technical information manual

NIM MODEL 428A & 428F

QUAD LINEAR
FAN-IN/FAN-OUT

WARRANTY

All LRS instruments are guaranteed to operate within their specifications for one year from the date of purchase. Under this warranty, any unit which fails to perform within specifications, as a result of defects in workmanship or materials, will be restored to specified operating condition free of charge except for shipping costs involved in the return of the unit to the factory.

In order that this warranty be considered valid, it is necessary that the LRS Warranty Card which accompanies the unit on delivery be completed and returned to the factory within 30 days of receipt of equipment.

All questions concerning repairs or replacement parts should be addressed directly to factory's Quality Control Manager. This procedure will insure the fastest possible service. Please include the Model Type, Serial Number, and ECN (Engineering Change Number) with all requests for parts or service.

ENGINEERING DEPARTMENT
LeCroy Research Systems Corp.
Spring Valley, New York

NOTE TO THE USER

LeCroy Research Systems is committed to providing unique, reliable, state-of-the-art instrumentation in the field of high-speed data acquisition and processing. Because of this commitment, and in response to information received from the users of our equipment, the Engineering Department at LeCroy is continually seeking to refine and improve the performance of our products.

While the actual physical modifications or changes necessary to improve a model's operation can be implemented quite rapidly, the corrected documentation associated with the unit usually requires more time to produce. Consequently, this manual may not agree in every detail with the accompanying unit. There may be small discrepancies that were brought about by customer-prompted engineering changes or by changes determined during calibration in our Test Department. These differences usually are changes in the values of components for the purposes of pulse shape, timing, offset, etc., and only rarely include minor logic changes. Where any such inconsistencies exist, please be assured that the unit is correct and incorporates the most up-to-date circuitry. Whenever original discrepancies exist, fully updated documentation should be available upon your request within a month after your receipt of the unit.

If you have any questions about the performance or operation of this unit, rapid assistance may be obtained from our Engineering Services Department in Spring Valley, NY, telephone 914-425-2000, or from your local distributor in countries other than the U.S.A.

LeCROY RESEARCH SYSTEMS

SHORT FORM MANUAL

BECAUSE OF THE SIMPLICITY OF THE CIRCUIT AND FUNCTIONS OF THIS LECROY MODEL, THE INCLUDED SCHEMATIC AND SPEC SHEET SHOULD BE ALL THAT IS REQUIRED FOR OPERATION.

IF YOU NEED ANY ADDITIONAL INFORMATION, PLEASE CONTACT LECROY ENGINEERING DEPARTMENT.

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See pocket in back of manual for schematics, parts lists, and additional addenda with any changes to manual.

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TECHNICAL DATA

LeCroy RESEARCH SYSTEMS

NIM Model 428F

Quad Linear Fan-In/Fan-Out

The LeCroy Model 428F Quad Linear Fan-In/Fan-Out combines the functions of two previously separate LeCroy linear circuits in one compact unit. Each of the Model 428F's four channels contains 4 direct-coupled linear bipolar inputs, a polarity inversion switch, and four direct-coupled linear outputs. The bipolar inputs, together with the polarity switch, allow convenient summing of either anode or dynode pulses. An output swing of +100 mV to −2 volts is compatible with all normal analog inputs (e.g., discriminators, ADC's, etc.) and also accommodates standard logic levels. Each of the Model 428F's inputs is provided LeCroy high-risk input protection circuitry which gives immunity to transient signals up to ±5 A for 0.5 microsecond.

The incorporation of the polarity switch is particularly significant in that it enables convenient, direct use of the fanned-out dynode signals for multiple fast logic decisions, while the anode signal can be directly applied to a current-integrating ADC.

All outputs are reverse-terminated and mutually isolated. The Model 428F utilizes a direct-coupled feedback-stabilized circuit design that provides excellent linearity, long-term stability, and uniformity of gain and pulse shape. The speed of the unit is suitable for all common photomultiplier and logic signals, and there are no duty cycle limitations or rate effects in the Normal Mode.

In the Inverting Mode, the Model 428F operates as a capacitively-coupled unit with a 400 μsec time constant, recovering to the average non-inverted DC input level. In addition, the Model 428F exhibits duty-factor-related baseline shifts equal to twice that of a normal AC-coupled circuit. Thus, although the Inverting Mode provides great versatility and convenience in application, some care must be exercised when using this mode with wide inputs or at high rates.

The Model 428F is packaged in a standard NIM #1 width module and utilizes ±12 V, ±24 V at little enough current to permit the use of 12 modules (48 channels) in a standard NIM power bin.

October, 1977

Innovators in Instrumentation

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SPECIFICATIONS
NIM Model 428F
QUAD LINEAR FAN-IN/FAN-OUT

INPUT CHARACTERISTICS

Number of Channels:	Four.
Inputs:	4 per channel; 50 Ω; direct-coupled in non-inverting mode. In inverting mode, operates as a capacitively-coupled unit with a 400 μsec time constant.
Polarity:	Positive or negative.
Reflection Coefficient:	Less than 7% for inputs of 2 nsec risetime.
Input Protection:	Inputs protected against 0.5 μsec transient overloads, up to ± 5 A.

OUTPUT CHARACTERISTICS

Outputs:	4 per channel; reverse-terminated; direct-coupled; for optimum output shape, three outputs must be terminated into 50 Ω. For proper operation, at least 2 outputs must be terminated on each channel used.
Integral Non-Linearity:	± 1% up to −1 volt.
Linear Range:	Normal Mode: +100 mV to > −2 volts. Inverting Mode: +100 mV to > −1.5 volts.
Maximum Amplitude:	Normal Mode: > −2.0 volts into 50 Ω. Inverting Mode: > −1.5 volts into 50 Ω.
Risetimes and Falltimes:	≤ 2.5 nsec, 10% to 90%, with outputs terminated in 50 Ω.
Gain:	Normal Mode: 1.0 ± 2% up to −2 volts. Inverting Mode: Approximately 0.98 up to −1.5 volts.
Duty Cycle Limitations:	None for direct-coupled outputs.
DC Offset:	Adjustable with front-panel potentiometer. Care should be taken to readjust DC level whenever the Normal/Inverting switch is used.
DC Offset Stability:	<60 μV/°C in normal and inverting modes.
Output DC Level Voltage Coefficient:	<25 μV/1% variation of any voltage in normal and inverting modes.
Interchannel Isolation:	40 dB.
Noise:	<750 μV rms.
Stage Delay:	<6 nsec.
Overload Recovery:	Approximately 2 nsec with four simultaneous NIM level (−800 mV) inputs).

GENERAL

Polarity Inversion:	A front-panel switch on each channel selects normal or inverting operation.
Packaging:	RF-shielded AEC/NIM #1 module; dimensions 1.375 x 8.75 x 10 inches deep. Lemo-type connectors.
Current Requirements:	+24 V at 80 mA, − 24 V at 80 mA, +12 V at 160 mA, −12 V at 160 mA.

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January, 1977

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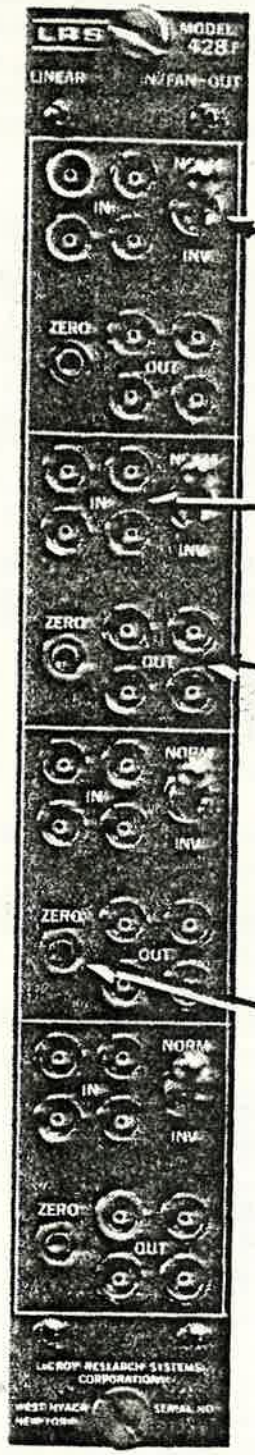
NIM Model 428F

Quad Linear Fan-In/Fan-Out



Mode Select Switch

Selects mode of operation for either negative polarity inputs (NORM position) or positive polarity inputs (INV position).

Inputs

Four per channel; 50 Ω impedance; ground potential DC level.

Outputs

Four per channel; reverse-terminated in 50 Ω; adjustable DC offset.

Maximum Amplitude:

Normal Mode: >-2.0 V into 50 Ω
Inverting Mode: >-1.5 V into 50 Ω

Output Zero Adjust

Controls variable DC output level. When adjusted to ground potential, facilitates cascading of units.

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4. OPERATION

4a. General

The LeCroy Model 428A and Model 428F are four-channel linear fan-in/fan outs packaged in a single-width NIM module. Each channel consists of a 4-fold bipolar fan-in and a 4-fold negative-only fan-out for nanosecond analog signals.

Each of the four channels operates independently of the other three. There are four 50 Ω inputs and four 50 Ω voltage source outputs per channel. A single front-panel switch in each channel selects the mode of operation for input signals of either positive or negative polarity, thus allowing both models to be used with either anode or dynode photomultiplier pulses.

The DC levels of the inputs of the Models 428A and 428F are at ground potential and the output DC levels may be adjusted to ground, thereby facilitating cascading of units.

The amplitude of the outputs of both models is equal to the algebraic sum of the inputs to the respective channel, with the polarity of the output determined by the Mode Select switch.

Because of their excellent linearity, noise characteristics (750 μV RMS) and risetime, the Models 428A and 428F are well suited for general utility processing of fast analog and logical signals.

4b. Outputs

The Model 428A has three DC-coupled outputs and one AC-coupled output per channel. In critical applications where substantial temperature fluctuations cause intolerable DC drifts, it is recommended that the AC-coupled output be used whenever input rates are low enough to prevent pileup from occurring. The AC coupling is achieved through the use of a 0.1 μF capacitor.

The Model 428F has four DC-coupled outputs per channel, reflecting the fact that the temperature stability of the Model 418F is so far superior to that of the 428A that AC coupling is most always unnecessary. The achievement of this superior stability has led to compromises in the Inverting Mode, which are not of concern at low rates and for pulse widths less than 10 μsec. Details of these effects in the Inverting Mode are discussed in Section 4e.

4c. Termination of Outputs

The Models 428A and 428F have been designed to give optimum output pulse shape with three outputs terminated in 50 Ω loads. Operation with fewer than three outputs terminated will result in increased overshoot. Operation with all four outputs terminated will be at the expense of slightly increased risetime. Operation with a single 50 Ω load is not recommended.

4d. Linearity

A typical integral linearity plot for the Models 428A and 428F is shown in Figure 1. The output of the unit under investigation was sampled uniformly over the range indicated. Four identical inputs and four 50 Ω loads were used. The data representing input voltage vs. output voltage were fit to the best straight line using a least-squares fitting procedure. The difference between the output voltage and best fit was plotted against input voltage. As is evident from the data presented, the linearity of the Models 428A and 428F is excellent to -1.5 V and remains quite good to -2.0 V.

4e. Stability

For the Model 428A, the instability figures for temperature and supply voltage changes as noted on the specifications sheet may limit the use of the DC-coupled output in critical ADC applications. For these applications, an AC-coupled output is provided.

The Model 428F, when used in the Normal Mode (NORM position of the Mode Select switch), is direct-coupled throughout and exhibits extremely high DC stability, independent of reasonable power supply voltage changes, temperature variations, rate effects or differences in input widths and amplitudes. When the Model 428F is used in the Inverting Mode (INV position of the Mode Select switch), the voltage and temperature stabilities are equally good. In this mode, however, caution must be taken when high rates, large input amplitudes or wide input pulses are expected. The slow, high-gain feedback used to provide the high DC stability in the Normal Mode will, in the Inverting Mode, cause the output to seek the average non-inverted DC level of the input, with a time constant of approximately 400 μsec. For the first 2 μsec of output duration, this effect will be less than 1%. Similarly, if the input duty factor (ratio of on-time to off-time) is high, baseline shifting will result. In a normal capacitively-coupled circuit, the baseline shifts by 1% of the input amplitude for each 1% of duty factor. For the Inverting Mode of the Model 428F, this shift is 2% for each 1% of duty factor. For example, assume there are two pulses that are 2 μsec apart. Each pulse is 100 mV in amplitude, and has a width of 20 nsec FWHM (full width half-maximum). The duty factor is 1% (20 nsec divided by 2 μsec). The second pulse will encounter a baseline shift of +2 mV (2% of the input amplitude) rather than a +1 mV shift which would exist in a

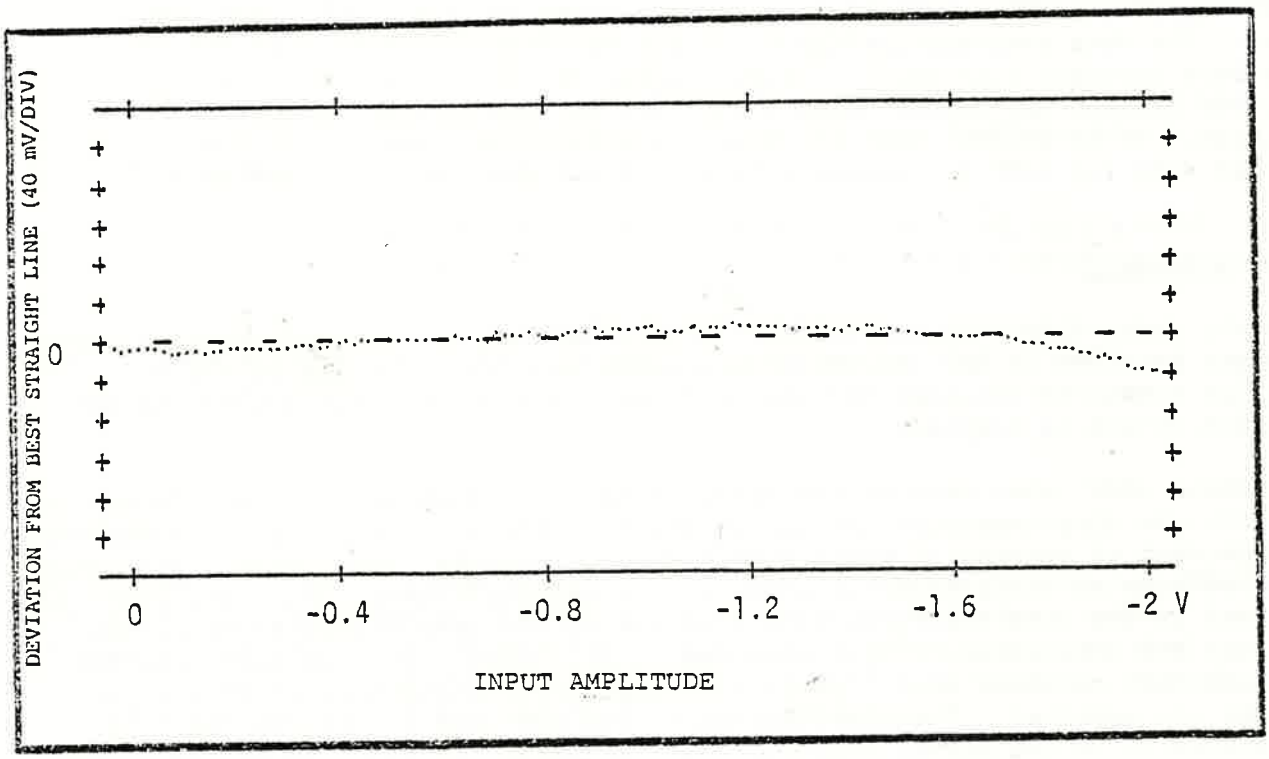

DEVIATION FROM BEST STRAIGHT LINE (40 mV/DIV)
0
0
-0.4
-0.8
-1.2
-1.6
-2 V
INPUT AMPLITUDE

Figure 1

normal AC-coupled circuit. Thus, for either high rates or large input widths, the Inverting Mode of the Model 428F should not be used for very critical applications.

4f. Output Zero Adjust

Care must be taken when adjusting the output DC levels of the Models 428A and 428F. The levels should be checked regularly and may require readjustment when the position of the Mode Select switch is changed. It is particularly important that the output DC level not be more positive than +100 mV or poor linearity will result.

5. FUNCTIONAL DESCRIPTION

For the purposes of the following circuit operation summary, refer to Figure 2.

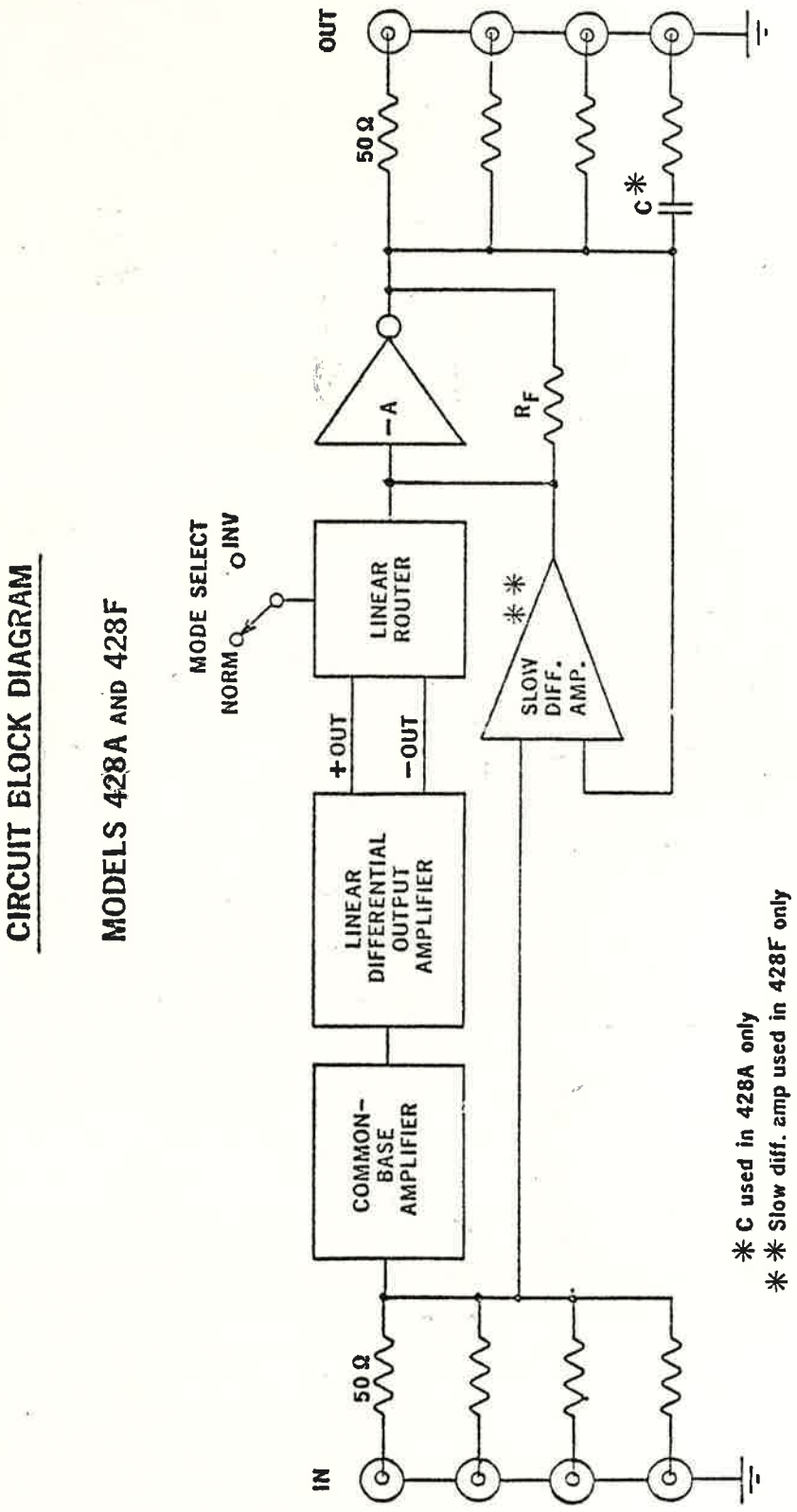
5a. Circuit Operation

Input signals are linearly added by summing resistors at the emitter of a grounded-base transistor amplifier. The collector of this transistor drives one side of a differential stage, which is linearized by means of emitter degeneration. The differential stage produces simultaneous inverted and non-inverted output currents which are received by PNP grounded-base level-shifting transistors. The outputs of these transistors are paralleled and one or the other is enabled by DC-switching of biasing circuitry, thus effecting polarity selection without the need for switches in signal paths. The selected current signal then drives the output stage, an inverting amplifier with a virtual ground input. The outputs are driven via 50Ω resistors which provide reverse termination and a measure of output isolation. For the Model 428A, one of the outputs is AC-coupled through a 0.1μF capacitor. The input and output levels of the Model 428F are continuously compared by a differential amplifier with a very slow (400μsec) time constant to provide DC stability.

All voltages are internally regulated (with appropriate tracking between regulators) to minimize effects due to noise or fluctuations of the external power supplies.

CIRCUIT BLOCK DIAGRAM

MODELS 428A AND 428F



* C used in 428A only

** Slow diff. amp used in 428F only

Figure 2

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