TECHNICAL DATA

LeCroy

SYSTEM 1440
MULTICHANNEL HIGH VOLTAGE WITH LOCAL OR REMOTE CONTROL

- High Density, Up to 256 Channels per Mainframe
- Remote Control Via CAMAC, VME, IBM™ PC, RS-232-C, or High Speed Parallel Port
- 2.5 kV, 2.5 mA per Channel, 16-Channel Plug-In Modules
- 5.6 kV, 1.0 mA per Channel, 8-Channel Plug-In Modules
- Positive and Negative Voltage Plug-In Modules in the Same Mainframe
- Selectable HV Ramp- up and Ramp-down Speeds
- Short-circuit and Arc Protection
- TTL System Interlock Input,HV Status Output

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FOR LARGE-SCALE PHOTOMULTIPLIER ARRAYS, WIRE CHAMBERS, GERMANIUM DETECTORS AND SILICON STRIP DETECTORS

System 1440 is a multichannel, programmable high voltage system designed for large scale applications where high reliability and performance are vital. The system provides up to 256 channels of high voltage in each mainframe. A hand-held unit provides local control.

Up to 16 mainframes, or 4096 channels, may be controlled and monitored via a single daisy chain RS-232-C connection. Control may also be exercised from VME, CAMAC (IEEE 583) or an IBM™ PC compatible computer via a high speed parallel I/O port.

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FEATURES

High Density - The 16-channel 2.5 kV plug-in card offers the highest density system available for the best cost/performance ratio.

Digital Voltage Sensing - A system ADC measures the actual output voltage, NOT the demand setting. Resolution ranges from 12 to 16 bits depending on the controller. The output polarity is also reported.

Current Sensing - Wire Chambers and Germanium Detectors must be protected by accurate current sensors. The 8-channel, 5.6 kV module offers current monitoring with a resolution of 62 nA.

Thermal Protection - A temperature monitor on each of the low voltage power supplies shuts off the high voltage in the event of overheating resulting from excessive loading, poor air flow, or high ambient temperatures.

Complete Remote Programmability - All operations may be performed from the hand-held terminal, via RS-232 or parallel port. VME, CAMAC or IBM/PC interfaces are also available. A simple command procedure, using ASCII character strings makes programming easy.

Continuous Memory - The internal memory is immune to occasional power failures. Battery backup protects the integrity of the memory.

FUNCTIONAL DESCRIPTION

The System 1440 is the most advanced modular multichannel high voltage system offered by LeCroy. Reliability, protection and precise control have been stressed in all aspects of its design.

MAINFRAMES AND CONTROLLERS

Convenience, versatility and reliability have been achieved through the use of modular construction. The microprocessor circuit, the power unit, two 31 V DC supplies and up to 16 multi-output HV modules plug into the mainframe. The system can provide negative outputs, positive outputs, or both. Systems of less than 256 channels may be easily established.

The 1440 System operates with a choice of controllers. The high performance Model 1445A, has 16 bits of precision (15 bits plus sign). In addition, the 1445A features the high-speed Systems Interface Bus (SIB) parallel port. The SIB port connects to the Model 1131 VME, 1691A IBM/PC, and 2891A CAMAC Interfaces.

The Model 1445 economy controller uses 13 bits (12 bits plus sign) to allow the output voltage of all channels to be measured. The voltage programmability of the HV modules is 12 bits (plus sign bit).

The System 1440 provides many features to protect its costly loads against HV damage. The HV run-up and run-down rates are digitally controlled (1445A Controller) or may be selected by a jumper option (1445 Controller). Rates as low as 10 V/sec can be selected. Rapid shutdown (panic-off) of all channels is provided locally by a push-button and also from a remote sensor TTL System Interlock input. The mainframe provides a clamp-to-ground output to indicate that the HV is on. The 1443/12 HV module, with block connectors, provides an interlock to disable all 16 channels when the Card Interlock contacts are opened.

The mainframe has two vernier potentiometers to provide separate hardware limits to set the maximum voltage output of the positive and negative channels. Two 8-bit registers are available to provide separate software limits for setting the output current limit threshold of the positive and negative channels. To avoid problems caused by the use of modules of the wrong polarity, the modules treat a demand voltage of the wrong polarity as a null operation and generates an error message. As a second safeguard, output polarity indication is provided in the voltage monitor readback.

PLUG-IN MODULES

The maximum output voltage available from the standard 1443 series module is 2500 V. The full scale of the system programming may be jumper selected to be 2500 V, 2047 V, 1500 V and 4095 V (2500 V is the maximum allowable demand value). This allows the range and resolution of the 1440 System to be matched to the experiment's requirements. The MOD100 option for the 1443 permits operation up to 3100 V at reduced current.

Safety features of the 1444 include:

1. Module Current Trip
2. Per Channel Hardware Voltage Limit
3. DC Current Trip Per Module
4. AC Current Trip Per 2 Channels
5. LED Trip Indicator
6. External Current and Voltage Monitor
7. Daisy-chain Trip

The 1444 Series plug-in modules have been designed for the higher voltages of delicate and expensive loads like wire chambers and Germanium detectors. These modules include many safety features, including current readback. They provide up to 5.6 kV at 1.0 mA per channel with < 60 nA least count current monitoring.

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The 1444 modules contain many of the features required by Silicon Strip Detectors including programmable current trip, voltage limit, external trip capability, very stable output voltage and current readback. The only difference is the voltage output level, which can be easily modified. LeCroy's Application Note AN-48 describes this modification of the 1444 module from 5.6 kV at 1 mA to less than 500 V (typically).

Since the user can mix high voltage modules in the same System 1440 Mainframe, the high voltage for all the detectors in an entire experiment can be in one format with one interface. This is far more time and cost effective compared to designing and building dedicated systems.

HAND-HELD CONTROLLER (Optional)

The Model 1447 hand-held controller allows local control of a 1440 System. By plugging the hand-held controller into the Auxiliary Control connector, commands can be issued to the mainframe without interruption of the other mainframes in the control daisy chain.

FAULT INDICATOR

A front-panel connector signals a fault by a clamp-to-ground. A fault condition is generated by a failure of any of the DC power supplies. The most common causes are over-temperature or over-current conditions.

PANIC-OFF

A front-panel push-button shuts down all supplies promptly for protection against the unexpected.

INTERLOCK

A front-panel BNC input accepts a TTL input, triggering a panic-off. Internal programming jumper allows user assignment of logic levels, allowing the input to be used as a fail-safe interlock or a remote panic-off.

ERROR INDICATOR

A front-panel Lemo connector used to indicate that all HV channels are operating. An error condition produces a TTL clamp-to-ground. Empty stations within the mainframe are ignored for this diagnostic. If the error is corrected, the Error Indicator output returns to its quiescent open circuit condition.

VOLTAGE LIMIT

Two front-panel adjustments set hardware limits separately for positive and negative channels.

SIMPLE INTERACTIVE TERMINAL OPERATION

An easy to understand mnemonic language allows all of the features of 1440 System to be exercised. This includes setting, measuring and adjusting any channel or all channels. The language allows commands to operate on groups of channels. The system can offer a status report and output an array of measurements of all outputs within the mainframe. Each mainframe is assigned a unique address, and must be selected before it can accept commands. Special shorthand allows the channel addressing to be skipped after the first reference. An RS-232-C type interface is used.

DAISY CHAIN

Up to 16 mainframes may be operated remotely in a chain. Serial Transmit and Receive lines are used.

HV STATUS OUTPUT

A front-panel Lemo output used to indicate HV present at rear connectors. May be used for personnel safety interlocks or as an independent indicator.

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Model 1443
16-Channel, 2.5 kV HV Modules

Each 1443 module has 16 independently controlled High Voltage outputs. These cards may be ordered with block connectors or with SHV connectors (F suffix) for the High Voltage outputs. Modules of different polarities and types may be combined in a single mainframe.

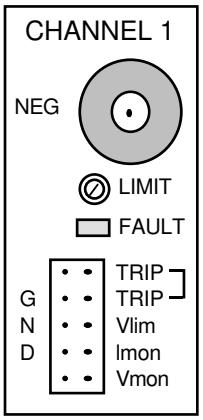
Model 1443
Block Connector Data

Pin Assignments

Pin	Function	
1	HV Output Channel	0
2	HV Output Channel	1
3	HV Output Channel	2
4	HV Output Channel	3
5	HV Output Channel	4
6	HV Output Channel	5
7	HV Output Channel	6
8	HV Output Channel	7
9	HV Output Channel	8
10	HV Output Channel	9
11	HV Output Channel	10
12	HV Output Channel	11
13	HV Output Channel	12
14	HV Output Channel	13
15	HV Output Channel	14
16	HV Output Channel	15
17	Ground Return	-
18	Ground Return	-
19	Interlock (short to 20 for enable)	-
20	Interlock (short to 19 for enable)	-

Model 1444
8-Channel, 5.6 kV HV Modules

Each 1444 module has 8 independently controlled High Voltage outputs, each with separate current read back. Modules may be ordered with either polarity and may be mixed in a mainframe.



Model 1444 Connector Layout for 1 of 8 Channels

Model 1449M/1449ME

GENERAL

HV Module Slots per Mainframe: 16.
Channels per Mainframe: Up to 256.
Maximum HV Output Power: 1.6 kW for Model 1449M; 800 W for Model 1449ME; for each plug-in module in excess of eight, deduct 15 W from the 800 W available.
Ramp Rates: The HV run-up and run-down rates may be selected by a jumper option and/or software on the 1445 or 1445A control units between 10-500 V/sec.

DISPLAY AND CONTROL

HV Enable Indicator Switch: Yellow lamp indicates HV is ready for turn on (i.e., HV Disable is not actuated and INTERLOCK is not asserted). Integral with front-panel HV ON indicator (red lamp) and HV Enable button. Rear-panel indicator lamp.
Input Power Status: *Model 1445A* - three LEDs indicate presence of +5 V, +15 V, and -15 V. *Model 1445* - two LEDs indicate presence of -15 V and +5 V. Active lit by +15 V.
System Active/ENB: Front-panel LED indicates modules enabled for generating HV.
Status: Lemo connector, TTL high = HV on, low = HV off.
Interlock: BNC connector, TTL high = on, low = off.
HV Limit Potentiometers: Set separate positive and negative hardware limits.

PROTECTION

System Protection: In the event of a power failure, the system will shut down in an controlled manner. A front-panel switch on the 1440 mainframe provides immediate shut down. Panic-off in the rear is accomplished by pulling out the power cord. An interlock is provided on the control unit that will disable all HV in the mainframe when driven to ground.
Thermal Protection: A temperature monitor on each of the low voltage power supplies shuts off the high voltage in the event of overheating that can result from excessive loading, clogged fan filters, or high ambient air temperatures.

MECHANICAL

Packaging: 19" rack-mount chassis, 17" wide x 22" deep x 26 1/4" high. (Add 3" to depth to include handle protrusion.)
Input Power: 180-260 V, AC 50/60 Hz, 15 A.
Humidity: 0 to 85% relative humidity.
Operating Temperature: 10°C to 40°C ambient.
Shipping Weight: 210 lbs. (95 kg).

Model 1443

Number of Channels: 16 per module; maximum of 256 channels per mainframe.
Output Voltage: 500 to 2500 V; < 500 V. Performance is not rated. Polarity indicated by N or P suffix.
Full Scale: 2500 V, 2047 V, 1500 V, 4095 V values available (limited to 2500 V max.) by mainframe jumper option.
Output Current: Up to 2.5 mA per channel. Reduced output current specification when all channels of a module are run at maximum voltage and current.
Voltage Regulation: 0.05% of full scale, line and load.
Programming Step: 0.025% of full scale.
Programming Accuracy: < ±(0.2% +2 V) for demand voltages > 500 V. Performance is not rated for < 500 V.
Programming Reproducibility: < 1 V at a constant load and temperature after 10 minute warm-up.
Voltage Monitor Accuracy: ±(0.1% +1.5 V).
Monitor Long-Term Stability: < 1.5 V/week at constant load and temperature.
Output Long-Term Stability: < 2 V/week at constant load and temperature.
Temperature Coefficient: Typically 0.005%/°C, maximum 0.01%/°C from 500 V to 2500 V (10°C to 40°C ambient).
Output Ripple: Typically < 50 mV peak-to-peak; < 250 mV peak-to-peak maximum.
Output Protection: Fully protected against arcs at load, short circuit and overload.
Output Connector Type: Multiconductor block-type connectors. SHV connectors specified by F suffix.

Model 1444

Number of Channels: 8 per module; maximum of 128 channels per mainframe.
Output Voltage: 500 V to 5600 V; < 500 V performance is not rated. Polarity indicated by N or P suffix.
Output Current: Up to 1 mA per channel.
Voltage Regulation: 0.05% of full scale, line and load.
Programming Step: Employs a 14-bit DAC with 0.5 V/LSB.
Programming Accuracy: < (0.1% +5 V).
Programming Reproducibility: < 1 V at a constant load and temperature.
Voltage Monitor Accuracy: ±(0.05% +0.5 V).
DC Current Monitor: The DC current drawn by the load is monitored via a 16-bit ADC (located in the 1445A).
Resolution: 60 nA/LSB, Accuracy: 0.2% ±4 LSB. Any DC trip value between 1 LSB and full scale (1 mA) can be programmed. A trip indicator on the 1440 front panel will light when any channel in the mainframe fails.
DC Current Trip: Programmable between 0 and 1 mA. One setting applies to all channels in module.
AC Current Trip: Programmable between approximately 200 nA and 3 mA (14-bit DAC). Same as DC current trip except for a low frequency cut off of 3 Hz ($\tau \approx 300$ msec) and a high frequency cut off of 150 Hz ($\tau \approx 6$ msec). Current spikes shorter than 6 msec are integrated and will trip the circuit only if the integrated value over 6 msec exceeds the pre-programmed trip value.
Output Long-term Stability: < 2 V/week at constant load and temperature.
Output Ripple: Typical < 5 mV RMS, maximum 10 mV RMS or 40 mV p-p.
External Monitoring Capability: 6 pins of the 10-pin header per channel are used for external monitoring; 2 pins monitor voltage (1000:1 reduction); 2 pins provide DC current measurement with 10 V/mA sensitivity; 2 pins monitor over-voltage protection (see below).
Over Voltage Protection: Adjustable by a front-panel potentiometer (one per channel) between 1 kV and 6 kV.
Inter-Channel Protection: 4 pins of the 10-pin header for each channel are available for daisy-chaining channels together such that when any channel on the daisy-chain fails, all channels on the daisy-chain will ramp down at the selected hardware rate.
Output Connector Type: SHV connectors.

SYSTEM COMPATIBILITY

The Model 1444 HV module is compatible with existing mainframes. However, if used with the older, economy 1445 Controller, the lack of a 16-bit ADC means lower accuracy and increased software effort (i.e., on the 1444, a demand of 2000 counts produces a voltage of 4000 V). In order to use all the features and the full precision of the 1444, the 1445A control unit must be used.

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ORDERING INFORMATION

MAINFRAME 1449M/1449ME

To order a 1440 System, it is first necessary to determine the total HV power required. For systems requiring less than full voltage and current, the low power mainframe, 1449ME, may suffice. If not, order the Model 1449M mainframe. Both versions include all logic and control units required for use with up to 256 HV channels. The 1449M provides a total of 1.6 kW. The Model 1449ME provides 800 W. For each plug-in module in excess of eight, 15 W must be deducted from the available 1449ME power.

Example: A system consisting of 176 channels, operating at 2 kV, each with a load of 2 mA must provide: 176 x 2 kV x 2 mA = 704 W. Since 11 cards are required, 755 W are available from the 1449ME, the lower priced 1449ME may be selected.

To upgrade the 1449ME for 1600 W operation, a Model 1442 DC Supply must be ordered. The time required to install and test the addition is less than 1 hour. No special tools are required.

16-CHANNEL HV MODULES 1443 SERIES

HV modules provide 16 outputs, up to 2.5 mA at 2500 V.

8-CHANNEL HV MODULES 1444 SERIES

HV modules provide 8 outputs, up to 1.0 mA at 5600 V.

Modules of positive and negative output are available and are denoted by P and N suffixes, respectively.

Model 1443N/12	2.5 kV, negative, block connector.
Model 1443P/12	2.5 kV, positive, block connector.
Model 1443NF/12	2.5 kV, negative, SHV connectors.
Model 1443PF/12	2.5 kV, positive, SHV connectors.
Model 1444P	5.6 kV, positive, SHV connector.
Model 1444N	5.6 kV, negative, SHV connector.
Model 1440X	Extender for 1443 Series HV module and controller. Intended as a service tool.
Model 1441	Power module (spare part). Included in 1449 mainframe.
Model 1442	DC supply. One included in 1449ME, two included in 1449M.
Model 1445	Economy controller with 13-bit ADC, RS-232 and 1447 ports.
Model 1445A	High performance controller with 16-bit ADC, SIB, RS-232 and 1447 ports.
Model 1447	Hand-held TTY.
Model 1131	Interface to VME (1445A only).
Model 2132	Interface to CAMAC.
Model 2891A	Interface to CAMAC (1445A only).

BLOCK CONNECTORS

Model HVCK20FB	Female bulkhead type (used on 1443/12 front panel).
Model HVCK20MB	Male bulkhead type.
Model HVCK20FC	Female cable type.
Model HVCK20MC	Male cable type (mates with 1443/12 front panel).

1445 CONTROLLER CABLES

CCHV16-M	Data cable used to connect the 1445 controllers to each other. M is the length of cable in meters.
CDHV16-M	Data cable used to connect the 1440 chain to a controller. A standard RS-232-C 25-pin "D" connector is employed at the controller end. M is the length of the cable in meters.
AD/TTY	Mates with CHV16 cable. Provides pigtails suitable for direct connection to a Teletype or a Data Terminal.
AD/CAM	Mates with CDHV16 cable. Provides connection to the Model 2132 CAMAC Interface.

1445A CONTROLLER CABLES

DC SIB/60-L	System Interface Bus (SIB) cable to connect VME Interface Model 1131, CAMAC Interface Model 2891A, and IBM PC Interface Model 1691A to the 1445A HV Controller. L is the length in feet.
ADD-SIB34/66	Cable adapter required for 2891A and 1691A connection to DC SIB/60-L.
403 630 009	RS-232 cable to link a daisy-chained 1445A Controller. Length is 5 ft.

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