD:SHORt:KEY?
Return Parameters : <NR1>
Query Example : LOAD:SHOR:KEY? — It returns the mode of short key in the electronic load.
Return Example : 1

LOAD:PROTection:CLEar

Type : Channel-Specific
Description : This command resets or returns status of the electronic load.
Syntax : LOAD:PROTection:CLEar
Parameters : For valid value range refer to respective specification.
Example : LOAD:PROT:CLE
Query Syntax : LOAD:PROTection:CLEar?
Return Parameters : <NR1>

Bit Position	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Condition	0	0	0	0	0	0	0	0	0	0	0	OT	RV	OP	OV	OC
Bit Weight												16	8	4	2	1

Query Example : LOAD:PROT? — It returns the electronic load status.
Return Example : 0

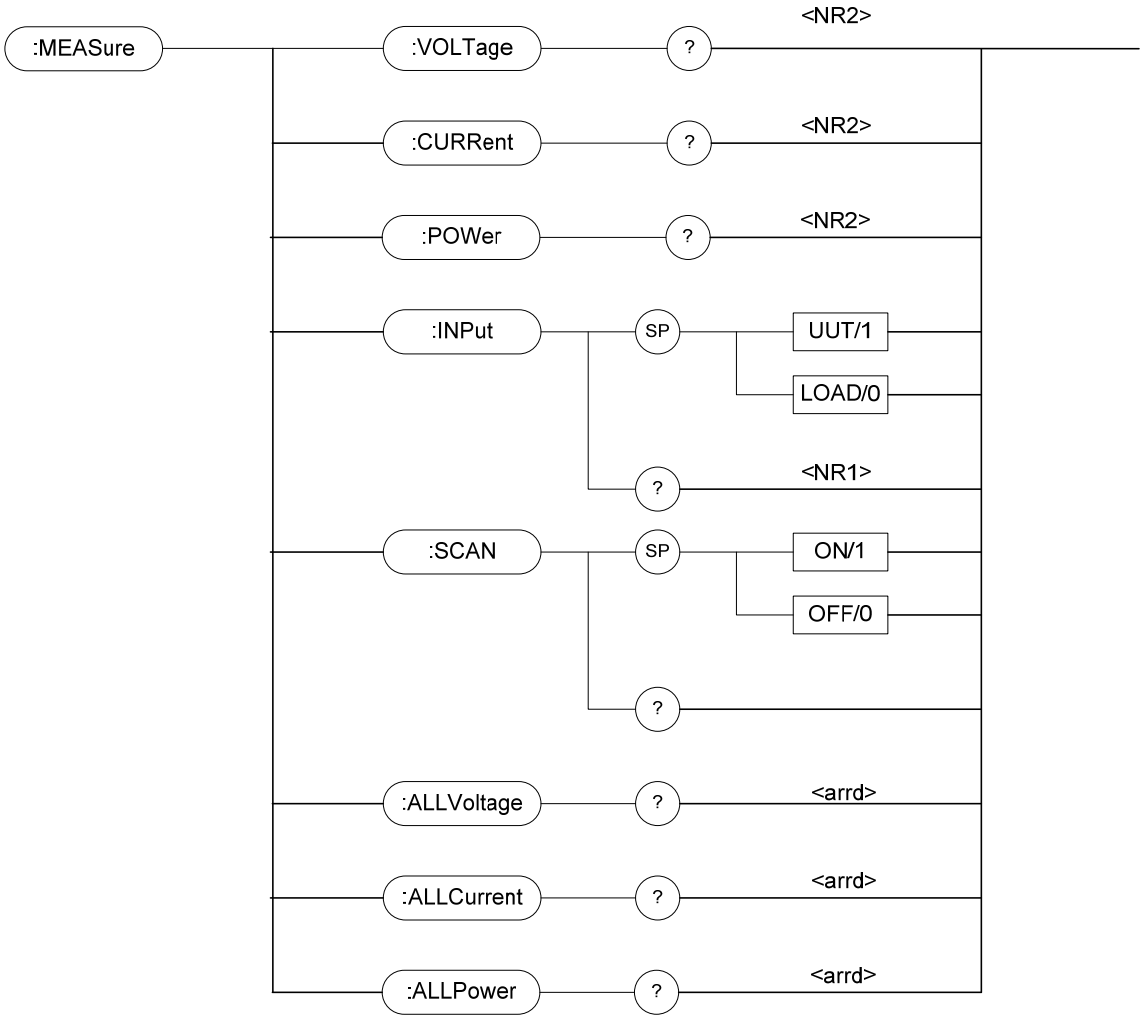
LOAD:CLEar

Type: All Channels
Description: It clears all data and return it to default.
Syntax: LOAD:CLEar
Parameters: None
Example: LOAD:CLE

LOAD:SAVe

Type:	All Channels
Description:	It saves the current data as default.
Syntax:	LOAD:SAVe
Parameters:	None
Example:	LOAD:SAV

7.2.8 MEASURE Subsystem



MEASure:VOLTage?

Type : Channel-Specific
Description : It returns the voltage measured at the input of electronic load.
Query Syntax : MEASure:VOLTage?
Return Parameters : <NR2> [Unit=Voltage]
Query Example : MEAS:VOLT?
Return Example : 8.12

MEASure:CURRent?

Type : Channel-Specific
Description : It returns the current measured at the input of electronic load.
Query Syntax : MEASure:CURRent?
Return Parameters : <NR2> [Unit=Ampere]

Query Example : MEAS:CURR?
Return Example : 3.15

MEASure:POWer?

Type : Channel-Specific
Description : It returns the power measured at the input of electronic load.
Query Syntax : MEASure:POWer?
Return Parameters : <NR2> [Unit=Watt]
Query Example : MEAS:POW?
Return Example : 3.15

MEASure:INPut

Type : Channel-Specific
Description : It selects the input port of electronic load to measure the voltage.
Syntax : MEASure:INPut?
Parameters : UUT/1, LOAD/0
Example : MEAS:INP UUT
MEAS:INP LOAD
Query Syntax : MEASure:INPut? It returns the input port which has been set.
Return Parameters : <NR1>
Query Example : MEAS:INP?
Return Example : 0

MEASure:SCAN

Type : All Channels
Description : It sets the scanning mode of frame to load module.
Syntax : MEASure:SCAN ON It enables the frame to scan the load module.
MEASure:SCAN OFF It disables the frame to scan the load module.
Parameters : ON/1, OFF/0
Example : MEAS:SCAN ON
MEAS:SCAN OFF
Query Syntax : MEASure:SCAN? It returns the scanning mode of the frame.
Return Parameters : <NR1>
Query Example : MEAS:SCAN?
Return Example : 1

MEASure:ALLVoltage?

Type : Channel-Independent
Description : It returns the voltage measured at the input of all load modules.
Query Syntax : MEASure:ALLVoltage?
Return Parameters : <aard> [Unit=Voltage]
Query Example : MEAS:ALLV?
Return Example : 1.2, 2, 0, 0, 10.2, 0, 0, 0

MEASure:ALLCurrent?

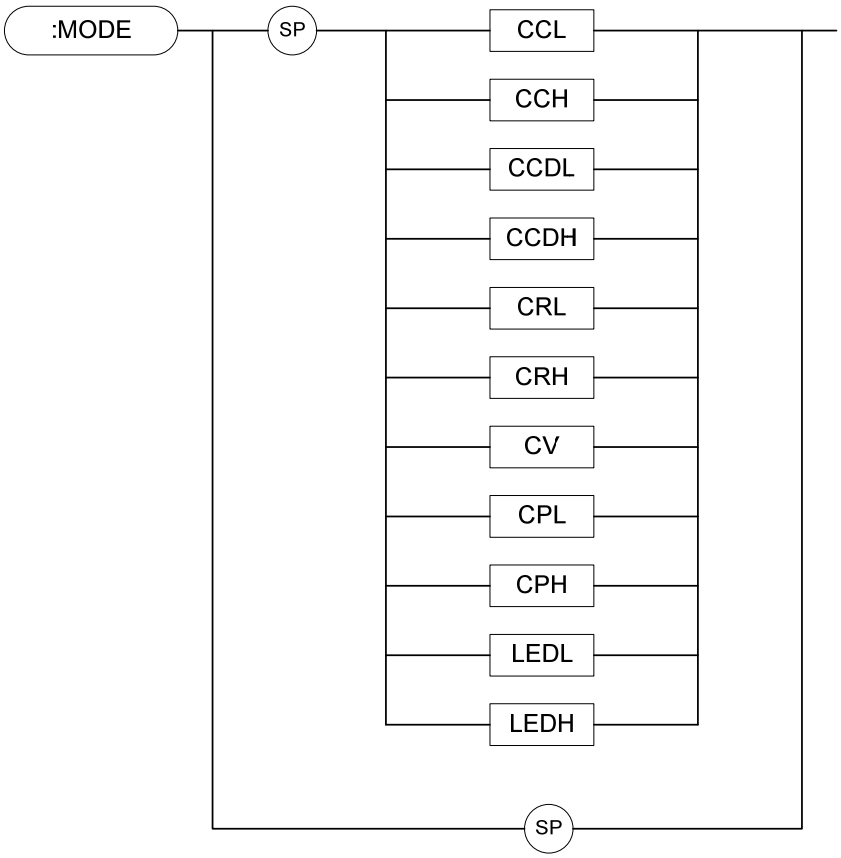
Type : Channel-Independent
Description : It returns the current measured at the input of all load modules.

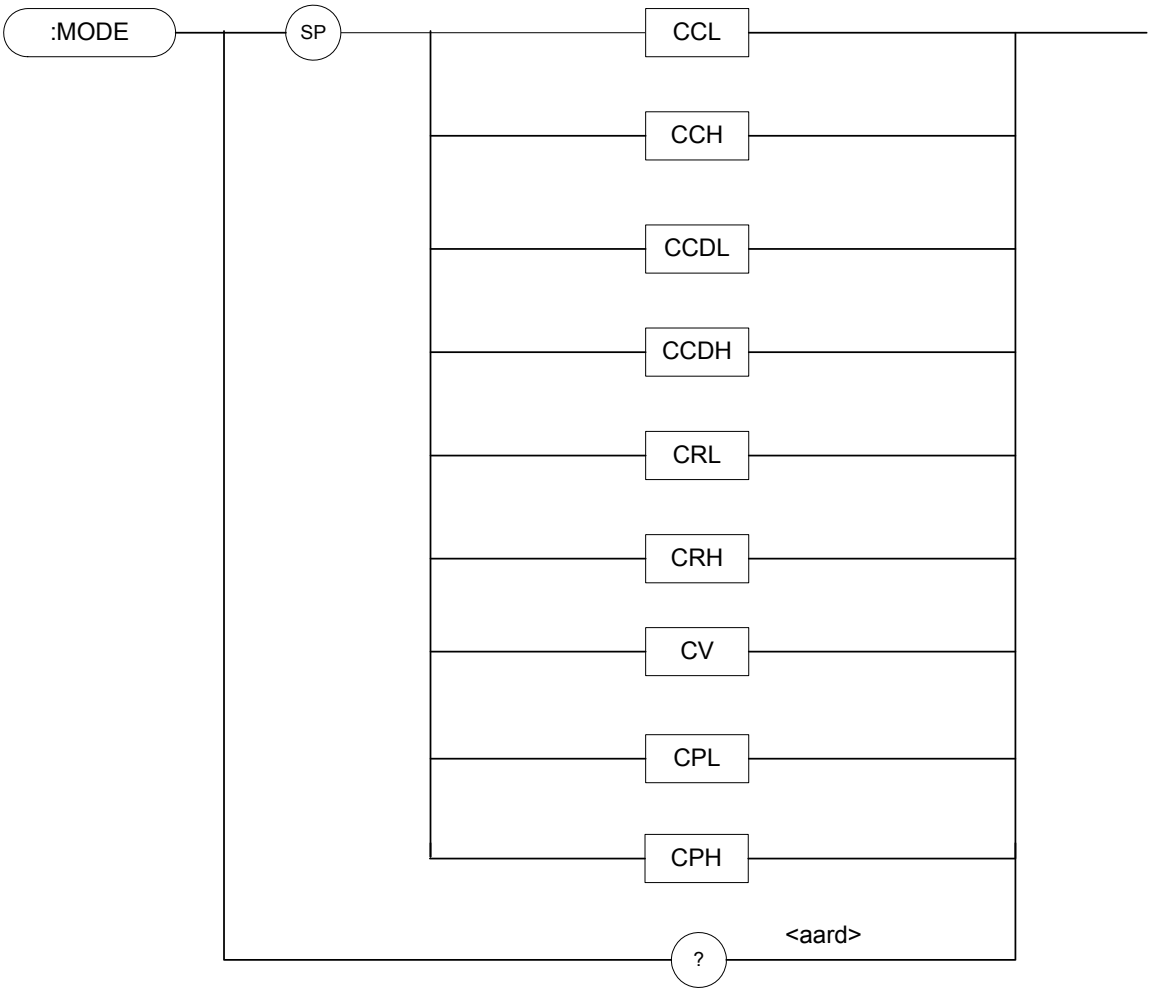
Query Syntax : MEASure:ALLCurrent?
Return Parameters : <aard> [Unit=Ampere]
Query Example : MEAS:ALLC?
Return Example : 0, 0, 0, 0, 5.12, 0, 12, 0

MEASure:ALLPower?

Type : Channel-Independent
Description : It returns the power measured at the input of all load modules.
Query Syntax : MEASure:ALLPower?
Return Parameters : <aard> [Unit=Watt]
Query Example : MEAS:ALLP?
Return Example : 0, 0, 0, 0, 5.08, 0, 12, 0

7.2.9 MODE Subsystem





MODE

Type : Channel-Specific

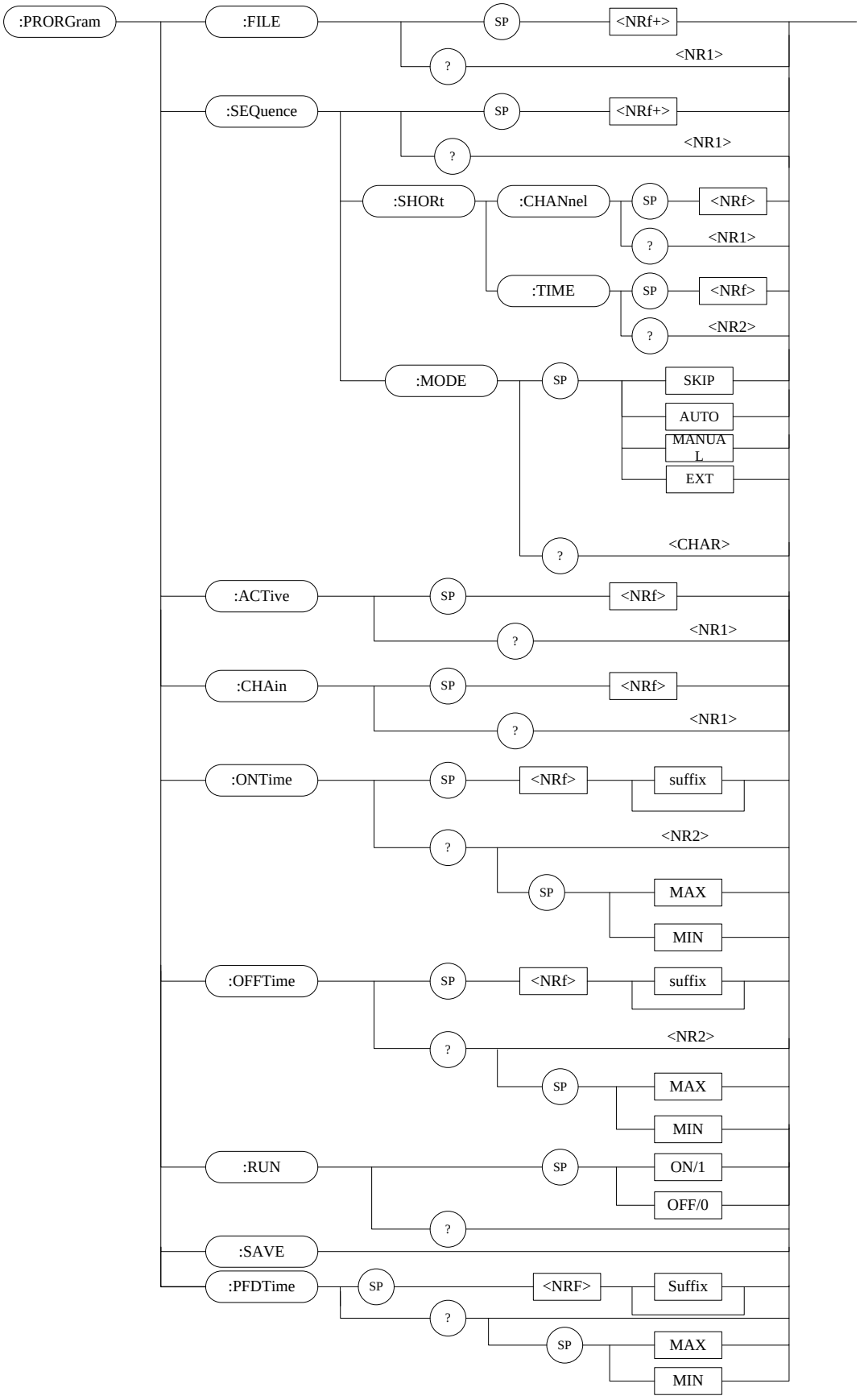
Description : This command sets operational modes of the electronic load.

Syntax :

MODE CCL	It sets the CC mode of low range.
MODE CCH	It sets the CC mode of high range.
MODE CCDL	It sets the CC dynamic mode of low range.
MODE CCDH	It sets the CC dynamic mode of high range.
MODE CRL	It sets the CR mode of low range.
MODE CRH	It sets the CR mode of high range.
MODE CV	It sets the CV mode.
MODE CPL	It sets the CP mode of low range.
MODE CPH	It sets the CP mode of high range.
MODE LEDL	It sets the LED mode of low range.
MODE LEDH	It sets the LED mode of high range.

Parameters	: CCL, CCH, CCDL, CCDH, CRL, CRH, CV, CPL, CPH, LEDL,LEDH	
Example	: MODE CCL	
Query Syntax	: MODE?	It returns the operational mode of the electronic load.
Return Parameters	: <aard>	
Query Example	: MODE?	
Return Example	: CCL	

7.2.10 PROGRAM Subsystem



PROGram:FILE

Type : By program file
Description : It sets the program number.
Syntax : PROGram:FILE <NRf+>
Parameters : 1 to 10
Example : PROG:FILE 10
Query Syntax : PROGram:FILE? It returns the active program number.
Return Parameters : <NR1>
Query Example : PROG:FILE?
Return Example : 10

PROGram:SEQuence

Type : By program file
Description : It sets the sequence of program file.
Syntax : PROGram:SEQuence <NRf+>
Parameters : 1 to 10
Example : PROG:SEQ3
Query Syntax : PROGram:SEQuence?
Return Parameters : <NR1>
Query Example : PROG:SEQ?
Return Example : 3

PROGram:SEQuence:MODE

Type : By program file
Description : It sets the the type of sequence.
Syntax : PROGram:SEQuence:MODE SKIP
PROGram:SEQuence:MODE AUTO
PROGram:SEQuence:MODE MANUAL
PROGram:SEQuence:MODE EXT
Parameters : SKIP, AUTO, MANUAL, EXT
Example : PROG:SEQ:MODE SKIP
PROG:SEQ:MODE AUTO
PROG:SEQ:MODE MANUAL
PROG:SEQ:MODE EXT
Query Syntax : PROGram:SEQ:MODE?
Return Parameters : SKIP, AUTO, MANUAL
Query Example : PROG:SEQ:MODE?
Return Example : AUTO

PROGram:SEQuence:SHORt:CHANnel

Type : By program file
Description : It sets the the short channel of program file sequence.
Syntax : PROGram:SEQuence:SHORt:CHANnel <NRf>
Parameters : 0 – 255

Channel	8	7	6	5	4	3	2	1
Bit Weight	128	64	32	16	8	4	2	1

Example : PROG:SEQ:SHOR:CHAN 3
Query Syntax : PROGram:SEQuence:SHORt:CHANnel?
Return Parameter : <NR1>
Query Example : PROG:SEQ:SHOR:CHAN?
Return Example : 3

PROGram:SEQuence:SHORt:TIME

Type : By program file
Description : It sets the short time of program file sequence.
Syntax : PROGram:SEQuence:SHORt:TIME
Parameters : 0 - 30.0
Example : PROG:SEQ:SHOR: TIME 10
Query Syntax : PROGram:SEQuence:SHORt:TIME?
Return Parameter : <NR2>
Query Example : PROG:SEQ:SHOR:TIME?
Return Example : 10

PROGram:ACTive

Type : By program file
Description : It selects the active load modules.
Syntax : PROGram:ACTive <NRf>
Parameters : 0 - 255

Channel	8	7	6	5	4	3	2	1
Bit Weight	128	64	32	16	8	4	2	1

Example : PROG:ACT 12
Query Syntax : PROGram:ACTive?
Return Parameters : <NR1>
Query Example : PROG:ACT?
Return Example : 12

PROGram:CHAin

Type : By program file
Description : It sets the type of program file in serial execution.
Syntax : PROGram:CHAin <NRf>
Parameters : 0 to 10 0 does not chain.
Example : PROG:CHA 7
Query Syntax : PROGram:CHAin?
Return Parameters : <NR1>
Query Example : PROG:CHA?
Return Example : 7

PROGram:ONTime

Type : By program file
Description : It sets the load on time of program file.
Syntax : PROGram:ONTime <NRf>
Parameters : For valid value range refer to respective specification.
Example : PROG:ONT 10
PROG:ONT 100ms
Query Syntax : PROGram:ONTime?
Return Parameters : <NR2> [Unit=Sec]
Query Example : PROG:ONT?
Return Example : 10

PROGram:OFFTime

Type : By program file
Description : It sets the load off time of program file.

Syntax : PROGram:OFFTime <NRf>
Parameters : For valid value range refer to respective specification.
Example : PROG:OFFT 20
PROG:OFFT 200ms
Query Syntax : PROGram:OFFTime?
Return Parameters : <NR2> [Unit=Sec]
Query Example : PROG:OFFT?
Return Example : 0.2

PROGram:PFDTime

Type : By program file
Description : It sets the the pass/fail delay time of program file.
Syntax : PROGram:PFDTime <NRf>
Parameters : For valid value range refer to respective specification.
Example : PROG:PFDT 1
PROG : PFDT 200ms
Query Syntax : PROGram:PFDTime?
Return Parameters : <NR2> [Unit=Sec]
Query Example : PROG:PFDT?
Return Example : 0.2

PROGram:SAVe

Type : By program file
Description : It saves the setting of program.
Syntax : PROGram:SAV
Parameters : NONE
Example : PROG:SAV

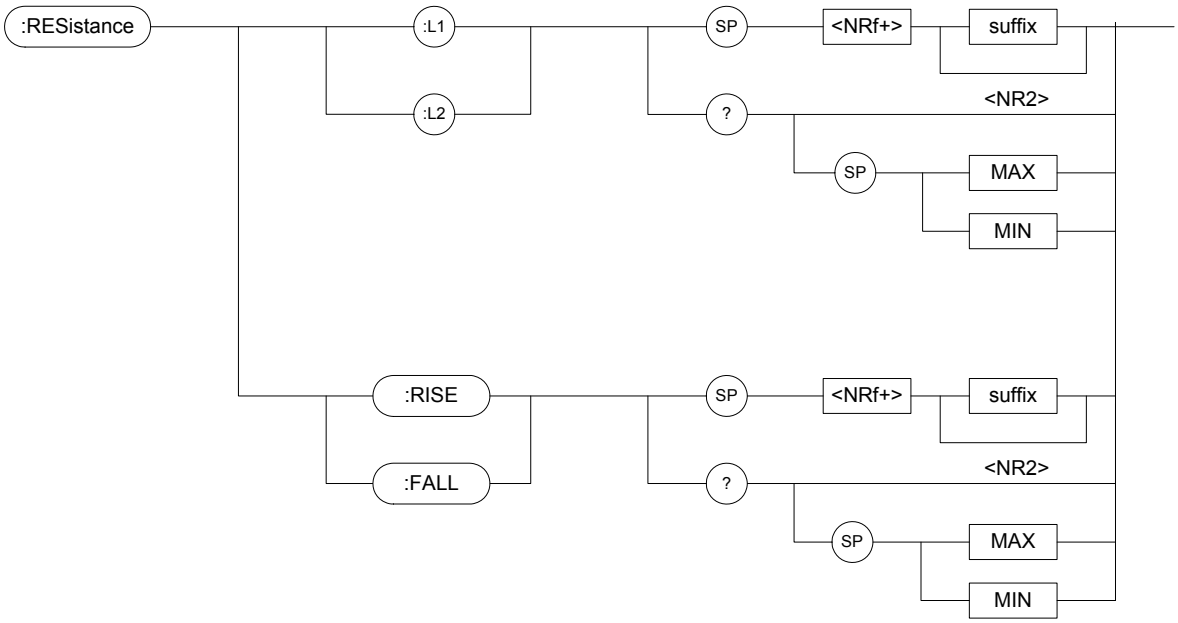
PROGram:RUN

Type : By program file
Description : It executes the program.
Syntax : PROGram:RUN ON
PROGram:RUN OFF
Parameters : ON/1, OFF/0
Example : PROG:RUN ON
Query Syntax : PROGram:RUN?
Return Parameter : <NR1>
Query Example : PROGram:RUN?
Return Example : 1

PROGram:KEY

Type : By program file
Description : It echoes the manual key code.
Syntax : PROGram:KEY <NR1>
PROGram:RUN OFF
Parameters : 0 – 9 -> K0 -> K9
10 -> Kup
11 -> Kdown
Example : PROG:KEY 11

7.2.11 RESISTANCE Subsystem



RESistance:L1/L2

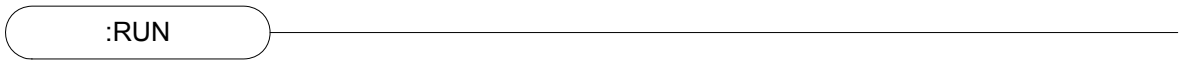
Type : Channel-Specific
Description : It sets the static resistance level of constant resistance mode.
Syntax : RESistance:L1 <NRf+> [suffix]
RESistance:L2 <NRf+> [suffix]
Parameters : For valid value range refer to respective specification.
Example : RES:L1 20 OHM It sets the constant resistance = 20 ohm for Load L1.
RES:L2 10 OHM It sets the constant resistance = 10 ohm for Load L2.
RES:L1 MAX It sets the constant resistance = maximum L1 value for Load L1.
RES:L2 MIN It sets the constant resistance = minimum L2 value for Load L2.
Query Syntax : RESistance:L1?
RESistance:L2?
RESistance:L1? MAX
RESistance:L2? MIN
Return Parameters : <NR2> [Unit=OHM]
Query Example : RES:L1? It returns the set resistance of the value of Load L1.
Return Example : 10

RESistance:RISE/FALL

Type : Channel-Specific
Description : It sets the resistive slew rate of constant resistance.
Syntax : RESistance:RISE <NRf+> [suffix]
RESistance:FALL <NRf+> [suffix]
Parameters : For valid value range refer to respective specification.
Example : RES:RISE 2.5 It sets the CR rise slew rate to 2.5A/μS.
RES:FALL 1A/μS It sets the CR fall slew rate to 1A/μS.

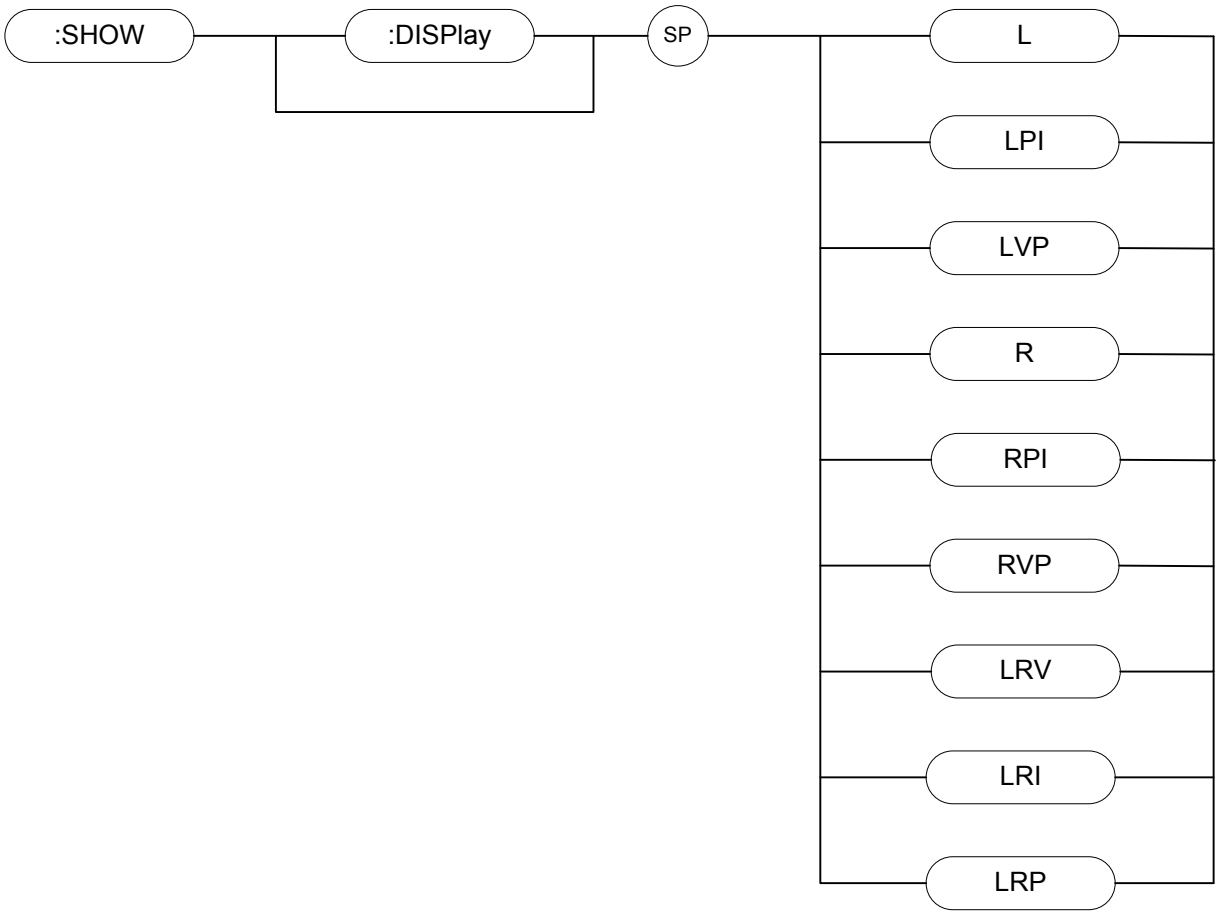
	RES:RISE MAX	It sets the CR rise slew rate to the maximum programmable value.
	RES:FALL MIN	It sets the CR fall slew rate to the minimum programmable value.
Query Syntax	: RESistance:RISE? RESistance:FALL? RESistance:RISE? MAX RESistance:FALL? MIN	
Return Parameters	: <NR2> [Unit=OHM]	
Query Example	: RES:RISE?	It returns the CR rise slew rate.
Return Example	: 2.5	

7.2.12 RUN Subsystem



Type : All Channels
Description : It sets all electronic loads to “ON”.
Syntax : RUN

7.2.13 SHOW Subsystem



SHOW:DISPlay

Type : Channel-Specific (Double Channel Module Only)

Description : It sets the the display mode of the electronic load.

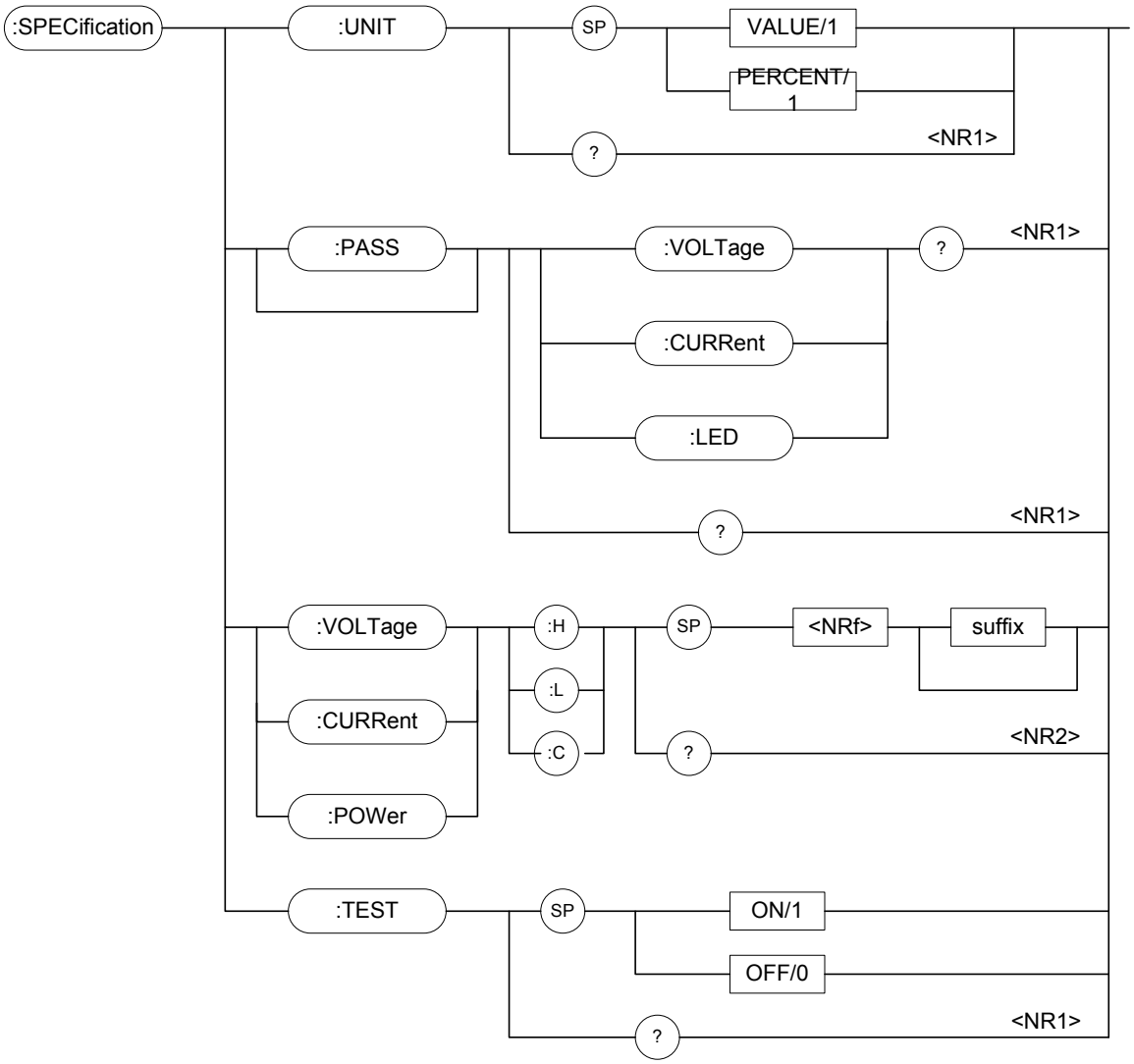
Syntax : SHOW:DISPlay L
SHOW:DISPlay LPI
SHOW:DISPlay LVP
SHOW:DISPlay R
SHOW:DISPlay RPI
SHOW:DISPlay RVP
SHOW:DISPlay LRV
SHOW:DISPlay LRI
SHOW:DISPlay LRP

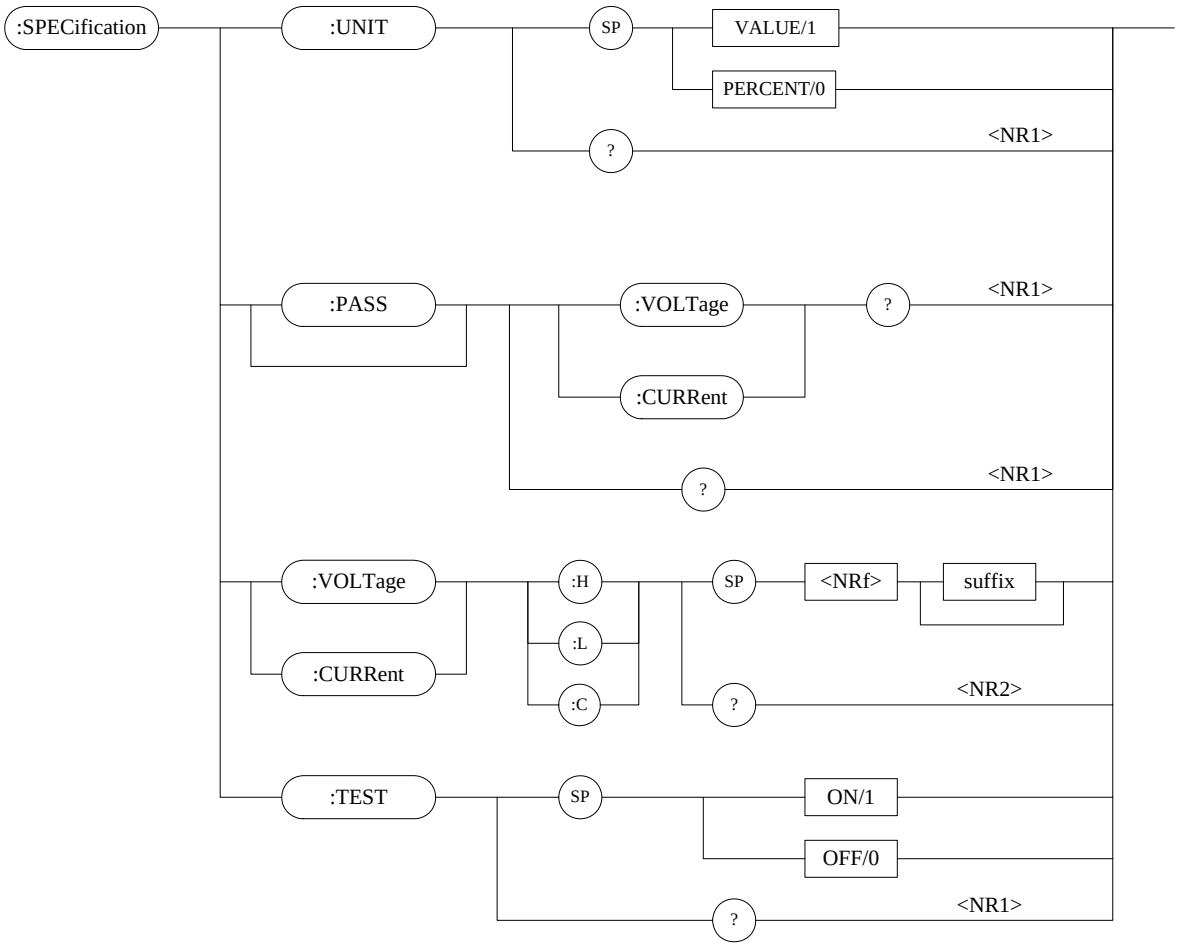
Parameters : L, LPI, LVP, R, RPI, RVP, LRV, LRI, LRP.

Example :

SHOW:DISP L	It displays the voltage and current values of channel L.
SHOW:DISP LPI	It displays the power and current values of channel L.
SHOW:DISP LVP	It displays the voltage and power values of channel L.
SHOW:DISP R	It displays the voltage and current values of channel R.
SHOW:DISP RPI	It displays the power and current values of channel R.
SHOW:DISP RVP	It displays the voltage and power values of channel R.
SHOW:DISP LRV	It displays the voltage value of channel L and channel R.
SHOW:DISP LRI	It displays the current value of channel L and channel R.
SHOW:DISP LRP	It displays the power value of channel L and channel R.

7.2.14 SPECIFICATION Subsystem





SPECification:UNIT

Type : All Channels
Description : It sets the specific entry mode.
Syntax : SPECification:UNIT VALUE
SPECification:UNIT PERCENT
Parameters : VALUE/1, PERCENT/0
Example : SPEC:UNIT VALUE
SPEC: UNIT PERCENT
Query Syntax : SPECification:UNIT?
Query Example : SPEC:UNIT?
Return Parameters : <NR1>
Return Example : 0

SPECification:VOLTage?

Type : Channel-Specific
Description : It requests the GO-NG result refer to the voltage specification.
Query Syntax : SPECification:VOLTage?
Query Example : SPEC:VOLT? It returns voltage GO-NG result to CC and CR modes.
Return Parameters : <NR1>
Return Example : 0 (NG), 1 (GO)

SPECification:CURRent?

Type : Channel-Specific
Description : It requests the GO-NG result refer to the current specification.

Query Syntax : SPECification:CURRent?
Query Example : SPEC:CURR? It returns the current GO-NG result to CC mode.
Return Parameters : <NR1>
Return Example : 0 (NG), 1 (GO)

SPECification:LED?

Type : Channel-Specific
Description : It requests the GO-NG result refer to the current specification.
Query Syntax : SPECification:LED?
Query Example : SPEC:LED? It returns the current GO-NG result to LED mode.
Parameters : <NR1>
Return Example : 0 (NG), 1 (GO)

SPECification?

Type : All Channels
Description : It requests GO-NG result reference to all channel specification.
Query Syntax : SPECification?
Query Example : SPEC? It returns all channel GO-NG result.
Return Parameters : <NR1>
Return Example : 0 (NG), 1 (GO)

SPECification:VOLTage

Type : Channel-Specific
Description : It sets the voltage specification.
Syntax : SPECification:VOLTage:H
SPECification:VOLTage:L
SPECification:VOLTage:C
Parameters : For valid value range refer to respective specification.
Example : SPEC:VOLT:H <NRf+> [suffix]
SPEC:VOLT:L <NRf+> [suffix]
SPEC:VOLT:C <NRf+> [suffix]
Query Syntax : SPECification:VOLTage:H?
SPECification:VOLTage:L?
SPECification:VOLTage:C?
Query Example : SPEC:VOLT:H?
Return Parameters : <NR2> [Unit=Voltage]
Return Example : 4.75

SPECification:CURRent

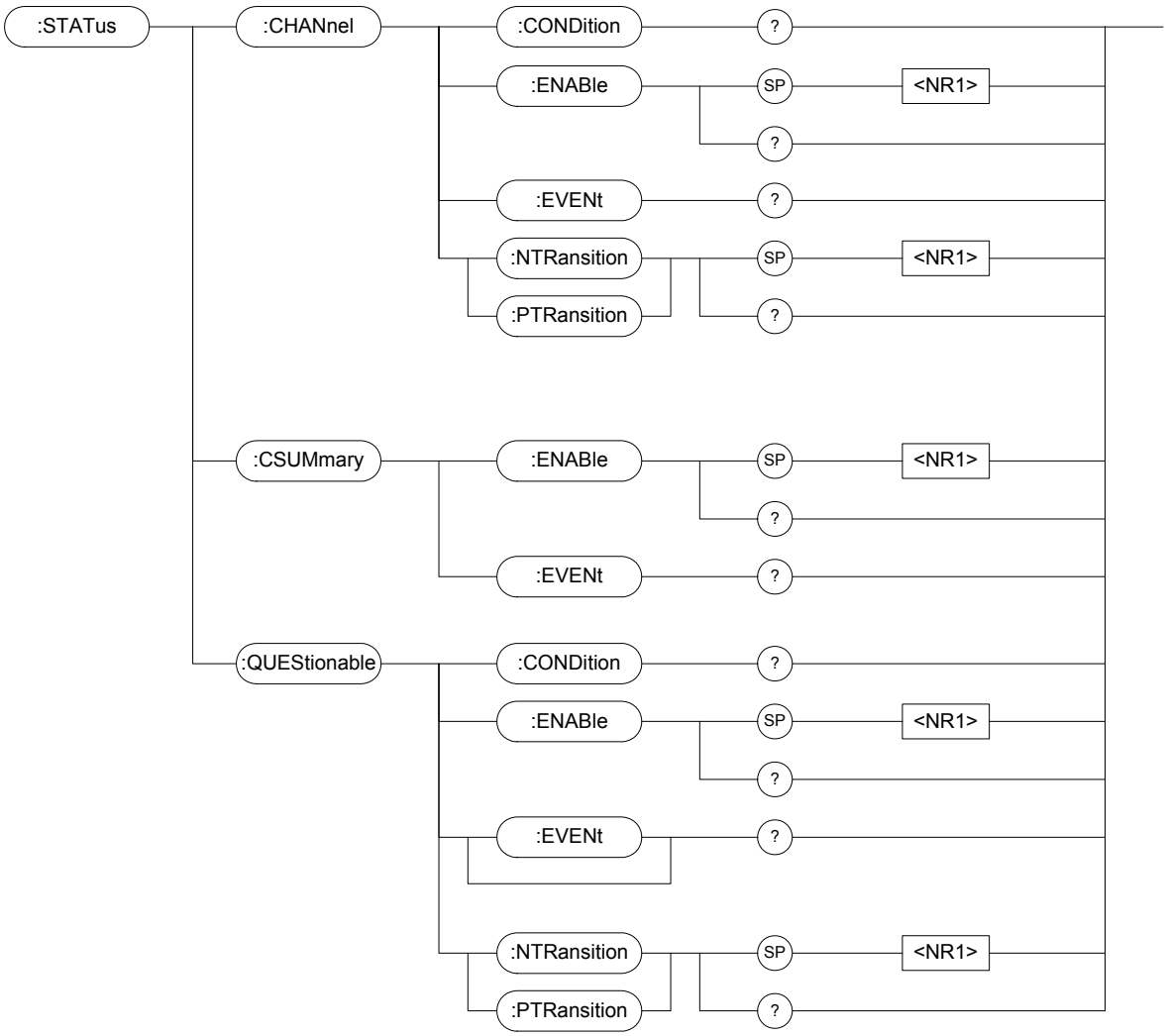
Type : Channel-Specific
Description : It sets the current specification.
Syntax : SPECification:CURRent:H
SPECification:CURRent:L
SPECification:CURRent:C
Parameters : For valid value range refer to respective specification.
Example : SPEC:CURR:H <NRf+> [suffix]
SPEC:CURR:L <NRf+> [suffix]
SPEC:CURR:C <NRf+> [suffix]
Query Syntax : SPECification:CURR:H?
SPECification:CURR:L?

SPECification:CURR:C?
Query Example : SPEC:CURR:H?
Return Parameters : <NR2> [Unit=Current]
Return Example : 4.75

SPECification:TEST

Type : Channel-Specific
Description : It starts or closes the specification test.
Syntax : SPECification:TEST ON
SPECification:TEST OFF
Parameters : ON/1, OFF/0
Example : SPEC:TEST ON
SPEC:TEST OFF
Query Syntax : SPECification:TEST?
Query Example : SPEC:TEST?
Return Parameters : <NR1>
Return Example : 1

7.2.15 STATUS Subsystem



STATus:CHANnel:CONDition?

Type : Channel-Specific
Description : It returns the channel status in real time.
Query Syntax : STATus:CHANnel:CONDition?
Return Parameters : <NR1>

Bit Configuration of Channel Status register

Bit Position	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Condition	0	0	0	0	0	0	0	0	0	0	0	OT	RV	OP	OV	OC
Bit Weight												16	8	4	2	1

Query Example : STAT:CHAN:COND? It returns status of the electronic load.
Return Example : 2048

STATus:CHANnel:ENABle

Type : Channel-Specific
Description : It masks for selecting which bits in the Event register are allowed to be summed into the corresponding channel bit of the Channel Summary Event register.
Syntax : STATus:CHANnel:ENABle
Parameters : 0 ~ 65535
Example : STAT:CHAN:ENABl 24
Query Syntax : STATus:CHANnel:ENABle
Return Parameters : <NR1>
Query Example : STAT:CHAN:ENABL? It returns the contents of Status Channel Enable register.
Return Example : 24

STATus:CHANnel:EVENt?

Type : Channel-Specific
Description : It records all channel events that have occurred since last time the register was read, and resets the Channel Event register.
Query Syntax : STATus:CHANnel:EVENt?
Return Parameters : <NR1>
Query Example : STAT:CHAN:EVEN? It reads and resets Channel Event register.
Return Example : 24

STATus:CHANnel:PTRansition/NTRansition

Type : Channel-Specific
Description : Programmable filters that determine what type of transition (0-to-1 or 1-to-0) in the Condition register will set the corresponding bit of the Event register.
Syntax : STATus:CHANnel:PTRansition/NTRansition <NRf>
Parameters : 0 ~ 65535
Example : STAT:CHAN:PTR 4 It sets the OP(over power bit 2) to 0-to-1.
STAT:CHAN:NTR 4 It sets the OP(over power bit 2) to 1-to-0.
Query Syntax : STATus:CHANnel:PTRansition?
STATus:CHANnel:NTRansition?
Return Parameters : <NR1>
Query Example : STAT:CHAN:PTR? It inquires setting of Channel PTRansition.
Return Example : 4

STATus:CSUMmary:ENABle

Type : Channel-Specific
Description : It masks for selecting which bits in the Channel Event register are allowed to be summed into the CSUM (Channel Summary) bit of the Status Byte register.
Syntax : STATus:CSUMmary:ENABle
Parameters :

Bit Configuration of Channel Summary register

Bit Position	7	6	5	4	3	2	1	0
Channel	8	7	6	5	4	3	2	1
Bit Weight	128	64	32	16	8	4	2	1

Example : STAT:CSUM:ENAB 3

Query Syntax : STATus:CSUMmary:ENABle?
Return Parameters : <NR1>
Query Example : STAT:CSUM:ENAB? It returns the setting of Channel Summary Enable register.
Return Example : 3

STATus:CSUMmary:EVENt?

Type : Channel-Specific
Description : It Indicates all channels on which an enable STAT:CHAN Event has occurred since last time the register was read.
Syntax : STATus:CSUMmary:EVENt
Parameters :

Bit Configuration of Channel Summary register

Bit Position	7	6	5	4	3	2	1	0
Channel	8	7	6	5	4	3	2	1
Bit Weight	128	64	32	16	8	4	2	1

Example : STAT:CSUM:EVEN 3
Query Syntax : STATus:CSUMmary:EVENt?
Return Parameters : <NR1>
Query Example : STAT:CSUM:EVEN? It returns the value of the Channel Summary Event register.
Return Example : 3

STATus:QUEStionable:CONDition?

Type : Channel-Specific
Description : It queries the Real-time ("live") recording of Questionable data.
Query Syntax : STATus:QUEStionable:CONDition?
Return Parameters : <NR1>
Query Example : STAT:QUES:COND? It returns the channel status.
Return Example : 6

STATus:QUEStionable:ENABle

Type : Channel-Specific
Description : It masks for selecting which bits on the Event register are allowed to be summed into the QUES bit of the Status Byte register.
Syntax : STATus:QUEStionable:ENABle
Parameters :

Bit Configuration of Questionable Status register

Bit Position	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Condition	0	0	0	0	0	0	0	0	0	0	0	TE	RV	PE	VE	CE
Bit Weight												16	8	4	2	1

Example : STAT:QUES:ENAB 24
Query Syntax : STATus:QUEStionable:ENABle?
Return Parameters : <NR1>
Query Example : STAT:QUES:ENAB It returns the setting of Status Questionable Enable register.
Return Example : 24

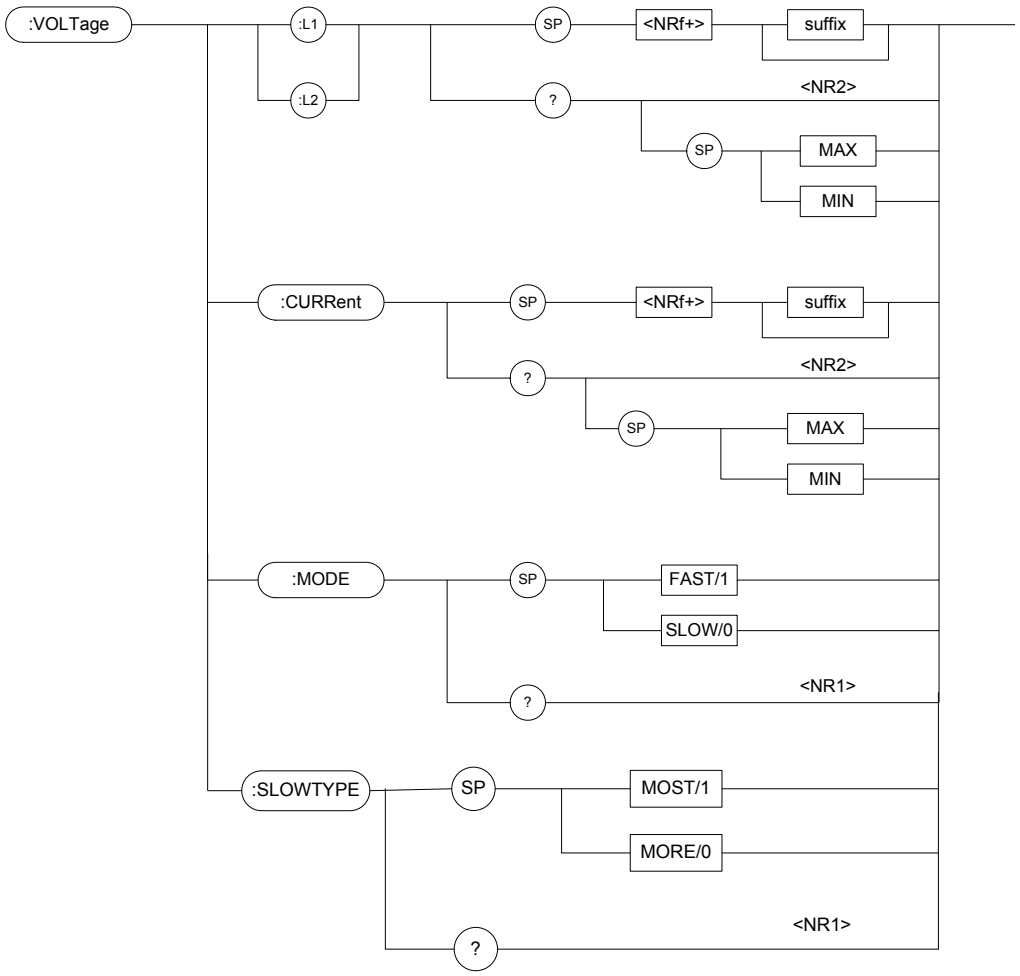
STATus:QUEStionable:EVENt?

Type : Channel-Specific
Description : It records all Questionable conditions that have occurred since last time the register was read.
Query Syntax : STATus:QUEStionable:EVENt?
Return Parameters : <NR1>
Query Example : STAT:QUES:EVEN? It returns the contents of Questionable Event register.
Return Example : 24

STATus:QUEStionable:PTRansition/NTRansition

Type : Channel-Specific
Description : Programmable filters determine what type of transition (0-to-1 or 1-to-0) in the Condition register will set the corresponding bit of the Event register.
Syntax : STATus:QUEStionable:PTRansition/NTRansition <NRf>
Parameters : 0 ~ 65535
Example : STAT:QUES:PTR 4 It sets the OP(over power bit 2) to 0-to-1.
STAT:QUES:NTR 4 It sets the OP(over power bit 2) to 1-to-0.
Query Syntax : STATus:QUEStionable:PTRansition?
STATus:QUEStionable:NTRansition?
Return Parameters : <NR1>
Query Example : STAT:QUES:PTR? It returns the setting on the QUEStionable Ptransition/ Ntransition.
Return Example : 4

7.2.16 VOLTAGE Subsystem



VOLTage:L1/L2

Type : Channel-Specific
Description : It sets the voltage of static load during constant voltage mode.
Syntax : VOLTage:L1
VOLTage:L2
Parameters : For valid value range refer to respective specification.
Example : VOLT:L1 8V — It sets the voltage of load L1 to 8V.
VOLT:L2 24V — It sets the voltage of load L2 to 24V
. VOLT:L1 MAX — It sets the voltage of load L1 to the maximum value.
VOLT:L2 MIN — It sets the voltage of load L2 to the minimum value.
Query Syntax : VOLTage:L1?
VOLTage:L2?
VOLTage:L1? MAX
VOLT:L2? MIN
Return Parameters : <NR2> [Unit=Voltage]

Query Example	: VOLT:L1?	It returns the set voltage value of load L1.
Return Example	: 0	

VOLTage:CURRent

Type	: Channel-Specific	
Description	: It sets the current limit of constant voltage mode.	
Syntax	: VOLTage:CURRent	
Parameters	: For valid value range refer to respective specification.	
Example	: VOLT:CURR 3	It sets the loading current limit as 3A during constant voltage mode.
	VOLT:CURR MAX	It sets the loading current limit as the maximum value during constant voltage mode.
	VOLT:CURR MIN	It sets the oading current limit as the minimum value during constant voltage mode.
Query Syntax	: VOLTage:CURRent?	
Return Parameters	: <NR2> [Unit=Amper]	
Query Example	: VOLT:CURR?	
Return Example	: 3	

VOLTage:MODE

Type	: Channel-Specific
Description	: It sets the response speed of CV mode.
Syntax	: VOLTage:MODE FAST VOLTage:MODE SLOW
Parameters	: FAST/1, SLOW/0
Example	: VOLT: MODE FAST VOLT:MODE SLOW
Query Syntax	: VOLTage:MODE?
Return Parameters	: <NR1>
Query Example	: VOLT:MODE?
Return Example	: 0

VOLTage:SLOWTYPE

Type	: Channel-Specific
Description	: It sets the response speed of slow type.
Syntax	: VOLTage:SLOWTYPE MOST VOLTage:SLOWTYPE MORE
Parameters	: MOST/1, MORE/0
Example	: VOLT: SLOWTYPE MOST VOLT: SLOWTYPE MORE
Query Syntax	: VOLTage: SLOWTYPE?
Return Parameters	: <NR1>
Query Example	: VOLT: SLOWTYPE?
Return Example	: 0

7.2.17 System Commands

M

Type : All Channels
Description : Set the load mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : M “n,n,n,n,n,n,n,n”
Parameters(n) : 0: do not change, 1: CCL, 2: CCH, 3: CCDL, 4: CCDH, 5: CRL, 6: CRH, 7: CV
Example : M “1,1,2,2,2,2,5,5”
M ”2,2,2,2,2,2,2,0”

AC

Type : All Channels
Description : Set the current level 1(L1) of CC mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : AC “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=Ampere]
Example : AC “1.0,1,2.5,5.0,10.5,4.5,2.0,2.0”

AR

Type : All Channels
Description : Set the resistance level 1(L1) of CR mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : AR “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=OHM]
Example : AR “1.0,0.1,0.2,0.5,0.15,0.4,0.2,0.2”

AV

Type : All Channels
Description : Set the voltage level 1(L1) of CV mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : AV “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=Volt]
Example : AV “5.0,5.5,3.3,5.1,12.0,-5.5,5.0,5.2”

CCR

Type : All Channels
Description : Set the rising slew rate of CC mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CCR “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=A/us]
Example : CCR “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

CCF

Type : All Channels
Description : Set the falling slew rate of CC mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CCF “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=A/us]
Example : CCF “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

CRR

Type : All Channels
Description : Set the rising slew rate of CR mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CRR “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=A/us]
Example : CRR “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

CRF

Type : All Channels
Description : Set the falling slew rate of CR mode to the eight channels in one frame. The frame will ignore the setting when the channel does not exist.
Syntax : CRF “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=A/us]
Example : CRF “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

LAT

Type : All Channels
Description : Set the action type of Von to the eight channels in one frame. The frame will ignore the setting when the channel does not exist.
Syntax : LAT “n,n,n,n,n,n,n,n”
Parameters(n) : 0: OFF, 1: ON
Example : LAT “0,1,1,1,0,1,0,1”

GO

Type : All Channels
Description : This command starts/stops current sinking of the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : GO “n,n,n,n,n,n,n,n”
Parameters(n) : 0: OFF, 1: ON, Other Value: no action
Example : GO “0,1,1,1,0,1,0,1”

VRB

Type : All Channels
Description : This command sets the voltage range of CC mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : VRB “n,n,n,n,n,n,n,n”
Parameters(n) : 0: LOW range, 1: HIGH range, Other Value: no action
Example : VRB “0,1,1,1,0,1,0,1”

VR

Type : All Channels
Description : This command sets the voltage range of CC mode to the eight channels in one frame. The frame will ignore the setting when the channel does not exist. The unit of the setting value is volt. Please refer to measurement section in the Specification table.
Syntax : VR “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=Volt]
Example : VR “-1,-1,2,16,80,10,80,16”

VON

Type : All Channels
Description : This command sets Von voltage to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : VON “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=Volt]
Example : VON “1.23,1.23,0,0,5,5,12,12”

CCSR

Type : All Channels
Description : Set both of the rising and the falling slew rate of CC mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CCSR “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=A/us]
Example : CCSR “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

CRSR

Type : All Channels
Description : Set both of the rising and the falling slew rate of CR mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CRSR “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=A/us]
Example : CRSR “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

CDL1

Type : All Channels
Description : Set the current level 1(L1) of CCDL/CCDH mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CDL1 “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=Ampere]
Example : CDL1 “1.0,1,2.5,5.0,10.5,4.5,2.0,2.0”

CDL2

Type : All Channels
Description : Set the current level 2(L2) of CCDL/CCDH mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CDL2 “n,n,n,n,n,n,n,n”
Parameters(i) : <NR2> [Unit=Ampere]
Example : CDL2 “1.0,1,2.5,5.0,10.5,4.5,2.0,2.0”

CDT1

Type : All Channels
Description : Set the active time T1 of current level 1(L1) of CCDL/CCDH mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CDT1 “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=Second]
Example : CDT1 “1.0,1,2.5,5.0,10.5,4.5,2.0,2.0”

CDT2

Type : All Channels
Description : Set the active time T2 of current level 2(L2) of CCDL/CCDH mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CDT2 “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=Second]
Example : CDT2 “1.0,1,2.5,5.0,10.5,4.5,2.0,2.0”

CDR

Type : All Channels
Description : Set the rising slew rate of CCDL/CCDH mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CDR “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=A/us]
Example : CDR “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

CDF

Type : All Channels
Description : Set the falling slew rate of CCDL/CCDH mode to the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : CDF “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=A/us]
Example : CDF “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

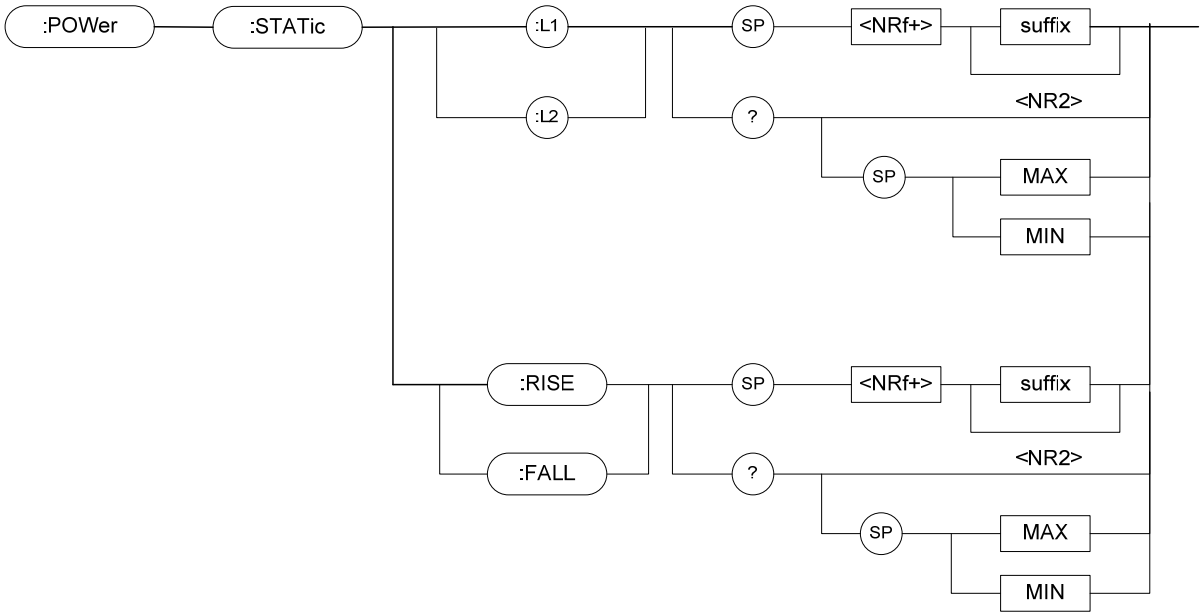
L

Type : All Channels
Description : Set the load level according to mode setting for the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : L “n,n,n,n,n,n,n,n”
Parameters(n) : <NR2> [Unit=Ampere(CCL/CCH)]
[Unit=OHM(CRL/CRH)]
[Unit=Volt(CV)]
Example : L “1.0,2.5,2.5,10,2.0,5.0,5.0,5.0”

SRA

Type : All Channels
Description : This command resets the Von control signal to initial state for the eight channels in one frame. The frame will ignore the setting if the channel does not exist.
Syntax : SRA “n,n,n,n,n,n,n,n”
Parameters(n) : 1: RESET, Other Value: no action
Example : SRA “0,0,1,1,1,1,1,0”

7.2.18 POWER Subsystem



POWer: STATic:L1/L2

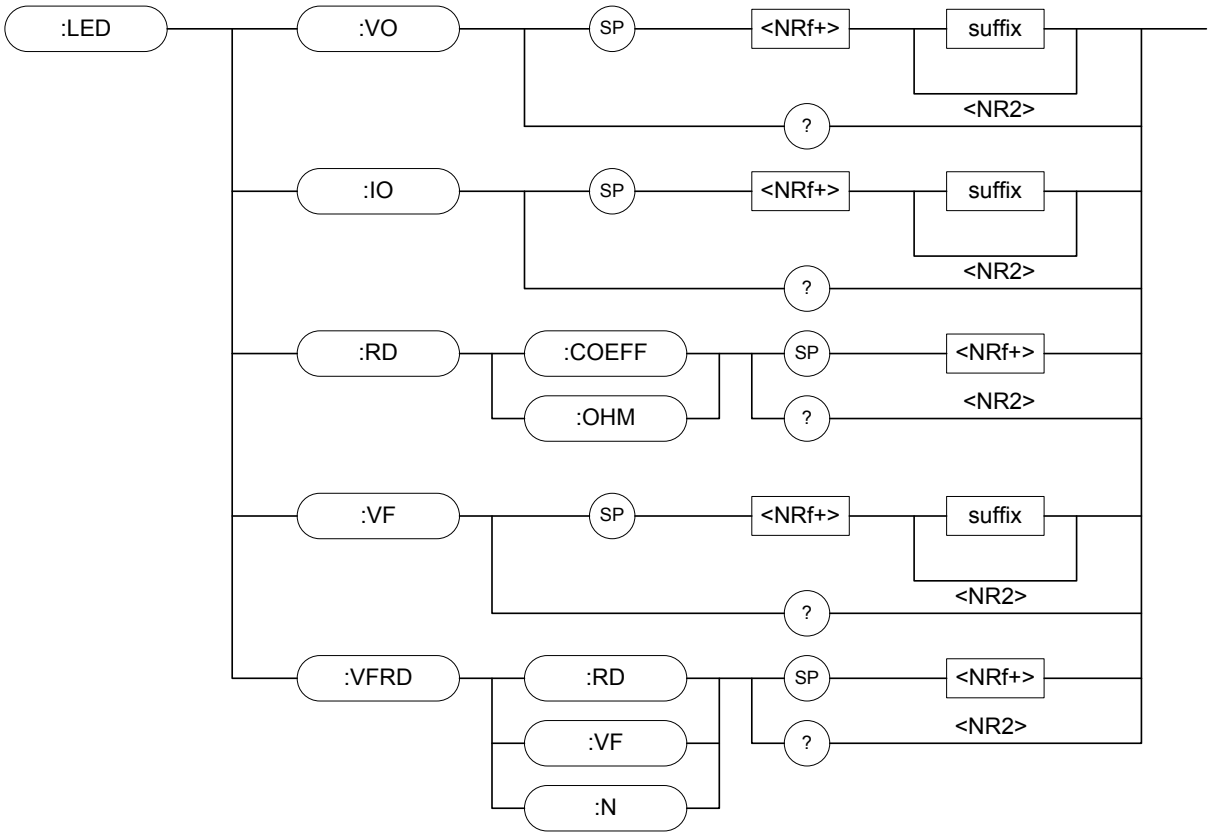
Type : Channel-Specific
Description : It sets the static power level of constant power mode.
Syntax : POWer:STATic:L1 <NR2> [suffix]
POWer:STATic:L2 <NR2> [suffix]
Parameters : For valid value range refer to respective specification.
Example : POW:STAT:L1 20 W It sets the constant power = 20 w for Load L1.
POW: STAT:L2 10 W It sets the constant power = 10 w for Load L2.
POW:STAT:L1 MAX It sets the constant power= maximum L1 value for Load L1.
POW:STAT:L2 MIN It sets the constant resistance = minimum L2 value for Load L2.
Query Syntax : POW: STAT:L1?
POW: STAT:L2?
POW: STAT:L1? MAX
POW: STAT:L2? MIN
Return Parameters : <NR2> [Unit=W]
Query Example : POW: STAT:L1? It returns the set power of the value of Load L1.
Return Example : 20

POWer: STATic:RISE/FALL

Type : Channel-Specific
Description : It sets the resistive slew rate of constant power
Syntax : POWer:STAT:RISE <NR2> [suffix]
POWer:STAT:FALL <NR2> [suffix]
Parameters : For valid value range refer to respective specification.
Example : POW:STAT:RISE 2.5 It sets the CP rise slew rate to 2.5w/μs.

	POW:STAT:FALL 1A/μs	It sets the CP fall slew rate to 1w/μs.
	POW:STAT:RISE MAX	It sets the CP rise slew rate to the maximum programmable value.
	POW:STAT:FALL MIN	It sets the CP fall slew rate to the minimum programmable value.
Query Syntax	: POWer:STAT:RISE?	
	POWer:STAT:FALL?	
	POWer:STAT:RISE? MAX	
	POWer:STAT:FALL? MIN	
Return Parameters	: <NR2> [Unit=W]	
Query Example	: POW:STAT:RISE?	It returns the CP rise slew rate.
Return Example	: 2.5	

7.2.19 LED Subsystem



LED:VO

Type	: Channel-Specific	
Description	: It sets the output voltage of LED driver.	
Syntax	: LED:VO <NRf+>	
Parameters	: For valid value range refer to respective specification.	
Example	: LED:VO 8	It sets V_o=8V.
	LED:VO 24	It sets V_o=24V.
Query Syntax	: LED :VO?	
Return Parameters	: <NRf+>	
Query Example	: LED:VO?	It returns the set V_o value.
Return Example	: 24	

LED:IO

Type	: Channel-Specific	
Description	: It sets the output current of LED driver.	
Syntax	: LED:IO <NRf+>	
Parameters	: For valid value range refer to respective specification.	
Example	: LED:IO 0.1	It sets I_o=0.1A.
	LED:IO 2	It sets I_o=2A.
Query Syntax	: LED :IO?	
Return Parameters	: <NRf+>	
Query Example	: LED:IO?	It returns the set I_o value.
Return Example	: 2	

LED:RD:COEFF

Type : Channel-Specific
Description : It sets the LED operating point impedance.
Syntax : LED:RD:COEFF <NRf+>
Parameters : 0.001~1
Example : LED:RD:COEFF 0.1 It sets Coeff=0.1
LED:RD:COEFF 1 It sets Coeff=1
Query Syntax : LED:RD:COEFF?
Return Parameters : <NRf+>
Query Example : LED:RD:COEFF? It returns the set Coeff value.
Return Example : 1

LED:RD:OHM

Type : Channel-Specific
Description : It sets the ohm of operating point impedance R_d.
Syntax : LED:RD:OHM <NRf+>
Parameters : For valid value range refer to respective specification.
Example : LED:RD:OHM 1 It sets rd OHM = 1ohm
LED:RD:OHM 10 It sets rd OHM = 10ohm
Query Syntax : LED:RD:OHM?
Return Parameters : <NRf+>
Query Example : LED:RD:OHM? It returns the set R_d ohm.
Return Example : 10

LED:VF

Type : Channel-Specific
Description : It sets the forward bias of LED.
Syntax : LED:VF <NRf+>
Parameters : For valid value range refer to respective specification.
Example : LED:VF 8 It sets V_F=8V.
LED:VF 24 It sets V_F=24V.
Query Syntax : LED :VF?
Return Parameters : <NRf+>
Query Example : LED:VF? It returns the set V_F value.
Return Example : 24

LED:VFRD:RD

Type : Channel-Specific
Description : It sets the Ohm of operating point impedance Rd.
Syntax : LED:VFRD:RD <NRf+>
Parameters : For valid value range refer to respective specification.
Example : LED:VFRD:RD 10 It sets Rd ohm = 10ohm.
Query Syntax : LED:VFRD:RD?
Return Parameters : <NRf+>
Query Example : LED:VFRD:RD? It returns the set Rd ohm.
Return Example : 10

LED:VFRD:VF

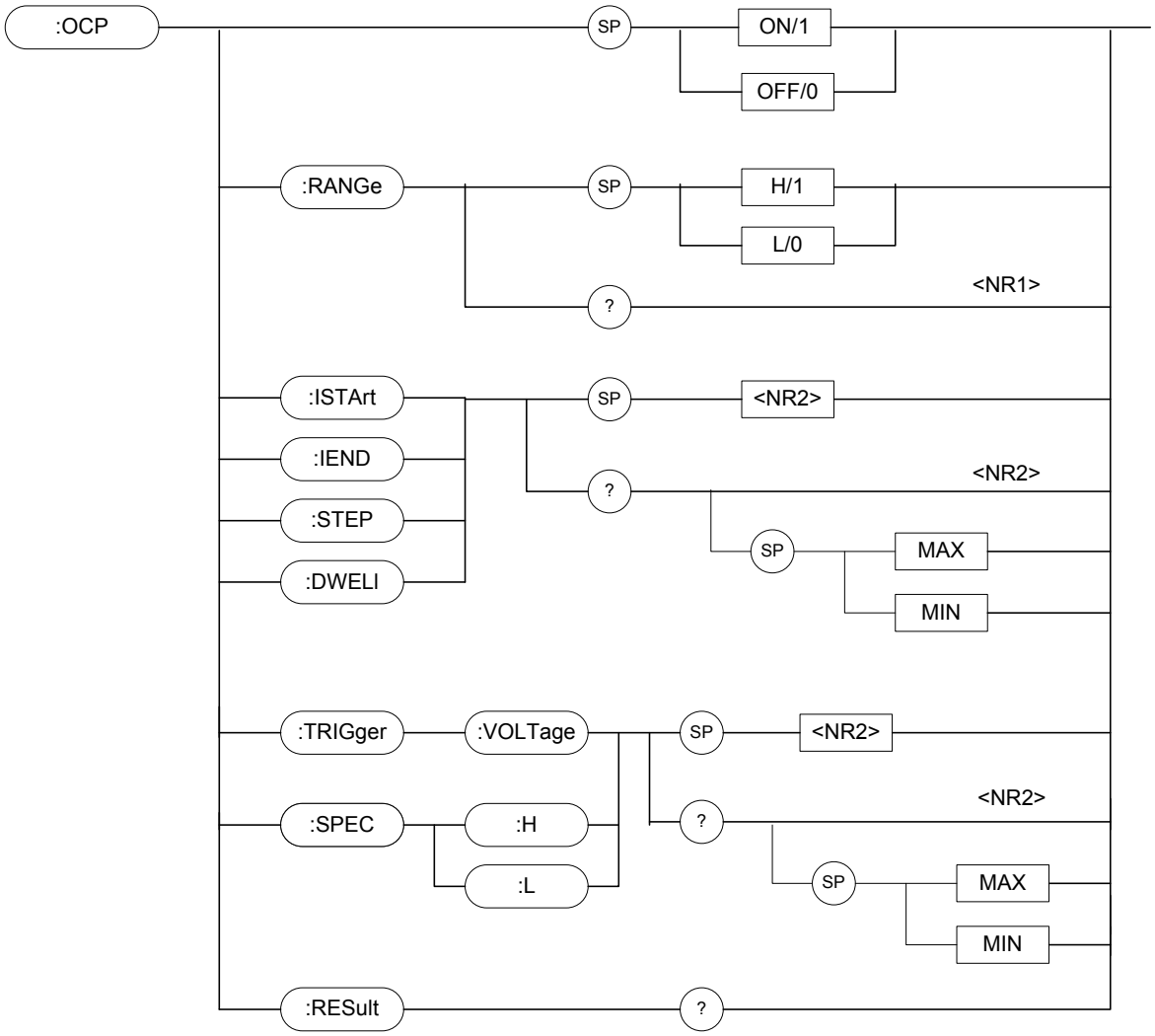
Type : Channel-Specific
Description : It sets the forward bias of LED.
Syntax : LED:VFRD:VF <NRf+>
Parameters : For valid value range refer to respective specification.

Example	: LED:VFRD:VF 8	It sets Vf=8V.
	LED:VFRD:VF 24	It sets Vf=24V.
Query Syntax	: LED:VFRD:VF?	
Return Parameters	: <NRf+>	
Query Example	: LED:VFRD:VF?	It returns the set Vf value.
Return Example	: 24	

LED:VFRD:N

Type	: Channel-Specific	
Description	: It sets the number of LED in series.設定	
Syntax	: LED:VFRD:N <NRf+>	
Parameters	: For valid value range refer to respective specification.	
Example	: LED:VFRD:N 8	It sets 8 LEDs in series..
	LED:VFRD:N 24	It sets 24 LEDs in series
Query Syntax	: LED:VFRD:N?	
Return Parameters	: <NR1>	
Query Example	: LED:VFRD:N?	It returns the number of LED in series.
Return Example	: 24	

7.2.20 OCP Subsystem



OCP

Type	: Channel-Specific	
Description	: It executes or cancels the OCP Test.	
Syntax	: OCP <NR1>	
Parameters	: ON/1, OFF/0.	
Example	: OCP ON	It executes the OCP Test.

OCP:RANGe

Type	: Channel-Specific	
Description	: It sets the range for OCP execution.	
Syntax	: OCP:RANGe <NR1>	
Parameters	: H/1, L/0.	
Example	: OCP:RANG H	It sets the range to High for OCP.
Query Syntax	: OCP:RANGe?	
Return Parameters	: <NR1>	
Query Example	: OCP:RANG?	It returns the range set for OCP.
Return Example	: 1	

OCP:ISTArt

Type : Channel-Specific
Description : It sets the start current for OCP test mode.
Syntax : OCP:ISTArt <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OCP:ISTA 0.5 It sets the starts current = 0.5A
OCP:ISTA MAX It sets the starts current = maximum value.
OCP:ISTA MIN It sets the starts current = minimum value.
Query Syntax : OCP:ISTArt?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Ampere]
Query Example : OCP:ISTA?
OCP:ISTA? MAX
OCP:ISTA? MIN
Return Example : 0.5

OCP:IEND

Type : Channel-Specific
Description : It sets the end current for OCP test mode.
Syntax : OCP:IEND <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OCP:IEND 3 It sets the end current = 3A
OCP:IEND MAX It sets the end current = maximum value.
OCP:IEND MIN It sets the end current = minimum value.
Query Syntax : OCP:IEND?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Ampere]
Query Example : OCP:IEND?
OCP:IEND? MAX
OCP:IEND? MIN
Return Example : 3

OCP:STEP

Type : Channel-Specific
Description : It sets the step count for OCP test mode.
Syntax : OCP:STEP <NR1>
Parameters : 1~1000.
Example : OCP:STEP 100 It sets the step = 100
OCP:STEP MAX It sets the step = maximum value.
OCP:STEP MIN It sets the step = minimum value.
Query Syntax : OCP:STEP?[<MAX | MIN>]
Return Parameters : <NR1>
Query Example : OCP:STEP?
OCP:STEP? MAX
OCP:STEP? MIN
Return Example : 100

OCP:DWELl

Type : Channel-Specific
Description : It sets the dwell time for OCP test mode.
Syntax : OCP:DWELI <NR1>
Parameters : 1~1000.
Example : OCP:DWEL 100 It sets the dwell time = 100
OCP:DWEL MAX It sets the dwell time = maximum value.

OCP:DWEL MIN It sets the dwell time = minimum value.
Query Syntax : OCP:DWEL?[<MAX | MIN>]
Return Parameters : <NR1>[Unit = ms]
Query Example : OCP:DWEL?
OCP:DWEL? MAX
OCP:DWEL? MIN
Return Example : 100

OCP:TRIGger:VOLTage

Type : Channel-Specific
Description : It sets the trigger voltage for OCP test mode.
Syntax : OCP:TRIGger:VOLTage <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OCP:TRIGger:VOLTage 4.5 It sets the start current = 4.5V
OCP:TRIGger:VOLTage MAX It sets the start current = maximum value.
OCP:TRIGger:VOLTage MIN It sets the start current = minimum value.
Query Syntax : OCP: TRIGger:VOLTage?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Voltage]
Query Example : OCP:TRIGger:VOLTage?
OCP:TRIGger:VOLTage? MAX
OCP:TRIGger:VOLTage? MIN
Return Example : 4.5

OCP: SPECification:L

Type : Channel-Specific
Description : It sets the low level current of specification for OCP test mode
Syntax : OCP:SPECification:L <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OCP:SPECification:L 1.5 It sets the low level current = 1.5A
OCP:SPECification:L MAX It sets the low level current = maximum value.
OCP:SPECification:L MIN It sets the low level current = minimum value.
Query Syntax : OCP:SPECification:L?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Ampere]
Query Example : OCP:SPECification:L?
OCP:SPECification:L? MAX
OCP:SPECification:L? MIN
Return Example : 1.5

OCP: SPECification:H

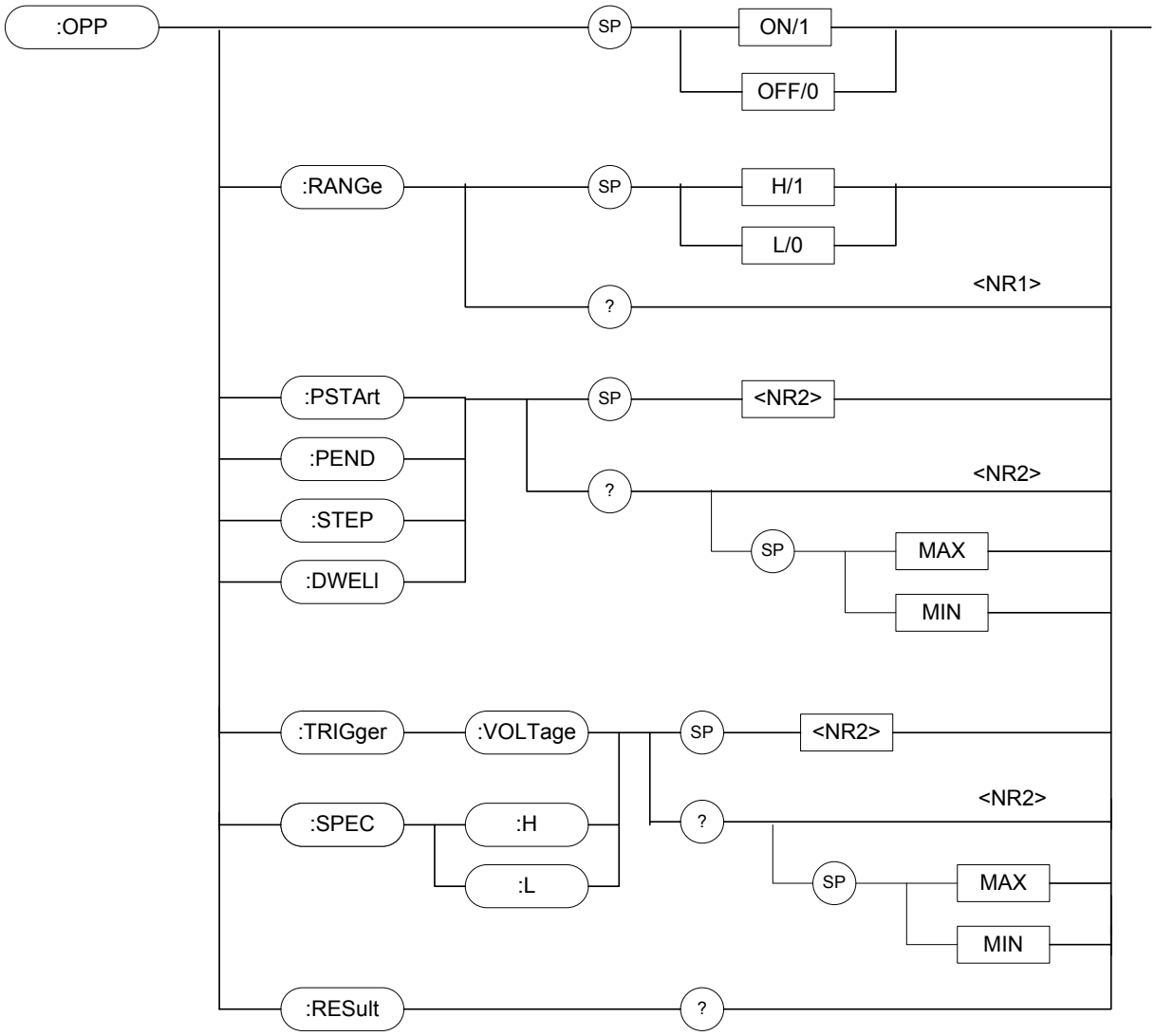
Type : Channel-Specific
Description : It sets the high level current of specification for OCP test mode
Syntax : OCP:SPECification:H <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OCP:SPECification:H 2.8 It sets the high level current = 2.8A
OCP:SPECification:H MAX It sets the high level current = maximum value.
OCP:SPECification:H MIN It sets the high level current = minimum value.
Query Syntax : OCP:SPECification:H?[<MAX | MIN>]

Return Parameters : <NR2>, [Unit = Ampere]
Query Example : OCP:SPECification:H?
OCP:SPECification:H? MAX
OCP:SPECification:H? MIN
Return Example : 2.8

OCP:RESult?

Type : Channel-Specific
Description : It returns the result of OCP test function.
Syntax : None
Parameters : None
Example : None
Query Syntax : OCP:RESult?
Return Parameters : When the returns are
-1 denotes the OCP test is stop.
-2 denotes the OCP test is ready to execute what wait for Von or other condition.
-3 denotes the OCP test is executed.
<arg1>,<arg2>
<arg1>: Pass/Fail. <NR1>, 0: PASS 1: FAIL [Unit = None]
<arg2>: OCP current. <NR2>, [Unit = Ampere]
Query Example : OCP:RES?

7.2.21 OPP Subsystem



OPP

Type : Channel-Specific
Description : It executes or cancels the OPP Test.
Syntax : OPP <NR1>
Parameters : ON/1, OFF/0.
Example : OPP ON Execute the OPP Test.

OPP:RANGe

Type : Channel-Specific
Description : It sets the range for OPP execution.
Syntax : OPP:RANGe <NR1>
Parameters : H/1, L/0.
Example : OPP:RANG H It sets the range to High for OPP.
Query Syntax : OPP:RANGe?
Return Parameters : <NR1>
Query Example : OPP:RANG? It returns the set range for OCP.
Return Example : 1

OPP:PSTArt

Type : Channel-Specific
Description : It sets the starts power for OPP test mode.
Syntax : OPP:PSTArt <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OPP:PSTA 5 It sets the Set starts power = 5W
OPP:PSTA MAX It sets the starts power = maximum value.
OPP:PSTA MIN It sets the starts power = minimum value.
Query Syntax : OPP:PSTArt?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Watt]
Query Example : OPP:PSTA?
OPP:PSTA? MAX
OPP:PSTA? MIN
Return Example : 5

OPP:PEND

Type : Channel-Specific
Description : It sets the end power for OPP test mode.
Syntax : OPP:PEND <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OPP:PEND 10 It sets the end power = 10W
OPP:PEND MAX It sets the end power = maximum value.
OPP:PEND MIN It sets the end power = minimum value.
Query Syntax : OPP:PEND?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Watt]
Query Example : OPP:PEND?
OPP:PEND? MAX
OPP:PEND? MIN
Return Example : 10

OPP:STEP

Type : Channel-Specific
Description : It sets the step count for OPP test mode.
Syntax : OPP:STEP <NR1>
Parameters : 1~1000.
Example : OPP:STEP 100 It sets the step = 100
OPP:STEP MAX It sets the step = maximum value.
OPP:STEP MIN It sets the step = minimum value.
Query Syntax : OPP:STEP?[<MAX | MIN>]
Return Parameters : <NR1>
Query Example : OPP:STEP?
OPP:STEP? MAX
OPP:STEP? MIN
Return Example : 100

OPP:DWELl

Type : Channel-Specific
Description : It sets the dwell time for OPP test mode.
Syntax : OPP:DWELl <NR1>
Parameters : 1~1000.
Example : OPP:DWEL 100 It sets the dwell time = 100
OPP:DWEL MAX It sets the dwell time = maximum value.

OPP:DWEL MIN It sets the dwell time = minimum value.
Query Syntax : OPP:DWEL?[<MAX | MIN>]
Return Parameters : <NR1>[Unit = ms]
Query Example : OPP:DWEL?
OPP:DWEL? MAX
OPP:DWEL? MIN
Return Example : 100

OPP:TRIGger:VOLTage

Type : Channel-Specific
Description : It sets the trigger voltage for OPP test mode.
Syntax : OPP:TRIGger:VOLTage <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OPP:TRIGger:VOLTage 4.5 It sets the start power = 4.5V
OPP:TRIGger:VOLTage MAX It sets the start power = maximum value.
OPP:TRIGger:VOLTage MIN It sets the start power = minimum value.
Query Syntax : OPP:TRIGger:VOLTage?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Voltage]
Query Example : OPP:TRIGger:VOLTage?
OPP:TRIGger:VOLTage? MAX
OPP:TRIGger:VOLTage? MIN
Return Example : 4.5

OPP: SPECification:L

Type : Channel-Specific
Description : It sets the low level power of specification for OPP test mode
Syntax : OPP:SPECification:L <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OPP:SPECification:L 5 It sets the low level power = 5W
OPP:SPECification:L MAX It sets the low level power = maximum value.
OPP:SPECification:L MIN It sets the low level power = minimum value.

Query Syntax : OPP:SPECification:L?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Watt]
Query Example : OPP:SPECification:L?
OPP:SPECification:L? MAX
OPP:SPECification:L? MIN
Return Example : 5

OPP: SPECification:H

Type : Channel-Specific
Description : It sets the high level power of specification for OPP test mode
Syntax : OPP:SPECification:H <NR2>
Parameters : Refer to respective specification for valid value range.
Example : OPP:SPECification:H 10 It sets the high level power = 10W
OPP:SPECification:H MAX It sets the high level power = maximum value.
OPP:SPECification:H MIN It sets the high level power = minimum value.

Query Syntax : OPP:SPECification:H?[<MAX | MIN>]
Return Parameters : <NR2>, [Unit = Watt]
Query Example : OPP:SPECification:H?
OPP:SPECification:H? MAX
OPP:SPECification:H? MIN
Return Example : 10

OPP:RESult?

Type : Channel-Specific
Description : It returns the result of OPP test function.
Syntax : None
Parameters : None
Example : None
Query Syntax : OPP:RESult?
Return Parameters : When the returns are
-1 denotes the OPP test is stop.
-2 denotes the OPP test is ready to execute what wait for Von or other condition.
-3 denotes the OPP test is executed.
<arg1>,<arg2>
<arg1>: Pass/Fail. <NR1>, 0: PASS 1: FAIL [Unit = None]
<arg2>: OPP power. <NR2>, [Unit = Ampere]
Query Example : OPP:RES?

8. Status Reporting

8.1 Introduction

This chapter discusses the status data structure of the Chroma 6330A series electronic load as shown in Figure 8-1 (on the next page). The standard registers, such as the Event Status register group, the Output Queue, the Status Byte and Service Request Enable registers perform standard GPIB functions and are defined in IEEE-488.2 Standard Digital Interface for Programmable Instrumentation. Other status register groups implement the specific status reporting requirements of the electronic load. The Channel Status and Channel Summary groups are used by multiple channel of electronic load to enable status information to be kept at its own Status register of each channel.

8.2 Register Information in Common

- *Condition register*
  The condition register represents the present status of electronic load signals. Reading the condition register does not change the state of its bits. Only changes in electronic load conditions affect the contents of this register.

- *PTR/NTR Filter, Event register*
  The Event register captures changes in conditions corresponding to condition bits in a condition register, or to a specific condition in the electronic load. An event becomes true when the associated condition makes one of the following electronic load-defined transitions:

  Positive TRansition (0 - to - 1)
  Negative TRansition (1 - to - 0)
  Positive or Negative TRansition (0-to-1 or 1-to-0)

  The PTR/NTR filters determine what type of condition transitions set the bits in the Event register. Channel Status, Questionable Status allow transitions to be programmed. Other register groups, i.e. Channel Summary, Standard Event Status register group use an implied Rise (0-to-1) condition transition to set bits in the Event register. Reading an Event register clears the register (all bits set to zero).

- *Enable register*
  The Enable register can be programmed to enable which bit in the corresponding Event register is logically-ORed into the Channel Summary bit.

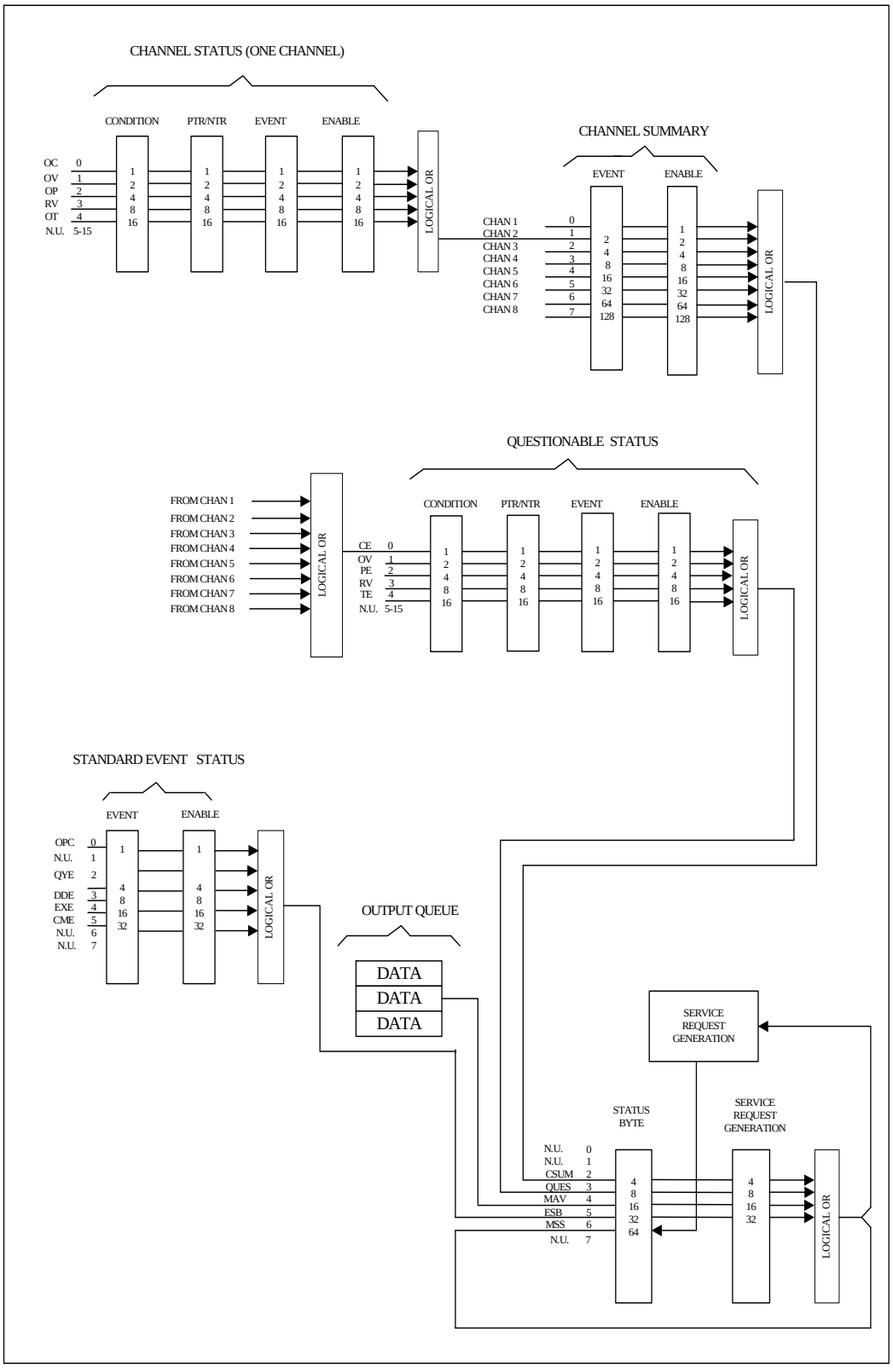


Figure 8-1 The Status Registers of Electronic Load

8.3 Channel Status

- The Channel Status register offers you one or more channel status conditions, which indicate certain errors or faults have occurred on specific channel. Table 8-1 describes the channel status conditions that are applied to the electronic load.
- When the bits of the Channel Status Condition register are set, the corresponding condition is true.
- Program the PTR/NTR filter to select which way of a condition transition on a bit in the Channel Status Condition register will set the corresponding bit in the Event registers. Reading of the Channel Status Event register resets itself to zero.
- The Channel Status Enable register can be programmed to specify which channel status event bit is logically-ORed to become the corresponding channel bit in the Channel Summary Event register.

Table 8-1 Bit Description of Channel Status

Mnemonic	Bit	Value	Meaning
OC	0	1	*Over current*. When an over current condition has occurred on a channel, Bit 0 is set and remains set until the over current condition is removed and LOAD:PROT:CLE is programmed.
OV	1	2	*Over voltage*. When an overvoltage condition has occurred on a channel, Bit 1 is set and remains set until the overvoltage condition is removed and LOAD:PROT:CLE is programmed.
OP	2	4	*Over power.* An overpower condition has occurred on a channel, Bit 2 is set and remains set until the overpower condition is removed and LOAD:PROT:CLE is programmed.
RV	3	8	*Reverse voltage on input.* When a channel has a reverse voltage applied to it, Bit 3 is set. It remains set until the reverse voltage is removed and LOAD:PROT:CLE is programmed.
OT	4	16	*Over temperature*. When over temperature condition has occurred on a channel, Bit 4 is set and the channel is turned off. It remains set until the channel has cooled down well below the over temperature trip point and LOAD:PROT:CLE is programmed.

8.4 Channel Summary

- The Channel Summary registers summarize the channel status conditions of up to 8 channels.
- When an enabled bit in the Channel Status Event register is set, it causes the corresponding channel bit in the Channel Summary Event register to be set.
- Reading of the Event register will reset it to zero.
- The Channel Summary Enable register can be programmed to specify which channel summary event bit from the existing channels is logically-ORed to become Bit 2 (CSUM bit) in the Status Byte register.

8.5 Questionable Status

- The Questionable Status registers offer you one or more questionable status conditions, which indicate certain errors or faults have occurred on at least one channel. Table 8-2 lists the questionable status conditions that are applied to the electronic load. These conditions are the same as the channel status conditions. Refer to Table 8-1 for a complete description.
- When corresponding bit of Questionable Status Condition register is set, the indicated condition is true.
- Program the PTR/NTR filter to select which way of a condition transition on a bit in the Questionable Status Condition register will set the corresponding bit in the Event registers.
- Reading of the Questionable Status Event register will reset it to zero.
- The Questionable status Enable register can be programmed to specify which questionable status event bit is logically-ORed to become Bit 3 (QUES bit) in the Status Byte register.

Table 8-2 Bit Description of Questionable Status

Mnemonic	Bit	Value	Meaning
CE/OC	0	1	Current Error (Over current)
OV	1	2	Over voltage
PE/OP	2	4	Power Error (Overpower)
RV	3	8	Reverse voltage on input
TE/OT	4	16	Temperature Error (Over temperature)

8.6 Output Queue

- The Output Queue stores output messages until they are read from the electronic load.
- The Output Queue stores messages sequentially on a FIFO (First-In, First-Out) basis.
- When there are data in the queue, it sets it 4 (MAV bit) in the Status Byte register.

8.7 Standard Event Status

- All programming errors that have occurred will set one or more of the error bits in the Standard Event Status register. Table 8-3 describes the standard events that apply to the electronic load.
- Reading of the Standard Event Status register will reset it to zero.
- The Standard Event Enable register can be programmed to specify which standard event bit is logically-ORed to become Bit 5 (ESB bit) in the Status Byte register.

Table 8-3 Bit Description of Standard Event Status

Mnemonic	Bit	Value	Meaning
OPC	0	1	*Operation Complete.* This event bit generated is responding to the *OPC command. It indicates that the device has completed all selected pending operations.
QYE	2	4	*Query Error*. The output queue was read when no data were present or the data in the queue were lost.
DDE	3	8	*Device Dependent Error.* Memory was lost, or self-test failed.
EXE	4	16	*Execution Error*. A command parameter was outside the legal range or inconsistent with the electronic load's operation, or the command could not be executed due to some operating condition.
CME	5	32	*Command Error.* A syntax or semantic error has occurred, or the electronic load has received a <GET> within a program message.

8.8 Status Byte Register

- The Status Byte register summarizes all of the status events from all status registers. Table 8-4 describes the status events that are applied to the electronic load.
- The Status Byte register can be read with a serial poll or *STB? query.
- The RQS bit is the only bit that is automatically cleared after a serial poll.
- When the Status Byte register is read with a *STB? query, Bit 6 of the Status Byte register will contain the MSS bit. The MSS bit indicates that the load has at least one reason for requesting service. *STB? does not affect the status byte.
- The Status Byte register is cleared by *CLS command.

Table 8-4 Bit Description of Status Byte

Mnemonic	Bit	Value	Meaning
CSUM	2	4	*Channel Summary*. It indicates if an enabled channel event has occurred. It is affected by Channel Condition, Channel Event and Channel Summary Event registers.
QUES	3	8	*Questionable*. It indicates if an enabled questionable event has occurred.
MAV	4	16	*Message Available.* It indicates if the Output Queue contains data.
ESB	5	32	*Event Status Bit*. It indicates if an enabled standard event has occurred.
RQS/MSS	6	64	*Request Service/Master Summary Status.* During a serial poll, RQS is returned and cleared. For an *STB? query, MSS is returned without being cleared.

8.9 Service Request Enable Register

- The Service Request Enable register can be programmed to specify which bit in the Status Byte register will generate service requests.

9. An Example of Use

In this chapter a basic example of controlling electronic load are provided for use of GPIB. The GPIB used here is made by NI (National Instruments).

Examples:

```
#include “dec1.h”

#include <stdio.h>
#include <stdlib.h>
#include <sring.h>
#include <iostream.h>
#include <time.h>

static int MTA,
           MLA;

static int bd;

const char LA = 0x20,
           TA = 0x40;

static void setNi( int pad, char *cardName )
{
    MTA = TA + pad;
    MLA = LA + pad;
    if ( (bd = ibfind ( cardName ) ) < 0 )   {
       puts ( “GPIB Card Found Error” );
       exit ( 1 );
    }
    if ( ibpad ( bd, pad ) & ERR )   {
        puts ( “GPIB Card Address Assignment Error” );
        exit ( 3 );
    }
    ibtmo ( bd, 10 );
  ibsic ( bd );
  ibsre ( bd, 1 );
}

static void Niwrite( int pad, char *cmdStr )
{
   char cmd[4];

  cmd[0] = UNL;
   cmd[1] = UNT;
   cmd[2] = MTA;
   cmd[3] = LA + pad;
   //
   ibcmd( bd, cmd, 4 );
   ibwrt ( bd, cmdStr, _fstrlen( cmdStr ) );
   ibcmd( bd, cmd, 2 );
```

```
}

static char rxBuf[ 64 ]

static void Niread( int pad, char *queryStr )
{
    char cmd[ 4 ];

     Niwrite( pad, queryStr );
     cmd[ 0 ] = UNL;
     cmd[ 1 ] = UNT;
     cmd[ 2 ] = TA + pad;
     cmd[ 3 ] = MLA;
    //
ibcmd( bd, cmd, 4 );
     ibrd( bd, rxBuf, sizeof( rxBuf ) - 1 );
     rxBuf[ ibcnt ] = ' \0 ';
     ibcmd( bd, cmd, 2);
}



void main( )
{
   setNi( 0, "GPIB" );                  // Set the status of PC's GPIB CARD.
   //
    Niread( 8, "*IDN?" );               // Read back identity code of 6334.
   cout << rxBuf << " \n\r ";           // Display on the screen of PC.
    //
    Niwrite( 8, "CHAN 1" );             // Set CHANNEL as 1.
    //
    Niread( 8,   "CHAN:ID?" );          // Read back identity code of channel 1.
    cout << rxBuf << " \n\r ";          // Display on the screen of PC.
    //
    Niwrite( 8, "MODE CCL" );                 // Set CHANNEL 1 MODE as CCL.
    Niwrite ( 8, "CURR:STATIC:L1 1" ):        // Set L1 current of CCL as 1A.
    //
    Niread( 8,   "LOAD ON" );                 // Start sinking current.
    //
    Niread( 8, "MEAS:VOLT?" );                // Measure the readings of voltage.
    cout << rxBuf << " \n\r ";                // Display on the screen of PC.
    //
    Niread( 8, "MEAS:CURR?" );                // Measure the readings of current.
    cout << rxBuf << " \n\r ";                // Display on the screen of PC.
    Niread( 8, "LOAD OFF" );                  // Stop sinking current.
    //
    ibsic ( bd );
    ibon1( bd, 0 );
    ibsre ( bd, 0 );
}
```

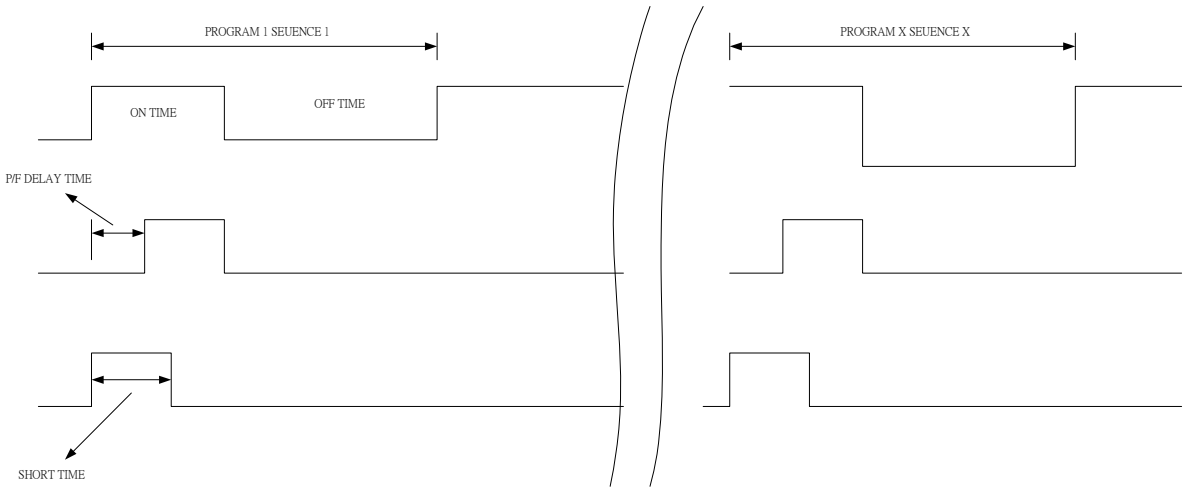
For the above example please refer to *Chapter 3*, and add corresponding commands according to setting and control.

Example of PROGRAM RUN

You can use the following control procedures to run the PROGRAM.

```
<1> PROGram:FILE 1                          // Set the PROGRAM FILE to be run
<2> PROGram:ACTive 15                       // Set the mapping action for Module Channel
                                            // chan 1 - chan 8 mapping value weights are
                                            // 1, 2, 4, 8, 16, 32, 64,128
<3> PROGram:CHAIN 0                         // program chain file No.
<4> PROGram:ONTime 3                        // on time setting
<5> PROGram:OFFTime 2                       // off time setting
<6> PROGram:SEQuence 1                      // Sequence No. setting
<7> PROGram:SEQuence:MODE AUTO              // Sequence mode setting
<8> PROGram:SEQuence:SHORt:CHANnel 1        // Sequence short channel setting
<9> PROGram:SEQuence:SHORt:TIME 1           // Sequence short setting

<10> PROGram:SEQuence 2                     // sequence 2,sequence 3,....setting
.
.
.
<11> PROGram:SAVE                           // Save program setting data
.
.
<12> PROGram:RUN                            // Run PROGRAM
.
.
.
<13> PROGram:RUN?                           // Check if PROGRAM is running
```



10. Verification

10.1 Introduction

This chapter contains test procedures for checking the operation and specification of the Chroma 6330A Series. The tests are performed using the Model 6330A and some required equipments. The required test equipments are listed in Table 10-1. Please refer the Performance Tests section for equipment connecting and test procedure. Users can use verification tables included at Verification Test Records section for checking specification. The performance tests confirm the Chroma 6330A Series meet its published specifications. For the detailed information of operation and programming please refer to the *Chapter 3, Chapter 4 and Chapter 5*.

If the 6330A requires service, refer to the list of Chroma Sales and Support Offices at the web site http://www.chromaate.com/english/contact/default.asp.

10.2 Equipment Required

The equipment listed in the following table, or the equivalent to this equipment, is required for verification.

Table 10-1

Equipment	Characteristics	Recommended Model
Voltmeter	5 1/2 digits or more	HP34401A, HP3458A
Current Shunt	0.05% accuracy	PRODIGIT 7550
	10 ohms@20mA	VALHALLA 2572A
	0.1 ohms@2A	
	0.01 ohms@20A	
	0.001 ohms@250A/100A	
	0.05……...mohms@1000A	
DC Source	500V/60V 100A/1000A	HP6035, HP6032
Oscilloscope	100MHz	Tektronics TDS340
Mainframe		Chroma 6334A

10.3 Performance Tests

10.3.1 CC Mode Verification

This test verifies if the current programming and the reading at the front panel display are within specifications when the module is operating in CC mode. For each DMM reading, the front panel display of current should be identical:

The reading of the Load in amps = Shunt current ± inaccuracy.
DMM (V): means DMM dc voltage of voltage measurement
DMM (I): means DMM dc voltage of current shunt measurement
DMM (DC): means DMM in dc voltage measurement

Shunt current (DMM Ai): means DMM (I) voltage/shunt resistor

10.3.1.1 Check the High Current Range

A. Connect the Load, DC source, DMM, current shunt as Figure 10-1 shows. Use DMM (I) to measure the voltage across the shunt resistor measurement port, and get the load current.

B. Select the right range for the current shunt resistor. Press **MODE** and use ▲ or ▼ key to select CCH and then the display shows:

```
MODE SELECT
      CCH
```

C. Press "**ENTER**" button to select the CC high range and press value of Table 10-2 to program current.

```
CCH1:    1.9995A
CCH2:    0.9990A
```

D. Turn on the DC source and set output voltage 5V. Set current limit of DC source larger than the set current of Table 10-2. Press **LOAD ON/OFF** to enable the load and wait for 30 seconds. Then record the shunt current and the front panel displayed readings. The current of load can be recorded from current shunt = DMM (I) voltage/current shunt resistor.

Table 10-2

Model Name	CCH Current Setting	Shunt Current		Front Panel Display Reading
		Max.	Min.	
63301A	40.0 A	40.12 A	39.88 A	DMM Ai ± 0.04 A
	0.4 A	0.4804 A	0.3196 A	DMM Ai ± 0.0202 A
63302A	20.0 A	20.06 A	19.94 A	DMM Ai ± 0.02 A
	0.2 A	0.2402 A	0.1598 A	DMM Ai ± 0.0101 A
63303A	60.0 A	60.18 A	59.82 A	DMM Ai ± 0.06 A
	0.6 A	0.7206 A	0.4794 A	DMM Ai ± 0.0303 A
63305A	10.0 A	10.03 A	9.97 A	DMM Ai ± 0.01 A
	0.1 A	0.1201 A	0.0799 A	DMM Ai ± 0.00505 A
63306A	120.0 A	120.36 A	119.64 A	DMM Ai ± 0.12 A
	1.2 A	1.4412 A	0.9588 A	DMM Ai ± 0.0606 A
63307AR	40.0 A	40.12 A	39.88 A	DMM Ai ± 0.04 A
	0.4 A	0.4804 A	0.3196 A	DMM Ai ± 0.0202 A
63308A	20.0 A	20.06 A	19.94 A	DMM Ai ± 0.02 A
	0.2 A	0.2402 A	0.1598 A	DMM Ai ± 0.0101 A
63310A	2.0 A	2.004 A	1.996 A	DMM Ai ± 0.002 A
	0.02 A	0.02202 A	0.01798 A	DMM Ai ± 0.00101 A
63312A	240.0 A	240.72 A	239.28 A	DMM Ai ± 0.36 A
	2.4 A	2.8824 A	1.9176 A	DMM Ai ± 0.1818 A
63313A	20 A	20.06 A	19.94 A	DMM Ai ± 0.02 A
	0.2 A	0.2402 A	0.1598 A	DMM Ai ± 0.0101 A

63323A	70.0 A	70.056 A	69.944 A	DMM Ai ± 0.056 A
	0.7 A	0.7283 A	0.6717 A	DMM Ai ± 0.02828 A

E. To set output voltage of DC source and CCH current in the Table 10-3 for testing model. Press **LOAD ON/OFF** to enable the load and slowly decrease the dc source voltage until DMM(V) display reached minimal operation voltage of the Table 10-3 for testing model. The current of load can be recorded from current shunt = DMM (I) voltage/current shunt resistor.

Table 10-3

Model Name	Output Voltage of DC Source Setting	Minimal Operation Voltage	CCH Current Setting	Shunt Current	
				Max.	Min.
63301A	1.8V	0.8V	40A	40.12 A	39.88 A
63302A	1.8V	0.8V	20A	20.006 A	19.94 A
63303A	1.8V	0.8V	60A	60.18 A	59.82 A
63305A	3V	2V	10A	10.03 A	9.97 A
63306A	1.8V	0.8V	120A	120.36 A	119.64 A
63307AR	1.8V	0.8V	40A	40.12 A	39.88 A
63308A	3V	2V	20A	20.006 A	19.94 A
63310A	7V	6V	2A	2.004 A	1.996 A
63312A	1.8V	0.8V	240A	240.72 A	239.28 A
63313A	5V	4V	20A	20.06 A	19.94 A
63323A	1.6V	0.6V	70A	70.056 A	69.944 A

10.3.1.2 Check the Low Current Range

A. Select the right range for the current shunt resistor. Press **MODE** and use ▲ or ▼ key to select CCL and then the display shows:

```
MODE SELECT
    CCL
```

B. Press "**ENTER**" button to select the CC high range and press value of Table 10-4 to program current.

```
CCL1:    1.9995A
CCL2:    0.9990A
```

C. Turn on the DC source and set output voltage 5V. Set current limit of DC source larger than the set current of Table 10-4. Press **LOAD ON/OFF** to enable the load and wait for 30 seconds. Then record the shunt current and the front panel displayed readings. The current of load can be recorded from current shunt = DMM (I) voltage/current shunt resistor.

Table 10-4

Model Name	CCL Current Setting	Shunt Current		Front Panel Display Reading
		Max.	Min.	
63301A	4.0 A	4.008 A	3.992 A	DMM Ai ± 0.004 A
	0.04 A	0.04404 A	0.03596 A	DMM Ai ± 0.00202 A
63302A	2.0 A	2.004 A	1.996 A	DMM Ai ± 0.002 A
	0.02 A	0.02202 A	0.01798 A	DMM Ai ± 0.00101 A
63303A	6.0 A	6.012 A	5.988 A	DMM Ai ± 0.006 A
	0.06 A	0.06606 A	0.05394 A	DMM Ai ± 0.00303 A
63305A	1.0 A	1.002 A	0.998 A	DMM Ai ± 0.001 A
	0.01 A	0.01101 A	0.00899 A	DMM Ai ± 0.000505 A
63306A	12.0 A	12.024 A	11.976 A	DMM Ai ± 0.012 A
	0.12 A	0.1321 A	0.1079 A	DMM Ai ± 0.00606 A
63307AL	5.0 A	5.01 A	4.99 A	DMM Ai ± 0.005 A
	0.05 A	0.05505 A	0.04495 A	DMM Ai ± 0.002525 A
63307AR	4.0 A	4.008 A	3.992 A	DMM Ai ± 0.004 A
	0.04 A	0.04404 A	0.03596 A	DMM Ai ± 0.00202 A
63308A	2.0 A	2.004 A	1.996 A	DMM Ai ± 0.002 A
	0.02 A	0.02202 A	0.01798 A	DMM Ai ± 0.00101 A
63310A	0.6 A	0.6012 A	0.5988 A	DMM Ai ± 0.0006 A
	0.006 A	0.006606 A	0.005394 A	DMM Ai ± 0.000303 A
63312A	24.0 A	24.048 A	23.952 A	DMM Ai ± 0.036 A
	0.24 A	0.2642 A	0.2158 A	DMM Ai ± 0.01818 A
63313A	5 A	5.01 A	4.99 A	DMM Ai ± 0.005 A
	0.05 A	0.05505 A	0.04495 A	DMM Ai ± 0.002525 A
63323A	7.0 A	7.0056 A	6.9944 A	DMM Ai ± 0.0056 A
	0.07 A	0.07283 A	0.06717 A	DMM Ai ± 0.002828 A

D. To set output voltage of DC source and CCL current in the Table 10-5 for testing model. Press **LOAD ON/OFF** to enable the load and slowly decrease the dc source voltage until DMM(V) display reached minimal operation voltage of the Table 10-5 for testing model. The current of load can be recorded from current shunt = DMM (I) voltage/current shunt resistor.

Table 10-5

Model Name	Output Voltage of DC Source Setting	Minimal Operation Voltage	CCL Current Setting	Shunt Current	
				Max.	Min.
63301A	1.8V	0.8V	4A	4.008 A	3.992A
63302A	1.8V	0.8V	2A	2.004A	1.996 A
63303A	1.8V	0.8V	6A	6.012 A	5.988 A
63305A	3V	2V	1A	1.002 A	0.998 A
63306A	1.8V	0.8V	12A	12.024 A	11.976A
63307AL	1.8V	0.8V	5A	5.01 A	4.99A
63307AR	1.8V	0.8V	4A	4.008 A	3.992A
63308A	3V	2V	2A	2.004 A	1.996 A
63310A	2.8V	1.8V	0.6A	0.6012 A	0.5988 A
63312A	1.8V	0.8V	24A	24.048A	23.952A
63313A	2V	1V	5A	5.01 A	4.99 A
63323A	1.1V	0.1V	7A	7.0056 A	6.9944 A

10.3.2 CR Mode Verification

This test verifies if the resistance programming is within specifications when the module is operating in the CR mode. The programmed resistance is calculated from the voltage divided by current. The voltage (DMM (V)) is across the module's input terminal or measurement terminal. The voltage (DMM (I)) is also across current shunt, shunt current = DMM (I) voltage/shunt resistor. If the voltage output and/or current limit in the DC source are/is wrongly set, the load module protection circuit of OPP or OCP may be triggered. Press **LOAD ON/OFF** to reset the protection circuit.

The Electronic Load modules implement constant resistance mode using CC circuits to regulate the input. The input voltage of the load is regarded as reference for current control. The formula I/V = 1/R.

V: input voltage as reference of D/A.
I: controlled parameter to determine the resistance.
1/R: conductance, reciprocal of resistance.

The specifications of CR mode accuracy are specified as conductance. The effect on the programmed resistance value is not linear over the resistance range, because the resistance is a reciprocal conductance. The electronic load is designed for high current applications of CR mode. Therefore, when large resistance is required, reading the voltage and current from the load, calculating the actual resistance, and adjusting the set value can improve accuracy. To calculate the accuracy of programmed value error, the programmed value must be reciprocated first. The error is then applied to the programmed value (conductance), and the result is once again reciprocated. The following example illustrates the worst case of error in CR mode.

Example 1: 0.0375 ohm to 150 ohm range (model 63301A, CRL)

The accuracy for this range is specified as 0.1S + 0.2%.
If 0.1 ohm is programmed, the actual resistance will be

Conductance:	10+(0.1+10×0.2%)	to	10–(0.1+10×0.2%)
Resistance:	0.0988 Ω	to	0.1012Ω

If 0.05 ohm is programmed, the actual resistance will be

Conductance:	20+(0.1+20×0.2%)	to	20–(0.1+20×0.2%)
Resistance:	0.04965Ω	to	0.05035 Ω

Connect the load module, DC source, DMM, and current shunt as shown in Figure 10-2. Use DMM (V) to measure the voltage across the module's input terminals, and DMM (I) across the shunt resistor measurement port. Be careful in making connections so that the contact resistance voltage drop will not affect the readings, or use remote sensing to sense the UUT voltage. Load resistance = DMM (V)/shunt current.

10.3.2.1 Check the High ohm Range

A. Press **MODE** and use ▲ or ▼ key to select CRH and then the display shows:

```
MODE SELECT
    CRH
```

B. Press "**ENTER**" button to select CR high ohm range.

```
CRH1:    2.000Ω
CRH2:    1.000Ω
```

C. Set the DC source to 10V for the model: 63301A, 63302A, 63303A, 63306A, 63307A, 63310A, 63312A, 63313A, 63323A. Set the DC source to 100V for the model: 63305A, 63308A. The current shunt range to 250A. Input the values of the resistance in the Table 10-6. After pressed **LOAD ON/OFF** to enable load on, and please see value of DMM(V) to adjust value of DC source same as setting value for testing model before, and waited for 30 seconds, record the voltage across the load input terminals DMM (V) and the shunt current reading DMM (I). Calculate the values of the resistance as DMM (V)/DMM (I). Check the values to fit the specification.

Table 10-6

Model Name	Resistance Setting	Appropriate Values	
		Max.	Min.
63301A	1.875Ω	1.9128Ω	1.8387Ω
	9.375Ω	10.356Ω	8.5636Ω
	18.75Ω	23.105Ω	15.776Ω
63302A	3.75Ω	3.9002Ω	3.611Ω
	18.75	23.105Ω	15.776Ω
	37.5Ω	60.096Ω	27.253Ω
63303A	1.25Ω	1.2671Ω	1.2333Ω
	6.25Ω	6.6738Ω	5.8768Ω
	12.5Ω	14.302Ω	11.101Ω
63305A	50Ω	66.756Ω	39.968Ω
	75Ω	120.19Ω	54.506Ω
	100Ω	200.4Ω	66.622Ω
63306A	0.625Ω	0.6423Ω	0.6086Ω
	3.125Ω	3.5796Ω	2.7728Ω
	6.25Ω	8.3556Ω	4.992Ω
63307AR	1.875Ω	1.9128Ω	1.8387Ω
	9.375Ω	10.356Ω	8.5636Ω
	18.75Ω	23.105Ω	15.776Ω
63308A	25Ω	28.604Ω	22.202Ω
	125Ω	334.22Ω	76.876Ω
	150Ω	602.41Ω	85.665Ω
63310A	10 Ω	10.111 Ω	9.8912 Ω
	50 Ω	52.687 Ω	47.574 Ω
	100 Ω	111.23 Ω	90.827 Ω
63312A	0.3125Ω	0.3212Ω	0.3043Ω

	1.5625Ω	1.7898Ω	1.3864Ω
	3.125Ω	4.1778Ω	2.496Ω
63313A	4 Ω	4.0161 Ω	3.9841 Ω
	20 Ω	20.45 Ω	19.569 Ω
	40 Ω	41.667 Ω	38.462 Ω
63323A	2 Ω	2.0534 Ω	1.9493 Ω
	10 Ω	11.39 Ω	8.9127 Ω
	20 Ω	26.385 Ω	16.103 Ω

* 63323A CC I-range HIGH.

10.3.2.2 Check the Low ohm Range

A. Press **MODE** and use ▲ or ▼ key to select CRL and then the display shows:

```
MODE SELECT
     CRL
```

B. Press "**ENTER**" button to select CR low ohm range.

```
CRL1:   2.000Ω
CRL2:   1.000Ω
```

C. Set the DC source to 1V for the model: 63301A, 63302A, 63303A, 63306A, 63307A, 63310A, 63312A, 63313A, 63323A. Set the DC source to 10V for the model: 63305A, 63308A. The current shunt range to 250A. Input the values of the resistance in the Table 10-7. After pressed **LOAD ON/OFF** to enable load on, and please see value of DMM(V) to adjust value of DC source same as setting value for testing model before, and waited for 30 seconds, record the voltage across the load input terminals DMM (V) and the shunt current reading DMM (I). Calculate the values of the resistance as DMM (V)/DMM (I). Check the values to fit the specification.

Table 10-7

Model Name	Resistance Setting	Appropriate Values	
		Max.	Min.
63301A	0.0375Ω	0.03772Ω	0.03729Ω
	0.1875Ω	0.1915Ω	0.1837Ω
	0.375Ω	0.3904Ω	0.3608Ω
63302A	0.075Ω	0.07572Ω	0.07429Ω
	0.375Ω	0.3904Ω	0.3608Ω
	0.75Ω	0.8126Ω	0.6964Ω
63303A	0.025Ω	0.02511Ω	0.02489Ω
	0.125Ω	0.1268Ω	0.1232Ω
	0.25Ω	0.2569Ω	0.2434Ω
63305A	1.25Ω	1.2847Ω	1.2171Ω
	6.25Ω	7.1592Ω	5.5457Ω
	12.5Ω	16.711Ω	9.984Ω
63306A	0.0125Ω	0.01263Ω	0.01238Ω
	0.0625Ω	0.06443Ω	0.06068Ω
	0.125Ω	0.1323Ω	0.1185Ω
63307AR	0.0375Ω	0.03772Ω	0.03729Ω

	0.1875Ω	0.1915Ω	0.1837Ω
	0.375Ω	0.3904Ω	0.3608Ω
63308A	0.625Ω	0.6465Ω	0.6049Ω
	3.125Ω	3.7125Ω	2.698Ω
	6.25Ω	9.1174Ω	4.7547Ω
63310A	3 Ω	3.0426 Ω	2.9586 Ω
	15 Ω	15.991 Ω	14.124Ω
	30 Ω	34.169 Ω	26.738 Ω
63312A	0.00625Ω	0.006332Ω	0.00617Ω
	0.03125Ω	0.03232Ω	0.03025Ω
	0.0625Ω	0.06635Ω	0.05907Ω
63313A	0.2 Ω	0.2008 Ω	0.1992 Ω
	1 Ω	1.0225 Ω	0.9785 Ω
	2 Ω	2.0833 Ω	1.9231 Ω
63323A	0.015 Ω	0.01517 Ω	0.01484 Ω
	0.075 Ω	0.07903 Ω	0.07136 Ω
	0.15 Ω	0.1688 Ω	0.135 Ω

* 63323A and 63313A CC I-range HIGH.

10.3.3 CV Mode Verification

This test verifies if the voltage programming and reading value at the front panel display are within specifications when the module is operating in CV mode. For each DMM (V) reading, the front panel display of voltage should be equivalent to:

Load module reading in volts = DMM (V) reading in volts ± inaccuracy.

A. Connect the Load module, DC source, DMM and current shunt as Figure 10-1 shows. Use DMM (V) to measure the voltage across the module's input terminal. Be careful in making connections so that contact resistance voltage drop will not affect the readings.

B. Set the current limit of CV mode as follows:
Press **CONF** and use ▲ or ▼ key to set the current limit of CV mode and then the display shows:

```
CV   CURR_LIMIT
CURRENT: 60.000A
```

Press **1** and **ENTER** to program current limit 1A for model 63301A, 63302A, 63303A, 63306A, 63307A, 63312A, 63313A and 63323A; press **0.5** and **ENTER** to program current limit 0.5A for model 63305A, 63308A, 63310A .

C. Press **MODE** and use ▲ or ▼ key to select CV and then the display shows:

```
MODE SELECT
      CV
```

D. Press "**ENTER**" button to select the CV range and press value of Table 10-8 to program voltage.

```
CV 1:     5.00V
CV 2:     6.00V
```

E. Press "**ENTER**" button to select response speeds of CV mode and press **1** and **ENTER** to set "FAST".

```
CV RESPONSE
1:FAST 2:SLO W
```

F. Set DC source to 80V/0.1A for model 63301A, 63302A, 63303A, 63306A, 63307A, 63312A and 63323A, 500V/0.1A for model 63305A, 63308A, 63310A a300V/0.1A for model 63313A also 120V/0.1A for model 63323A.

G. After pressed the button **LOAD ON/OFF** to enable load on and waited for 30 seconds, record the voltage across the load input terminal.

Table 10-8

Model Name	CV Voltage Setting	DMM(V)		Front Panel Display Reading	
		Max.	Min.	Max.	Min.
63301A 63302A 63303A 63306A 63307AR 63312A	60V	60.11V	59.89V	DMM (V) +0.035V	DMM (V) –0.035V
	40V	40.1V	39.9V	DMM (V) +0.03V	DMM (V) –0.03V
	5V	5.0825V	4.9175V	DMM(V) +0.02125V	DMM (V) –0.02125V
63305A 63308A 63310A	480V	480.74V	479.26V	DMM (V) +0.245V	DMM (V) –0.245V
	250V	250.63V	249.38V	DMM (V) +0.1875V	DMM (V) –0.1875V
	5V	5.5025V	4.4975V	DMM(V) +0.1263V	DMM (V) –0.1263V
63313A	280V	280.44V	279.56V	DMM(V) +0.145V	DMM(V) -0.145V
	150V	150.38V	149.63V	DMM(V) +0.1125V	DMM(V) -0.1125V
	5V	5.3025V	4.6975V	DMM(V) +0.07625V	DMM(V) -0.07625V
63323A	100V	100.17V	99.83V	DMM(V) +0.055V	DMM(V) -0.055V
	60V	60.15V	59.85V	DMM(V) +0.045V	DMM(V) -0.045V
	5V	5.1225V	4.8775V	DMM(V) +0.03125V	DMM(V) -0.03125V

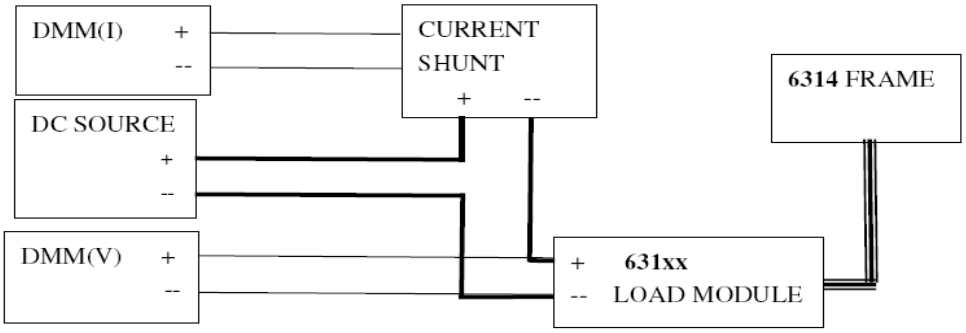


Figure 10-1

10.3.4 Dynamic and Slew Rate Circuit Test

This test verifies the slew rate circuit operation and the dynamic current waveform period specifications when the module dynamic is operating in CC mode.

Connect the Load module, DC source, oscilloscope, and current shunt as Figure 10-2 shows. Use oscilloscope to measure the waveform across the shunt resistor measurement port. To reduce the current waveform overshoot caused by cable inductance, make the cables as short as possible. Adjust the oscilloscope for rise or fall time display. The rise time measured from 10% to 90% and the fall time from 90% to 10%.

10.3.4.1 Check Dynamic Constant Current Low Range

A. Press **MODE** key first, then use ▲or ▼ key to select Dynamic Constant Current low range

MODE SELECT CCDL

B. Press "**ENTER**" button to select CCDL range. The LCD shows below:

CCDL1: 0.000A CCDL2: 0.000A

C. Turn on the DC source and set output voltage 5V. Set current limit of DC source larger than the set current of Table 10-29. Table 10-9 shows the setting values of each model.

Table 10-9

Model	CCDL1	CCDL2	CCDLT1	CCDLT2	CCDL _/‾	CCDL ‾_
63301A	4A	0A	0.5ms	0.5ms	160mA/us	160mA/us
63302A	2A	0A	0.5ms	0.5ms	80mA/us	80mA/us
63303A	6A	0A	0.2ms	0.2ms	250mA/us	250mA/us
63305A	1A	0A	0.1ms	0.1 ms	40mA/us	40mA/us
63306A	12A	0A	0.5ms	0.5ms	500mA/us	500mA/us
63307AL	5A	0A	0.1ms	0.1ms	200mA/us	200mA/us
63307A	4A	0A	0.1ms	0.1 ms	160mA/us	160mA/us
63308A	2A	0A	0.2ms	0.2ms	80mA/us	80mA/us

63312A	24A	0A	0.5ms	0.5ms	1A/us	1A/us
63313A	5A	0A	0.5ms	0.5ms	200mA/us	200mA/us
63323A	7A	0A	0.5ms	0.5ms	250mA/us	250mA/us

10.3.4.2 Check Dynamic Constant Current High Range

A. Press **MODE** key first, then use ▲or ▼ key to select Dynamic Constant Current high range.

```
MODE SELECT
    CCDH
```

B. Press "**ENTER**" button to select CCDH range. The LCD shows below:

```
CCDH1:    0.000A
CCDH2:    0.000A
```

C. Turn on the DC source and set output voltage 5V. Set current limit of DC source larger than the set current of Table 10-210. Table 10-10 shows the setting values of each model.

Table 10-10

Model	CCDH1	CCDH2	CCDHT1	CCDHT2	CCDH _/‾	CCDH‾_
63301A	40A	0A	0.1ms	0.1ms	1600mA/us	1600mA/us
63302A	20A	0A	0.1ms	0.1ms	800mA/us	800mA/us
63303A	60A	0A	0.1ms	0.1ms	2.5A/us	2.5A/us
63305A	10A	0A	0.1ms	0.1ms	400mA/us	400mA/us
63306A	120A	0A	0.1ms	0.1ms	5A/us	5A/us
63307AR	40A	0A	0.1ms	0.1ms	1600mA/us	1600mA/us
63308A	20A	0A	0.1ms	0.1ms	800mA/us	800mA/us
63312A	240A	0A	0.1ms	0.1ms	10A/us	10A/us
63313A	20A	0A	0.1ms	0.1ms	800mA/us	800mA/us
63323A	70A	0A	0.1ms	0.1ms	2.5A/us	2.5A/us

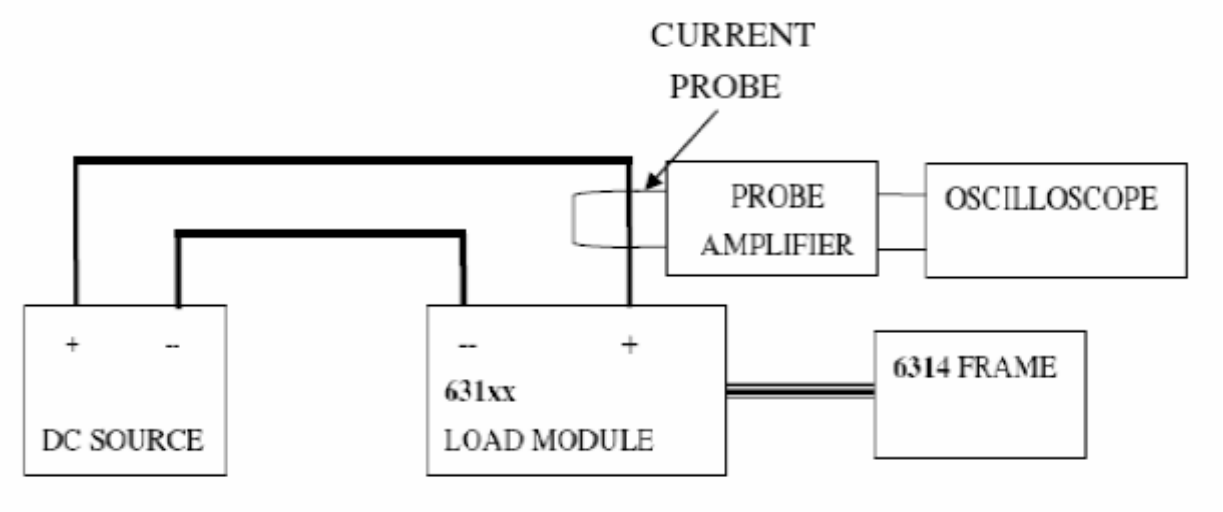

CURRENT
PROBE
PROBE
AMPLIFIER
OSCILLOSCOPE
+
–
DC SOURCE
–
+
631xx
LOAD MODULE
6314 FRAME

Figure 10-2

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