

CAMAC ECLine  
MODEL 4516  
16 CHANNEL, 3 FOLD  
PROGRAMMABLE LOGIC UNIT

USER'S MANUAL

June 1982



A T T E N T I O N

CRATE POWER SHOULD BE TURNED OFF DURING INSERTION AND REMOVAL OF UNIT TO AVOID POSSIBLE DAMAGE CAUSED BY MOMENTARY MISALIGNMENT OF CONTACTS.

SEE POCKET IN BACK OF MANUAL FOR SCHEMATICS, PARTS LISTS AND ADDITIONAL ADDENDA WITH ANY CHANGES TO MANUAL.

A T T E N T I O N





## GENERAL INFORMATION

### PURPOSE

This manual is intended to provide instruction regarding the setup and operation of the covered instruments. In addition, it describes the theory of operation and presents other information regarding its functioning and application.

The Service Documentation should be consulted for the schematics, parts lists and other materials that apply to the specific version of the instrument as identified by its ECO number.

### UNPACKING AND INSPECTION

It is recommended that the shipment be thoroughly inspected immediately upon delivery. All material in the container should be checked against the enclosed Packing List and shortages reported promptly. If the shipment is damaged in any way, please notify the Customer Service Department or the local field service office. If the damage is due to mishandling during shipment, you may be requested to assist in contacting the carrier in filing a damage claim.

### WARRANTY

LeCroy warrants its instrument products to operate within specifications under normal use and service for a period of one year from the date of shipment. Component products, replacement parts, and repairs are warranted for 90 days. This warranty extends only to the original purchaser. Software is thoroughly tested, but is supplied "as is" with no warranty of any kind covering detailed performance. Accessory products not manufactured by LeCroy are covered by the original equipment manufacturers warranty only.

In exercising this warranty, LeCroy will repair or, at its option, replace any product returned to the Customer Service Department or an authorized service facility within the warranty period, provided that the warrantor's examination discloses that the product is defective due to workmanship or materials and has not been caused by misuse, neglect, accident or abnormal conditions or operations.

The purchaser is responsible for the transportation and insurance charges arising from the return of products to the servicing facility. LeCroy will return all in-warranty products with transportation prepaid.

This warranty is in lieu of all other warranties, express or implied, including but not limited to any implied warranty of merchantability, fitness, or adequacy for any particular purpose or use. LeCroy shall not be liable for any special, incidental, or consequential damages, whether in contract, or otherwise.

**PRODUCT ASSISTANCE** Answers to questions concerning installation, calibration,

and use of LeCroy equipment are available from the Research System Division Customer Services Department, 700 Chestnut Ridge Road, Chestnut Ridge, New York 10977-6499 (914) 578-6030, or your local field service office.

#### **MAINTENANCE AGREEMENTS**

LeCroy offers a selection of customer support service. For example, Blue Ribbon service provides guaranteed three-day turn around on repairs, a direct access number for product application assistance, yearly calibration and the addition of engineering improvements. Maintenance agreements provide extended warranty that allows the customer to budget maintenance costs after the initial warranty has expired. Other services such as installation, training, on-site repair, and addition of engineering improvements are available through specific Supplemental Support Agreements. Please contact the Customer Service Department or the local field service office for details.

#### **DOCUMENTATION DISCREPANCIES**

LeCroy is committed to providing state-of-the-art instrumentation and is continually refining and improving the performance of its products. While physical modifications can be implemented quite rapidly, the corrected documentation frequently requires more time to produce. Consequently, this manual may not agree in every detail with the accompanying product and the schematics in the Service Documentation. There may be small discrepancies in the values of components for the purposes of pulse shape, timing, offset, etc., and, occasionally, minor logic changes. Where any such inconsistencies exist, please be assured that the unit is correct and incorporates the most up-to-date circuitry.

#### **SOFTWARE LICENSING AGREEMENT**

Software products are licensed for a single machine. Under this license you may:

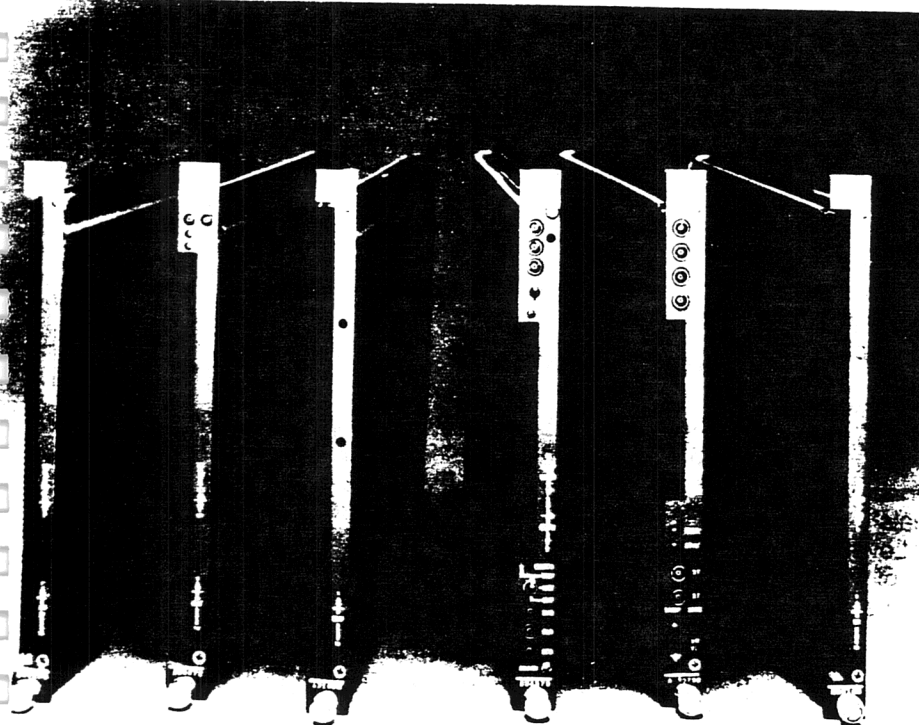
- Copy the software for backup or modification purposes in support of your use of the software on a single machine.
- Modify the software and/or merge it into another program for your use on a single machine.
- Transfer the software and the license to another party if the other party accepts the terms of this agreement and you relinquish all copies, whether in printed or machine readable form, including all modified or merged versions.

# **ECLine/CAMAC**

## **Programmable First Level Trigger Modules**

---

**4418 PROGRAMMABLE LOGIC DELAY/FAN-OUT**  
**4504 FLASH ADC**  
**4508 PROGRAMMABLE LOOKUP UNIT**  
**4516 PROGRAMMABLE LOGIC UNIT**  
**4532 MAJORITY LOGIC UNIT**  
**4564 OR LOGIC UNIT**



- **High Speed First Level Trigger Decisions**
- **Programmable Logic Functions**
- **Compatible with ECLine Data Handler Modules**
- **Compatible with ECLine Discriminators, ADC/TDC, and MWPC Systems**
- **Designed-in Expandability**

### **FAST, FIRST LEVEL TRIGGER PROCESSING**

The LeCroy ECLine family of programmable logic modules include logic delays, Boolean logic and other functions vital for high speed trigger systems. It also includes fast table lookup permitting pre-programmed responses to digital data. Functions are performed in only a few tens of nanoseconds, permitting data to be screened prior to recording and increasing the sensitivity of the experiment.

## FEATURES

**High Speed** - Maximum rates of 65 to 150 MHz, depending on module and programmed features.

**Multiple Functions** - Relative timing adjustable by programmable logic delay, Majority Logic and simple Boolean Logic (AND/OR) for coincident events, Programmable lookup for complex functions.

**Fan-Out Capability** - Use of ECL (Emitter Coupled Logic) levels provides outputs suitable for fan-out to several modules (termination resistors may need to be removed on inputs).

**Use of Multichannel Differential ECL** - Signals for economic, fast, noise immune interconnections.

## FUNCTIONAL DESCRIPTION

LeCroy's ECLine family of programmable logic modules are designed to quickly characterize data so that a rough go/no-go decision can be made for further processing. For example, discriminators are employed to ensure that analog signals are of sufficient amplitude to be interesting, and to provide logic outputs of fixed duration. This stage is then followed by a coincidence latch which records the pattern of "interesting signals" that occur within the same time window. The First Level Trigger modules ensure that specific combinations of signals have occurred. (Information on Discriminators and Latches may be found on other ECLine Programmable Logic Data Sheets.)

This first stage of data handling can then either reject the event as uninteresting, or can pass data on for further processing. The more sophisticated line of ECLine Data Handling modules include data conversion, arithmetic operations, fast "do loop" type operations, and specialized pattern recognition/ interpretation. Information on LeCroy Data Handling modules may be found on the Data Handlers technical data sheet. All functions are programmable to provide complete computer control of the triggering and data acquisition systems.

The LeCroy ECLine modules are compatible with the sophisticated FERA (Fast Encoding and Readout ADC) analog and time interval digitizing systems, as well as with the PCOS III Multiwire Proportional Chamber System. For exceptional data rates and on-board event accounting, the ECLine modules are also compatible with the LeCroy FASTBUS Multiple Event Buffer Memory, Model 1892. This compatibility provides a convenient method of storing data from ECLine modules, combining data from ECLine and FASTBUS (IEEE-960) systems, and provides the exceptional speed and data handling capability of the FASTBUS Standard.

### Model 4418 Logic Delay/Fan-Out

Fast, passive logic delays are of prime importance for allowing all signals to arrive simultaneously at a data acquisition module. The LeCroy Model 4418 has 16 passive, tapped delay lines, one for each input. Each delay is individually set by computer via CAMAC in 1, 2 or 4 nsec increments (depending on sub-model or "MOD" selected), over a range of fifteen increments. The selection directs an output to "view" a particular tap on the delay line. For example, this feature would give the user a means of accurately aligning signals in time to compensate for differences in cable lengths.

Deadtimeless operation at speeds up to 100 MHz is assured by using passive delay lines and ECL switches. This feature provides the reliability of cable delays together with the speed and fan-out of ECL circuitry. As an added feature, each output is present three places on the front panel to provide additional fan-out capability. The cost of this device rivals cable delays.

### Model 4504 Flash ADC

Four independent 4-bit (plus overflow) Flash ADC's are incorporated in the Model 4504. The sampling rate is adjustable from 20 to 100 MHz via front-panel control. Alternatively, a front-panel strobe input can be used to externally control the sampling rate.

The 4-bit ECL outputs are accompanied by a strobe output signal to indicate that the outputs are valid. This feature provides a convenient means to strobe subsequent logic (for example, the Model 4508 Programmable Logic Unit) that uses the Flash ADC results. A front-panel VETO input is provided for disabling the unit during periods when no input data can be processed.

The most common use of the 4504 is as a multiple threshold discriminator. The input may be derived directly from the detectors themselves or the analog outputs of other ECLine modules (Model 4532 for example).

### Model 4508 Programmable Lookup Unit

Two independent 8-bit Programmable Lookup Units (PLU's) are included in the Model 4508. Each unit has an 8-bit digital input and an 8-bit digital output. The unit functions as an 8-bit addressable RAM. The contents are pre-programmed via CAMAC by the user. Each 8-bit input is a RAM address, and each 8-bit output is the content of this addressed location.

Output patterns are programmed into the PLU for each of the 256 possible input patterns. This unit can act as a complex logic module, a programmable calibration unit, or it may control the actions of subsequent logic based on the input pattern and programmed lookup table.

Each section of the Model 4508 can operate in one of three modes: Shaped, Overlap or Continuous. In the Shaped Mode, the outputs are a pulse of duration set by a front-panel adjustment. The inputs must be accompanied by a front-panel Strobe input signal. In Overlap Mode, the output pulse width (on all 8 bits) equals the input width if the Strobe input signal arrives

before the input. Finally, in Continuous Mode, the output width reflects the time coincidence between Strobe and the inputs pulses.

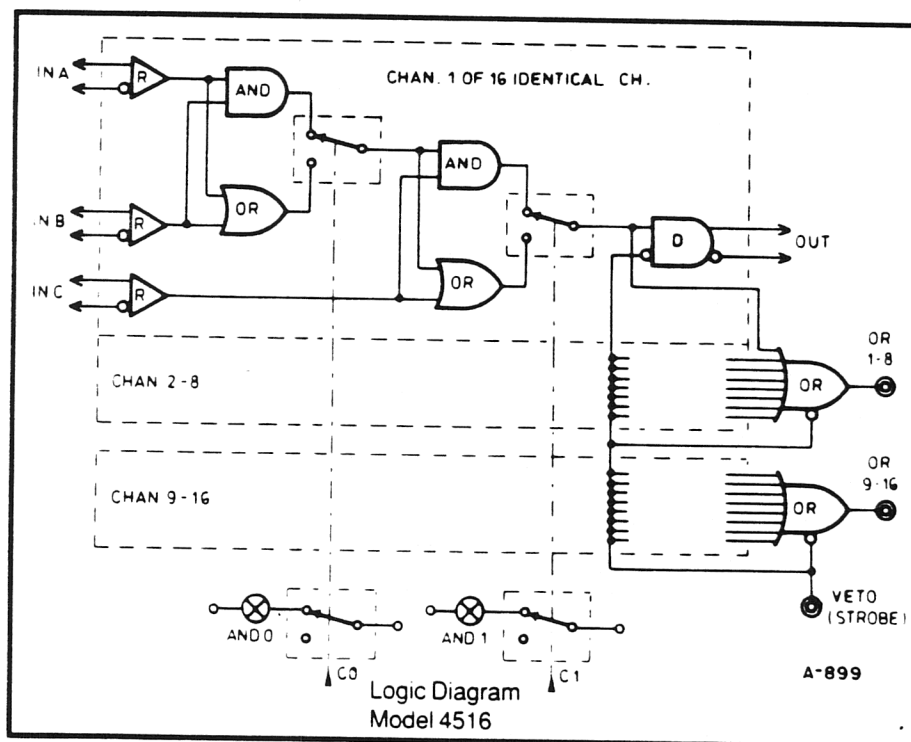
### Model 4516 3-Fold AND/OR Logic Unit

Each of the 16 channels of the Model 4516 has three inputs (A, B and C). All channels have a front-panel output that is one of the Boolean combinations:  $(A \cdot B \cdot C)$ ,  $(A+B) \cdot C$ ,  $(A \cdot B) + C$ , or  $(A+B) + C$ . The choice of logical function, AND ( $\cdot$ ) or OR ( $+$ ), is set for all channels by two switches. These switches are set either by rear-panel manual switch settings or by computer command via CAMAC.

The 150 MHz speed of Model 4516 lends great versatility to this simple module. It can be used as a front-end AND/OR logic module, or an integral component in a higher level trigger processor.

### Model 4532 Majority Logic Unit

Experiments that require a minimum number of signals to be present need a Majority Logic Unit. Each of the 32 inputs of the 4532 that is in a logical 1 state gives an incremental increase in a current sum output. An



onboard discriminator may then be used to signal when a user set current threshold (multiplicity) is exceeded. The current sum of each 4532 is available on two bridged outputs than permit daisy chaining of several modules. This feature extends the useful number of input sums by 32 inputs per daisy-chained module. For dynamic sampling, the analog output may be connected to an input of the Model 4504 Flash ADC. This unit provides a 4-bit digital output useful for trigger processing circuits.

The status of up to 32 inputs can be monitored and recorded by issuing a strobe. Since the inputs are edge-triggered, the strobe may be a gate of arbitrary duration. Then any inputs which are on during any portion of the gate are recorded and stored in a pattern register. The pattern register can then be read by computer via CAMAC. Alternatively, the 4532 can operate in Overlap Mode where the input pattern is not latched, and the outputs follow the inputs dynamically.

Other features of the Model 4532 are fast OR'ing of adjacent inputs, cluster mode operation, and provisions for cascading several 4532s for use in large detector arrays. Sixteen front-panel outputs give a fast OR output of inputs 1 and 2, 3 and 4, etc. These outputs reduce the number of signals that a second level trigger processor must view, while still maintaining a segmented set of signals. Next, in Cluster Mode, the 4532 will assume that adjacent hits indicate a single event and present only a single increment to the current output. This feature is useful in wire chambers where the close wire spacing often results in two or more adjacent wires

giving signals from a single track. Finally, there is a provision for cluster Carry In and Carry Out to permit cascading several modules and permit cluster mode operation across module boundaries.

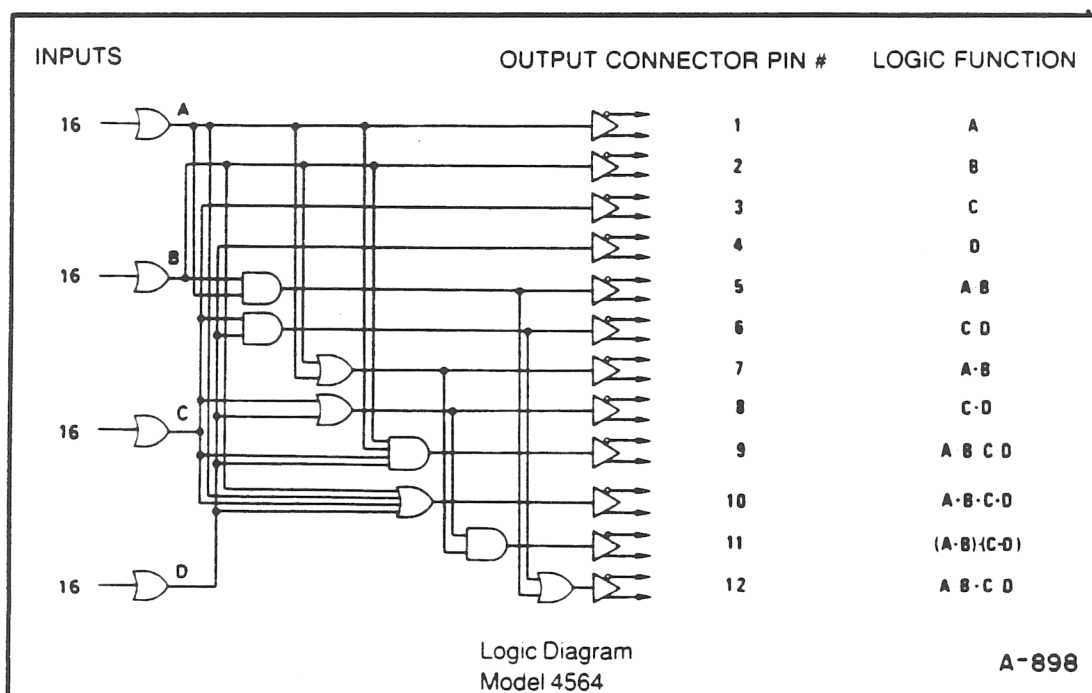
## Model 4564

### 16 to 64 Fold OR Logic Unit

The Model 4564 is a simple and versatile logic module. It consists of four groups (A,B,C and D) of 16 input OR's followed by a set of additional 2 fold and 4 fold OR and AND functions. These various logic outputs, shown pictorially below, are simultaneously available on a rear-panel connector and the transit time is independent of the function. In addition, the outputs are capable of rates in excess of 100 MHz. Output width is dependent on the input pulse overlap.

For greater flexibility, the 4564 also offers four discriminator/ shaper channels. Internal jumpers allow any of the 12 logic combinations to be input to these channels. The output of discriminators/shapers can be triggered on the leading or trailing edge of the input (jumper selectable) and the width is adjustable from 15 nsec to greater than 500 nsec. Output polarity is also selectable via internal switches. These outputs can be used simply as an adjustable width logic fan-out or can allow for more sophisticated functions.

A typical application of the 4564 is to perform a simple track or pattern recognition for Veto or gate applications.



## SPECIFICATIONS

### Model 4418 Programmable Logic Delay Fan-Out

**Inputs:** 16, DC coupled 100  $\Omega$  impedance, on 34-pin header for ECL signals. 100 MHz maximum rate (>35 MHz for Long Range Option), <10 nsec double pulse resolution (<30 nsec for long range option). Minimum width: 5 nsec.

**Delay:** 15-30 nsec in 1 nsec steps (4418/16), 15-45 nsec in 2 nsec steps (4418/32), 15-135 nsec in 8 nsec steps (4418/128): Long Range Option. Delays set by computer for each channel individually.

**Outputs:** Three for each input, on three 34-pin headers, for compatibility with complementary ECL devices. Width equal to input duration  $\pm 1.2$  nsec ( $\pm 4$  nsec Long Range Option). Risetime and falltime: 2.5 nsec.

**Battery Back-Up:** Preserves stored delays for at least 2 hours in the event of power loss.

**Crosstalk:** Synchronous pulses in adjacent channels can be affected by  $\pm 1$  nsec typically.

**Power:** +6 V/50 mA, -6 V/2.5 A (15.3 W total)

### Model 4504 Flash ADC

**Inputs:** Four on coaxial connectors, 50  $\Omega$  impedance, 10 nsec minimum width. Analog input range user defined between -2.5 V and +2.5 V. Range, set by computer command by giving low and high voltage reference levels, is divided by 15 to obtain resolution (4 bits).

**Strobe:** One ECL input for external strobe selected by front-panel switch. Leading edge initiates digitizing of all four inputs simultaneously; falling edge transfers digitized values to outputs and holds until next strobe. Maximum frequency 100 MHz. Alternate switch setting provides internal 20 MHz-100 MHz free-running strobe. Internal strobe frequency set by front-panel adjustment.

**Veto:** One ECL input inhibits strobe signal.

**Outputs:** Four, 4-bit ECL outputs on 8-pin headers. Overflow bits provided on 4 two-pin headers.

**Strobe Out:** Two on two-pin headers (ECL pulses) and two on Lemo connectors (-600 mV pulses) timed with digital outputs for downstream logic. Width is adjustable by front-panel potentiometer in the range of 5 to 25 nsec.

**Test Points:** Two front-panel test points permit measurement of voltage reference levels.

**Input-Output Delay:** Strobe trailing edge to digital outputs, typically 15 nsec.

**Power:** +6 V/1.1 A, -6 V/1.5 A, +24 V/6 mA (15.7 W total)

### Model 4508 Memory Lookup Unit

**Inputs:** Two, 8-bit inputs on 34-pin header. 100  $\Omega$  for complementary ECL. Minimum width 10 nsec, maximum rate 65 MHz.

**Strobe:** Two on Lemo connectors, one per input section, 50  $\Omega$  impedance. Requires -600 mV signal, 5 nsec minimum width and must precede input by 2 nsec for exact time coincidence. Latches inputs, except in overlap mode. Maximum frequency >65 MHz. Strobe must be followed by clear except in Overlap Mode.

**Clear:** Two on Lemo connectors, one per input section, 50  $\Omega$  impedance. Requires -600 mV signal, 5 nsec minimum width to clear. Clears pattern register and resets outputs in all modes.

**Outputs:** Two, 8-bit outputs on 34-pin headers, ECL signals. Width of output in Shaped mode set by front-panel adjustment between <5 nsec to >100 nsec.

**Synchro Output:** Two on Lemo connectors, one per output section, 50  $\Omega$  impedance. Supplies -600 mV pulse out when outputs are ready. Typically used for strobing next unit, or for self-clearing.

**Modes:** Overlap (OVL) - Output pulse width determined by coincidence between Inputs and Strobe.

Shaped (SHP) - Output pulse width is determined by a front-panel adjustment from <5 to >100 nsec. The unit must be cleared before another input can be latched.

Continuous (CNT) - Output state is latched by the Strobe, until a Clear is applied.

**Propagation Delay:** (17  $\pm$  3) nsec in Overlap Mode. In other modes (21  $\pm$  1) nsec independent of logic function and determined by Strobe timing.

**Power:** +6 V/0.5 A, -6 V/2.6 A (18.6 W total)

### Model 4516 Programmable Logic Unit

**Inputs:** 16 sets of three inputs, 100  $\Omega$  (high impedance by removal of socketed terminators), DC coupled, on 34-pin headers, for ECL signals, minimum 2 nsec risetime. Maximum rate 150 MHz.

**Veto:** One rear-panel Lemo connector, 50  $\Omega$  impedance. Requires -600 mV signal. Permits gating of outputs, including OR outputs. Must overlap coincidence for the three front-panel inputs by >5 nsec.



**Outputs:** 16, one per set of three inputs, complementary ECL logic levels on 34-pin header.

**OR Out:** Two, one for OR of first 8 outputs, one for second 8 outputs (factory option permits OR'ing of all 16 outputs).

**Double Pulse Resolution:** 5 nsec at minimum input width.

**Coincidence Width:** >3.5 nsec determined by input pulse width.

**Input-Output Delay:** A or B to OUT by 11 nsec typ.; A or B to OR by 12 nsec. typ.; C to OUT by 8 nsec. typ.; C to OR by 9 nsec typ.; VETO to OUT by 8 nsec typ.; VETO to OR by 6 nsec typ.

**Power:** +6 V/50 mA, -6 V/1.25 A (7.8 W total)

## Model 4532 Majority Logic Unit

**Input:** All inputs accept differential ECL level (-0.8 V, -1.7 V) into 110  $\Omega$  input impedance (high input impedance is possible by removing socket-mounted terminators).

**Data Input (IN):** 32 in two 34-pin front-panel connectors; minimum input pulse width 6 nsec.

**Reset Input (RTI):** Fast reset of the input registers; generates a reset of the analog majority output and of the comparator outputs (MDO, DMO). When the analog output is cascaded with other units, the RTI resets only the contribution from the modules that received the RTI. Minimum input pulse width 6 nsec, maximum width DC. In Memory Disable mode, the RTI is inhibited.

**Gate Input (GAI):** Normally open when unconnected. Normally closed when connected to a cable providing standard ECL levels. In Memory Disable Mode, data pulses having an overlap with the GAI will contribute to the outputs. In Memory Enable Mode, data pulses having their leading edge inside the GAI time will be accepted and stored. By deriving the GAI from the DMO, an internally generated time window is possible. Minimum overlap time width with input pulses for majority decisions, 10 nsec. Minimum overlap time width with input pulses for logical OR's, 3 nsec, maximum width DC.

**Cluster Carry (CCI):** When Cluster Selection is Enabled, receives the carry information on the cluster from the Cluster Carry Output (CCO) of any adjacent majority logic unit.

**Analog Majority Inpt/Output (AMIO):** High impedance current source; AMIO connectors can be used for daisy chaining of analog majority information within a unit. Transit time between AMIO connectors 2 nsec. Unused output must be terminated with 50  $\Omega$ .

**Output:** All logic outputs provide complementary ECL levels (-0.8 V, -1.7 V) and are capable of driving differential 110  $\Omega$  loads.

**Data Outputs (OUT):** 16 in a 34 pin front-panel connector. In Memory Disable Mode, provides pulses corresponding to an overlap coincidence between the gate pulse and the data inputs. In Memory Enable Mode, provides levels started by the coincidence between the gate pulse and the leading edge of the data pulses.

**OR Output (ORO):** Provides the logical OR of the 32 channels, otherwise behaves as data outputs.

**Strobe Output (STO):** Provides a pulse, suitable for strobing of subsequent logic units, at the end of the gate input and delayed by the internal transit time (6 nsec). Width adjustable from 10 to 25 nsec by a trimmer (STROBE WIDTH) accessible from the side of the module.

**Majority Discriminated Output (MDO):** The AMIO input/output is internally used as input to an adjustable threshold comparator providing the MDO output. Threshold adjustable from 1 to 16 hits by a front-panel potentiometer (MA THR). The output will be a pulse or a level depending on the selected operating mode.

**Delayed Majority Output (DMO):** Reproduces the output MDO above, after an adjustable delay. A switch on the side of the module (DM RANGE) selects one of two delay ranges: 10-100 nsec or 50-1000 nsec. A front-panel potentiometer (DMO DELAY RANGE) permits continuous adjustment. The DMO is cleared as soon as the MDO is cleared.

**Cluster Carry (CCO):** When Cluster Selection is Enabled, indicates that Output channel 32 was hit for use in conjunction with channel 1 of a logically adjacent cluster logic in another 4532 module (CCI) input.

**Mode Selection:** A Memory Enable switch, accessible on the side of the module, selects one of the following modes: Memory Disable - Functions are disabled; the multiplicity calculation is performed on the overlap of the data inputs. Memory Enable - The data inputs are latched; the multiplicity is determined by the number of leading edges of data input pulses occurring during the gate time. In this mode the unit needs to be cleared either by the reset input (RTI) or by a resetting function.

**Cluster Slection:** The Cluster Enable switch, accessible on the side of the module, determines one of the two following modes: Cluster Disable - Each data input provides one hit on the Analog Majority Output AMIO; the Cluster Carry Input (CCI) is disabled. Cluster Enable - Any group of adjacent input data pulses will be considered as a single hit. Provision has been made for the clusters to extend beyond the 32 inputs. If an input is present on the logically adjacent channel to input 1 of this unit but is located in another unit, the CCI can be used to indicate its presence. The CCO of this module indicates that channel 32 of this module is present.



**Input-Output Delay:** Data IN to AMIO - 16 nsec; AMIO to MDO output - 5 nsec; End of gate IN to Strobe OUT by 6 nsec; Data IN to Data OUT by 12 nsec; Data IN to OR OUT by 16 nsec; Reset IN to Data OUT by 20 nsec; Reset IN to OR OUT by 24 nsec; Data IN 32 to Cluster Carry OUT by 11 nsec; Cluster Carry IN to Data IN 1 by 2 nsec. Gate pulse must precede Data pulse by at least 7 nsec.

**Power:** +6 V/200 mA, -6 V/<3.6 A, +24 V/5 mA, -24 V/7 mA (23 W total).

### Model 4564 16 to 64 Fold OR Logic Unit

**Inputs:** 64 in four 2 x 17 front-panel connectors, 110  $\Omega$  impedance. Minimum width 6 nsec, maximum frequency >100 MHz.

**Overlap Outputs:** Rear-panel 2 x 17 pin connector, pins 1 to 12. ECL signals. Width corresponds to overlap ( $\pm 2$  nsec) of inputs of logic function. minimum output 5 nsec, maximum output frequency >100 MHz; transit time 12 nsec  $\pm 1$  nsec typical. independent of logic function; double pulse resolution 10 nsec typical.

**Shaped Outputs:** Rear-panel connector pins 13 to 16, any of overlap logic can be converted via jumper option to any of the four discriminator/shapers, output is differential ECL levels and width is internally adjustable from 15 to >500 nsec, can be triggered in leading or trailing edge of inputs (jumper selectable); output polarity internally switch selectable; maximum frequency: 30 MHz, double pulse resolution: 33 nsec.

**Power:** +6 V/150 mA, -6 V/1.5 A, -24 V/20 mA (10.4 W total)

## CAMAC COMMANDS, FUNCTION CODES AND RESPONSES

### Model 4418 Programmable Logic Delay/Fan-Out

F16•(A0 to A15): Load delay time setting on write lines W1 to W4. One subaddress for each channel.

X, Q: An X and Q response are generated when a valid N, A, F command is recognized.

### Model 4504 Flash ADC

F(0)•A(0): Read digital outputs; R1 to R16, 4 bits per channel.

F(0)•A(1): Read digital overflow, R1 to R4, 1-bit per channel.

F(16)•A(0): Write Low Reference Voltage (VL) on 8 bits; range from -2550 mV to +2250 mV in steps of 20 mV.

F(16)•A(1): Same as above but for the High Reference Voltage (VH).

F(25)•A(0,1): Equivalent to C.

C: Generates a strobe during S2 time. This function is not affected by I or VETO input and may be disabled by a side-panel switch. The digital outputs will be set depending on the analog value of the inputs; in particular, if the inputs are disconnected all the digital outputs will correspond to 0 V at the inputs. The output logic state will be determined by the VL and VH reference voltages.

I: Inhibit strobe.

X, Q: X=1 and Q=1 responses are generated for any of the above functions.

### Model 4508 Programmable Lookup Unit

F(0)•A(0): Read first section 8-bit input pattern.

F(0)•A(1): Read second section 8-bit pattern.

F(0)•A(2): Read first section memory content at the given address; the memory content is displayed on read lines R1-R8, the given address on read lines R9-R16.

F(0)•A(3): As F(0)•A(2) but for the second section.

F(2)•A(0): Read first section 8-bit pattern and reset at S2; reset output levels when operating in continuous mode.

F(2)•A(1): Same as F(2)•A(0), but for the second section.

F(2)•A(2): Read first section memory content at the given address (as for F(0)•A(2)) and increment address by one at S2.

F(2)•A(3): Same as F(2)•A(2), but for the second section.

F(9)•A(0): Clear first section pattern; reset first section output levels when operating in continuous mode.

F(9)•A(1): As above, but for the second section.

F(9)•A(2) or

F(9)•A(3): Reset memory address in both sections.

F(16)•A(0): Load first section memory content at the given address; data have to be sent on write lines W1-W8;  
 F(16)•A(1): As above, but for the second section.  
 F(16)•A(2): Random access to the first section memory (the selected address has to be sent on write lines W9-W16); load memory content with data present on W1-W8, at the selected address.  
 F(16)•A(3): Same as above, but for the second section.  
 F(18)•A(0): Load first section memory content, at the given address, with data present on W1-W8; increment address by 1.  
 F(18)•A(1): As above, but for the second section.  
 F(18)•A(2) or  
 F(18)•A(3): Load the memory's address register (this address has to be sent on write lines W9-W16).  
 Z or C: The address register for the memories of both sections is set to 0; pattern registers are cleared.  
 X: An X=1 response is generated for any valid CAMAC function.  
 Q: A Q=1 response is generated for any valid CAMAC function, except when the memory addresses overflow. (This latter feature permits one to recognize when the reading or the loading of a memory has been completed).

### Model 4516 Programmable Logic Unit

F(26)•A(0): Sets all C0's to AND Mode.  
 F(24)•A(0): Sets all C0's to OR Mode.  
 F(26)•A(1): Sets all C1's to AND Mode.  
 F(24)•A(1): Sets all C1's to OR Mode.  
 F(27)•A(0): Gives a Q response if C0 switch is in AND Mode.  
 F(27)•A(1): Gives a Q response if C1 switch is in AND Mode.  
 X: An X response is generated when a valid N, A, F command is recognized.  
 Z: Sets all channels to OR Mode.

### Model 4532 Majority Logic Unit

F(0)•A(0), A(1): Read input pattern. A(0): channels 1 to 16. A(1): channels 17 to 32. A Q response is generated in Memory Enable Mode only.  
 F(1)•A(0): Read status register; R1 = 1 if LAM is ON; R2 = 1 if LAM Enable switch is ON; R3 = 1 if MEMORY Enable switch is ON; R4 = 1 if CLUSTER Enable switch is ON. Q response is always generated.  
 F(2)•A(0): Read input pattern, channels 1 to 16. Q response is generated in Memory Enable Mode only.  
 F(2)•A(1): Read input pattern, channels 17 to 32, and clears the 32-channel memory and LAM at S2. Q response is generated in Memory Enable Mode only.  
 F(8)•A(0): Test LAM; a Q response is generated if L is ON.  
 F(9)•A(0): Clears the data memory and LAM.  
 F(10)•A(0): Test and clear LAM, clears LAM. Q response is generated if L is ON. The clear LAM operation is not executed if Q response is missing.  
 Z, C: Clears data memory and LAM.  
 L: A Look-At-Me signal is generated (in Memory Enable Mode only) at the end of the gate input if the OR output is set. The LAM may be enabled or disabled by the LAM enable switch accessible on the side of the module.  
 X: An X=1 response is generated for any executable function.  
 Q: A Q=1 response is generated for any executable function in Memory Enable Mode only.

**Model 4564 OR Logic Unit** - The Model 4564 does not utilize CAMAC Commands or Function Codes.

## INTRODUCTION

The CAMAC Model 4516 is a logic unit characterised by high density, programmability and high speed operation. Its particular design makes the unit flexible for a large variety of applications, some of which will be discussed later. The unit is conceived as sixteen identical channels each of them accepting three inputs and providing one output.

Programmability concerns the possibility of selecting the logic function required on the three inputs, out of any combination of AND and OR.

The bloc diagram in the following figure, shows the principle of the circuit.

The output of each channel can be vetoed (or strobed) by a common pulse. The 16 outputs are also grouped in groups of height to build two eightfold OR which, also can be strobed by the general strobe pulse.



## CIRCUIT DESCRIPTION

Looking at the detailed circuit diagram, the following should be noted.

The differential ECL input pulses are terminated on  $2 \times 56 \Omega$  resistors. This termination is mounted on SIL sockets and it is easily removed if high input impedance is desired.

The input pulses are then accepted by a line receiver 10115, the output of which goes, through a  $110 \Omega$  resistor, to a  $220 \Omega$  termination, before entering the next line receiver. The point between the  $110 \Omega$  and  $220 \Omega$  resistors is where channels A and B meet together. The voltage drop on the  $220 \Omega$  resistor will then be proportional to the number of coincident inputs. That is, the voltage drop, when both the A and B channels are receiving a pulse, will be twice as much as if only channel A or channel B were receiving a pulse.

The discrimination at the level of the second line receiver (for instance IC 20 for the first logic channel) will allow then the choice between an AND function and an OR function.

The discrimination level is applied for instance on pin 13 of IC20. The level is generated by an operational amplifier (IC 27) sensible in input to a voltage level correlated to a TTL logic level COR 0. The latter can be generated either by manual operation (rear panel three position switch), or by remote control through the CAMAC functions  $F(26)*A(0)$  for AND mode and  $F(24)*A(0)$  for OR mode.

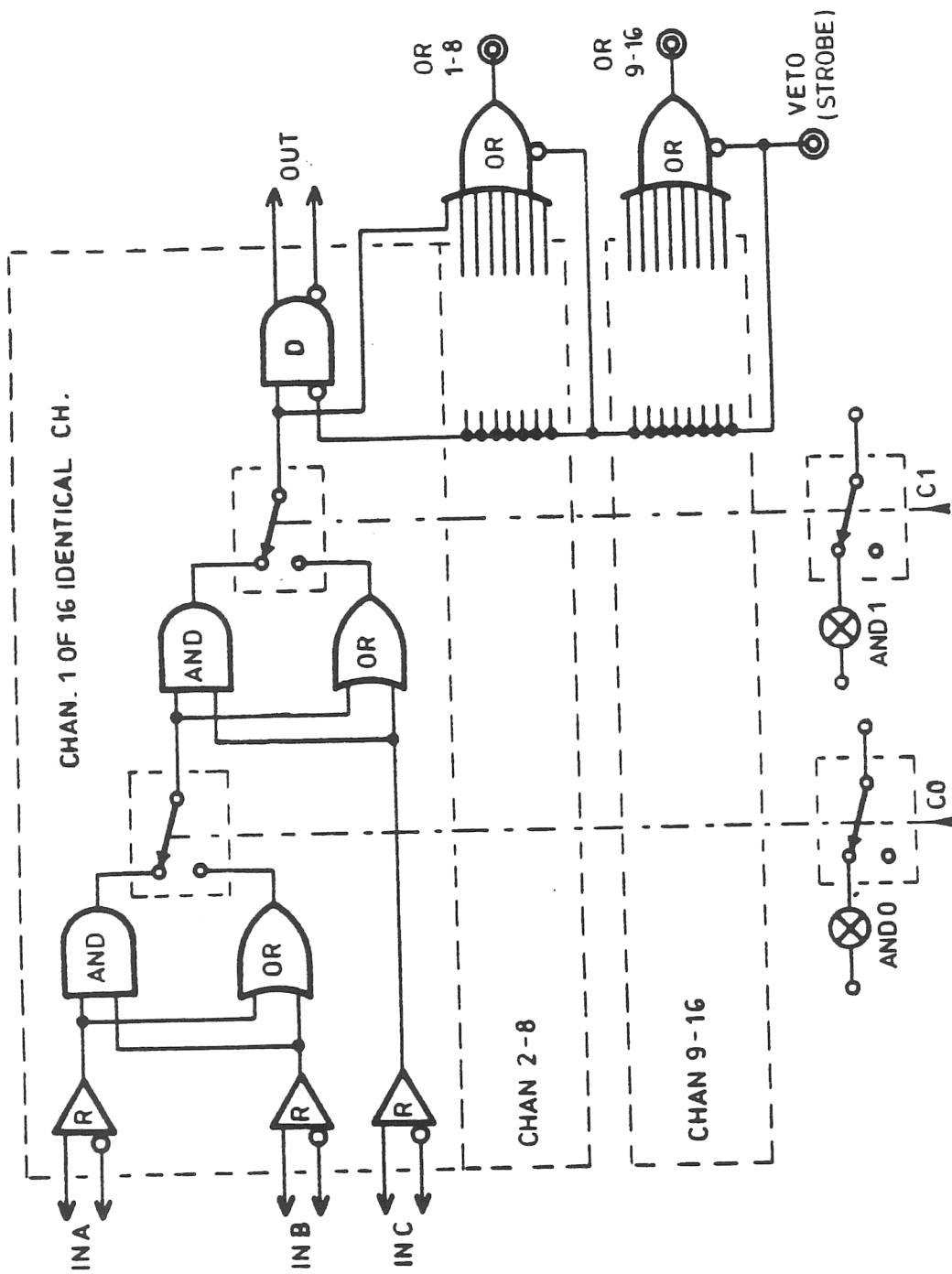
The same arguments apply for the second level of logic between C and (A,B). The discrimination between AND and OR is performed for instance on IC 26. The logic level COR 1 determines which logic function has to be performed.

Also COR 1 can be generated either by manual operation or by CAMAC functions  $F(26)*A(1)$  for AND mode and  $F(24)*A(1)$  for OR mode.

For each of the two levels of logic, the AND operation is marked out by the firing of a front panel LED, as well as by a  $Q=1$  response to a CAMAC  $F(24)*A(0)$  ( $*A(1)$ ).

The output of the second level of logic (for instance the output of IC 26) is sent on one side to a line transmitter 10101 generating the final output, on the other side to a diode matrix building up a general OR over eight channels.

An eventual veto input will act either on the two general OR outputs as well as on the single channel outputs. The veto will be effective during the time in which it is overlapped with the outputs. On the contrary, a complementary NIM signal applied to the veto input will act as a strobe.

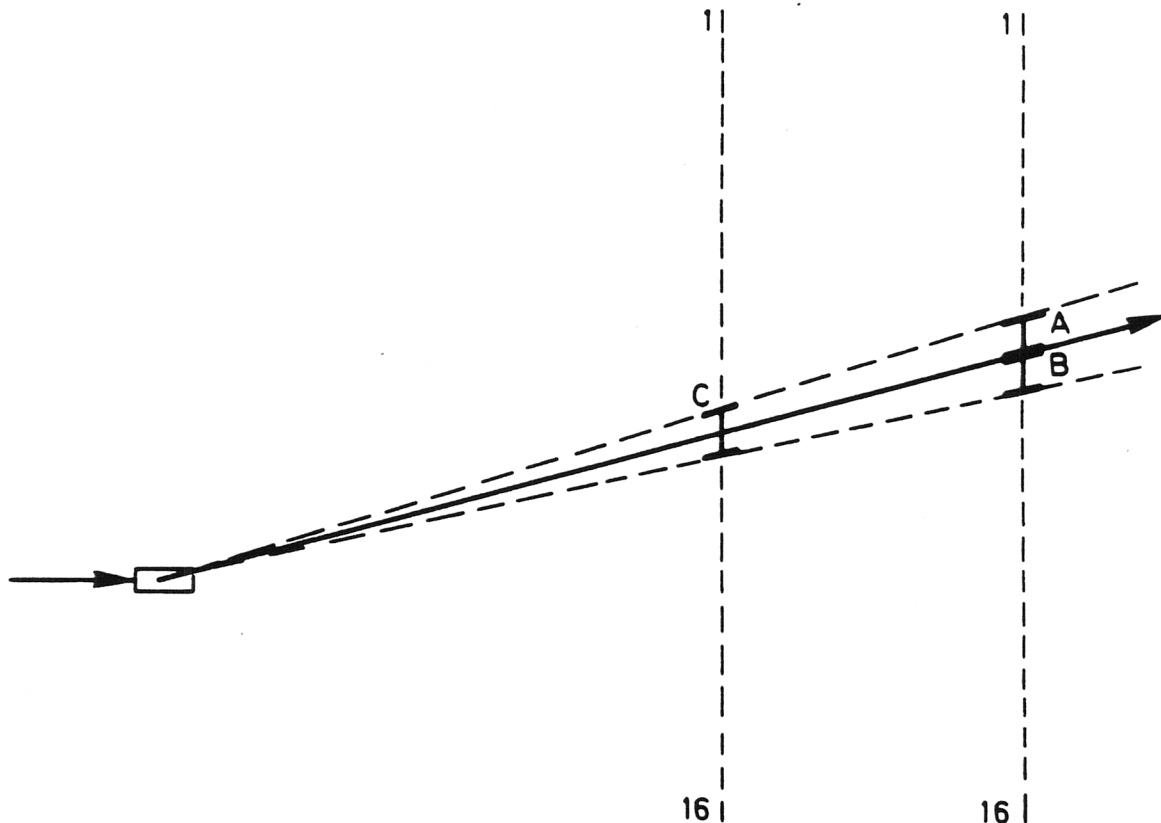


## APPLICATIONS

The idea which is at the base of the 4516 is to have a logic element, one channel of 4516, which is intrinsically simple and flexible so that it can be used as a building bloc for any kind of more complicate logic.

So the application of the module is in principle everywhere a logic problem is present. In particular the circuit can also be used to build large OR's up to 24 inputs. Two of this OR's are housed in the same 4516.

Another typical application of the 4516 is for coincidence matrices.



Looking at the figure let's suppose to have two hodoscope planes and that a trigger is required when the two planes are traversed by a particle originated from the target.

Let's also suppose that the shadow of each counter A of the first hodoscope, projected from the target, covers two counters, B and C, of the second hodoscope. A good particle is defined by the logic function  $(A \text{ OR } B) \text{ AND } C$ , which is exactly what each section of 4516 is able to do. A single 4516 covers completely the needs in the example shown. The two OR outputs could give for instance two separate triggers for the upper and lower solid angle. On customer request, the two OR outputs can also be cabled in order to give both a general OR over all inputs, that is over 48 inputs.



## POSSIBILITY OF CASCADING MODULES

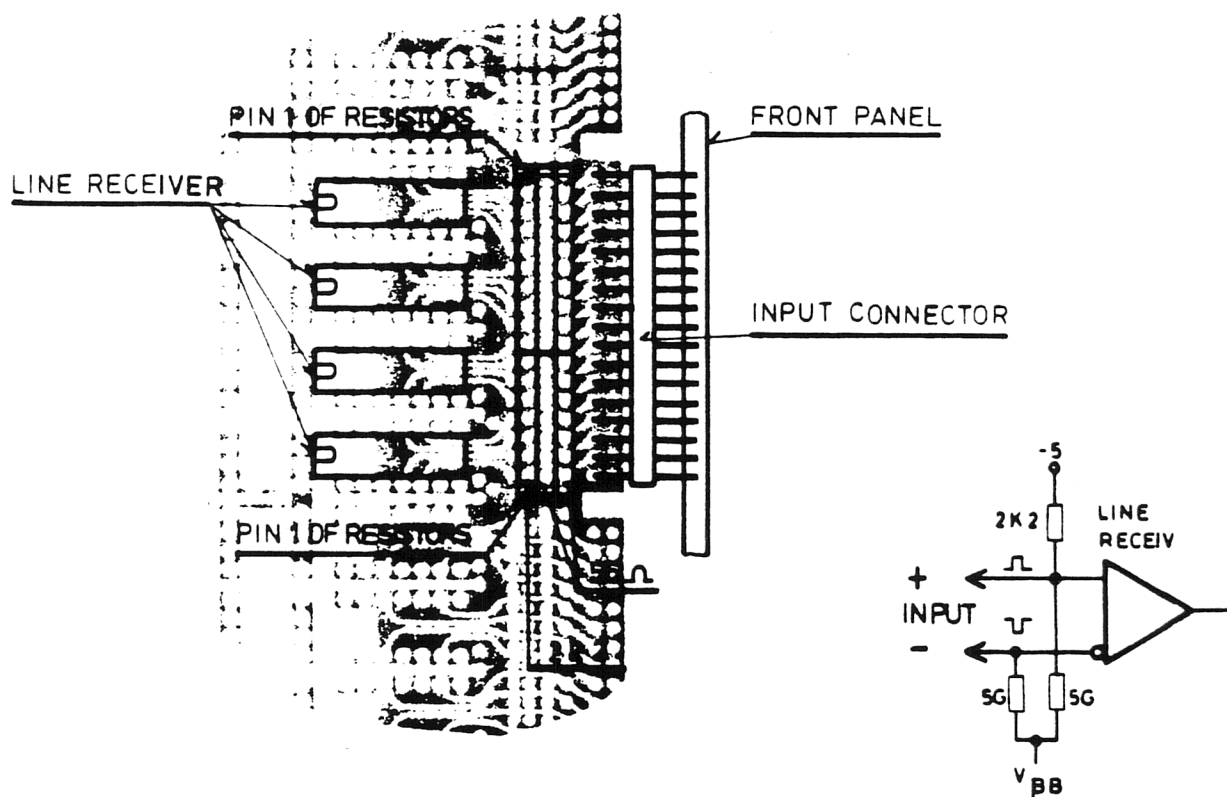
All differential ECL inputs, in ECLine modules, are terminated inside the module by two 50 ohms resistors to VBB, realizing a differential matching impedance of 112 ohms.

The input terminations are included in socket mounted, single in line resistor arrays, which can be removed if more than one unit have to be cascaded on the same driving cable. In this case, only the last unit in the daisy chain must be terminated for proper operation. (For more details see also the ECLine Application Note).

Figures below show the standard input stage of an ECLine module and the lay-out on the board.

WARNING : The resistor arrays are not symmetrical and they must be mounted in the proper way.

## LOCATION OF INPUT TERMINATOR



## ECL CABLES

Interconnections between different ECLine modules, for transmission of different ECL pulse pairs, can be made either by multiwire cables or by single twisted pair cables for one to one connections.

Such interconnecting cables can be purchased by LeCROY and in particular, as multiwire cables, two types are available, one for short connections using just flat cable, the second one for long interconnections using twisted and flat ribbon cable.

The denomination of such cables is as follows :

- STC-DC/34-LL            Multiwire cable for short interconnections
- LTC-DC/34-LL            Multiwire cable for long interconnections
- STP-DC/02-LL           Single twisted pair cable.

Where LL is the cable length in feet which should be specified by the customer.

TECHNICAL INFORMATION  
(SCHEMATICS, PARTS LISTS)



PART NUMBER	DESCRIPTION	QUANTITY PER
103307103	CAP CERA MONO 50V .01 UF	41
142824685	CAP TANT DIP CASE 6.8 UF	7
161030000	RES COMP ZERO OHMS	4
161335102	RES CARBON FILM 1 K	6
161335103	RES CARBON FILM 10 K	6
161335111	RES CARBON FILM 110 OHMS	64
161335132	RES CARBON FILM 1.3 K	2
161335151	RES CARBON FILM 150 OHMS	1
161335201	RES CARBON FILM 200 OHMS	2
161335202	RES CARBON FILM 2 K	3
161335220	RES CARBON FILM 22 OHMS	6
161335221	RES CARBON FILM 220 OHMS	36
161335241	RES CARBON FILM 240 OHMS	2
161335331	RES CARBON FILM 330 OHMS	2
161335470	RES CARBON FILM 47 OHMS	3
161335471	RES CARBON FILM 470 OHMS	16
161335510	RES CARBON FILM 51 OHMS	3
161335512	RES CARBON FILM 5.1 K	2
161335621	RES CARBON FILM 620 OHMS	2
161335681	RES CARBON FILM 680 OHMS	2
161335821	RES CARBON FILM 820 OHMS	1
181457102	RES VARI CERMET 1 K	2
181457502	RES VARI CERMET 5 K	2
190042222	RESISTOR NETWORK 2.2 K	3
190042471	RESISTOR NETWORK 470 OHMS	2
190042560	RESISTOR NETWORK 56 OHMS	6
190842222	RESISTOR NETWORK 2.2 K	3
190842471	RESISTOR NETWORK 470 OHMS	2
190842560	RESISTOR NETWORK 56 OHMS	6
200031033	IC 2-INPUT NAND SN7403N	1
200031047	IC 3-INPUT NAND SN74LS10N	1
200031049	IC D-TYP FLOP SN74LS74N	1
200031051	IC 2-INPUT NOR SN74LS02N	1
200031057	IC 3-INPUT NOR SN74LS27N	1
200031077	IC 3-INPUT AND SN74LS11N	1
200041062	IC DEC/DEMULTP SN74LS138N	1
204042003	IC LINE RECEIVER MC10115P	16
204042011	IC LINE RECEIVER MC10116P	6
204042016	IC 2-INPUT OR/NOR F10101P	4
208011007	IC DUAL OP AMP LM358N	1
230110005	DIODE SWITCHING 1N4448	1
235010005	DIODE RECTIFIER 1N4005	1
235050001	DIODE RECTIFIER 1N4139	1
253010800	DIODE HOT CARRIER HP2800	2
253010835	DIODE HOT CARRIER HP2835	22
256233209	DIODE LED RED MV5075C	2
270130401	TRANSISTOR NPN A401	4
275170002	TRANSISTOR PNP 2N5771	4
300020001	BEAD SHIELDING "1/2" SIZE	26
300050001	CHOKE FERRITE SINGLE LEAD	2
402130001	CONN LEMO RT ANGLE PC MTG	3
403119234	HEADER RT ANGLE 34-PIN	4
405812002	SOCKET STRIP SOLDR 20 POS	9
409152200	SWITCH TOGGLE PC MTG SPDT	2



FIS/NCA V4.3A  
ZZBPSS.NCA;  
ZZIPMS.NCA;

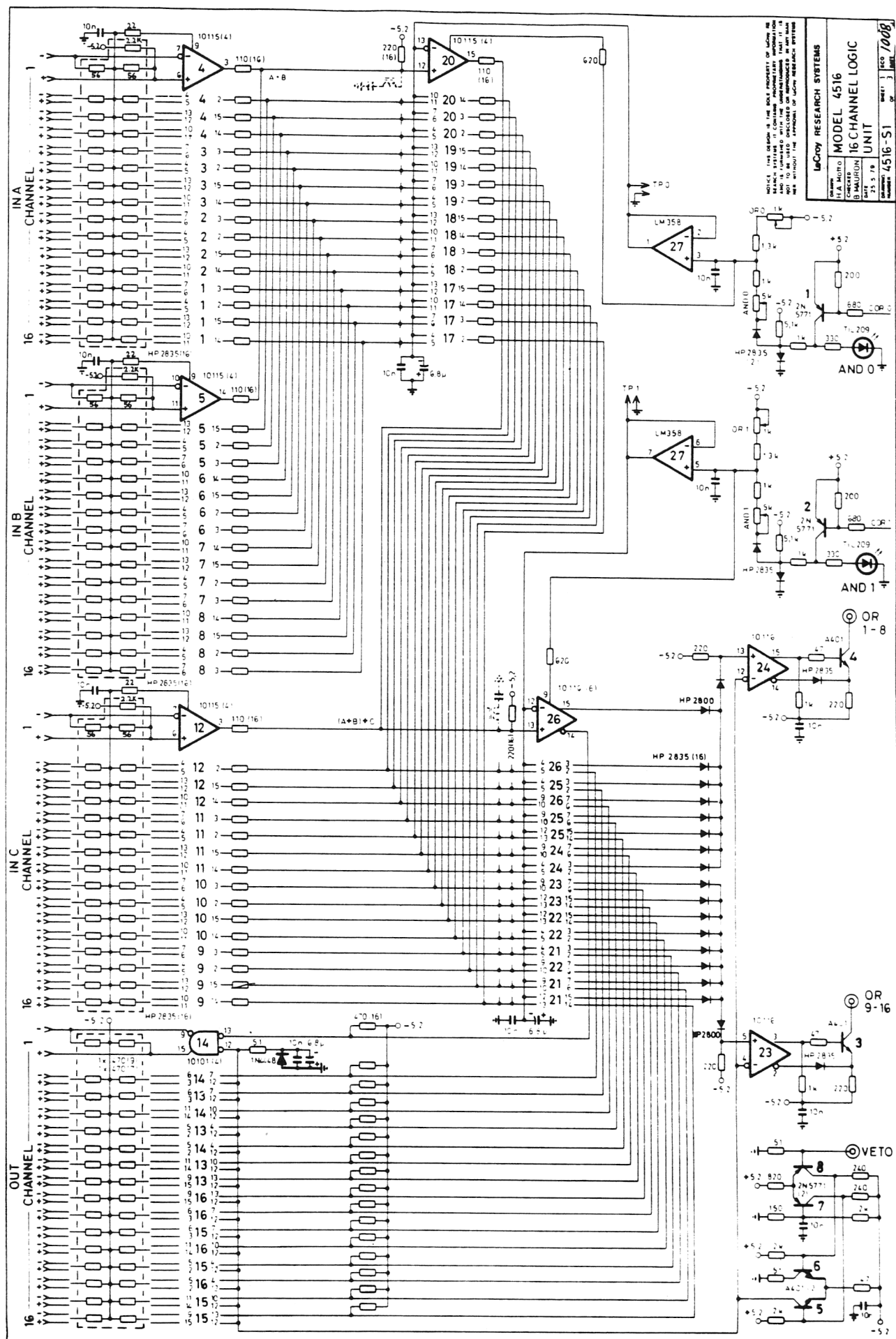
LECROY CORPORATION  
4516 PARTS LIST

PART NUMBER	DESCRIPTION	QUANTITY PER
433220002	FUSE PICO II 125V 3 AMP	1
433221004	FUSE PICO II 125V 1 AMP	1
454310002	HDR DIP SOLD TO PC BD 2	4
500110001	TRANSIPAD "SMALL"	4
521000004	SPACER HEX 2-56X.417	4
540203001	SIDE COVER CAMAC STD(LIP)	1
540206078	RAIL CAMAC STD TOP W/LIP	1
540206178	RAIL CAMAC STD BOT W/LIP	1
540209001	REAR PANEL CAMAC SIZE #1	1
555430003	CAPTIVE SCREW ASSEMBLY	1
560256005	SCREW PHILIPS 2-56X5/16	4
560440003	SCREW PHILIPS 4-40X3/16	4
564440004	SCREW ROUND PHIL 4-40X1/4	2
567440006	SCREW FLAT PHIL 4-40X3/8	2
568256002	SCREW FLAT PHIL 2-56X1/8	4
714516003	PC BD PREASS'Y 4516	1
724516003	FRONT PNL PREASS'Y 4516	1
734516003	SIDE CAMAC LEFT 4516	1
794516003	REAR PNL REASS'Y 4516	1

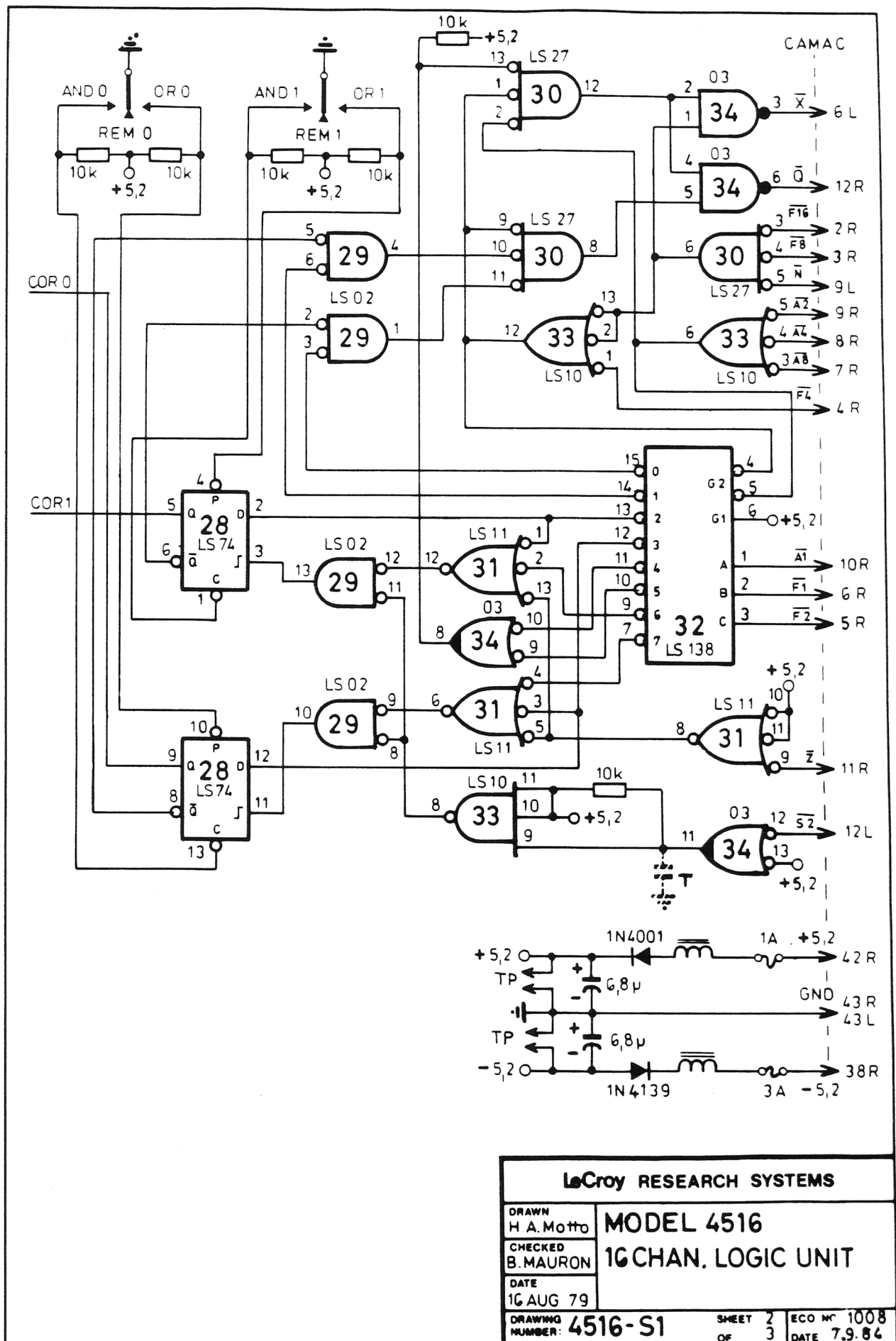
End of report. 73 Details encountered.














Le Croy	I.C.	Designation	GND		-5,2	+5,2
204 042 003	10115	1,2,3,4,5,6,7,8,9,10,11,12, 17,18,19,20	10	1	8	
204 042 016	10101	13,14,15,16	16	1	8	
204 042 011	10116	21,22,23,24,25,26	16	1	8	
208 011 007	LM 358	27			4	8
200 031 049	74 LS 74	28	7			14
200 031 051	74 LS 02	29	7			14
200 031 057	74 LS 27	30	7			14
200 031 077	74 LS 11	31	7			14
200 041 062	74 LS 138	32	8			16
200 031 047	74 LS 10	33	7			14
200 031 033	7403	34	7			14

NOTICE THIS DESIGN IS THE SOLE PROPERTY OF LeCROY CORPORATION. IT CONTAINS PROPRIETARY INFORMATION AND IS FURNISHED WITH THE UNDERSTANDING THAT IT IS NOT TO BE USED, DISCLOSED OR REPRODUCED IN ANY MANNER WITHOUT THE APPROVAL OF LeCROY CORPORATION.

### LeCroy RESEARCH SYSTEMS

DRAWN  
H A Motto  
CHECKED  
B MAURON  
DATE  
16 AUG 79  
DRAWING  
NUMBER

**MODEL 4516**  
**16 CHANNEL LOGIC**  
**UNIT**

**4516-S1**

SHEET 3  
OF 3

ECO N° 1008  
DATE 7.9.84

