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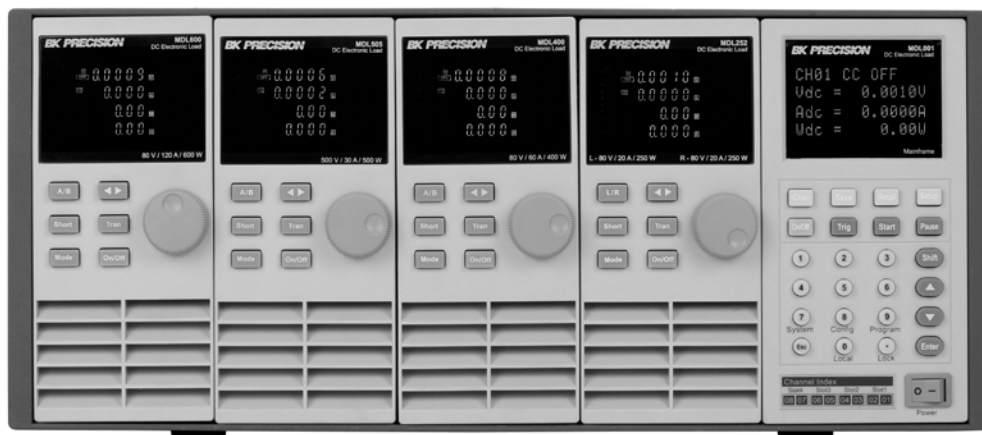
BK PRECISION[®]

M DL Series

Programmable DC Electronic Load

Models: M DL001, M DL002, M DL200, M DL252,
M DL302, M DL305, M DL400, M DL505, M DL600

USER MANUAL



Safety Summary

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. We assume no liability for the Customer's failure to comply with these requirements.

ENVIRONMENTAL CONDITIONS

This instrument is intended for indoor use, pollution degree 2 environments. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters. Refer to the specifications tables for the AC mains voltage requirements and ambient operating temperature range.

BEFORE APPLYING POWER

Verify that all safety precautions are taken. Note the instrument's external markings described under "Safety Symbols".

GROUND THE INSTRUMENT

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cover must be connected to an electrical ground. The instrument must be connected to the AC mains power through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Note: Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of fumes or flammable gases.






KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers except as instructed in this guide for installing or removing electronic load modules. Component replacement and internal adjustments must be made only by qualified service personnel. Do not replace components with power cable connected. Under certain conditions dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power, discharge circuits, and remove external voltage sources before touching components.

DO NOT SERVICE OR ADJUST ALONE

Do not try to do some internal service or adjustment unless another person capable of rendering first aid resuscitation is present.

Safety Symbols

-  Direct current
-  Alternating current
-  Both direct and alternating current
-  Protective earth (ground) terminal
-  Attention (refer to accompanying documents)

WARNING

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.

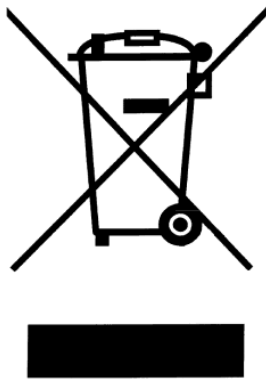
CAUTION

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

Compliance Statements

Disposal of Old Electrical & Electronic Equipment (Applicable in the European Union and other European countries with separate collection systems)

This product is subject to Directive 2002/96/EC of the European Parliament and the Council of the European Union on waste electrical and electronic equipment (WEEE), and in jurisdictions adopting that Directive, is marked as being put on the market after August 13, 2005, and should not be disposed of as unsorted municipal waste. Please utilize your local WEEE collection facilities in the disposition of this product and otherwise observe all applicable requirements.



CE Declaration of Conformity

The DC electronic load meets the requirements of Low Voltage Directive 73/23/EEC and Electromagnetic Compatibility Directive 89/336/EEC amended by 93/68/EEC.

Low Voltage Directive

- EN61010-1:2001

EM C Directive

- EN50081-1
- EN50082-1

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Product Overview

This section describes the main features and menus of the MDL Series DC Electronic Load. The MDL Series is comprised of two parts, mainframes and modules. The mainframes mentioned are the MDL001 mainframe and the MDL002 mainframe extension. Modules in this series include the MDL200, MDL252, MDL302, MDL305, MDL400, MDL505, and MDL600. Unless otherwise noted, this document will refer to all of these instruments as “electronic load”. The range of each module’s specific voltage, current, and power is listed in the Specifications section.

Description

The MDL Series is a multi-channel programmable DC electronic load system. With programming and remote control capabilities, the MDL Series DC electronic load can provide multiple solutions according to the requirements of your design and is suitable for testing a wide range of power sources from multi-output DC power supplies to batteries, fuel cells, and photovoltaic arrays.

Up to four modules can be installed into the MDL001 mainframe to support up to a total of 8 channels. Adding the MDL002 mainframe extension will enable the system to support four additional module slots for a maximum of 16 channels. The electronic load is configured by installing user-selectable modules into the mainframe and operated using the front panel keypad and rotary knob. It can also be controlled remotely via USB, RS-232, LAN, or GPIB interface. The electronic load modules all have similar functions, but may differ in range of input voltage, current, and power. The high resolution voltage and current measurement system provides both accuracy and convenience.

The electronic load can be used in one of five different operation modes: constant voltage (CV), constant current (CC), constant resistance (CR), constant power (CW), or constant impedance (CZ). All panel operation and programming functions are carried out on the MDL001 mainframe panel. A wide range of dynamic loading applications can be simulated through user-programmable slew rates, load levels, duration, and conducting voltage.

Features

- CC/CV/CR/CW/CZ operating modes
- Removable modules for easy system flexibility
- Bright VFD display for both mainframe and modules
- Power range up to 2400 W (4800 W with mainframe extension)
- Supports up to 16 channels with mainframe extension
- Operate identical modules in parallel mode for high current applications
- Synchronous load on/off function
- 16-bit voltage and current metering providing high resolution of 0.1 mV and 0.01 mA
- Transient mode up to 25 kHz
- List mode (sequence mode) – minimum 20 us step width with 84 user programmable steps
- Adjustable slew rate in CC mode
- Automatic test function
- 101 memory areas to save/recall setting parameters
- Analog current control and monitoring
- Remote sensing
- Standard LAN, GPIB, USBTMC compliant USB, and RS-232 interfaces with SCPI protocol support
- OVP/OCP/OPP/OTP and reverse voltage protection

Front Panel

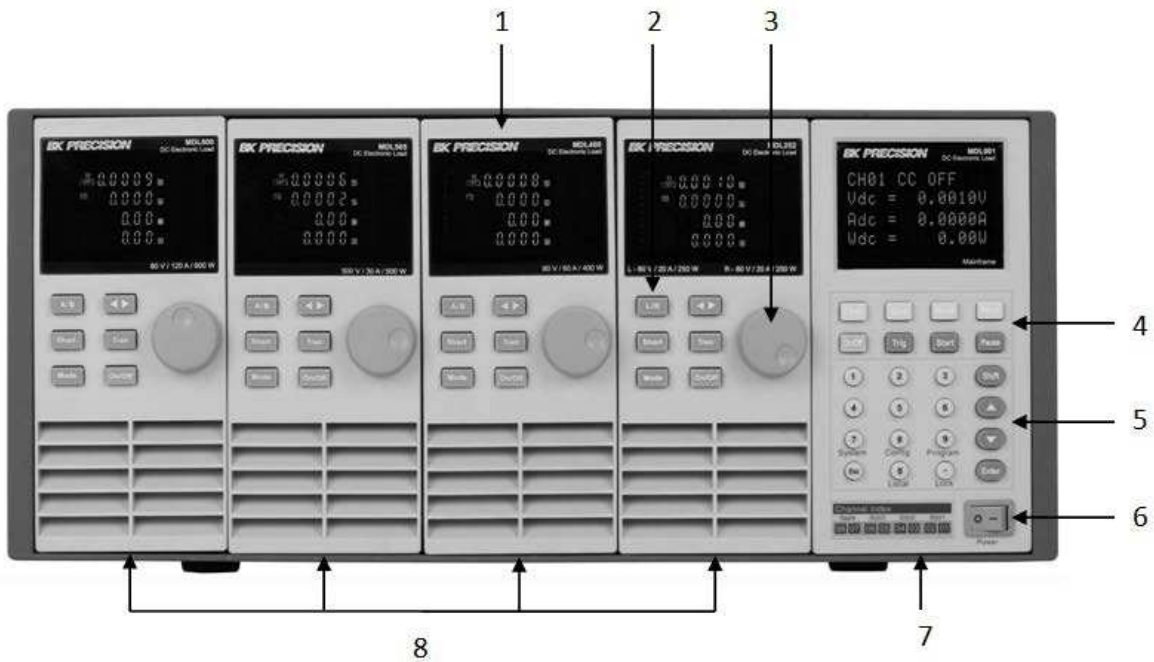


Figure 1 - M DL Series Front Panel

- 1) VFD DISPLAY
Displays electronic load information.
- 2) MODULE PANEL KEYS
Controls module functions. Refer to Module section for more details on the use of these keys.
- 3) ADJUSTMENT KNOB
Used to change parameters.
- 4) MAINFRAME FUNCTION KEYS
Controls each channel's operating status. Refer to Mainframe section for more details on the use of these keys.
- 5) MAINFRAME NUMERIC ENTRY AND SHIFT KEYS
Refer to Mainframe section for more details on the use of these keys.
- 6) POWER SWITCH
Turns the system on or off.
- 7) MAINFRAME
- 8) MODULES

Rear Panel

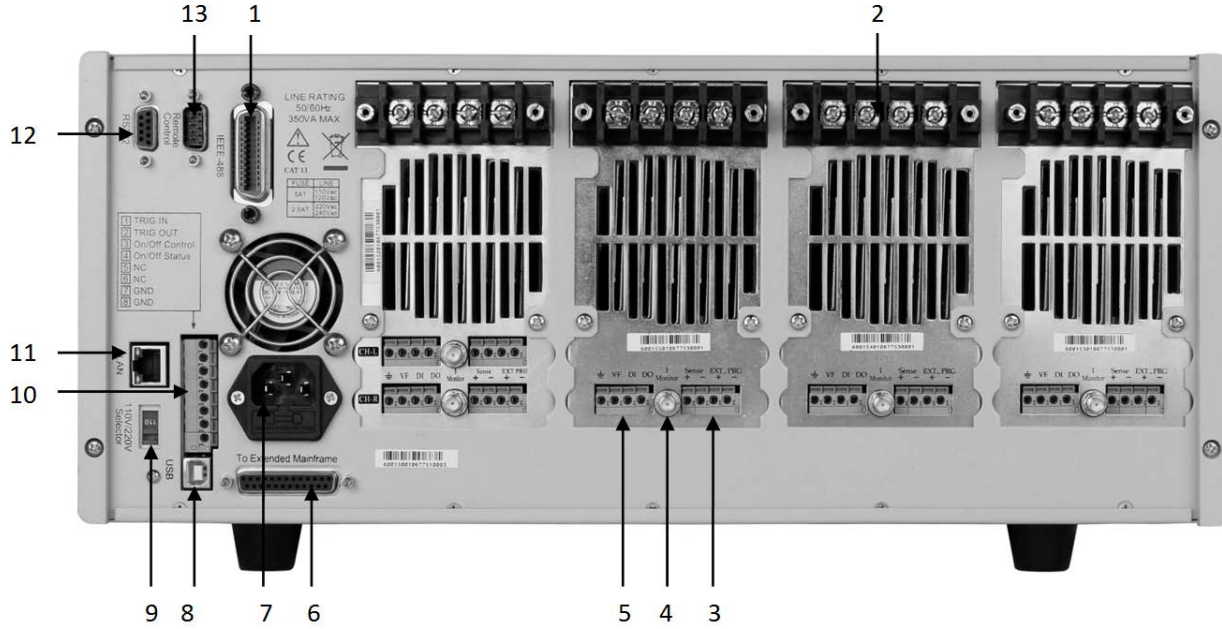


Figure 2 - M DL Series Rear Panel

- 1) GPIB interface
- 2) Input terminal of module
- 3) Remote measurement and external input control terminal
- 4) Current monitoring output
- 5) Digital I/O and VF output terminal
- 6) Extended module interface
- 7) AC Power input socket
- 8) USB interface
- 9) Line voltage selection switch (110V/220V)
- 10) Trigger I/O and load on/off terminals
- 11) LAN interface
- 12) RS-232 interface
- 13) Not used – for factory use only

Protection Functions

The electronic load has the following protection functions: Overvoltage protection (OVP), overcurrent protection (OCP), overpower protection (OPP), overtemperature protection (OTP), and local and remote reverse voltage protection (LRV/RRV).

The mainframe will act appropriately once any of the above protections are active. You can press any button on the front panel to restore the protection function. For example, if the electronic load triggers the overtemperature protection, the buzzer will alarm, the input will automatically turn off, and the mainframe VFD will display OTP.

Overvoltage Protection (OVP)

If the OVP circuit has triggered, input will turn off, buzzer alarm will go off, and the status register's OV and VF bit will be set. The mainframe will display OVP and the condition will remain until they are reset. Once overvoltage protection occurs, the 8-pin connector's VF pin on the rear panel will output TTL high voltage level. You can control the output state of the power supply under test via this pin (see Figure 31).

Operations to Clear the OVP State

Check whether the input voltage is within the electronic load's rated voltage or the programmed protection voltage ranges. If it is outside the range, please disconnect the device under test. Then press any key on the front panel or remotely send SCPI command PROTection:CLEar. The OVP displayed on the front panel will turn off and the electronic load exits OVP protection state.

Overcurrent Protection (OCP)

The electronic load includes both hardware and software overcurrent protection features.

Hardware OCP - The electronic load's maximum input current will be limited to approximately 110% of the current range. Once the hardware OCP is triggered, the status register's OC bit will be set. When the hardware OCP is removed, the status register's OC bit will be reset. Hardware overcurrent protection will not affect the electronic load's on/off state.

Software OCP - Users can set the electronic load's software OCP value with the following steps.

Panel Operations	VFD Display
1. Power on the electronic load.	Self-test
2. Press Shift + (8) to enter Configuration menu.	Sync On Set Von Meter Protect List Ext. Ctrl Set About Exit
3. Press ▼ key to select <Protect> and press Enter to go into protection menu.	Max Power Set Alimit State Alimit Point Alimit Delay Plimit Point Plimit Delay OnTimer State OnTimer Set Exit
4. Press ▼ key to select <Alimit State> and press Enter. Select <On> and press Enter to confirm.	On Off (Default)
5. Press ▼ key to select <Alimit Point> and press Enter. Input OCP current value and press Enter to confirm.	Current Limit Set= 40.000A
6. Press ▼ key to select <Alimit Delay> and press Enter. Input delay time before alarm and press Enter to confirm.	Current Limit Delay= 3S
7. Press Esc key to exit menus.	

If the electronic load's current value is above the set overcurrent protection value, the electronic load will automatically turn off and the VFD will display OCP. At the same time, the OC and PSbits in the status register will be set and remain until they are reset.

Operations to Clear the OCP State

Check whether the input current is within the electronic load's rated current or the programmed protection current ranges. If it is outside the range, disconnect the device under test. Then press any key on the front panel or remotely send SCPI command PROTection:CLEar. The OCP displayed on the front panel will turn off and the load exits OCP protection state.

Overpower Protection (OPP)

The electronic load includes both hardware and software OPP features.

Hardware OPP – In the event that the electronic load’s input power exceeds the set power protection limit, the hardware OPP will limit the power. Once the hardware OPP is triggered, the status register’s OP bit will be set. When the hardware OPP is removed, the status register’s OP bit will be reset. Hardware overpower protection will not turn the electronic load’s input off.

Software OPP - Users can set the electronic load’s software OPP value with the following steps.

Panel Operations	VFD Display
1. Power on the electronic load.	Self-test
2. Press Shift + (8) to enter Configuration menu.	Sync On Set Von Meter Protect List Ext. Ctrl Set About Exit
3. Press ▼ key to select <Protect> and press Enter to go into protection menu.	Max Power Set Alimit State Alimit Point Alimit Delay Plimit Point Plimit Delay OnTimer State OnTimer Set Exit
4. Press ▼ key to select <Plimit Point> and press Enter. Input OPP power value and press Enter to confirm.	Power Limit Set= 210.00W
5. Press ▼ key to select <Plimit Delay> and press Enter. Input delay time before alarm and press Enter to confirm.	Power Limit Delay= 3S
6. Press Esc key to exit menus.	

If the electronic load’s power value is above the set overpower protection value, the electronic load will automatically turn off and the VFD will display OPP. At the same time, the OP and PSbits in the status register will be set and remain until they are reset.

Operations to Clear the OPP State

Check whether the input power is within the rated power range or the programmed protection ranges. If it is outside the range, disconnect the device under test. Then press any key on the front panel or remotely send command PROTection:CLEar. The OPP displayed on the front panel will turn off and the electronic load exits OPP protection state.

Overtemperature Protection (OTP)

Each module has an overtemperature protection circuit, which will turn off the input if the internal temperature exceeds safe limits. When the electronic load's internal circuit temperature is over 85°C, the load will enable OTP. Input will automatically be turned off and the VFD will display OTP. At the same time the OT and PSbits in the status register will be set and remain until they are reset.

Operations to Clear the OTP State

When the electronic load temperature has dropped below the protection point, press any key on the front panel or remotely send command PROTection:CLEar. The OTP displayed on the front panel will turn off and the electronic load exits OTP protection state.

Reverse Voltage Protection (LRV/ RRV)

This function protects the electronic load in case the input DC voltage lines are connected with the wrong polarity. When a reverse voltage (LRV – local reverse voltage, RRV – remote reverse voltage) connection condition is detected, the input will immediately turn off, the buzzer will alarm the user, and the status register's reverse voltage (LRV/ RRV) and VF bits will be set. The mainframe will display LRV/ RRV until they are reset.

In this condition, the 8-pin connector's VF pin will output a high level. You can disconnect the power supply via this signal (see Figure 31).

Operations to Clear the Reverse Voltage State

Check whether the connection is reversed. If so, disconnect the device to be measured and the reverse voltage state will be cleared.

Menu List

The following menus can be viewed on the VFD display. Use ▲ ▼ keys to scroll through the menu list and press Enter key to enter the selected menu function. Use ▲ ▼ keys to scroll through the VFD screen and press Enter key to enter its submenu. Press Esc to go back to the previous menu selection. Pressing number keys can directly select a channel.

Setup Menu

Press Setup key to enter the setup menu.

SETUP		
MODE	Select working mode	
	CONST CURRENT	Load works in CC mode
	CONST VOLTAGE	Load works in CV mode
	CONST RESISTANCE	Load works in CR mode
	CONST POWER	Load works in CW mode
	CONST IMPEDANCE	Load works in CZ mode
CC/ CV RANGE	Switch the range	
	HIGH RANGE	Set high range
	LOW RANGE	Set low range
I / V / R / W SET	Set the working current/voltage/resistance/power value	
Vmax/ Amax	Set up the maximum voltage/current limit for Automatic test mode	
Vmin/ Amin	Set up the minimum voltage/current limit for Automatic test mode	
f=2.500A/us	Set the rising slew rate (only in CC mode)	
f=2.500A/us	Set the falling slew rate (only in CC mode)	
TRAN A=0.00A	Set up level A value	
Ta=0.0005S	Set up level A width	
TRAN B=0.00A	Set up level B value	
Tb=0.0005S	Set up level B width	
T MODE	Set up the transient mode	
	CONTINUOUS	Continuous mode
	PULSE	Pulse mode
	TOGGLE	Toggle mode
RLC R=7500.0Ω	Set up the resistance value	
RLC L=0uH	Set up the inductance value	
RLC C=10uF	Set up the capacitance value	
EXIT	Exit the setup menu	

System Menu

Press Shift + ⑦ key to enter the System menu.

M E N U		
INITIALIZE		
	INITIALIZE DEFAULT SET	Resume all configuration to default settings
POWER ON SET		
	RST (DEFAULT)	Set the load's input state to default at power on
	SAV0	Set the load's input state to SAV0 at power on
BUZZER SET	Set up the buzzer state	
	ON	Enable the function
	OFF (DEFAULT)	Disable the function
LOAD ON KNOB	Module knob mode setting	
	UPDATE (DEF)	Real-time update
	OLD	No update (when turning load ON/OFF, original value before use of rotary knob will be set)
TRIGGER SOUR.	Set up the trigger mode	
	M ANUAL (DEF)	Manual trigger
	EXTERNAL	External signal trigger mode
	HOLD	Hold trigger mode
	BUS	Bus trigger mode
	TIM ER	Timer trigger
TRIGGER TIM ER	Trigger timer setting	
	TRIGGER TIM ER SET	Set the time of the trigger timer
COM M UNICATION	Select the interface for remote communication	
	RS232 (DEF)	
	USBTM C-USB488	
	GPIB	
	ETHERNET	
RS232 SET		
	BAUDRATE SET	Set up the communication baud rate
		4800 (DEFAULT)
		9600
		19200
		38400
		57600
		115200

RS232 SET		
	PARITY SET	Set up the communication parity
		NONE (DEFAULT)
		ODD
		EVEN
	HANDSHAKE SET	Select the handshake protocol
		NONE (DEFAULT)
		CTS/ RTS
		XON/ XOFF
GPIB ADDRESS	GPIB address setting	
	GPIB ADDRESS SET	Set up communication address
ETHERNET SET	Ethernet settings	
	GATEWAY SET	Gateway setting
	IP SET	IP setting
	MASK SET	Mask setting
	PORT SET	Port setting
	EXIT	
EXPAND MODULE	Module expansion	
	ON	Enable the function
	OFF (DEFAULT)	Disable the function
LANGUAGE SET	Communication protocol	
	SCPI (DEFAULT)	SCPI protocol
	EXTEND TABLE	Expand SCPI protocol, compatible with others
ABOUT	Mainframe production information	
	MDL###	Mainframe production model number
	SN: #####	Mainframe production serial number
	VER: 1.43	Mainframe software version
EXIT		

Configuration Menu

Press Shift + (8) key to enter the channel Configuration menu.

MENU			
SYNC ON SET	Setup Synchronization ON / OFF function		
	ON (DEFAULT)	Turn on synchronization function	
	OFF	Turn off synchronization function	
VON			
	VON POINT	Set the load's Von point	
	VON LATCH	Von latch state	
		ON (DEFAULT)	Turn on Von latch
		OFF	Turn off Von latch
	EXIT	Exit the menu	
AVERAGE COUNT	Average count setting 2 ^X (adjustable from 2 ² to 2 ¹⁶)		
V AUTORANGE	Auto switching voltage range		
	ON (DEFAULT)	Enable this function	
	OFF	Disable this function	
PROTECT	Load protecting function		
	MAX POWER SET	Set up hardware power protection state	
	ALIMIT STATE	Set up software current protection state	
		ON	Turn on software current protection state
		OFF (DEFAULT)	Turn off software current protection state
	ALIMIT POINT	Set up software current protection value	
	ALIMIT DELAY	Set up software current protection delay	
	PLIMIT POINT	Set up software power protection value	
	PLIMIT DELAY	Set up software power protection delay	
	ON TIMER STATE	Set up LOAD ON timer state	
	ON TIMER SET	Set up LOAD ON timer time	
	EXIT	Exit the menu	
LIST			
	FUNCTION MODE	Select mode	
		FIXED	Choose fixed operation mode
		LIST	Choose list operation mode
	RECALL LIST	Recall list operation file	

	EDIT LIST	Edit list operation file
		HIGH RANGE Edit high range of list operation
		LOW RANGE Edit low range of list operation
EXT. CTRL SET	External analog control function	
	ON	Turn on external analog control function
	OFF (DEFAULT)	Turn off external analog control function
REM SENSE SET	Remote sense function	
	ON	Enable remote sense function
	OFF (DEFAULT)	Disable remote sense function
ABOUT	Module production information	
	M DL###	Channel production model
	SN: #####	Channel production serial number
	VER: 1.35	Channel software version
EXIT	Exit the menu	

Automatic Test Menu

Press Shift + ⑨ key to enter the program menu.

PROGRAM	
RUN PROGRAM	Run the testing file
RECALL PROG	Recall the testing file
EDIT PROGRAM	Edit the testing file
EXIT	

Installation

Inspection

This instrument was carefully inspected before shipment. Upon receipt, inspect the instrument for damage that might have occurred during transit. If any sign of damage is found, please notify your B&K Precision distributor.

The following standard and optional accessories are provided with each mainframe or module.

Mainframes include:

- Power cord
- User manual
- Mainframe extension cable accessory (MDL002 only)

Modules include:

- Certificate of calibration and test report

Optional accessories:

Rack mount kit RK153 (available for mainframes MDL001 and MDL002)

Cleaning

Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.



WARNING: To prevent electric shock, please unplug the power cord connected to the unit before cleaning.

Installing Modules



CAUTION : Static electricity may damage load modules. Please install modules according to standard electrostatic prevention. Avoid touching joints and circuit boards.

One can install any combination of modules up to 2400 W total in the MDL001 mainframe in any order. This also applies to the MDL002 mainframe extension, allowing a maximum of 4800 W total when connecting the MDL001 and MDL002 together. The procedure of installing modules to the mainframe extension is the same as that of the MDL001 mainframe.

Installation Procedure

1. Turn the mainframe off and disconnect the power cord.
2. Loosen screws on front panel plastic cover and remove from mainframe.

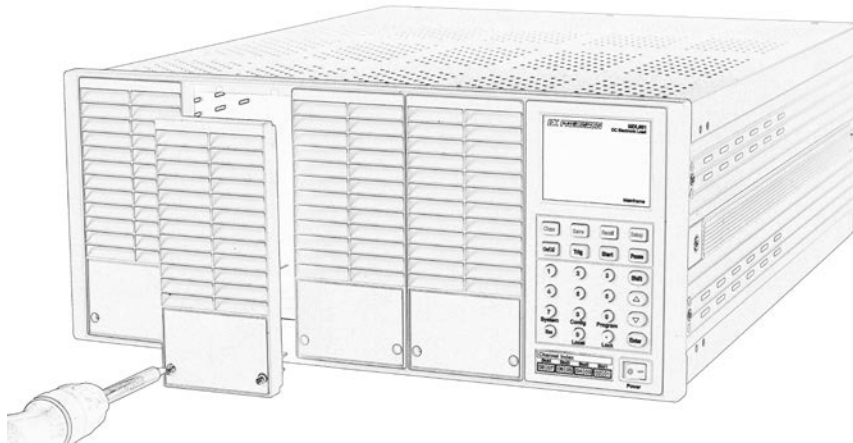


Figure 3a - Module Installation

3. Remove plastic cover on rear with flat-blade screwdriver.

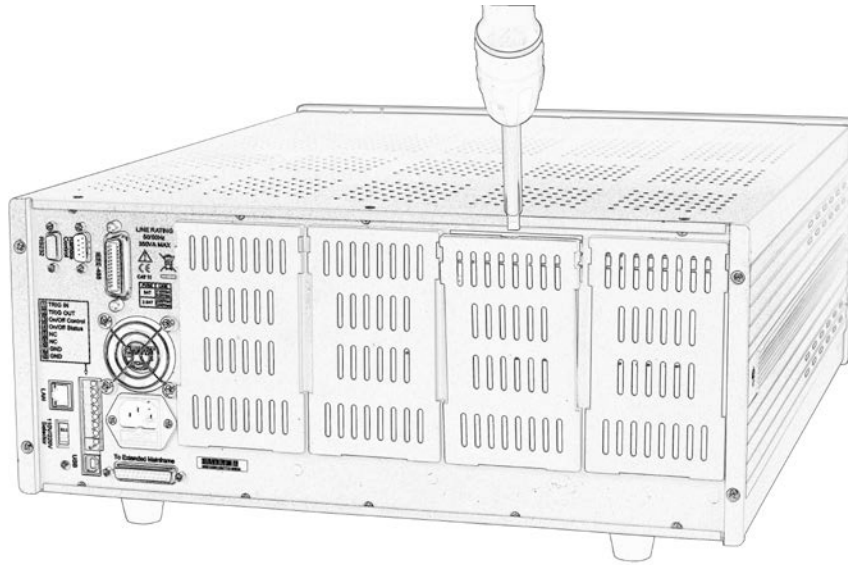


Figure 3b - Module Installation

4. Insert and slide the selected modules into the slot.

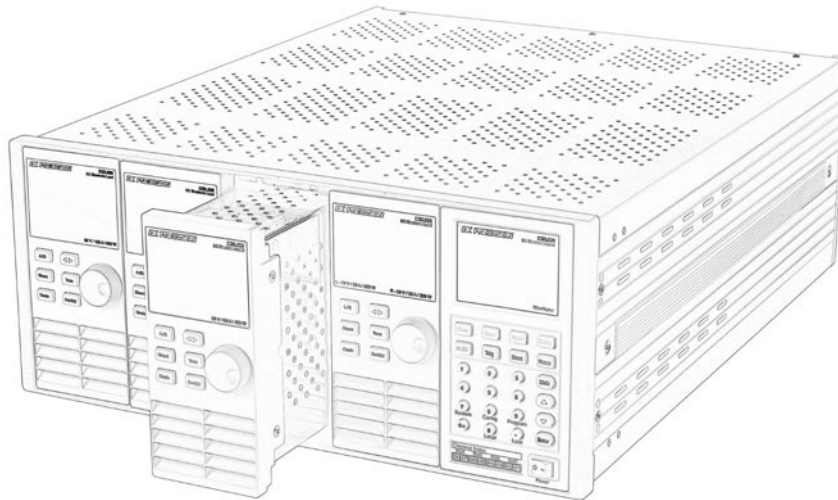


Figure 3c - Module Installation

5. Insert and tighten module screws on rear panel.

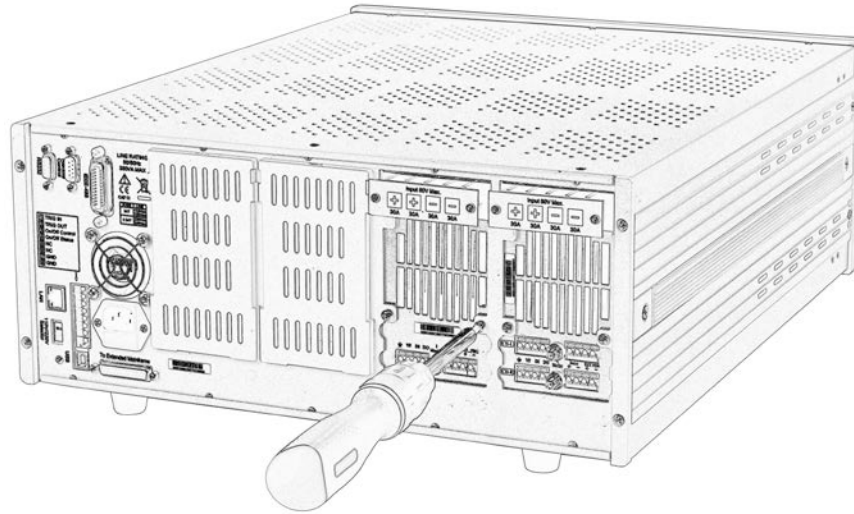


Figure 3d - Module Installation

6. Install more modules in other slots following the same process (steps 2 through 5).
7. Reconnect the power cord.

Channel Number

The channel number for all modules is determined by the location of the modules in relation to the mainframe and ordered from right to left. With the MDL001 mainframe, the total number of channels is 8. Channels 1 and 2 are next to the mainframe front panel, while channels 7 and 8 are located on the left side. Load channel number is fixed even if the location is unoccupied. Dual-channel modules such as the MDL252 and MDL302 have two channels. If it is a single-channel module, the channel number is automatically assigned the first number of the slot. Figure 4 shows the default channel number order.

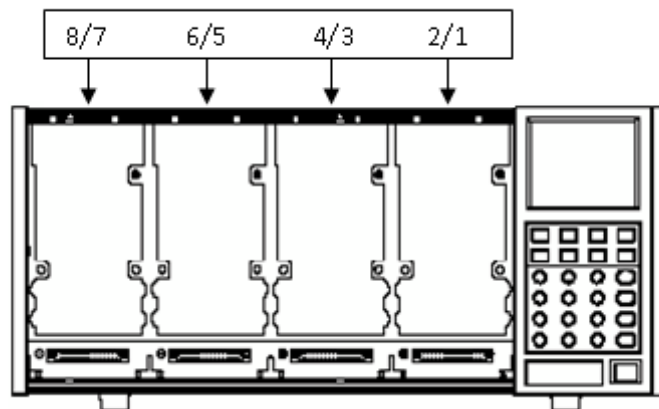


Figure 4 - Channel Number Distribution

The following figures show examples of how channels are assigned when single-channel and dual-channel modules are installed.

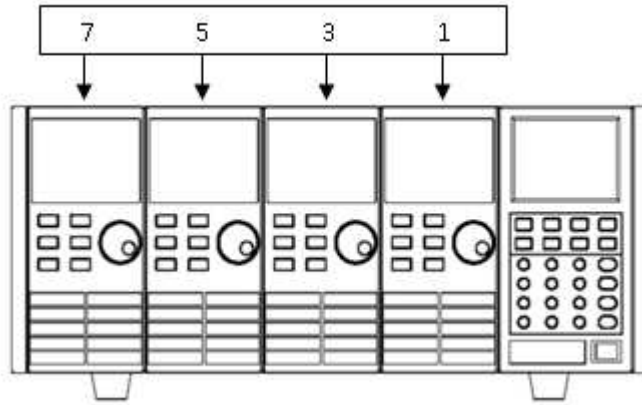


Figure 5 - Channel Number Order When Installing Four Single-Channel Modules

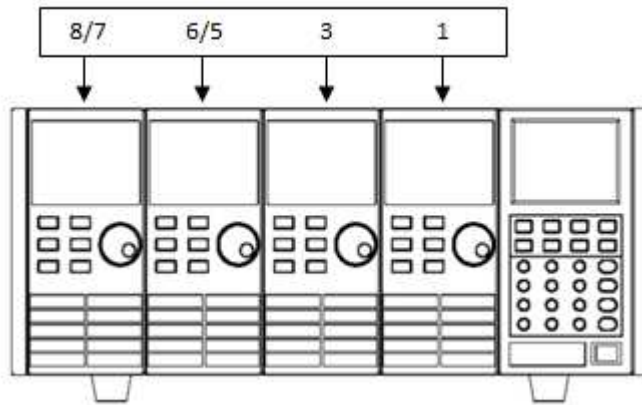


Figure 6 – Channel Number Order When Installing Two Single-Channel Modules and Two Dual-Channel Modules

Note : Mainframe extension module channels are numbered 11-18.

Location

The operating temperature of the MDL Series DC Electronic Load is 0 to 40 °C. A fan cools the electronic load by drawing air through both the top and front, and then exhausting it out the back. Therefore, the electronic load must be installed in a location that allows sufficient space on the front and back of the unit for adequate air circulation. Minimum clearances for bench operation are 2 inches from the top and 3 inches from the front and back. If there are radiator fans in your