OPERATOR'S MANUAL

NIM MODEL 428F

QUAD LINEAR
FAN-IN / FAN-OUT

CE

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(ECO 1013)

LeCroy

Innovators in Instrumentation

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CE CONFORMITY

CONDITIONS FOR CE CONFORMITY

Since this product is a subassembly, it is the responsibility of the end user, acting as the system integrator, to ensure that the overall system is CE compliant. This product was demonstrated to meet CE conformity using a CE compliant crate housed in an EMI/RFI shielded enclosure. It is strongly recommended that the system integrator establish these same conditions.

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.

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.

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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.
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428F QUAD LINEAR FAN-IN/FAN-OUT
429A QUAD LOGIC FAN-IN/FAN-OUT

- 4 Inputs, and at Least 4 Outputs Per Channel
- Positive or Negative Inputs
- NIM Packaging
- High Speed

FOR COMBINING INPUTS OR DISTRIBUTING MULTIPLE OUTPUTS

Fan-in/fan-out units are accessory modules used to simplify the configuration of an experimental set up. The fan-in function adds or combines multiple analog signals and ORs logic signals for later processing. The fan-out function makes multiple outputs from one or more analog or logic inputs. Fan-outs are commonly used to distribute gate or veto signals over a number of data acquisition units.

LeCroy's fan-in/fan-out units are available for use with either analog (linear) or logic signals. They are NIM standard modules for maximum flexibility.

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FEATURES

Multiple Independent Units - Each module contains four sections of fan-in/fan-out.

Multiple Inputs - 4 inputs per channel.

Multiple Outputs - Each channel has 4 outputs and the Model 429A also has 2 complementary outputs.

Flexible Accessory - Fan-in/fan-outs are useful utility modules which should be part of every lab.

FUNCTIONAL DESCRIPTION

Both fan-in/fan-out modules have the same basic function of combining the inputs and distributing multiple outputs. The Model 428F is used with linear (analog) inputs while the Model 429A is used with logic (NIM or TTL) signals. In either case, they are high performance versatile accessory modules which can be used in CAMAC crates if desired with the Model 4501A NIM-to-CAMAC adaptor.

Model 428F

Each channel of the Model 428F Quad Linear Fan-In/ Fan-Out contains 4 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 V is compatible with all normal analog inputs (e.g., discriminators, ADCs, etc.) and also accommodates standard logic levels. Each of the 428F's inputs is provided with input protection circuitry which gives immunity to transient signals up to ±5 A for 0.5 microseconds.

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 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 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 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.

Model 429A

The Model 429A is a multi-functional fast logic module designed to fulfill a wide variety of signal handling needs. It combines the operations of TTL-to-NIM level translation, logic fan-in, logic fan-out, and polarity inversion in one low-cost module. Each of the 4 channels of the 429A has four inputs which accept both NIM and TTL levels. This is particularly useful for test setups and experiments where digital triggers and/ or control logic may use both signal standards.

Each channel of the 429A includes four independent logic inputs, four normal logic outputs, and two complementary logic outputs. Channels may be paralleled to provide up to 16 inputs and 24 outputs by means of a front-panel switch. An efficient circuit design holds power dissipation of the entire module to within the NIM standard.

The 429A eliminates the extra cabling and time delay involved when conventional fan-ins and fan-outs must be cascaded. In addition, it eliminates the common use of expensive logic units to perform logical ORing with adequate fan-out. The ability to conveniently parallel channels permits the 429A a degree of flexibility and efficiency heretofore unavailable.

Inputs are 50 Ω impedance for NIM or TTL signals. Unused inputs need not be terminated. Inputs may be driven with single or double amplitude NIM signals or TTL signals without affecting output amplitude. The three pairs of bridged outputs are direct-coupled current sources which deliver -32 mA into two 50 Ω loads. Output duration is equal to the logical OR of the input durations.

The circuitry of the 429A is completely direct-coupled and compatible with either normal or complementary logic signals in any duty ratio. Channel paralleling is accomplished by means of a single front-panel locking switch that is not in the signal path and hence permits switching with minimal effect on signal fidelity. Front-panel LEDs located between channels light to indicate channels that are combined, providing a clear, easily-interpreted display of the unit's status.

Model 428F

Number of Sections: 4 independent sections with 4 inputs per section. A front-panel switch on each section which selects normal or inverting mode.

INPUT

No. of Inputs: 4 per channel; 50 Ω ±5 %; direct-coupled in non-inverting mode. In inverting mode operates as a capacitively-coupled unit with a 400 μsec time constant. Inputs protected against 0.5 μsec transient overloads, up to ±5 A.
Signal Level Requirements: Positive or Negative analog signals.
Reflection Coefficient: Less than 7% for inputs of 2 nsec rise time.

OUTPUT

No. of 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.
Output Levels: Linear range in normal mode is limited to: +100 mV to > -2 V, with maximum amplitude of > -2 V into 50 Ω and gain of 1.0 ±2% up to -2 V. Linear range in inverting mode: +100 mV to > -1.5 V, with maximum amplitude of > -1.5 V into 50 Ω and gain of approximately 0.98 up to -1.5 V.
Rise Times: ≤ 2.5 nsec, 10% to 90%, with outputs terminated in 50 Ω.
Fall Times: ≤ 4 nsec 10% to 90%, with outputs terminated in 50 Ω. Integral non-linearity: ±1% up to -1 V.

MISCELLANEOUS

DC Offset: Adjustable with front-panel potentiometer. Care should be taken to readjust DC level whenever the Normal/Inverting switch is used. Stability: < 60 μV/°C in normal and inverting modes.
Output DC Level Voltage Coefficient: < 25 μV/1% variation of any supply voltage in normal and inverting modes.
Interchannel Isolation: 40 dB.
Noise: < 750 μV R.M.S.
Overload Recovery: Approximately 2 nsec with four simultaneous NIM level (-800 mV) inputs.

GENERAL

Rate: DC to 100 MHz typically.
Input/Output: < 6 nsec.
Duty Cycle Limitations: None for direct-coupled outputs.
Packaging: RF-shielded AEC/NIM #1 module. Lemo-type connectors.
Power Requirements: 80 mA at +24 V, 80 mA at -24 V, 160 mA at +12 V, 160 mA at -12 V.

Model 429A

Number of Sections: 4: may be cascaded by means of front-panel switch to form dual 8-fold fan-in/12-fold fan-out or single 16-fold fan-in/24-fold fan-out, with LED indication.

INPUT

Number of Inputs: 4 per section; 50 Ω ±5%; direct-coupled. Quiescent level is 0 V DC.
Signal Level Requirements: Standard NIM logical 1 input levels, -12 mA to -36 mA; Standard TTL logical 1 input levels, +2 V to +5 V; signal width must be 4 nsec minimum, FWHM.
Reflection Coefficient: < 10% for input rise times ≥ 2 nsec.

OUTPUT

Number of Outputs: 4 normal (2 bridged pairs); 2 complementary (1 bridged pair).
Output Levels: Normal NIM (quiescently 0 mA, -32 mA into two 50 Ω loads during output). Complementary NIM (quiescently 32 mA into two 50 Ω loads, 0 mA during output). Duration is equal to the logical sum of the input durations.
Rise Times: 2.3 nsec typical, 2.8 nsec maximum.
Fall Times: 2.3 nsec typical, 2.8 nsec maximum.

MISCELLANEOUS

Time Variation of Output with Input Amplitude: < 1 nsec worst case between inputs of -600 mV and -1.6 V; typically < 0.5 nsec.
Time Variation Between Outputs: 4 channels, 4 x 6 operation: < 0.2 nsec; 2 channels, 8 x 12 operation: < 0.4 nsec; 1 channel, 16 x 24 operation: < 0.9 nsec.

GENERAL

Rate: DC to 100 MHz.
Input/Output: < 6.5 nsec.
Duty Cycle Limitations: None.
Packaging: RF-shielded AEC/NIM #1 module. Lemo-type connectors.
Power Requirements: 35 mA at +12 V, 50 mA at -12 V, 295 mA at +6 V, 460 mA at -6 V.

SECTION 1

SPECIFICATIONS

1.3 Operating Characteristics

The LeCroy Model 428F is a four-channel linear fan-in/fan-out 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 the 428F to be used with either anode or dynode photomultiplier pulses.

The DC levels of the inputs of the Model 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 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 Model 428F is well suited to general utility processing of fast analog and logical signals.

1.4 Outputs

The Model 428F has four DC-coupled outputs per channel, reflecting the fact that the temperature stability of the Model 428F makes AC coupling almost 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 1.4.3

1.4.1 Termination of Outputs

The Model 428F has been designed to give optimum output pulse shape with three outputs terminated in 50 Ω loads. Operation with fewer than three outptus 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.

1.4.2 Linearity

A typical integral linearity plot for the Model 428F is shown in Figure 1.1. 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 Model 428F is excellent to -1.5 V and remains quite good to -2.0 V.

1.4.3 Stability

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 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.

1.4.4 Output Zero Adjust

Care must be taken when adjusting the output DC levels of the Model 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.

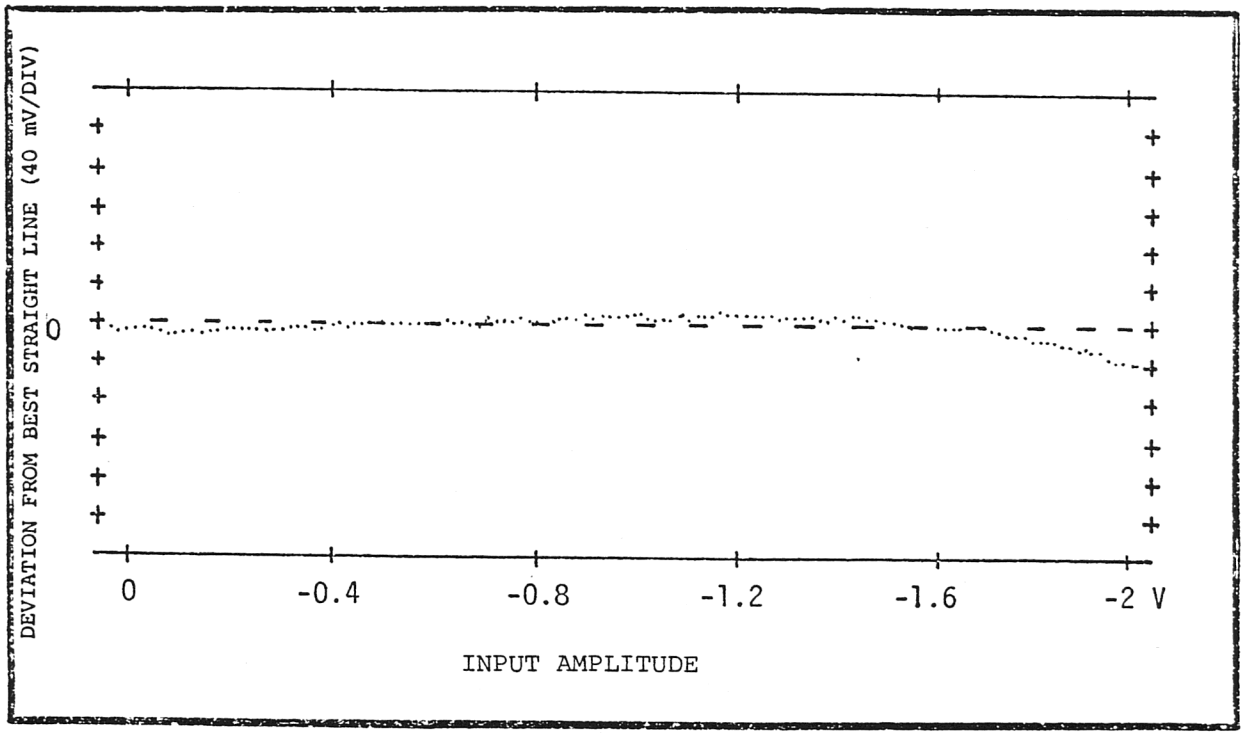

DEVIATION FROM BEST STRAIGHT LINE (40 mV/DIV)
0
0
-0.4
-0.8
-1.2
-1.6
-2 V
INPUT AMPLITUDE

Figure 1.1

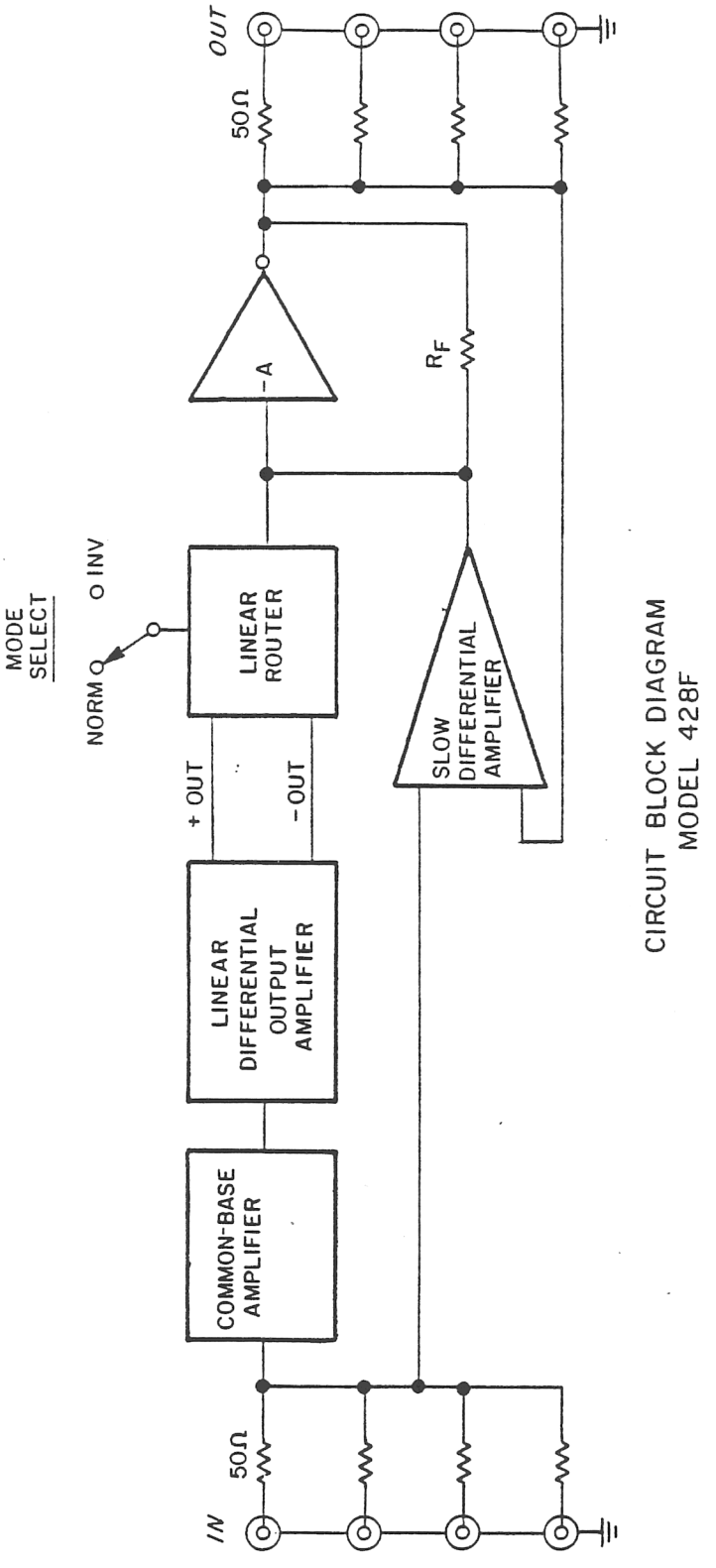
SECTION 2

TECHNICAL DESCRIPTION

For the purpose of the following circuit operation summary, refer to the Block Diagram (Figure 2.1). Complete schematics are contained in the rear pocket of this manual.

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 50 Ω resistors which provide reverse termination and a measure of output isolation. The input and output levels of the Model 428F are continuously compared by a differential amplifier with a very slow (400 μsec) 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
MODEL 428F

Figure 2.1

TECHNICAL INFORMATION

(PARTS LIST, SCHEMATICS)

PART NUMBER	DESCRIPTION REMARK	QTY PER
102245103	CAP CERA DISC 25V .01 UF	54
102412820	CAP CERA DISC 100V 82 PF	4
102444151	CAP CERA DISC 100V 150 PF	1
102944100	CAP CERA DISC 1KV 10 PF	4
106435103	CAP CERA MONO .01UF	8
142224476	CAP TANT DIP CASE 47 UF	4
142824685	CAP TANT DIP CASE 6.8 UF	32
158639002	CAP VARIABLE 9-50 PF	4
158819002	CAP VARI CERA 3.0 - 10 PF	8
161225103	RES CARBON FILM 10 K	16
161225225	RES CARBON FILM 2.2 MEG	4
161225515	RES CARBON FILM 5.1 MEG	4
161335101	RES CARBON FILM 100 OHMS	4
161335102	RES CARBON FILM 1 K	4
161335113	RES CARBON FILM 11 K	4
161335122	RES CARBON FILM 1.2 K	4
161335182	RES COMP 1/4W 5% 1.8 K	1
161335200	RES CARBON FILM 20 OHMS	2
161335390	RES CARBON FILM 39 OHMS	4
161335560	RES CARBON FILM 56 OHMS	4
161335561	RES CARBON FILM 560 OHMS	4
161335821	RES CARBON FILM 820 OHMS	4
161445027	RES CARBON FILM 2.7 OHMS	4
161555301	RES COMP 1W 5% 300 OHMS	1
168531247	RES PREC RN55D 30.1 OHMS	4
168531268	RES PREC RN55D 49.9 OHMS	20
168531273	RES PREC RN55D 56.2 OHMS	8
168531277	RES PREC RN55D 61.9 OHMS	16
168531343	RES PREC RN55D 301 OHMS	16
168531389	RES PREC RN55D 909 OHMS	4
168531393	RES PREC RN55D 1.00 K	7
168531397	RES PREC RN55D 1.10 K	4
168531406	RES PREC RN55D 1.37 K	4
168531410	RES PREC RN55D 1.50 K	4
168531413	RES PREC RN55D 1.62 K	4
168531434	RES PREC RN55D 2.67 K	4
168531439	RES PREC RN55D 3.01 K	1
168531443	RES PREC RN55D 3.32 K	8
168531450	RES PREC RN55D 3.92 K	5
168531489	RES PREC RN55D 10.0 K	4
168531497	RES PREC RN55D 12.1 K	1
168531518	RES PREC RN55D 20.0 K	9
181457103	RES VARI CERMET 10 K	1
181457201	RES VARI CERMET 200 OHMS	1
181457502	RES VARI CERMET 5 K	1
182527102	RES VARI CERMET 1 K	4
208011003	IC SINGLE OP AMP LM301AN	8
208033001	IC TRANS ARRAY CA3046	4
230110005	DIODE SWITCHING 1N4448	14
240225705	DIODE ZENER 4.7V 1N5992A	2
240225706	DIODE ZENER 5.6V 1N5994A	3
253010835	DIODE SCHOTTKY HP2835	8

PART NUMBER	DESCRIPTION REMARK	QTY PER
270130401	TRANSISTOR NPN A401	4
270150001	TRANSISTOR NPN 2N3053	2
275140545	TRANSISTOR HF PNP MRF545	4
275150003	TRANSISTOR PNP 40319	1
275170002	TRANSISTOR PNP 2N5771	8
275170003	TRANSISTOR PNP A441	4
275190001	NOT FOR NEW DESIGNS OBS	1
300010001	BEAD SHIELDING FERRITE	4
300020001	BEAD SHIELDING "1/2" SIZE	4
300050001	CHOKE FERRITE SINGLE LEAD	28
400010008	SOCKET IC SOLD TAIL DIP-8	8
400020014	SOCKET IC SOLD TAIL DIP-14	4
402030000	CONN CO-AX LEMO	32
402030001	HOOD FOR BULKHD LEMO CONN	16
402030002	SPANNER NUT SMALL OD LEMO	32
402030003	GROUND LUG NONLOCK LEMO	12
405112001	CONNECTOR BLOCK (PIN)	1
405212002	GUIDE PIN (MALE)	1
405213001	GUIDE PIN (MALE)	1
405312001	GUIDE PIN (FEMALE)	2
405410016	CONNECTOR PIN (MALE)	5
405613001	CONNECTOR HOOD	1
410112102	SWITCH TOGGLE SPDT	4
500120002	TRANSIPAD "LARGE"	7
521400024	SPACER ROUND #4 3/4	2
540103102	SIDE COVER NIM LEFT	1
540103103	SIDE COVER NIM RIGHT	1
540104101	WRAPAROUND NIM SIZE #1	1
540105001	BRACKET NIM WRAP SIZE #1	2
540109100	SWITCH HOLE PATTERN COVER	1
555611001	CAPTIVE SCREW 6-32	2
555621002	CAPTIVE SCREW RETAINER	2
560440005	SCREW PHILIPS 4-40X5/16	6
560440014	SCREW PHILIPS 4-40X7/8	2
560440015	SCREW PHILIPS 4-40X15/16	2
567256004	SCREW FLAT PHIL 2-56X1/4	4
568440003	SCREW FLAT PHIL 4-40X3/16	10
577400001	WASHER SHAKEPROOF SIZE 4	4
580440001	NUT HEX STANDARD 4-40	2
585141237	RIVET "POP" ALU 1/8X.237	2
590001022	WIRE TEFLON 7/30 BLK 22	1
590111022	WIRE TEFLON 7/30 BRN 22	1
590221022	WIRE TEFLON 7/30 RED 22	1
590551022	WIRE TEFLON 7/30 GRN 22	1
590881022	WIRE TEFLON 7/30 GRAY 22	1
591552126	WIRE TEF WHT SOLID AWG 26	1
593910001	CABLE CO-AXIAL RG178B/U	7
700428201	HEATSINK TO-18 428F	4
710428023	PC BD PREASS'Y 428F	1
720428023	FRONT PNL PREASS'Y 428F	1

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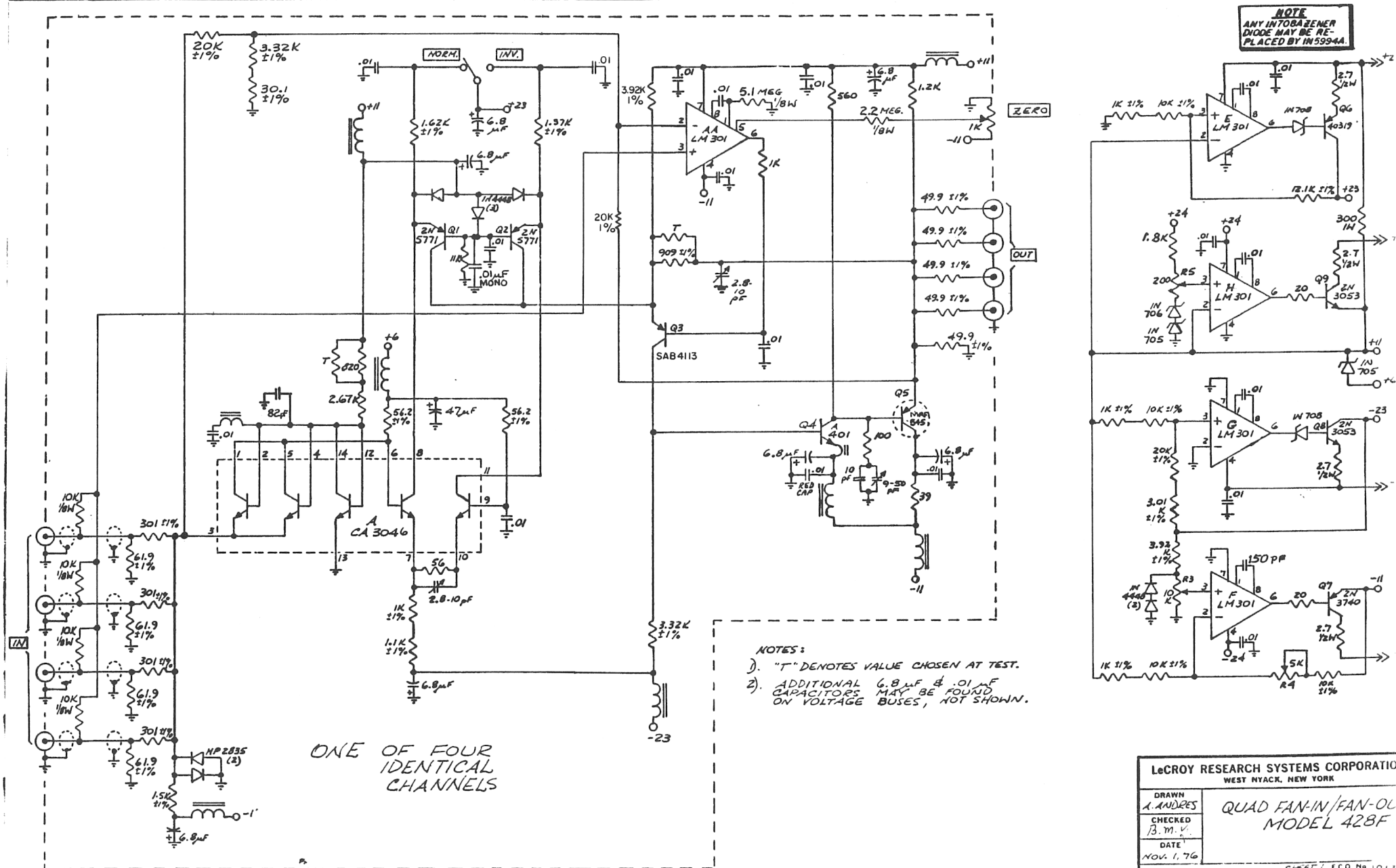

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MODEL 428F

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