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TECHNICAL DATA

LeCroy

SYSTEM HV4032A WITH LOCAL AND REMOTE CONTROL

- **Up to 32 Independent Channels per Mainframe**
- **Safely Interlocks, Trips and Fault Reporting**
- **Local or Remote Control**
- **Multiple Mainframe Daisy-Chain Control**
- **Comprehensive Microprocessor Control and Monitor**

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FOR PHOTOMULTIPLIER AND WIRE CHAMBER APPLICATIONS

The HV4032A System is a modular, programmable, microprocessor controlled, High Voltage Power System for photomultiplier and wire chamber applications. Control and readback for up to eight plug-in pods is provided by the HV4032A/M Mainframe. Plug-in pods are available for either polarity and for systems requiring up to either 3.3 kV or 7 kV (Series VII). Any combination of eight pods may be used in a single mainframe, and each kind of pod is automatically identified by the mainframe. Up to 32 individually controlled channels of high voltage are housed in a single mainframe, depending upon the application. The mainframes themselves are programmed either locally with push-button controls and an LED display, or remotely. The latter is done with a daisy-chained link of up to 16 mainframes to either a computer terminal or a CAMAC interface for computer control and fault reporting.

Corporate Headquarters: Chestnut Ridge, NY USA
Tel: (914) 578-6013 Fax: (914) 578-5984

European Headquarters: Geneva, Switzerland
Tel: (41) 22 719 2228 Fax: (41) 22 719.2230

E-Mail: lrs_sales@lecroy.com *lrs_support@lecroy.com* *lrs_service@lecroy.com*

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FEATURES

Modular Construction - All four types of plug-in pods may be used simultaneously in a single mainframe. Pods are easily and quickly installed via rear-panel access, without dismounting the mainframe or removal of access panels. An internal dataway of the HV4032A/M allows pods to identify themselves.

Continuous Memory - High voltage settings are stored in a battery backed-up memory, and can be recalled on demand. The new 80186 CPU board uses a replaceable lithium coin cell, which is located adjacent to the jumper section in the front right corner of the CPU board, and is installed with the "+" side up. This battery has a life of 10 years and thus gives continuous protection against power failures. When the battery needs replacement, memory will be lost if the power is turned off.

Digital Voltage Control - A 12-bit ADC reads the actual output voltage and compares the result to the demand (programmed) value. Deviations beyond the control range indicate channel failures. Failures result in system shutdown and are reported on the front panel and via any computer interface.

Thermal Protection - A temperature monitor on the internal power supply shuts off the high voltage in the event of overheating. This can be the result of excessive loading, a clogged fan filter, or high ambient temperatures.

CAMAC Programmability - All operations that can be performed from the front panel are available through the Model 2132 CAMAC (IEEE-583) Interface. Simple binary control words make programming the HV4032A/M easy. A unique RESPONSE feature may be enabled, indicating the completion of each command.

Current Limit/Trip - All 3.3 kV pod channels have fixed current limits. Series VII channels are limited separately in programmable 1 µA steps with ±(5 µA + 5%) accuracy. For Series VII pods only, a current trip crowbar action is initiated when surges are detected. This protects against detector damage from high voltage breakdown.

FUNCTIONAL DESCRIPTION

The HV4032A System consists of up to eight pods in each HV4032A/M Mainframe with provision for remote operation of all channels in up to 16 mainframes. A single LeCroy Model 2132 CAMAC (IEEE-583) Interface (Page 303) permits the control by daisy-chaining connections of the whole HV system (e.g. gain adjustment of the photomultiplier by controlling and reading the dynode chain voltage). The system provides a status output, for a remote HIGH VOLTAGE ON indicator.

Each voltage channel employs a high-efficiency switching supply with low ripple and a safe, low stored-energy output stage. Channel output is controlled by a microprocessor in the mainframe which establishes demand settings, continuously measures the output voltage (using a 12-bit ADC), compares the output with the 12-bit programmed demand, and adjusts the output to maintain constant voltage. Any channel which cannot be brought into regulation, either due to overload or channel failure, is shut down and reported by the CPU to the user's data acquisition system.

Voltage run-up and run-down are performed at safe rates of 1 kV/sec for 3.3 kV channels and 2 kV/sec for Series VII channels. Series VII also allows for current-limited run-up at less than 2 kV/sec. Under current-limited conditions, the voltage run-up speed is set by the rate at which the load capacitance can be charged.

Series VII has special algorithms to automatically allow for this mode.
The system is fail-safe against erroneous voltage or current-limit demands which occur in day-to-day programming. Series VII provides for setting individual hardwired voltage and current limits, using rear-panel terminals. This safeguard is in addition to the mainframe front-panel vernier which sets the system voltage limits. The vernier setting establishes the maximum demand voltage of the 3.3 kV pods and sets a Series VII limit at twice this value.

Numerous safeguards and error checking subroutines are included in the HV4032A/M microprogram. The memory stores all of the system parameters (demand voltages for each channel, current limits for Series VII channels, idle-down voltages for the system and the mainframe pod complement), and is safeguarded by battery back-up. The replaceable lithium cell guards against memory loss due to power failures for years. Extensive self-checking is embedded in critical data words to assure memory integrity.

All pod voltages are programmable, and Series VII pods are also programmable for current limit, with separate settings for each channel in 1 µA steps. Each Series VII pod also has a fast current trip circuit, sensitive to current surges. All pods identify themselves to the CPU and may therefore be randomly placed in the mainframe, without restriction. Placing

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one or more Series VII pods in a mainframe activates special firmware to perform current limit and current monitor functions on those stations containing Series VII channels.

Series VII supplies include innovative load protection features. An extremely fast current surge detector allows each channel to initiate a trip sequence as soon as a fault is detected. Power supply output is stopped within 50 µsec of the sensing of the fault. This trip feature is the first step in the load protection sequence of Series VII. To fully protect the chamber, the energy stored in the HV cable and Series VII output filter capacitor must be dissipated. It is shunted to ground and discharged with a response time of typically less than 1 msec. Application of this crowbar protection is a first from LeCroy. Any and all Series VII channels (up to 16) can be ganged for common HV trip to prevent the potentially dangerous voltage imbalances which can result from the shutdown of only one channel. When configured as a daisy chain, the channel initiating the trip reports its action to the user.

For the unexpected, the HV4032A/M also includes a PANIC OFF, allowing all channels to be shut down in less than 20 msec (full load). Local PANIC OFF is accommodated via a large illuminated front-panel switch. AN INTERLOCK (BNC) connector can be daisy-chained to other mainframes in the HV system. The trip is reported in CAMAC or TTY mode operations.

Full digital control for all functions is provided locally via front-panel push-button and provided remotely via computer or TTY. Front-panel decimal displays identify the channel addressed for control, as well as the value of the parameter that is inserted. Channel numbers 0 through 31 identify a voltage channel. For 7 kV supplies, the odd numbered channels are omitted, and a "c" register is added to indicate current settings. Thus, with 7 kV pods in locations 1 and 2, and 3.3 kV pods in the remaining locations, the active channel number would be 0, 0c, 2, 2c, 4, 4c, 6, 6c, 8, 9 ... Demand voltage for the selected channel is set via each of the Channel 0 through 31 registers (except those registers assigned a current demand value, as just described). Preset registers have addresses which are larger than 31 and contain settings for groups of channels. Groups can be set to a common value defined by these registers for system initialization. This parallel load feature is active only when the HV is off.

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Address 33	3.3 kV Preset Register	Sets all 3.3 kV pods (negative and positive) to a common value. This is useful for system initialization. All channels can start out at a common value and then be trimmed individually as required. Resolution is ±1 V, with a channel-to-channel accuracy of ±(0.1% + 1.5 V). See example below.
Address 70	Series VII Preset Register	Sets all 7 kV pods (negative and positive) to a common value. Resolution is 2 V, with a channel-to-channel accuracy of ±(0.1% + 3 V).
Address 70c	Series VII Current Preset Register	Presets the current limit of all Series VII pods. Setting is made in 1 µA steps, with an accuracy of ±(5% + 5 µA).
Address 43	3.3 kV Idle-Down Register	Sets the idle down voltage for all 3.3 kV channels to this idle-down value.
Address 47	Series VII Idle-Down Register	Sets the idle down voltage for all Series VII pods. It functions exactly as register 43, permitting all Series VII supplies to have their own common idle-down register.
Address 99	Diagnostic Register	Used for calibration and diagnosis, using procedures described in the manual.

Address 33
3.3 kV Preset Register



Table 1: Preset Registers with Addresses and Functions

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FRONT-PANEL FEATURES HV4032A

1 STATUS OUTPUT

A front-panel Lemo output indicates HV present at rear connectors. This may be used for personnel safety interlocks or as an independent indicator.

2 PROGRAMMED RUN-UP/RUN-DOWN

An HV turn-on command initiates a programmable ramp up and down of all channels. Typically the ramp rate is a safe 1 kV/sec for 3.3 kV supplies and 2 kV/sec for 7 kV supplies. A turn-off command ramps down similarly. Series VII supplies (pods) also permit programmed current-limited run-up over the range of 10 to 500 µA, determined by the load capacitance, C, and the current limit i, (dV/dt = i/C).

3 ZERO (Z)/RESTORE (R)

Momentary push-buttons. Depressing ZERO (Z) loads demand voltage of a selected channel into a buffer, then loads a zero into the demand voltage register. A slow voltage run-down to < 100 V (no load; < 20 µA for personnel safety) is initiated for the selected channel. Depressing RESTORE (R) initiates slow run-up of a selected channel previously ZERO'd, if HV is ON. Active only in LOCAL mode.

4 LOCAL/REMOTE

Front-panel slide switch selects LOCAL or REMOTE control of mainframe. In REMOTE control, the unit automatically distinguishes between ASCII characters from a TTY and binary words from the Model 2132 CAMAC Interface. TTY operation may run at either 110 or 300 baud; 80186 CPU boards allow baud rates of 110, 300, and 2400, as set by a user-selected internal plug. (Factory set at 300 baud.)

5 MAINFRAME ADDRESS

Each mainframe may be assigned an address between 1 and 16. This permits unambiguous addressing of mainframes that are daisy chained together for remote control. Special shorthand allows the addressing to be skipped after the first reference.

6 VOLTAGE LIMIT

Front-panel hardware voltage limit for all channels. The clamp point for 7 kV (Series VII) channels is twice that of the 3.3 kV channels. When a demand voltage exceeds the limit, the CPU detects a failure, zeros the channel, and reports the shutdown. Series VII pods have a rear-panel current and voltage clamp for each channel.

7 INTELLIGENT ON/OFF

Upon loss of AC power, the ON/OFF switch position is stored in memory, as is a self-test pattern. When AC power is restored, the self-test pattern is checked for integrity. A successful self-test pattern check ensures integrity of stored demand voltages and switch settings. If shutdown was by user switch-off, the Model HV4032A/M stands by. If shutdown resulted from a power failure at a time when the HV was on, a controlled voltage run-up is executed unless Series VII pods are present. If any stations have 7 kV pods, the system stands by.

8 INTELLIGENT DAISYCHAIN

Up to 16 mainframes may be linked together with Serial Transmit, Receive, and Control bus lines. An identifier line allows the system to differentiate between CAMAC and TTY modes. This allows ASCII coding for TTY operation and binary coding for CAMAC control.

9 CHANNEL DISPLAY

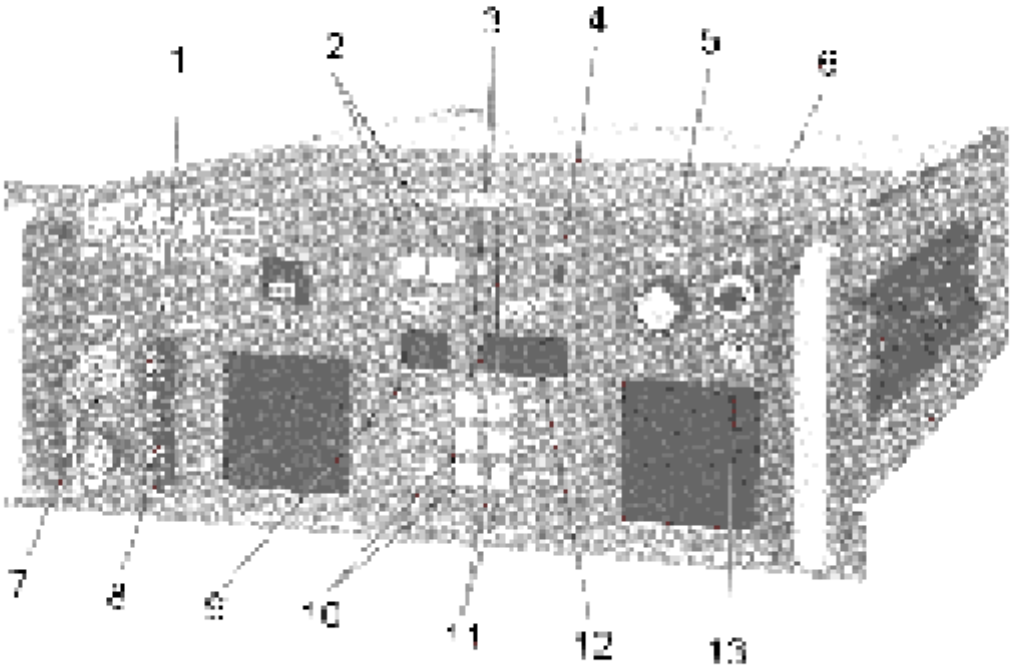
LED display showing the channel selected corresponds to the Voltage (or current for Series VII pods) output or demand setting shown in the VOLTAGE display.

10 VOLTAGE (V)/CHANNEL (C)

Momentary push-buttons enable a VOLTAGE or a CHANNEL to be changed by INCREASE or DECREASE switches. When V is depressed, the demand voltage of the selected channel is displayed. When V is released, the measured output is displayed. Active only in LOCAL mode. V is also used to set current limit for 7 kV pods.

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11 INCREASE (↑)/DECREASE (↓)

Momentary push-buttons increase (decrease) channel number if CHANNEL push-button is depressed simultaneously; or increase (decrease) voltage (or current for Series VII pods) of selected channel if VOLTAGE push-button is also depressed. Internal software prohibits settings in excess of pod design.

12 VOLTAGE DISPLAY

LED display showing the measured output voltage or, when the V button is depressed, the demand voltage. The left most digit displays a "c" when an output current is displayed (Series VII pods only) instead of a voltage.

13 INTERLOCK

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

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SPECIFICATIONS HV4032A

GENERAL

Pods/Mainframe: Eight.
I/O Connectors (J1 and J2): Two multi-pin connectors, with front-panel retainers, provide daisy chain capability. Five wire pairs interconnect the modules. Two pairs are 20 mA current loops (transmit and receive), two pairs are used for bus control and one pair mates with LeCroy Model HVCK-14. Differentiates between CAMAC and TTY remote operation.
Packaging: 19" rack-mount chassis, 17" x 28 1/4" x 6 5/8". Side-panel slides facilitate internal access.
Voltage Required: 100 - 130 V, 60 Hz, or 205 - 260 V, 50 Hz (≤ 750 W at full load). Selected by rear-panel switch.
Maximum Output: 208 W - all channels.
Operating Temperature: 5°C to 40°C.
Voltage Regulation: 0.05% line; ±0.5 V load.
Common Voltage Limit: Mainframe Front-Panel Control. 3.3 kV pods: V_{max} about ((.314 x S) + .2) kV. Series VII pods: V_{max} ((.628 x S) + .96) kV.
HV Output Connector: SHV (Note 1).
Ambient Humidity: 0 - 90% relative humidity.

HIGH VOLTAGE PLUG-IN PODS

Series VII Safety

Current Surge Detector: One per channel. Responds to current surges of ≥ 50 µA and a rise time ≤ 25 µsec. Initiates fast current trip and output crowbar.
Fast Current Trip: Shuts down supply with 50 µsec of surge detector output. Residual energy remains on output filter capacitance and cable until output crowbar is activated. Up to 32 channels may be ganged via rear-panel connector, current trip by any one causes all to trip.
Output Crowbar: Discharges output filter capacitance and cable capacitance by a clamp to ground through 50 kΩ.
Crowbar Response Time: Typically < 2 msec.
Manual Voltage Limit: One voltage-programmable rear-panel node per channel. Internally connected to +15 V via 5.6 kΩ ±5% resistor. V_{max} = 0.8 V_{mode} kV (Note 2).
Manual Current Limit: One voltage-programmable rear-panel node per channel. Internally connected to +15 V via 4.3 kΩ ±5% resistor. I_{max} = 50 V_{mode} µA (Note 2).

ORDERING INFORMATION

For any configuration, including fewer than eight pods, order the HV4032A/M Mainframe and up to eight pods, which may be mixed in any combination of the four models shown in the HV port selection chart. Although a mainframe may hold eight pods, any number from one to eight may be installed.

INTERFACE

To interface up to 16 mainframes to the CAMAC control system, order one Model 2132 CAMAC Interface and the appropriate cables as described below. Larger systems require one additional Model 2132 CAMAC Interface for each 16 additional mainframes.

HARDWIRED VOLTAGE AND CURRENT LIMIT FIXTURE

Model HV4032A7X is an optional plug-in board with four trimpots used to set the voltage and current limits for the two channels in a pod. Order one board per Series VII pod if this feature is desired.

EXTERNAL TRIP CIRCUIT CONNECTOR

Commoning of surge detector trip circuits, requires that all channels which must crowbar together be linked through external wiring. Connection diagrams, supplied with the mainframe, require use of an AMP 87456-7 twelve-contact housing (with inserts) for each Series VII pod.

MODEL 2132 CAMAC INTERFACE

The Model 2132 is a single-width CAMAC Interface designed for use with up to 16 of the Model HV4032As in a daisy chain. This unit is also compatible with the Models HV4032 and HV4032P. The unit offers 40 words of buffering on both input and output. The 2132 employs two interrupt registers, L1 and L2. One is designed to offer a CAMAC LAM upon non-routine phenomena such as channel failures, whereas the other is used for routine responses. Control words and responses employ a simple binary code. A control line is employed to identify the controller in use as either Model 2132 or a TTY.

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ACCESSORIES

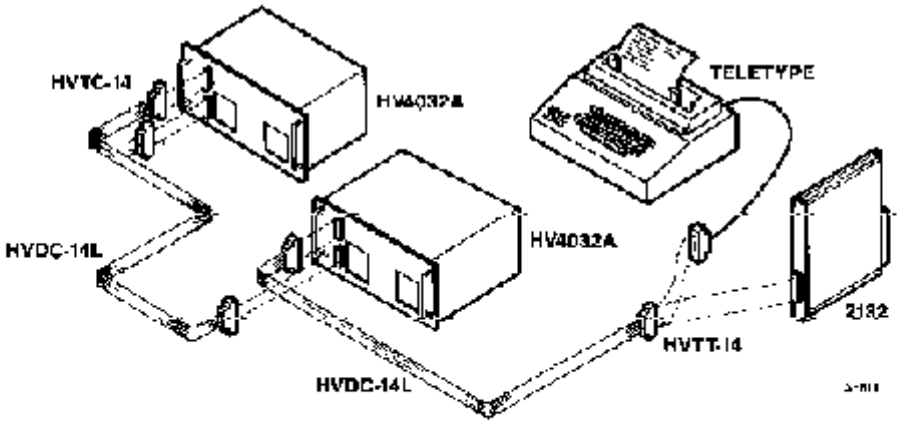
Model HVDC-14L - A data cable used to connect HV4032A chassis to one another or to the Model 2132. Includes one LeCroy HVCK-14 connector at each end. The length in feet, L, must be specified.

Model HVTC-14 - A terminator for the HV4032A daisy chain. One employed at the far end from the controller (CAMAC or TTY). One required per daisy chain.

Model HVTT-14 - Consists of all the parts required to connect a HV4032A daisy chain to a teletype. The HVTT-14 consists of mating connector to the HVCK-14 with a pair of pigtails to be connected to the teletype.

Model HVCK-14A - Connector kit to mate with the HV4032A front-panel daisy chain connectors.

Model HVAK - Adapter kit to allow change of retention hardware to mate with HV4032A system connector.



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HV POD SELECTION GUIDE

Pod Designation	HV4032A1N & HV4032A1P	HV4032A7N & HV4032A7P
Channels/Mainframe	32 maximum	16 maximum
Channels/Pod	4	2
Voltage Output for HV4032A*N for HV4032A*P Recommended range for rated performance	 0 to -3.3 kV (Note 3) 0 to +3.3 kV ≥ ±1 kV	 0 to -7 kV (Note 4) 0 to +7 kV ≥ ±1.5 kV
Current Output Channel (For rated performance)	2.5 mA maximum	500 µA maximum
Current Limit/Channel	3 ±0.3 mA Fixed (Also limited by maximum power output. See below.)	Programmable/channel 5 - 500 µA. ±(5% + 5 µA) at 25°C
Current Limit Programming Step	N/A	1 µA
Current Trip	Limit only	Surges of ≥ 100 µA in ≤ 25 µsec (Response time typically 50 µsec)
Power Output	6.5 W/channel maximum. Derate at 75 mW/°C above 30°C ambient	3.5 W/channel maximum
Current Monitor	No	1 per channel
Current Monitor Resolution	—	1 µA
Voltage Monitor Resolution	1 V	2 V
Programming Step	1 V	2 V
Voltage Regulation	0.05% line; ±0.5 V load	0.05% line; ±1 V load
Voltage Accuracy (Channel-to-channel matching)	±(0.1% + 1.5 V) (In HV4032A/M mainframe at 25°C after 30 min. stabilization at a fixed demand voltage.)	±(0.1% + 3 V)
Ripple (at rated load)	< 25 mV R.M.S. for < 1 kHz Bandwidth < 100 mV R.M.S. wideband (Note 5)	Typically 25 mV p-p < 50 mV R.M.S. wideband (Note 6)
Output Voltage Temperature Coefficient	Typically 0.005%/°C at 2 kV < 0.01%/°C (+ 45°C ambient)	Typically 0.005%/°C at 5 kV

Notes
1. Kings type 1064-1 connectors available at extra cost on Series VII only. Specify HV4032A7N/200 or HV4032A7P/200.
2. V_{out} = voltage applied at voltage/current limit connector.
3. Minimum non-zero demand voltage is 80 V.
4. Minimum non-zero demand voltage is 160 V.
5. Digital regulation updates of ±250 mV DC ≥ 250 msec apart.
6. Digital regulation updates of ±500 mV DC ≥ 250 msec apart.

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