Y-Series
Computer
Plug-in Circuits

VT Plug-in
Decades

Diode/Matrix
Plug-in Circuits

Standard Series
Plug-in Circuits

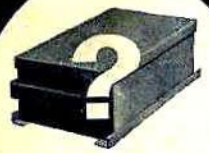
W-Series
Silicon
Plug-in Circuits

Ruggedized
Plug-in Circuits

T-Series
Germanium
Plug-in Circuits

Minisig
Indicators

N-Series
Transistorized
Decades



Custom
Circuitry and
Packaging

ENGINEERED ELECTRONICS COMPANY

PACKAGED CIRCUIT MODULES

RELIABLE
BUILDING BLOCKS
FOR
ELECTRONIC EQUIPMENT
AND SYSTEMS

ENGINEERED ELECTRONICS Company

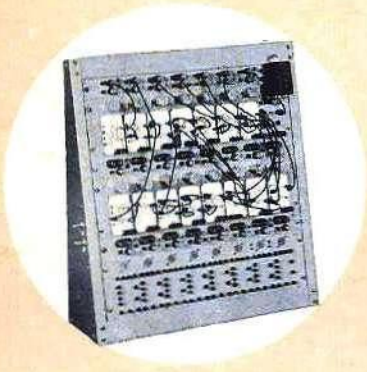
CATALOG NO. 9

AUTOMATION
INSTRUMENTATION
COMPUTING
DATA HANDLING
TIMING
CALIBRATING
TELEMETERING
TESTING

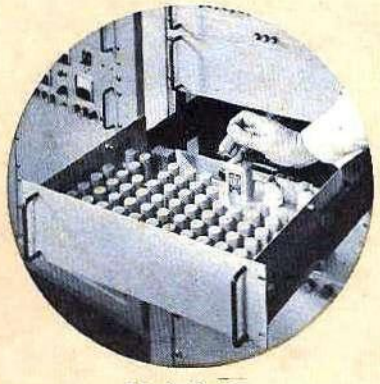
PACKAGED CIRCUIT MODULES FOR SYSTEMS ENGINEERING

ENGINEERED ELECTRONICS Company

ENGINEERED ELECTRONICS COMPANY
506 East First Street, Santa Ana, California
Telephone Kimberly 7-5651
P. O. Box 659
TWX: Santa Ana, California 5255
Our New Headquarters after January 1, 1960, will be
1441 East Chestnut Ave., Santa Ana, Calif.

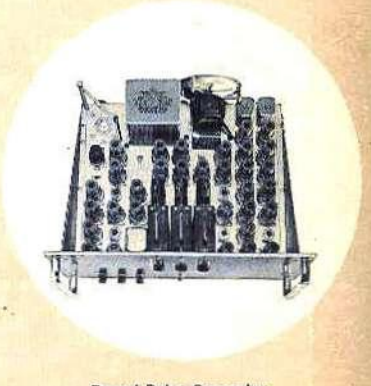


T-Series Breadboard



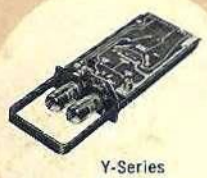
T-Series System

Time and Frequency Digitizer Unit



Preset Pulse Generator

EECO PACKAGED CIRCUIT MODULES



Y-Series
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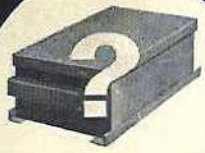
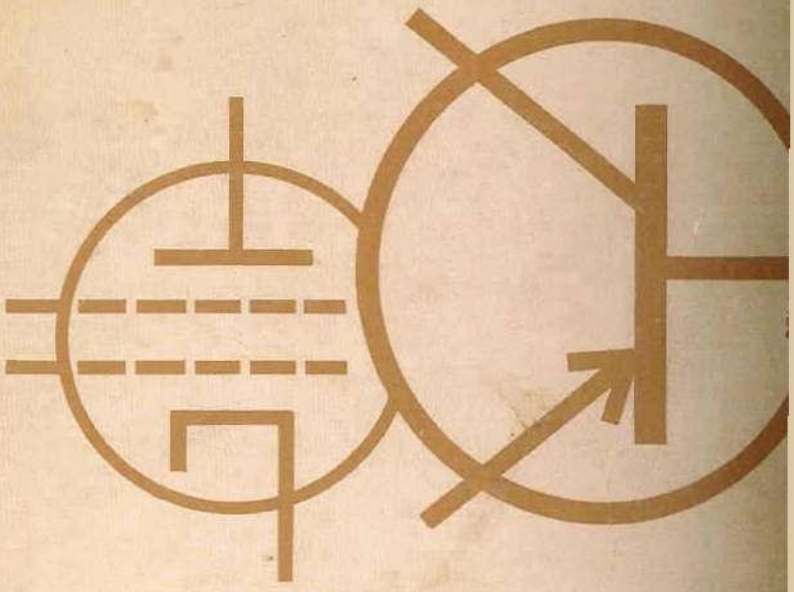


Custom
Circuitry and
Packaging



ENGINEERED ELECTRONICS CO

PACKAGED CIRCUIT MO

RELIABLE
BUILDING BLOCKS
FOR
ELECTRONIC EQUIPMENT
AND SYSTEMS

CATALOG NO. 9

ENGIN
ELECTR
Com

BE SURE TO SEND US YOUR

"CATALOG RECORD CARD"

THIS CATALOG IS INCOMPLETE

Our printing schedule fell apart at the seams and the following sections of the book are missing. We will send you the missing sections as soon as they are printed:

- Application Notes: the application section on Standard Series will be essentially the same as in Catalog 856-B; applications on T-Series, N-Series, and R-Series will be combined in one greatly expanded section based on the coverage in Catalog TR-758A; Y-Series and W-Series will be treated only briefly in keeping with the reduced catalog coverage on these circuits.

- Y-Series Computer Circuits: a short section outlining the usage, features, and general characteristics of this family of two-tube and diode logic circuits.

- W-Series Transistor Circuits: a short section on these high-temperature (100°C) silicon transistor circuits; coverage similar to Y-Series.

- Diode Modules, Vacuum Tube Counters, and Custom Fabrication Services: essentially the same coverage given in catalog 856-B but expanded slightly to cover new products and services.

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 818, Sec. 34.9, P. L. & R., Santa Ana, California

ENGINEERED ELECTRONICS COMPANY

1441 East Chestnut Avenue

Santa Ana, California

CATALOG RECORD CARD

Engineered Electronics Company
1441 East Chestnut Avenue
Santa Ana, California

Gentlemen:

I have your Catalog No. 859, effective February 15, 1960. Please keep me up to date.

PLEASE TYPE OR PRINT

NAME _____ TITLE _____

COMPANY _____

DEPARTMENT _____ MAILING STATION _____

ADDRESS _____ PHONE _____ EXT. _____

CITY _____ STATE _____

SIGNED _____

CATALOG No. 859
REVISION: A
DATE: Feb. 15, 1960

HOW TO USE THIS BOOK

TO USE COLOR CODE

Each major EECO family of circuit modules is color-coded in its own section of the catalog as follows:

Standard and Ruggedized Series (one-tube plug-in circuits)	BLUE
T-Series Germanium Transistor Plug-in Circuits	RED
N-Series Transistorized Decades	GREEN
R-Series Minisig® Sensitive Indicators	ORANGE
General material, including:	
Miscellaneous Equipment	BROWN
Y-Series Computer plug-in circuits	BROWN
W-Series Silicon Transistor plug-in circuits	BROWN
Applications	PURPLE
Price Sheets (at end of Catalog)	SAME COLOR AS CORRESPONDING CIRCUIT
Sales Representatives (last page in Catalog)	WHITE

ENGINEERED ELECTRONICS Company

TO FIND THE CIRCUIT YOU WANT

Select the category on the tabs at the right and flip the pages. Repeat the process from the back of the book. Your thumb will guide you to all catalog circuits in the category selected.

Flip-Flops are used for counting, frequency division, time selection, etc. Input signal is pulse or step function; output is step function.

Amplifiers build up weak signals, regenerate pulses, etc. Input is sine wave, complex wave, or pulse, depending on model.

DC Logics perform "AND", "OR", "AND NOT", and other logical functions. Diodes are connected in networks to satisfy Boolean Algebra equations.

Pulse Generators are used to generate and/or alter waveforms. Typical circuits include one shots, blocking oscillator, etc.

Counters accumulate pulses and store information. They consist of flip-flops packaged as a counting matrix.

Oscillators generate sine or square-wave signals. Circuits include crystal, phase-shift, and multivibrator versions.

Drivers supply power signals to a signal line, neon lamp, relay, etc. Circuits include blocking oscillators, transistor switches, etc.

Pulse Logics (or Gates) are used to pass or block pulse signals as required. Circuits perform "AND" or "OR" functions; multiple-input circuits available.

Inverters give 180° phase reversal and/or amplification. Linear, pulse, and DC inverter circuits are available.

Indicators incorporate transistorized driver circuit for high sensitivity. Basic application is where signal level is inadequate for conventional indicator.

Delay circuits are used to delay pulses in time, for temporary storage, etc. Input is a pulse or step function; output is step function.

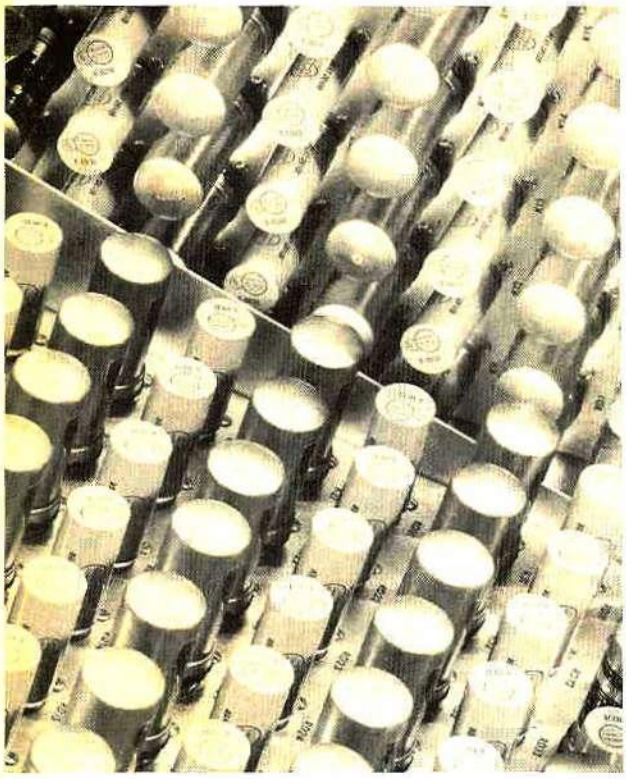
Buffers are used for isolation between active circuit and its load. Circuits include cathode followers and emitter followers.

Triggers generate a step function when the input signal exceeds a threshold. Circuits for this application are modified Schmitt triggers, or squaring amplifiers.

Miscellaneous circuits include reset generators, bias regulators, shift registers, flip-flops and logic, thyratron pulse generators, adder/subtractor circuits, etc.

CATALOG REVISION SCHEDULE

DATE: FEBRUARY 15, 1960



IS YOUR BOOK UP-TO-DATE?

This catalog has been designed and bound in a fashion calculated to make revisions easy. We want you to have complete and accurate catalog information, and propose to keep your catalog current by a combination of two procedures: 1) by sending an up-to-date catalog in the first place; 2) by sending revisions and additions as they are made, to *catalog holders of record.* (PLEASE SEND US THE RECORD CARD. THIS IS THE ONLY RECORD WE KEEP AS TO WHO HAS OUR CATALOGS AND WANTS TO BE KEPT UP TO DATE.)

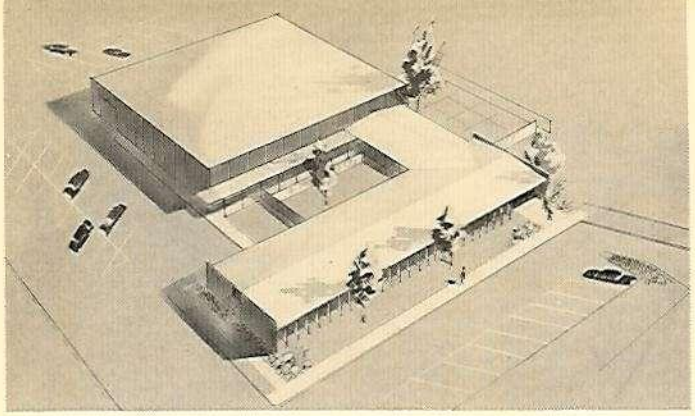
The original bulk printing of this catalog was done in October and November of 1959. *Original pages are undated.* As catalogs are assembled from this bulk supply, additions of new circuits and new application data, or revisions to circuit specifications or applications, etc., are inserted. *These new pages and substitution pages are dated, and are listed on the Revision Schedule.* The resulting catalogs that are assembled from the bulk supply and new pages are up to date as of the REVISION DATE printed on the Revision Schedule.

When we print new catalog sheets, application notes, etc., we will send these new *dated* sheets to catalog holders along with a Revision Schedule for insertion into their books. Since the Revision Schedule also shows a cumulative summary of the changes made since the original catalogs were assembled, it is a useful guide to check on the status of the catalog. All that is required is to compare the book against the dated changes on the Revision Schedule. (A current Revision Schedule is available at any time on request, if the catalog holder suspects he may have missed receiving catalog changes or additions.)

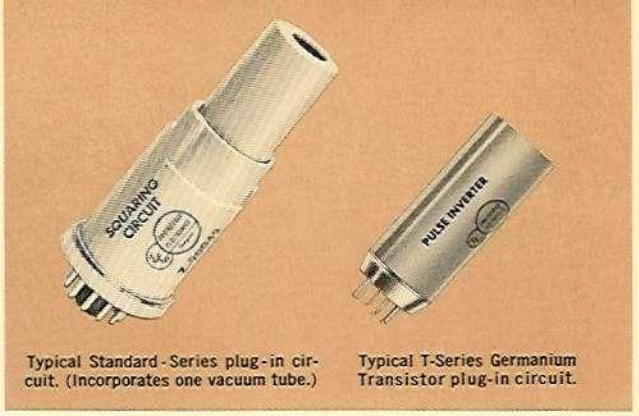
NOTE: The first few times you unsnap the binder of this Catalog, you'll have to pry hard. Don't despair!

REVISIONS

SECTION	PART	TYPE OF CHANGE	DATE
Z (Blue)	Power Supplies	Specifications added	Feb. 15, 1960
Z (Blue)	Z-8318	Specifications clarified	Feb. 15, 1960
Z (Blue)	Z-90015	Specifications (frequency range of input increased)	Feb. 15, 1960
T (Red)	T-1018	Specifications clarified; schematic changed	Feb. 15, 1960
T (Red)	T-103	Specifications clarified	Feb. 15, 1960
T (Red)	T-107 & T-127	Specifications (crystal specifications added)	Feb. 15, 1960
T (Red)	T-109	Symbol corrected	Feb. 15, 1960
T (Red)	T-110	Specifications (output duration clarified)	Feb. 15, 1960
T (Red)	T-129	Symbol corrected	Feb. 15, 1960
T (Red)	T-114, T-115, & T-116	Specifications (operating temperature range increased)	Feb. 15, 1960
T (Red)	T-117	Specifications (loading increased)	Feb. 15, 1960
T (Red)	T-118	Specifications (loading increased)	Feb. 15, 1960
T (Red)	T-123	Table I (load & connection guide added)	Feb. 15, 1960
T (Red)	T-120, T-121 & T-128	Specifications (power requirements clarified); schematic note added	Feb. 15, 1960
T (Red)	T-404, T-405, T-406, T-407, T-620, T-621, T-623, & T-627	Specifications (signal driving levels added)	Feb. 15, 1960
T (Red)	T-410A & T-630	Symbol & schematic added for T-630; deleted for T-408. Specifications changed to reflect substitution	Feb. 15, 1960
T (Red)	T-424	Specifications revised (logic functions clarified; Table III changed)	Feb. 15, 1960
T (Red)	T-427A, T-428A T-607A, T-608A T-609A, T-626A	Specifications clarified & changed; suffix "A" added to all circuit numbers	Feb. 15, 1960
T (Red)	T-612, T-613, & T-628	Specifications (application notes added); T-628 schematic changed	Feb. 15, 1960
N (Green)	N-101	Specifications (operating temperature range changed)	Feb. 15, 1960
N (Green)	N-104	Specifications (operating temperature range changed)	Feb. 15, 1960
R (Orange)	R-341, R-342, & R-441	R-342 added; Specifications amplified to reflect addition; power requirement table added	Feb. 15, 1960



Architect's drawing of our new Santa Ana plant and facilities scheduled for completion in January, 1960.



Typical Standard-Series plug-in circuit. (Incorporates one vacuum tube.)

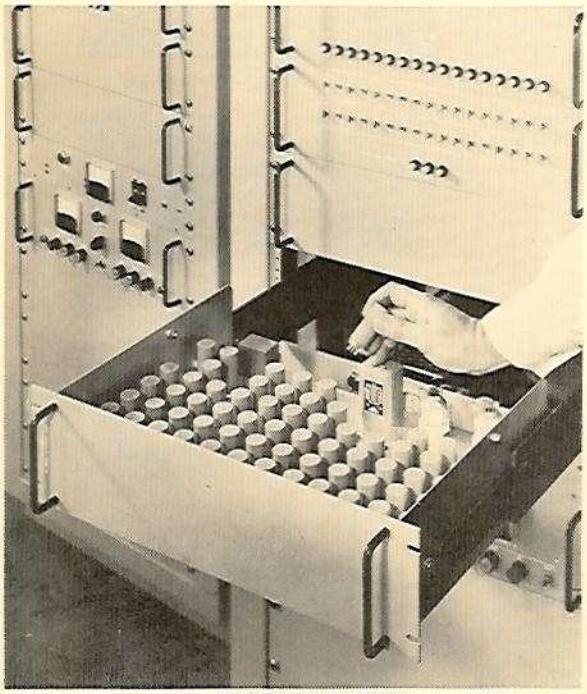
Typical T-Series Germanium Transistor plug-in circuit.

ABOUT ENGINEERED ELECTRONICS COMPANY

The Engineered Electronics Company devotes its major effort to the *production* of highly engineered, reliable packaged circuit modules designed to form building blocks for automation, instrumentation, data handling, computing, timing, telemetering, calibrating, testing, and other equipment and systems.

The complexity of modern, high-speed electronic systems makes the modular approach to systems development a practical necessity. The design, development, and actual packaging of modular plug-in circuits, however, can be both costly and time consuming to anyone not specializing in that field. For this reason, the demand for reliable "off-the-shelf" packaged circuits has been constantly growing.

As specialists, we have kept pace with that increasing demand through the years by observing the most modern and efficient production methods. Today our modular plug-in units comprise many complete families of proven functional circuits. The circuits within any one family are electronically compatible and uniformly packaged in handy, compact plug-in form. And we are able to supply these thoroughly tested, reliable "off-the-shelf" units both quickly and at low cost. As a result, our customers realize an actual saving, not only in the cost of our circuits, but also in reduced time required for systems development when our modular units are used.



Typical T-Series system.

LOANER POLICY

Because our experience indicates that engineers become regular customers once they have used Engineered Electronics Company plug-in modules, we are prepared to loan you, without obligation, a reasonable quantity of cataloged units for a 30-day trial period. If, at the end of the loan period, you wish to retain the loaned plug-ins, an invoice in the amount of the catalog price will be rendered. Should you so desire, you may return the loaners at any time prior to the expiration of the 30-day loan period without charge. We suggest that you write for further details.

WE ARE AT YOUR SERVICE

Our complete staff of engineering, sales, and production personnel is ready at all times to fill your exact requirements for packaged circuit modules, both quickly and efficiently. In addition, our representatives are strategically located throughout the United States to serve you personally in your own area.

T. W. Jarmie,
President and Treasurer

F. J. Temple,
Vice President,
Engineering and
Manufacturing

A. B. Williams,
Vice President,
Sales

B. Dempster, President and Treasurer

R. B. Bonney, Vice President

ABOUT ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA

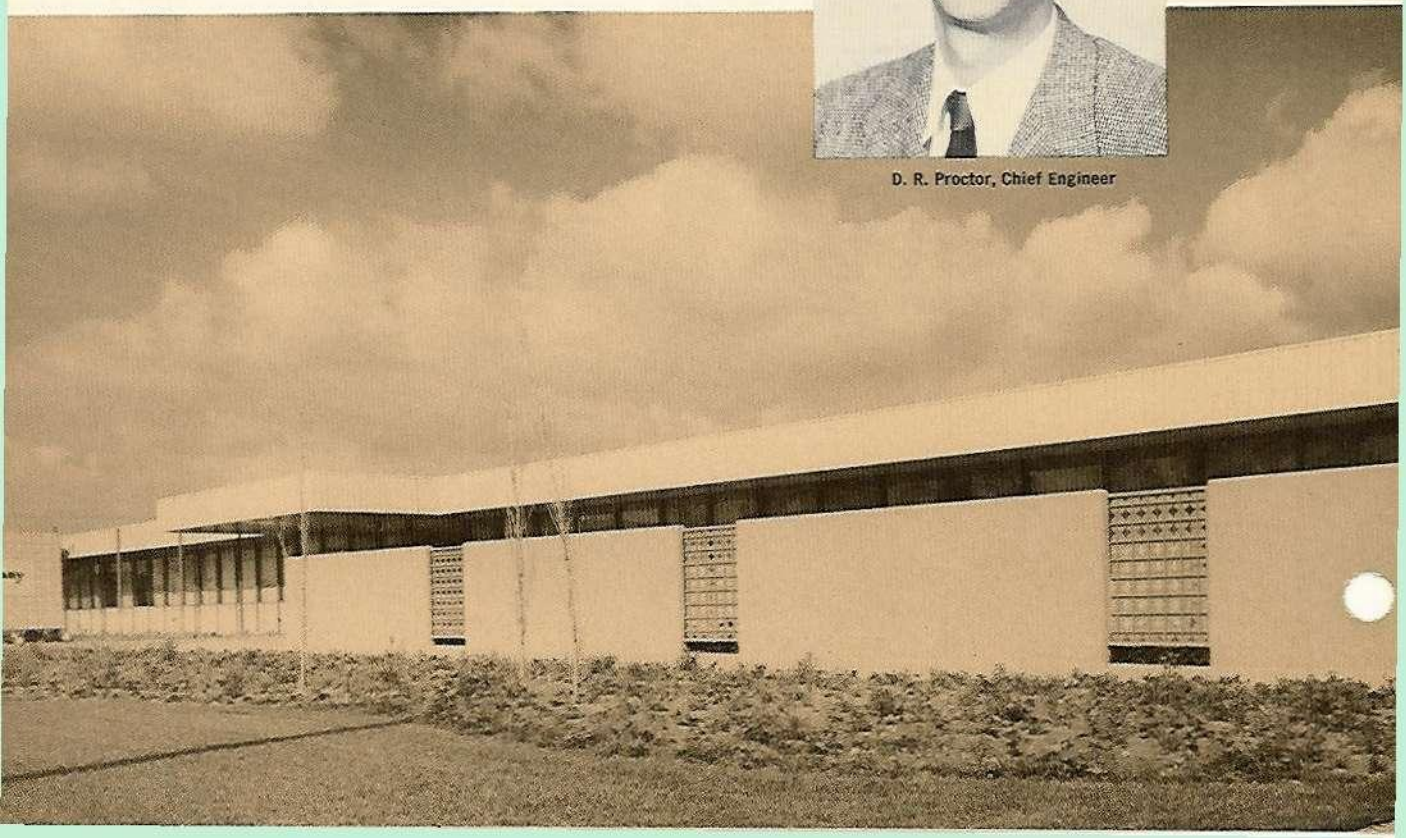
The Electronic Engineering Company of California, our parent company, devotes its major effort to the design and development of electronic equipment and systems of a highly complex nature for the armed services and commercial companies. Since its founding in 1947 it has realized a consistent growth as a result of its high-caliber engineering management and personnel, which is reflected in the excellence of the equipment it designs and develops.

Most of the equipment developed by the parent company incorporates packaged electronic circuits manufactured by Engineered Electronics Company.

W. R. McQuiston, Sales Manager

D. R. Proctor, Chief Engineer

The beautiful headquarters facilities of the Electronic Engineering Company of California is located at 1601 East Chestnut Avenue, Santa Ana, California. It is adjacent to the new home of its subsidiary, Engineered Electronics Company.



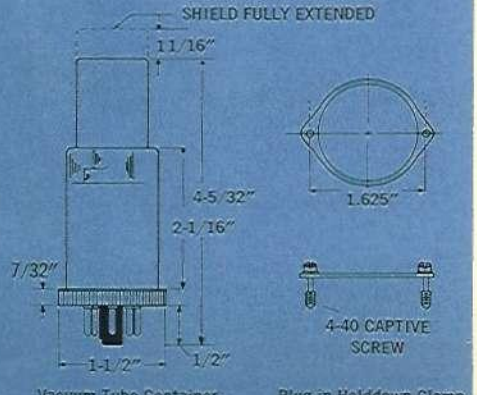
ACTUAL SIZE

STANDARD-SERIES AND RUGGEDIZED-SERIES PACKAGED CIRCUITS

This family of proven one-tube plug-in circuits, for application in military and industrial electronic systems, is available in either the Standard-Series or the Ruggedized-Series package. The major catalog numbers shown at the top of each schematic are carried over from previous catalog issues for your convenience and represent circuits in the Standard-Series package. We now offer these same circuits in several models, and part numbers for these models are shown elsewhere on each page. In these part number tabulations, asterisks are used to denote circuits with uniform power connections (i.e., B+ at pin 2; cathode return at pin 1) to simplify power connections.

For new equipment, it is suggested that units with standardized power connections be selected. However, where direct replacement in existing equipment is involved, the choice of model number should be based upon existing power wiring. The choice of package (i.e., Standard or Ruggedized) is naturally dependent upon the environmental conditions under which the circuit is to operate. (Ruggedized-Series units that are directly interchangeable with Standard-Series units are always shown with the equivalent Standard-Series number appended as a slash number.)

PACKAGE PATENTED, U.S. PAT. OFF.



STANDARD-SERIES OUTLINE

THE STANDARD-SERIES PACKAGE

The EECO Standard-Series package employs sturdy mechanical construction and uses premium components throughout. Each circuit is housed in a die-cast aluminum, baked enameled container. The design of the repairable electronic sub-assembly protects all electrical components against stress or tension, and provides either an 8- or 11-pin header, as appropriate to the circuit.

Units are finished in gray baked enamel and weigh approximately 3.25 ozs. Dimensions are shown in the outline drawing. A holddown clamp with two #4-40 captive screws (19/32" or 27/32" long) is available to hold unit firmly in the socket. This clamp shoulders against the screw cap and is secured to the panel or chassis in this position by means of the two captive screws. This clamp also affords a convenient method of grounding the case.

THE RUGGEDIZED-SERIES PACKAGE

Electrically the same as the EECO Standard Series, these newer units have been *ruggedized* for even greater reliability and more efficient performance. Each unit incorporates the IERC Shield to protect the tube from vibration and shock as well as to dissipate heat more effectively, thereby promoting longer tube life. As in the Standard Series, the mechanical design and construction assure full protection to electrical components against stress or tension. At the same time, all Ruggedized units are compatible with Standard-Series hardware, Systems Development Rack, etc. The holddown clamp for the Ruggedized Series contains three captive screws to give 3-axis stability. Screw sizes are the same as for the Standard Series, i.e., #4-40 (19/32″ or 27/32″ long). The holddown clamp also serves as a convenient case grounding device.

ENVIRONMENTAL CONSIDERATIONS

Both the Standard Series and the Ruggedized Series are moisture- and fungus-proofed for optimum performance under extreme conditions of humidity. Thousands of these units are in daily use in the tropics.

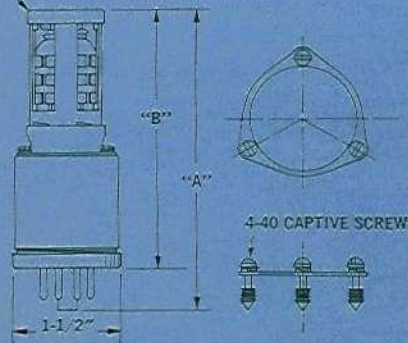
In general, Standard-Series units are designed for use in ground equipment at fixed installations. The ambient temperature normally should not exceed +150°F (+65°C) in the immediate vicinity of the package. Therefore, forced-air cooling should be supplied if needed.

ACTUAL SIZE

PACKAGE PATENTED, U.S. PAT. OFF.

In general, Ruggedized-Series units are designed for use in ground equipment at fixed installations; but, since they have better resistance to shock and vibration than Standard-Series units, they are also suitable for service in mobile equipment. Representative circuits in the Ruggedized package have been tested against MIL E-5272A for shock (Procedure 1, paragraph 4.15.1) and vibration (Procedure 1, paragraph 4.7.1). They give specified performance under:

- Shock 15G
- Vibration .....±10G; 5-500 cps
- Heat .....+160°F (+71°C)
- Cold .....−65°F (−54°C)



Vacuum Tube Container TUBE ACCOMMODATED	Plug-in Holddown Clamp DIM. "A"	DIM. "B"
7- or 9-pin Short	3-11/16″	3-1/8″
7- or 9-pin Medium	4-3/16″	3-5/8″
7- or 9-pin Tall	4-11/16″	4-1/8″

RUGGEDIZED-SERIES OUTLINE

ACCESSORIES

● Description clarified and specifications added 2/15/60.

SYSTEMS DEVELOPMENT RACKS Z-95100 AND Z-95101

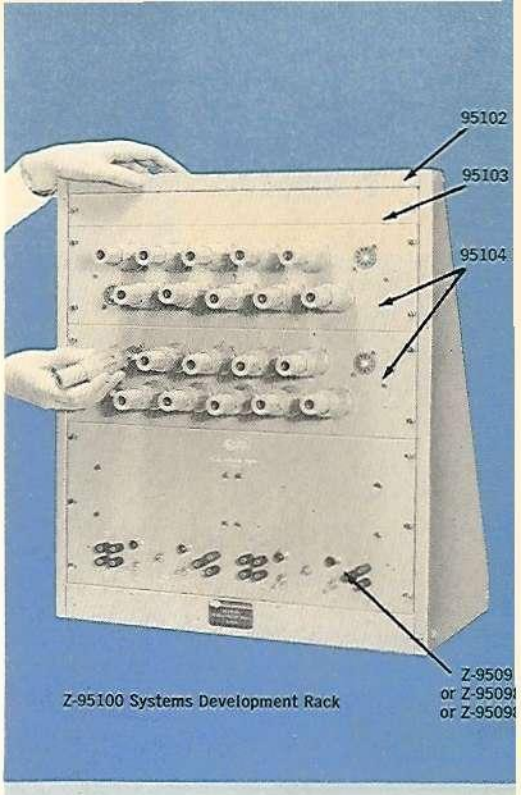
The Systems Development Rack is designed to simplify the "breadboarding" of functional diagrams when the engineer is designing new systems with EECO Standard- or Ruggedized-Series plug-in circuits.

After drawing a functional diagram with EECO symbols, the systems engineer can quickly build up the system by making socket-to-socket signal connections and plugging in appropriate Standard-Series or Ruggedized-Series packaged circuits, thus checking out his system design.

EECO Systems Development Racks are available complete (less power supply) in two models:

Z-95100 (illustrated) is complete with sockets, filament wiring, power cabling, etc.

● Z-95101 is identical with Z-95100 except that panels are reversed so that solder terminals of sockets face front of rack to provide easy access for soldering signal connections.



Z-95100 Systems Development Rack

POWER SUPPLIES AND COMPANION EQUIPMENT Z-95000 SERIES

EECO Z-95000-Series Power Supplies are specially made for service with Standard- and Ruggedized-Series Plug-in Circuits. Their primary application is in Systems Development Rack service, or as companion units for panel-equipped, chassis-mounted, plug-in circuits systems as shown in the illustrations.

Output power is available at binding posts on the front, and at an octal socket on the rear. Power input is through a 6-foot a-c cord at the rear of the chassis.

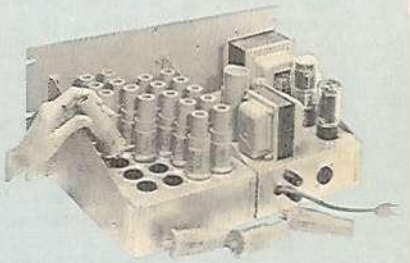
The basic Z-95000-Series Power Supply, Z-95091, is a single-chassis unit that will provide B+ and filament power for an average of 24 plug-in circuits. It is available either with or without a standard 19-inch panel. The Z-95098 is like the Z-95091, with the addition of a VR tube bias supply.

The basic Z-95091 and Z-95098 units are available singly, in pairs, or in combination. The table lists the various models that can be supplied.

The single, panel-mounted units include a blank chassis that can be punched and fitted with sockets or other components, either to build up companion equipment or for breadboarding with plug-in circuits.

POWER SUPPLIES

	TYPE	NUMBER
SINGLE UNITS	Chassis Unit	Z-95091
	Chassis Unit with Bias Supply	Z-95098
	Panel with Z-95091	Z-95091-1
	Panel with Z-95098	Z-95098-1
DUAL UNITS	Panel with two Z-95091's	Z-95091-2
	Panel with one Z-95091 and one Z-95098	Z-95098-3
	Panel with two Z-95098's	Z-95098-2



Sockets have been installed in the Blank Chassis o this Single-Unit Panel-Model Power Supply to permi "Breadboarding" with Plug-in Circuits

BLANK PLUG-IN PACKAGES AND ACCESSORY HARDWARE

Blank Standard-Series and Ruggedized-Series Containers, as well as accessory hardware for companion equipment are available in limited quantities for prototype development by systems engineers. A complete listing of available hardware may be found in the price list.

CUSTOM CIRCUITS

In order to ensure complete system or equipment compatibility, EECO will package large or small quantities of any circuit of your design in Standard- or Ruggedized-Series plug-in containers. Prices on your special circuits may be estimated within 15% to 25% by comparing your circuit with similar circuits in the appropriate EECO series, assuming use of our regularly stocked components. When quotations are requested, or when orders are placed on an "advise-price" basis, the following is required:

1. Circuit schematic.
2. Bill of materials, with
   Tube Type;
   Resistor values, tolerances, and wattages;
   Capacitor values, tolerances, and voltages.

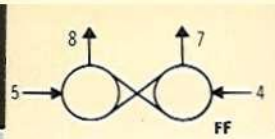
NOTE: Unless component values are otherwise specified, 5% resistors and 20% capacitors will be quoted.

Orders for JAN-type tubes must be accompanied with government contract number. Your circuits are maintained confidential unless otherwise specified.

● SPECIFICATIONS

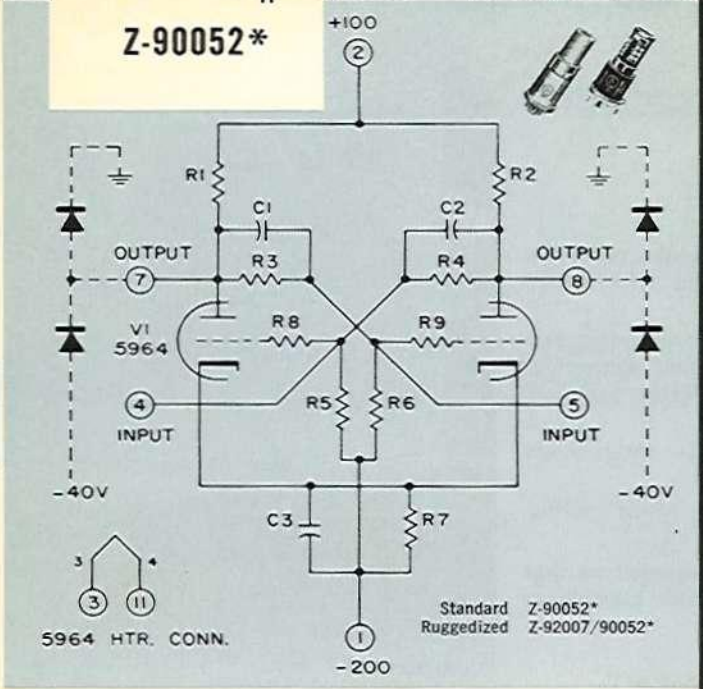
- Input: 105 to 125 volts ac, 60 cps.
- Outputs:
- 200 volts dc at 200 ma, regulated. Either plus or minu terminal may be grounded. Output voltage control i screwdriver adjustable, at the front of unit. Contro range is approximately 175 to 225 volts.
- 6.3 volts ac at 8 amperes, center-tapped, unregulated.
- Models with Bias Supply also provide 0 to —145 volts d at 5 ma, regulated (OD3/VR150 regulator tube). Outpu voltage control is located at front of unit.
- Regulation: With output voltage set at 200 volts, regulatio is 1% or better versus changes in load (0 to 130% rate load) with 115 volts ac input; 1% or better versus lin voltage variation (±10 volts) at rated load. Bias voltag regulation depends on setting of control potentiometer
- Switching: Line and B+ (toggle switches).
- Warm-up Time: 1 minute.
- Overload Protection: Line fuses, both sides of line.
- Tube Complement: 5U4, 6AS7, OD3/VR150, 12AY7 (i Z-90016). Models with bias supply have an additiona OD3/VR150.
- Weight and Dimensions:

TYPE	MODEL NO.	WEIGHT (Lbs.)	HEIGHT	WIDTH	DEPTH
Chassis	Z-95091	19	8″	8″	12½″
Chassis	Z-95098	20	8″	8″	12½″
Panel	Z-95091-1	23	8¾″	19″	12½″
Panel	Z-95091-2	41	8¾″	19″	12½″
Panel	Z-95098-1	24	8¾″	19″	12½″
Panel	Z-95098-2	42	8¾″	19″	12½″
Panel	Z-95098-3	43	8¾″	19″	12½″

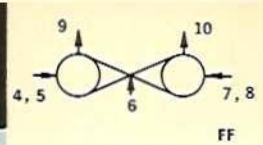


Flip-Flop

Z-90052*

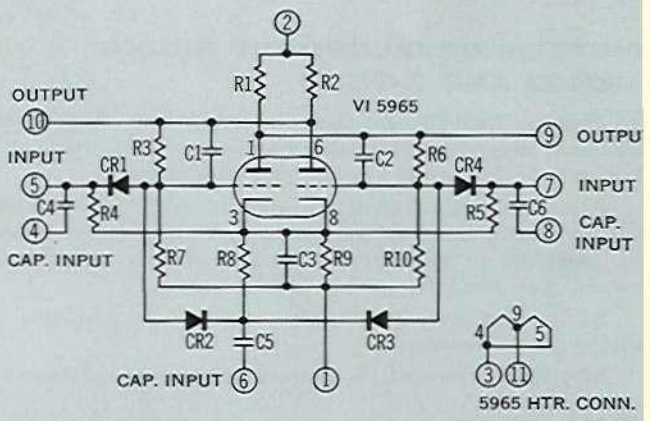


Standard Z-90052*
Ruggedized Z-92007/90052*



Flip-Flop

Z-90392*



Standard Z-90392*
Ruggedized Z-92086/90392*

SPECIFICATION

This flip-flop is designed to drive logical circuits, "and" and "or," using diodes. The outputs (pins 7 and 8) of the unit are clamped by external diodes so that the flip-flop may be loaded heavily and still maintain a constant voltage excursion between the two clamped potentials (ground and −40 volts). It is capable of operating at rates up to 100 kc. Each flip-flop will drive a succeeding flip-flop without an intermediate stage.

Output Signal (pin 7 and pin 8) (no load):

Amplitude: 40-volt (±0.5 volt) swing from ground to −40 volts dc.

Rise Time (Neg. going): Less than 1 microsecond.

Decay Time (Pos. going): Less than 4 microseconds.

Minimum Load Resistance: 33,000 ohms (to ground or −40 volts).**

Maximum Load Capacitance: 150 $\mu\mu$f (to ground or −40 volts).

Input Signal (pin 4 and pin 5):

When used as a binary counter with 33-$\mu\mu$f coupling to each grid and light flip-flop loads, the following is the minimum input signal requirement to the 33-$\mu\mu$f capacitors:

Amplitude: 40-volt negative pulse or square wave.*

Rise Time: Less than 3 microseconds.

For maximum load and 33-$\mu\mu$f coupling capacitors:

Amplitude: 40-volt negative pulse or square wave for input of 0 to 20 kc. 80-volt negative pulse or square wave for input frequencies of 100 kc.

Rise Time: Less than 3 microseconds.

Power Requirements:

+100 volts dc at 6.8 ma. Pin 2 to be positive with respect to ground.

−200 volts dc at 8 ma. Pin 1 to be negative with respect to ground.

−40 volts dc at 4.4 ma. Clamp voltage. See schematic.

6.3 volts at 450 ma. DC potential on heater to be between −10 volts and −180 volts of ground.

Tube Type: 5964. Header: 11-pin.

*With input pulse rise times shorter than 3 microseconds, such as from another Z-90052, input amplitude may be lower.

**May be directly coupled with cathode follower Z-90053 for driving loads of less than 33,000 ohms resistance.

SPECIFICATION

The Z-90392 is a high-speed, bi-stable multivibrator designed for use in counting and frequency division applications. It will operate in the binary mode to above 1 mc. This design features flexibility of input connections so that binary counting, counting employing feedback, and both AC and DC resetting may be readily accommodated. The output of one Z-90392 may be used to drive another Z-90392 without the use of intermediate amplifiers.

Output Signal (pins 9 and 10), all values nominal:

Amplitude: 54 volts peak-to-peak; from +138 volts to +192 volts (no load).

Rise Time (negative going, no load): 0.4 microsecond.

Decay Time (positive going, no load): 0.8 microsecond.

Maximum Load: One Z-90392 and 39K resistive load or one Z-90392 and 33$\mu\mu$f capacitive load.

Input Signal: The input is a negative pulse or square wave applied to pin 6.

Amplitude: 50 volts nominal at 0.4 microsecond for 0 to 600 kc. 65 volts nominal at 0.1 microsecond for 600 kc to 1 mc.

The unit may typically be driven by a Z-90049 squaring circuit, provided that the output signal is adjusted to the proper amplitude, the value of which depends upon the frequency and rise time from the squaring circuit. A typical squaring circuit, Z-90049, can drive the flip-flop from 0 to 600 kc if the output of the squaring circuit is shunted with 22K to ground. A 100K shunt is required for the typical squaring circuit for frequencies above 600 kc.

The output of squaring circuits that have slower rise times and/or smaller amplitudes will require different values of shunting resistors.

Power Requirements:

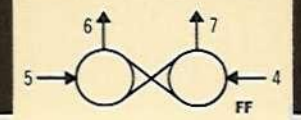
200 volts dc at 15.2 ma. Pin 2 to be positive with respect to pin 1.

6.3 volts ±5% at 450 ma. DC potential on heaters to be between +150 and −100 VDC of pin 1.

Tube Type: 5965.

Header: 11-pin.

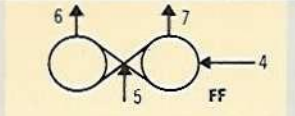
*Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.



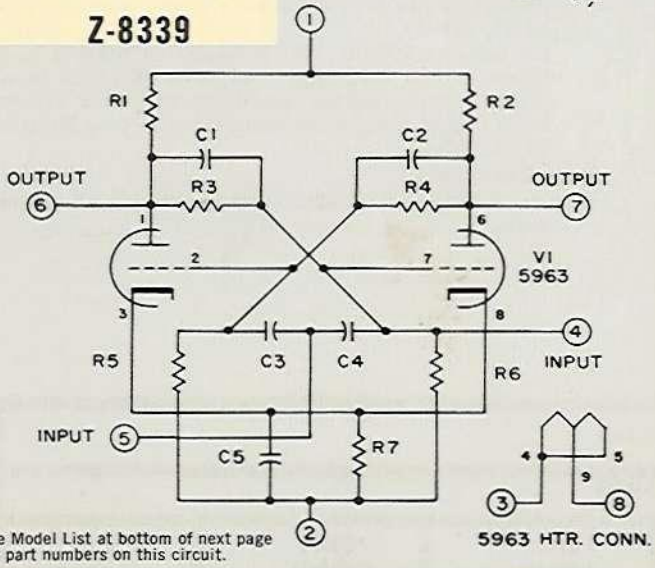
Z-8336

5963 HTR. CONN.

See Model List at bottom of next page for part numbers on this circuit.

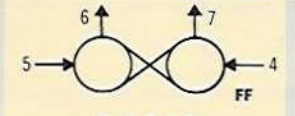


Z-8339

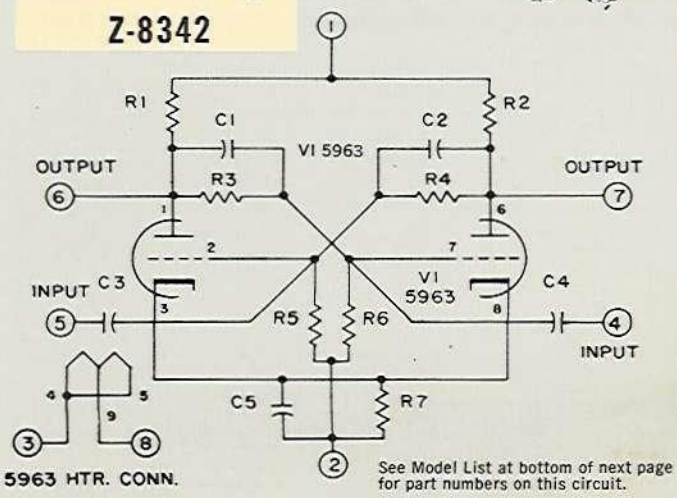


5963 HTR. CONN.

See Model List at bottom of next page for part numbers on this circuit.

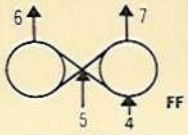


Z-8342

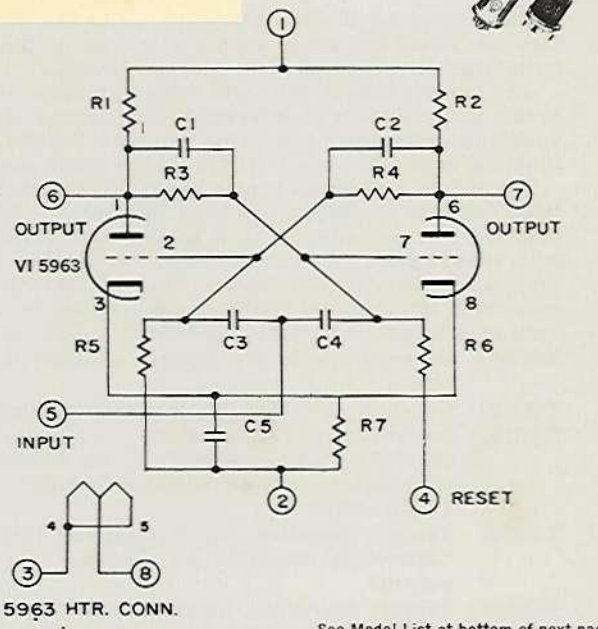


5963 HTR. CONN.

See Model List at bottom of next page for part numbers on this circuit.

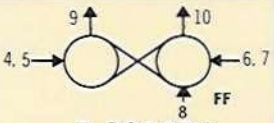


Z-90059

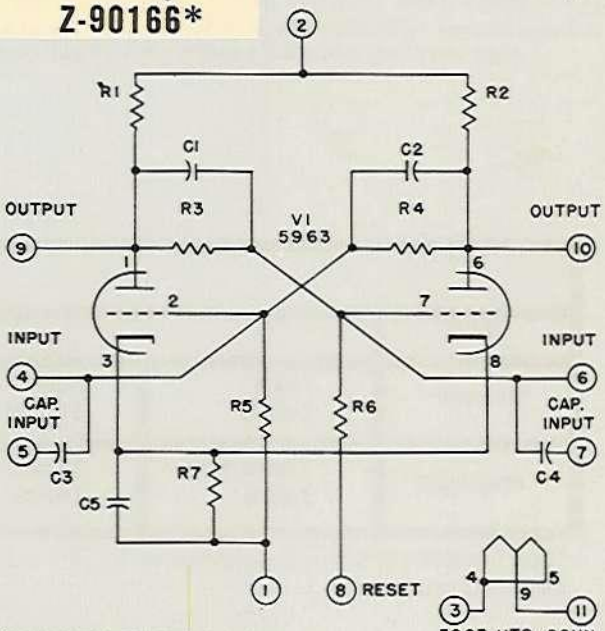


5963 HTR. CONN.

See Model List at bottom of next page for part numbers on this circuit.



Z-90166*



5963 HTR. CONN.

See Model List at bottom of next page for part numbers on this circuit.

SPECIFICATION

The flip-flop circuits shown above are very similar, differing mainly in the input connections that are available for use. The input and output signal characteristics, as well as the power requirements, are identical for the various circuits. All of these circuits may be used for

(Continued)

medium-speed application at speeds up to 100 kc, and they are suited for use in counters, frequency dividers, switching networks, and time selection circuits.

Any one of these circuits will drive any other circuit in this group without an intervening amplifier. External coupling capacitors are required with Z-8336; the coupling capacitors are included in the other circuits.

The salient differences among these circuits are tabulated below as an aid in specifying the model or models required. For new equipment, it is suggested that units with standardized power connections be selected. However, where direct replacement in existing equipment is concerned, the choice of model number should be based upon existing power wiring. (See MODEL LIST, below.)

Z-8336: Set-reset operation; requires external capacitors.

Z-8342: Set-reset operation; input capacitors included.

Z-90166: Set-reset operation; direct and capacitor-coupled inputs provided. Provision for manual or electronic reset (Z-90020) is included. Takes 11-pin socket.

Z-8339: Trigger operation; input capacitors included. Connection available for feedback via R-C network.

Z-90059: Trigger operation; input capacitors included. Provision for manual or electronic reset (Z-90020) is included.

Output Signal (pins 9 and 10 on Z-90166; pins 6 and 7 on other circuits):
Amplitude: 100 volts (no load), 93 volts (flip-flop load).
Rise Time (Negative going): 2 microseconds.
Decay Time (Positive going): 8 microseconds.

Input Signal (Z-90059: pin 5; Z-90166: pins 5 and 7, or when coupling into pins 4 and 6 with 10 $\mu\mu$f capacitors; Z-8339 and Z-8342: pins 4 and 5; Z-8336: pins 4 and 5 when these two pins are coupled with external capacitors):
Frequency Range: 0 to 100 kc.
Minimum Duration: 7 microseconds.
Rise Time: 0.5 microsecond to 3 microseconds.
Amplitude: Negative pulse or square wave with a minimum amplitude dependent upon frequency and load as follows:

1. No load (13 $\mu\mu$f shunted by 10 megohms):
   A. 55 volts (0 to 10 kc input frequency).
   B. 70 volts (10 kc to 50 kc).
   C. 100 volts (50 kc to 100 kc).
2. Loaded by any one flip-flop in this group of circuits:
   A. 60 volts (0 to 10 kc).
   B. 80 volts (10 kc to 50 kc).
   C. 110 volts (50 kc to 100 kc).
3. Maximum load (100,000 ohms shunted by 33 $\mu\mu$f):
   A. 60 volts (0 to 10 kc).
   B. 80 volts (10 kc to 50 kc).
   C. 120 volts (50 kc to 100 kc).

Power Requirements:
200 volts dc at 3.5 ma. Pin 2 to be positive with respect to pin 1 in all circuits incorporating standardized power connections; pin 1 to be positive with respect to pin 2 in all other circuits (see MODEL LIST, below).
6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −25 volts of pin 1 in all circuits incorporating standardized power connections and of pin 2 in all other circuits (see MODEL LIST, below).

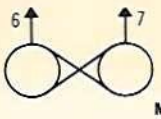
Tube Type: 5963.

Header: Z-90166 and Z-92010/90166: 11-pin; all others: 8-pin.

MODEL LIST

SERIES	MODEL NUMBER				
STANDARD	Z-8336 Z-90399*	Z-8339 Z-90400*	Z-8342 Z-90401*	Z-90059 Z-90402*	Z-90166*
RUGGEDIZED	Z-92000/8336 Z-92001*	Z-92002/8339 Z-92003*	Z-92004/8342 Z-92005*	Z-92008/90059 Z-92009*	Z-92010/90166*

*Units furnished with uniform power connections (i.e., B+ at pin 2, cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.



Multivibrator

Z-90036*

Standard Z-90036*
Ruggedized Z-92041/90036*

SPECIFICATION

A multivibrator for generating a square- or rectangular-wave output at rates up to 100 kc. This unit may be operated free running or it may be synchronized by injecting negative pulses into either grid. Frequency is determined by external timing capacitors and by the dc voltage applied to pin 8, the latter providing a method of fine frequency control.

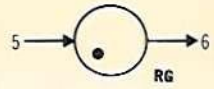
Output Signal (pin 6 or 7) (no load):
- Amplitude: 140-volt peak-to-peak square or rectangular wave, ±10 volts.
- Minimum Load Resistance: 200,000 ohms.

Input Signal for Locked-in Operation (pin 4 or 5):
- Amplitude: Negative pulse 15 volts peak-to-peak, minimum.

Power Requirements:
- 200 volts dc at 9 ma. Pin 2 to be positive with respect to pin 1.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −90 volts of pin 1.
- Bias: Pin 8 to be positive with respect to pin 1.

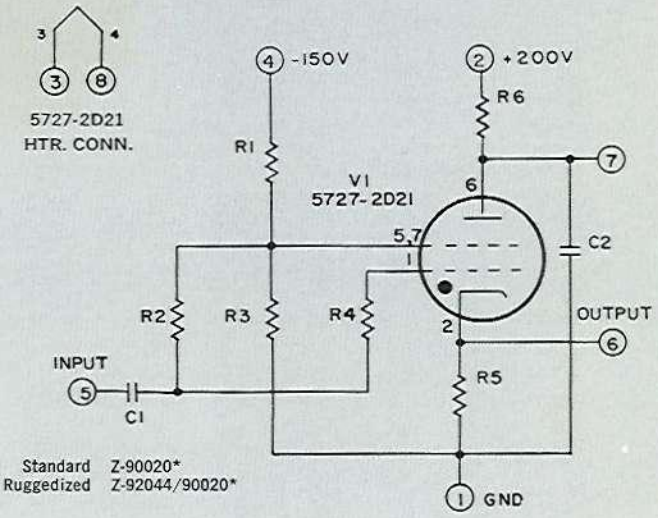
Tube Type: 5963.

Header: 11-pin.



Reset Generator

Z-90020*



Standard Z-90020*
Ruggedized Z-92044/90020*

SPECIFICATION

This circuit is designed to reset simultaneously several decade scalers such as the ZA-10057, and flip-flops such as Z-90059 and Z-90166. It is also useful as a low-impedance pulse source for other applications.

Output Signal (pin 6) (no load):*
- Amplitude: 90- to 170-volt peak-to-peak positive pulse.
- Rise Time: .06 microsecond or less.
- Impedance: Less than 25 ohms.

Input Signal (pin 5):**
- Amplitude: 25 volts peak-to-peak positive, minimum, with duration of 4 microseconds.
- Impedance: Approximately 6,000 ohms.

Power Requirements:
- 200 volts dc with negligible current requirements.
- −150 volts dc with negligible current requirements.
- 6.3 volts at 600 ma.

Tube Type: 5727 or 2D21.

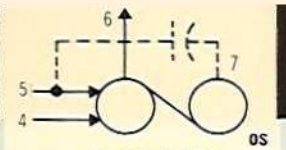
Header: 8-pin.

*Output amplitude and rise time are dependent upon input pulse rate. At rates below 100 pps, output is maximum and drops to 90 volts at 500 pps.

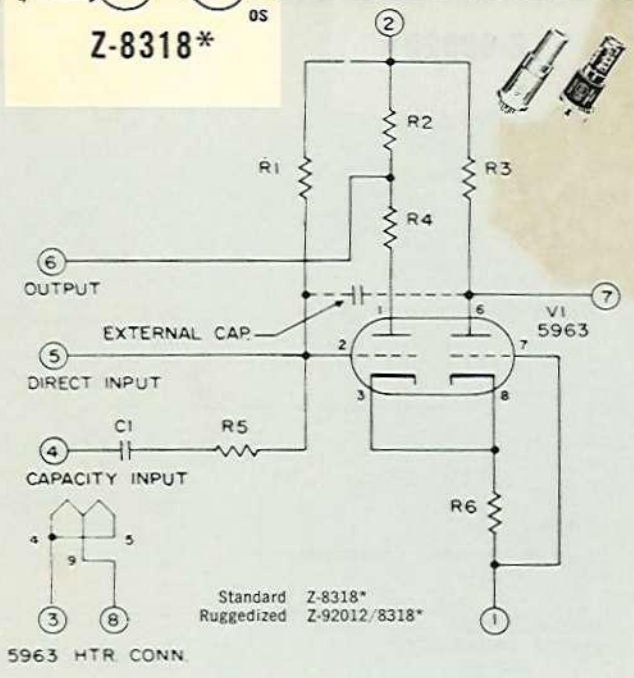
**Minimum input amplitude varies inversely with input pulse duration.

*Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.

One Shot



Z-8318*



SPECIFICATION

● Specifications revised 2/15/60.

This one-shot circuit is designed to provide one positive rectangular pulse (pin 6) of constant duration and amplitude for each input trigger. The output pulse duration is determined by the size of an external capacitor connected between pin 7 and pin 5. Triggering is normally accomplished by a negative pulse inserted at pin 4, although pin 5 or pin 7 may also be used for signal injection. The circuit is commonly used by differentiating the output to obtain a delayed negative pulse.

Output Signal (pin 6) (no load):

Amplitude: 100-volt positive pulse.

Duration: Dependent upon the size of the external capacitor connected between pin 5 and pin 7. The size of the external capacitor (C) for a desired output pulse duration (T) > 200 microseconds can be approximated by:

$$C\ (\mu\mu f) = \frac{T\ (\text{microseconds})}{0.7}$$

Minimum Duration: 50 microseconds.

● Rise Time: 4 to 10 microseconds (positive-going).

● Decay Time: 3 microseconds (negative-going).

Jitter: Less than 3 parts per 1,000 with reasonable care in external capacitor wiring and lead length.

Maximum Duty Cycle: Varies depending on pulse duration. For example: 35% with duration of 200 microseconds and 60% with duration of 1 millisecond.

Minimum Load Resistance: 100,000 ohms.

Input Signal (pin 4):

For output duty cycle of 50% or less and output duration of 1200 microseconds:

Input Impedance: 100 $\mu\mu f$ in series with 220,000 ohms.

Amplitude: 40-to 60-volt, negative pulse, depending on frequency.

Rise Time: 5 microseconds maximum.

Duration: 10 microseconds minimum.

NOTE: Longer output durations and greater duty cycles will require slightly larger amplitudes.

Power Requirements:

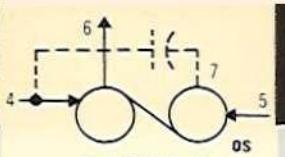
200 volts dc at 5 ma. Pin 2 to be positive with respect to pin 1.

6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −60 volts of pin 1.

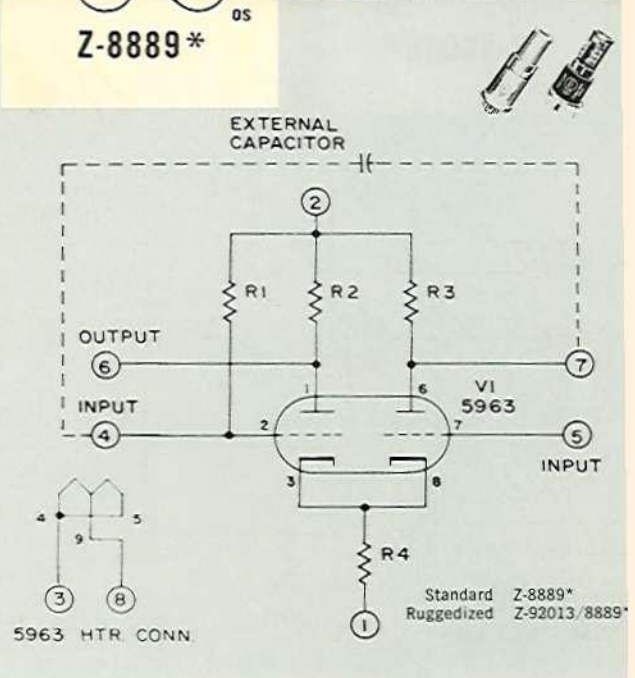
Tube Type: 5963.

Header: 8-pin.

One Shot



Z-8889*



SPECIFICATION

The Z-8889 is an "adjustable-pulse-duration" one shot (range of better than 50 to 1) with a short recovery time and fast rise and decay times. It may be used at rates up to 80 kc. This unit is also useful as a fixed-frequency divider. Triggering is normally accomplished by a positive pulse at pin 5 or a negative pulse at pin 4 or pin 7.

Output Signal (pin 6) (no load):

Amplitude: 60-volt positive pulse.

Duration: Output pulse duration (T in microseconds) is dependent upon the size of external capacitor (C in $\mu\mu f$) connected between pin 4 and pin 7 as well as upon the dc voltage (V) between pin 5 and pin 1. (Pin 5 is 8 volts positive, minimum.) It can be approximated by the following:

$$C = \frac{T}{0.08\ V - 0.6}$$

Minimum Duration: 10 microseconds.

Rise Time: Less than 0.8 microsecond (no load).

Decay Time: Less than 0.8 microsecond (no load).

Jitter: Hum or random noise coupled into pin 5 will cause jitter according to $t = 0.08VC$, where t is the jitter in microseconds, V is the peak-to-peak noise voltage, and C is the size of the external capacitor in $\mu\mu f$.

Output Impedance: Less than 4,700 ohms.

Maximum Duty Cycle: 90%.

Input Signal (pin 5):

Amplitude: 27-volt positive pulse, minimum.*

Duration: 2 microseconds minimum.

Overshoot: Overshoot should be kept to a minimum in order to prevent the output duration from becoming a function of the input trigger pulse.

Input Signal (pin 4):

Amplitude: 35-volt negative pulse, minimum.

Duration: 1 microsecond, minimum.

Overshoot: 3 volts, maximum.

Power Requirements:

200 volts dc at 12.5 ma. Pin 2 to be positive with respect to pin 1.

6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −45 volts of pin 1.

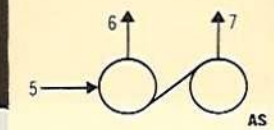
Tube Type: 5963.

Header: 8-pin.

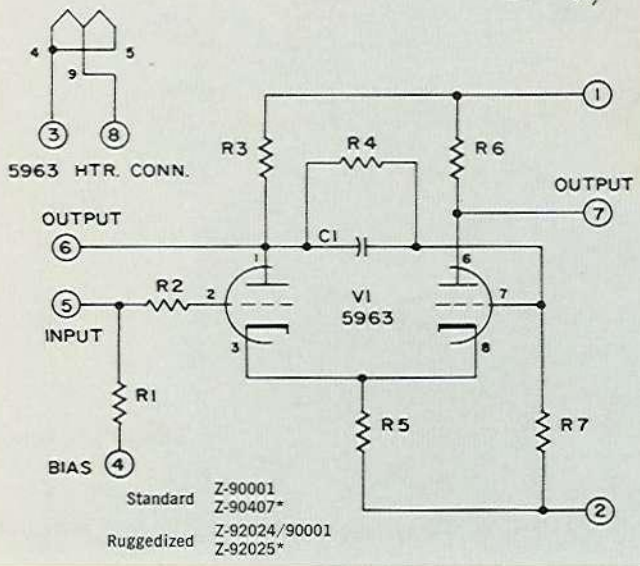
*Minimum input with pin 5 is 9 volts positive with respect to pin 1.

*Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchange

Squaring Circuit (0 to 100 kc)



Z-90001



Standard Z-90001 Z-90407*

Ruggedized Z-92024/90001 Z-92025*

SPECIFICATION

The Z-90001 squaring circuit is designed to convert sine or complex waveforms of frequencies between 0 and 100 kc into square or rectangular waves of standard amplitude and rise and decay times. The grid-leak resistor for the input section is brought out to pin 4 so that input sensitivity and output wave shape symmetry may be adjusted according to the specific application.

Output Signal (pin 7) (no load):
- Amplitude: 100±10-volt peak-to-peak pulse or square wave.
- Duration: Function of input waveform and external bias on pin 4.
- Rise Time (Negative going): 1 microsecond approx.
- Decay Time (Positive going): 3 microseconds approx.
- Output Impedance: Less than 22,000 ohms.

Output Signal (pin 6) (no load):
- Amplitude: 100±10 volts.
- Rise Time (Negative going): 0.8 microsecond.
- Decay Time (Positive going): 1.2 microseconds.
- Phase: 180° out of phase with pin 7.

Output Impedance: Less than 33,000 ohms.

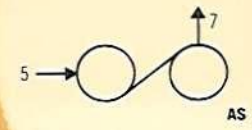
Input Signal (pin 5):
- The input is coupled into pin 5, while pin 4 is returned to a fixed bias. With the bias at pin 4 set for maximum sensitivity (pin 4 between +50 volts and +90 volts of pin 2, depending upon application), the minimum input amplitude is 15 volts peak-to-peak for signals from 0 to 20 kc, and 30 volts peak-to-peak at 100 kc. With pin 4 at 60 volts positive with respect to pin 2, minimum input is 30 volts peak-to-peak from 0 to 100 kc.

Power Requirements:
- 200 volts dc at 3.5 ma. Pin 1 to be positive with respect to pin 2.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −20 volts of pin 2.

Tube Type: 5963.

Header: 8-pin.

Squaring Circuit (0 to 200 kc)



Z-90021*

Standard Z-90021*

Ruggedized Z-92026/90021*

SPECIFICATION

The Z-90021 is a regenerative amplifier designed to accept sine wave or complex wave inputs of frequencies from 0 to 200 kc, and produce a square or rectangular pulse having sharp rise and decay times. This circuit is frequently used to drive decades or flip-flops, and also finds use as a base or peak clipper.

The grid resistor (R-5) is brought out to pin 4 to increase the flexibility of the unit. Pin 4 is normally operated at the same potential as pin 1; however, by applying a bias to pin 4, the input sensitivity and output wave symmetry may be adjusted for a given application.

Output Signal (pin 7) (no load):
- Amplitude: 130-volt peak-to-peak square or rectangular wave.
- Rise Time (Negative going): 0.8 microsecond.
- Decay Time (Positive going): 1.2 microseconds.
- Output Impedance: Less than 10,000 ohms.

Input Signal (pin 5):
- The following applies to a sine wave input with pin 4 connected to pin 1. Greater sensitivity may be obtained by using a small positive bias at pin 4. The bias voltage for maximum sensitivity depends upon input source impedance and frequency.
- Amplitude: 27 volts peak-to-peak, minimum.
- Impedance: 10,000 ohms plus impedance of bias source.

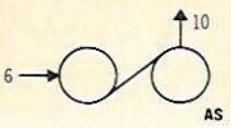
Power Requirements:
- +200 volts dc at 14 ma. Pin 2 to be positive with respect to pin 1.
- −150 volts dc at 2 ma. Pin 6 to be negative with respect to pin 1.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −70 volts of pin 1.

Tube Type: 5963.

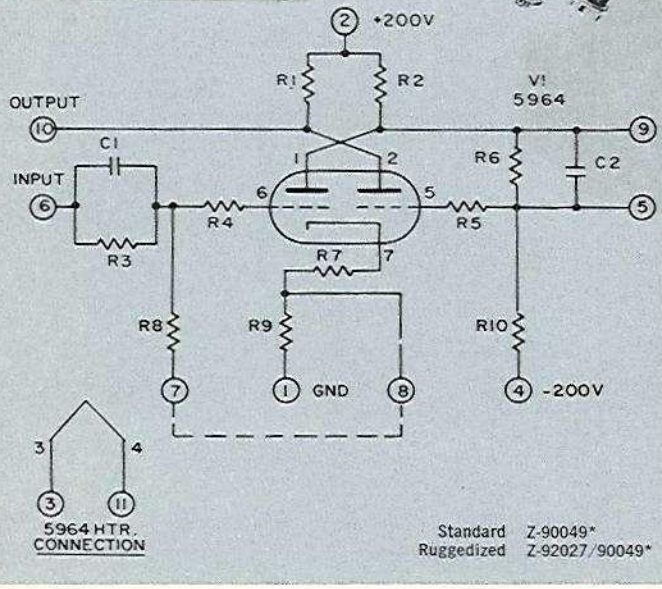
Header: 8-pin.

* Units furnished with uniform pow… at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circ…uits have these connections interchanged.

Squaring Circuit (0 to 1 mc)



Z-90049*



Standard Z-90049*
Ruggedized Z-92027/90049*

SPECIFICATION

The Z-90049 is a squaring circuit designed to operate from 0 to 1 megacycle. It takes a sine or complex waveform input and provides a square or rectangular wave output having fast rise and decay times. This unit is designed to drive high-speed flip-flops and may also be used as a base-and-peak clipper. Pin 7 is normally connected externally to pin 8. Depending upon the application, however, pin 7 can be connected to a positive bias of between 0 and +50 volts with respect to pin 1 in order to obtain a desired input sensitivity or output wave symmetry.

Output Signal (pin 10) (no load):

Amplitude: 110-volt peak-to-peak square or rectangular wave up to 200 kc; 85 volts at 1 megacycle.
Rise Time (Negative going): 0.4 microsecond or less.
Decay Time (Positive going): 0.8 microsecond or less.
Output Impedance: Less than 10,000 ohms.

Input Signal (pin 6):

With pin 7 connected to pin 8, the minimum peak-to-peak input signal is 25 volts. Greater sensitivity may be obtained by using an external positive bias on pin 7 of from 15 volts to 30 volts, depending upon source impedance and frequency.

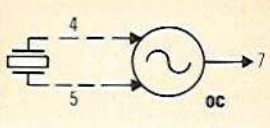
Power Requirements:

+200 volts dc at 12 ma. Pin 2 to be positive with respect to pin 1.
−200 volts dc at 1 ma. Pin 4 to be negative with respect to pin 1.
6.3 volts at 450 ma. DC potential on heater to be between +90 volts and −60 volts of pin 1.

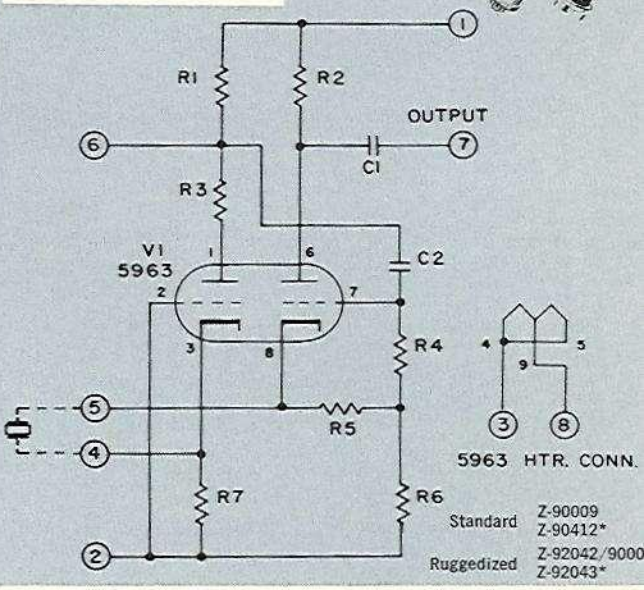
Tube Type: 5964.

Header: 11-pin.

Crystal Oscillator



Z-90009



Standard Z-90009 Z-90412*
Ruggedized Z-92042/9000 Z-92043*

SPECIFICATION

A crystal oscillator unit for applications requiring an accurate frequency in the range from 90 kc to 250 kc. The circuit oscillates at the series resonant point of the external crystal, thereby providing a non-critical, low-impedance input connection for the external crystal. Units are normally supplied without crystals, but may be supplied with crystals cut to specific frequencies.

Output Signal (no load):

Approximately 40 volts peak-to-peak.

Load Impedance:

100,000 to 250,000 ohms. Lower load impedance will result in lower output amplitude. Oscillator frequency is independent of external load.

Accuracy:

This unit is recommended as a precision frequency source in the range from 90 kc to 250 kc. The accuracy depends on the type of crystal and the ambient temperature range of operation (see below).

Power Requirements:

200 volts dc at 3.5 ma. Pin 1 to be positive with respect to pin 2.
6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −70 volts of pin 2.

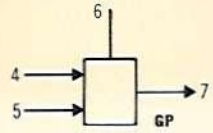
Tube Type: 5963.

Header: 8-pin.

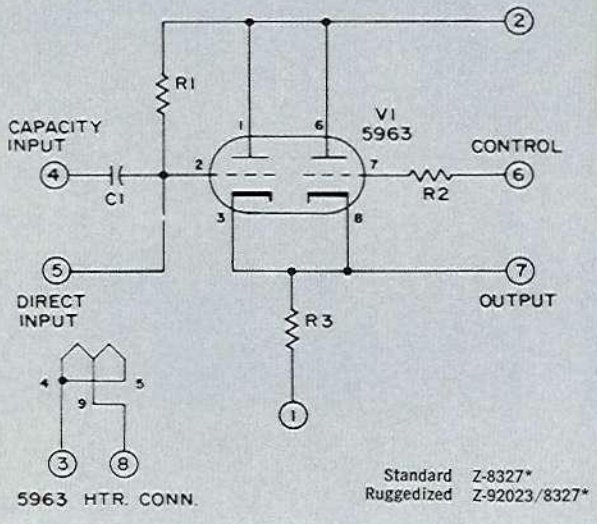
Crystals and ovens can be supplied for use with this oscillator. Specify operating frequency, accuracy, ambient temperature range, and heater voltage (115 volts or 28 volts).

*Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.

Pulse Gate



Z-8327*



Standard Z-8327*
Ruggedized Z-92023/8327*

SPECIFICATION

The Z-8327 is a high-speed, non-inverting coincidence gate operating as a cathode follower. The input signal is a negative pulse or square wave coupled to pin 4 or pin 5, with pin 6 used as the control input and pin 7 as the output. This circuit is designed to operate with a flip-flop directly coupled to pin 6 for the gating input.

Output Signal (pin 7) (no load):
- The following applies to the output measured at pin 7 with a 100-volt negative input pulse to pin 4.
- Coincident Signal Out: 82-volt negative pulse.
- Anti-coincident Signal Out: 10-volt negative pulse.

Input Signal (pin 4):
- Amplitude: 100-volt negative pulse, maximum.

Input Signal (pin 5):
- Negative pulse or square wave for direct-connected operation.
- Amplitude: 100 volts, maximum.

Control Signal (pin 6):
- Gate Closed: Pin 6 to be 10 volts negative with respect to pin 2.
- Gate Open: Pin 6 to be 100 volts negative with respect to pin 2.
- Gate Opening Time: 10 microseconds.

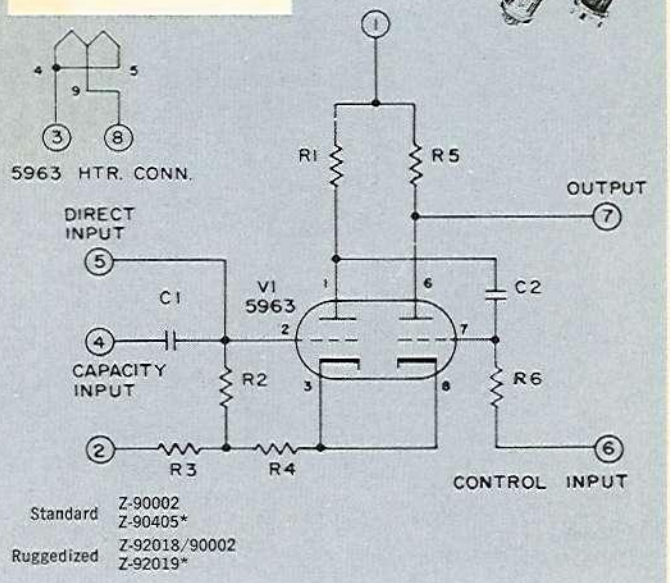
Power Requirements:
- 200 volts dc at 2 ma. Pin 2 to be positive with respect to pin 1.
- 6.3 volts at 300 ma. DC potential on heaters to be between −10 volts and −100 volts of pin 2.

Tube Type: 5963.

Header: 8-pin.

Gate Circuit

Z-90002



Standard Z-90002
Z-90405*
Ruggedized Z-92018/90002
Z-92019*

SPECIFICATION

The Z-90002 is a gated amplifier designed to accept negative pulses at pin 4. It puts out negative pulses at pin 7 when pin 6 is 10 volts negative with respect to pin 2. When pin 6 is 100 volts negative with respect to pin 2, no output is present at pin 7. The gating voltage may be obtained from a flip-flop or one shot operating with a negative supply.

Output Signal (pin 7) (no load):
- Amplitude: 100-volt negative pulse.
- Rise Time: 1.5 microseconds.
- Decay Time: 7.5 microseconds max.
- Impedance: 18,000 ohms.

Input Signal (pin 4):*
- Amplitude: 20-volt negative pulse, minimum.
- Rise Time: 3 microseconds, maximum.

Input Signal (pin 5):
- Pin 5 is available for use with an external coupling capacitor for signals having rise times longer than 3 microseconds.

Control Input (pin 6):
- Gate Open: Pin 6 to be 10 volts negative with respect to pin 2.
- Gate Closed: Pin 6 to be 100 volts negative with respect to pin 2.
- Gate Opening Time: 28 microseconds.

Power Requirements:
- 200 volts dc at 2.5 ma. Pin 1 to be positive with respect to pin 2.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −60 volts of pin 2.

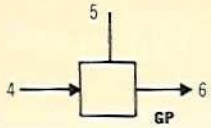
Tube Type: 5963.

Header: 8-pin.

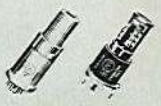
*Note: These input requirements are for duty cycle of 10% or less. With larger duty cycle, greater amplitude is required.

*Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.

Pentagrid Gate



Z-90023*



Standard Z-90023*
Ruggedized Z-92022/90023*

SPECIFICATION

This unit is designed for use as a coincidence gate. The control grid of the pentagrid is biased at −50 volts with respect to pin 1 and is driven by positive pulses applied to pin 4. The gating signal is applied to pin 5. Pin 6 is used as the output with negative pulses present only when pin 5 is at the same potential as pin 1, and pin 4 is driven by a positive waveform.

Output Signal (pin 6) (no load):
- Amplitude: 180-volt negative pulse.
- Rise Time: 5 microseconds, minimum.*
- Decay Time: 10 microseconds, minimum.
- Impedance: Less than 82,000 ohms.

Input Signal (pin 4):
- Amplitude: 53-volt positive pulse, minimum.
- Duration: 12 microseconds, minimum.
- Impedance: 100,000 ohms.
- Note: The above minimum input requirements are for inputs with duty cycles of 10% or less. Larger duty cycles will require larger input amplitudes.

Input Signal (pin 5):
- Gate Open: Pin 5 at the same dc potential as pin 1.
- Gate Closed: Pin 5 at 20 volts negative (minimum) with respect to pin 1.
- Gate Opening Time: 10 microseconds.**
- Impedance: 100,000 ohms.

Power Requirements:
- +200 volts dc at 2 ma. Pin 2 to be positive with respect to pin 1.
- +70 volts dc approximately at 14 ma. Pin 7 to be positive with respect to pin 1.
- −50 volts dc bias. Pin 8 to be negative with respect to pin 1.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −90 volts of pin 1.

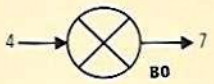
Tube Type: 5915.

Header: 11-pin.

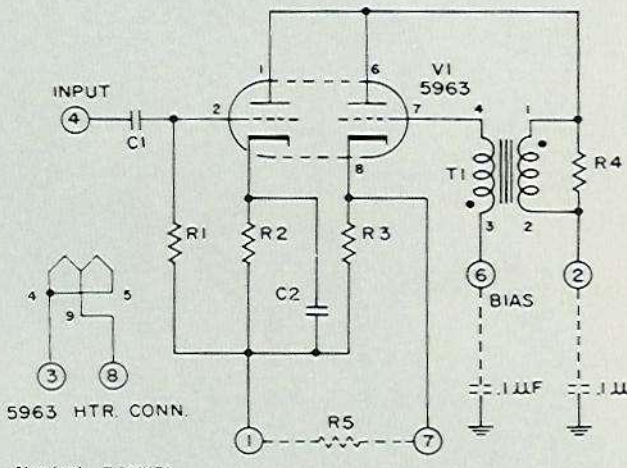
*External resistance may be connected between pins 2 and 6 for shorter rise times.

**With gate controlled by flip-flop such as Z-8336.

Blocking Oscillator



Z-90015*



Standard Z-90015*
Ruggedized Z-92011/90015*

SPECIFICATION

● Specifications revised 2/15/60.

This circuit is designed to be driven with a positive pulse having minimum input specifications as set forth below. The amplitude of the output pulse and the resulting pulse width can be varied by use of an external resistor. The tabulation below indicates how the pulse amplitude and pulse width can be controlled with different values of external resistance.

Output Signal (pin 7) (no load):

When triggered at specified input from a low-impedance source:

	R = 92 Ohms	R = 1,000 Ohms
Amplitude	34 volts p-p	88 volts p-p
Pulse Width	2.3 microseconds	1.0 microsecond
Bias	−30 volts	−27 volts
Rise Time	0.4 microsecond or less	0.4 microsecond or less

Note: $R_0 = \frac{R_3 R_5}{R_3 + R_5}$

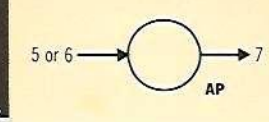
Input Signal (pin 4):
- Amplitude: 40-volt positive pulse.
- Pulse Width: 3 microseconds, minimum.
- ● Frequency: 0 to 5,000 pulses per second.
- Rise Time: 1 microsecond, maximum.

Power Requirements:
- 200 volts dc. Pin 2 to be positive with respect to pin 1.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and ground.
- Bias: −27 volts to −30 volts. Pin 6 to be negative with respect to pin 1.

Tube Type: 5963.

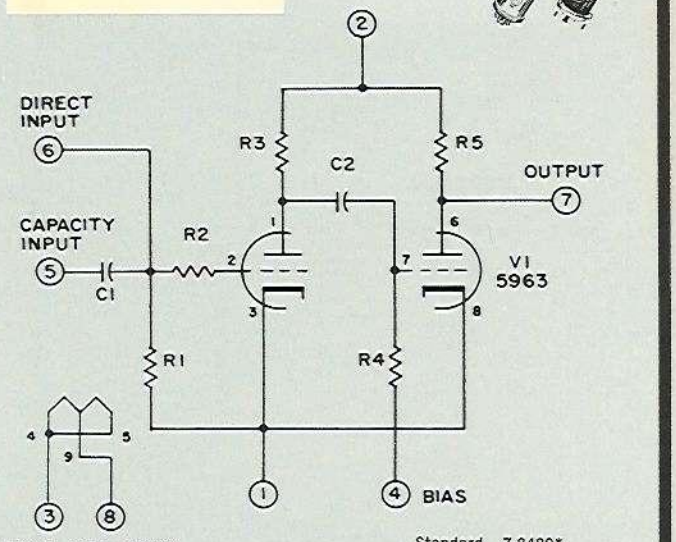
Header: 8-pin.

*Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.



Pulse Amplifier

Z-8489*



Standard Z-8489*
Ruggedized Z-92029/8489*

SPECIFICATION

A pulse amplifier which accepts negative pulses or square waves and delivers constant-amplitude negative pulses at a low impedance with short rise and decay times. It is designed to improve the rise time of weak signals and to be used as a driver amplifier.

Output Signal (pin 7) (no load):
- Amplitude: 85-volt negative pulse.
- Rise Time: 2 microseconds.
- Decay Time: 3 microseconds.
- Minimum Load Resistance: 50,000 ohms.

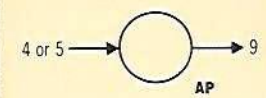
Input Signal (pin 5):
- Amplitude: 30-volt negative pulse, minimum.
- Duration: 3 microseconds, minimum.

Input Signal (pin 6):
- Pin 6 is available as a direct input for signals having poor rise time. (Couple signal through an external capacitor.)
- Amplitude: 30-volt negative pulse, minimum.

Power Requirements:
- 200 volts dc at 1.2 ma. Pin 2 to be positive with respect to pin 1.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −90 volts of pin 1.
- −50 volts dc bias. Pin 4 to be negative with respect to pin 1.

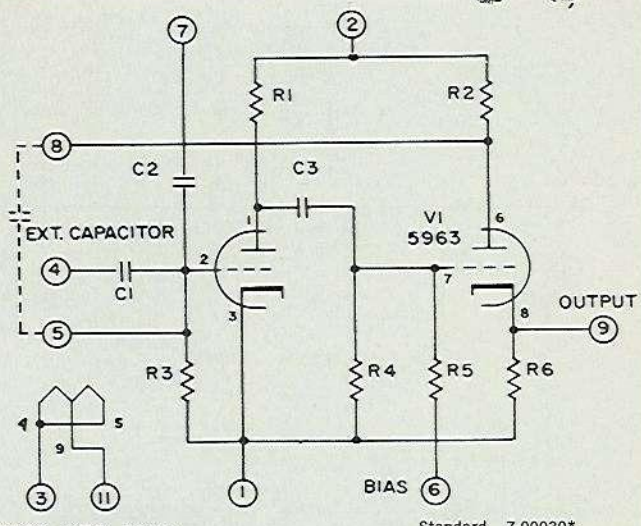
Tube Type: 5963.

Header: 8-pin.



Pulse Amplifier

Z-90030*



Standard Z-90030*
Ruggedized Z-92030/90030*

SPECIFICATION

A regenerative pulse amplifier designed to accept a negative input pulse of relatively long rise time and produce a standard-amplitude positive output pulse of fast rise time. Output pulse duration is 10 microseconds or greater, as determined by an externally connected capacitor. This amplifier has a low output impedance. Maximum frequency of operation is 100 kc.

Output Signal (pin 9) (no load):
- Amplitude: 90-volt positive pulse.
- Rise Time: 2 microseconds.
- Decay Time: 0.8 microsecond.
- Duration: Determined by external capacitor connected between pin 5 and pin 8. For a duration of approximately 4 microseconds, omit external capacitor and jumper pin 7 to pin 8.

Impedance: Approximately 7,000 ohms.

Input Signal (pin 4):

The minimum input amplitude is dependent upon the input frequency, rise time, and the bias at pin 6. Minimum pulse duration is 5 μs. Typical input requirements are:

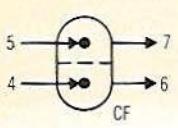
Amplitude:	20 volts	35 volts
Frequency:	100 kc	1 kc
Rise Time:	3 μs	40 μs
Bias:	0 to −10 volts	−23 to −33 volts

Power Requirements:
- +200 volts dc at 3 ma. Pin 2 to be positive with respect to pin 1.
- 0 to −50 volts dc at 0.1 ma. Pin 6 to be negative with respect to pin 1.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and 0 volts with respect to pin 1.

Tube Type: 5963.

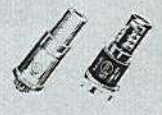
Header: 11-pin.

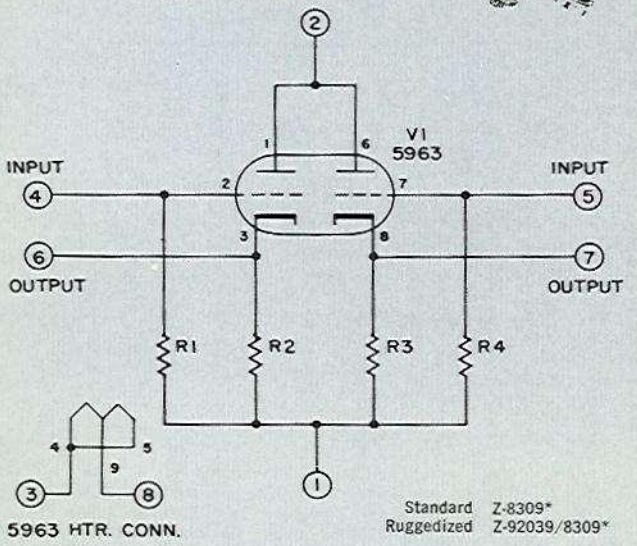
*Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.



Dual Cathode Follower

Z-8309*





Standard Z-8309*
Ruggedized Z-92039/8309*

SPECIFICATION

Two cathode followers are provided in one plug-in unit. The two circuits are independent and can be used as isolation amplifiers or as impedance-matching devices.

Output Signal (pins 6 and 7):

The cathode follower output is greater than 90% of the input signal.

Input Signal (pins 4 and 5):

Direct Coupled: The input may be direct coupled to a flip-flop or similar circuit. The B+ voltage for the Cathode Follower must be at least 60 V more positive than the most positive input signal.

A.C. Coupled: The Cathode Follower may be A.C. coupled to other circuits. To maintain a gain greater than 0.9, the input must be biased externally to at least +60 V from the voltage of Pin 1. This may be accomplished by adding a 2.2 Meg resistor from the input pin to Pin 2.

Note: Other circuit configurations are possible, including capacitor input to the grid to obtain a differentiated output signal.

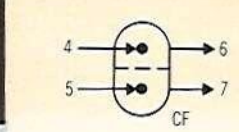
Power Requirements:

200 volts dc at 9 ma to 18 ma. Pin 2 to be positive with respect to pin 1.

6.3 volts at 300 ma. Heater-to-cathode rating of 5963 is ±90 volts.

Tube Type: 5963.

Header: 8-pin.



Dual Cathode Follower

Z-90053*

Standard Z-90053*
Ruggedized Z-92040/90053*

SPECIFICATION

This cathode follower is designed specifically for driving logical circuits, "and" and "or," using type 1N191 or equivalent diodes. This unit can be used with a flip-flop (such as Z-90052) to drive an external load.

Output Signal (pins 6 and 7):*

Amplitude: 39 volts peak-to-peak (no load).
30 volts peak-to-peak (10,000-ohm load).

Input Signal (pins 4 and 5):*

Amplitude: 40 volts peak-to-peak.

Power Requirements:

+100 volts dc at 5.5 ma to 10 ma. Pin 2 to be 100 volts positive with respect to ground.

−100 volts dc at 5.5 ma to 10 ma. Pin 1 to be 100 volts negative with respect to ground.

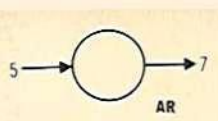
6.3 volts at 900 ma. DC potential on heaters to be between +50 volts and −90 volts of ground.

Tube Type: 5687.

Header: 11-pin.

*Typical operating conditions when driven through 100-ohm coupling resistors from flip-flop Z-90052 and with no connections to pins 8 and 9.

* Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.



Linear Amplifier

Z-8324

SPECIFICATION

A general-purpose, resistance-capacity coupled amplifier with internal feed-back. It is especially adaptable for applications requiring the amplification of low-level sinusoidal, complex, and transient signals such as from data pick-up units. Additional pin connections are provided for the use of external frequency-response compensating networks.

Output Signal (pin 7):
- Impedance: Approximately 10,000 ohms.
- Total Harmonic Distortion: Less than 1% (measured at 1,000 cycles per second).

Input Signal (pin 5):
- Maximum Amplitude: 0.3 volt peak-to-peak.
- Impedance: 470,000 ohms.

Voltage Amplification: Approximately 40 db.

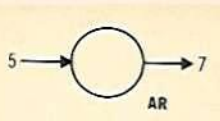
Frequency Response: ±1 db from 9 to 200,000 cycles per second.

Power Requirements:
- 200 volts dc at 2.5 ma. Pin 1 to be positive with respect to pin 2.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and —90 volts of pin 2.

Tube Type: 12AX7.

Header: 8-pin.

NOTE: It is important that the case of this unit be grounded for optimum circuit performance. A holddown clamp or similar grounding device is required.



Linear Amplifier

Z-8762

SPECIFICATION

A general-purpose, resistance-capacitance coupled amplifier. It is designed to be used for amplification of sinusoidal or complex waveforms whose amplitudes may be as high as 2.8 volts peak-to-peak. An additional pin connection is provided for the use of external frequency-response compensating networks.

Frequency Response: ±1 db from 5 to 40,000 cycles per second. Response may be improved by adding feedback from pin 7 to pin 4 or pin 6.

Input Signal (pin 5):
- Amplitude: .7 volt rms for linear operation.
- Impedance: 500,000 ohms at 50 kc.

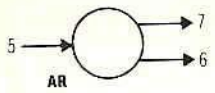
Amplification: 34 db.

Power Requirements:
- 200 volts dc at 5 ma. Pin 1 to be positive with respect to pin 2.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and —80 volts of pin 2.

Tube Type: 5963.

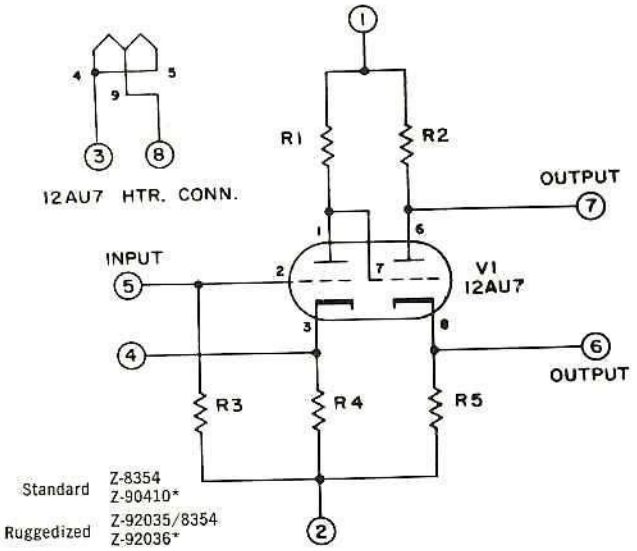
Header: [illegible]-pin.

*Units furnished with uniform powerections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Circuits have these connections interchanged.



Amplifier Phase Inverter

Z-8354



SPECIFICATION

A general-purpose amplifier-phase inverter. It is designed for use with push-pull amplifier unit, Z-8351, and with preamplifier, Z-8324, when additional gain is needed. Where a greater dynamic range, lower distortion, or frequency compensation is desired, an external feedback network may be used between pin 7 and pin 4, or from a following stage to pin 4.

Output Signal (pins 6 and 7):
Push-pull output.
Impedance: Approximately 22,000 ohms (pin 7). Approximately 2,400 ohms (pin 6).
Total Harmonic Distortion: Less than 4%.

Input Signal (pin 5):
Amplitude: 2 volts peak-to-peak, maximum, with a 200-volt plate supply.
Impedance: 470,000 ohms.

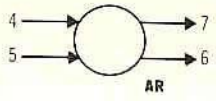
Amplification: 22 db.

Frequency Response: ±1 db from 0 to 100,000 cycles per second.

Power Requirements:
+200 volts to +300 volts dc (7 ma at 250 volts dc). Pin 1 to be positive with respect to pin 2.
6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −15 volts of pin 2.

Tube Type: 12AU7.

Header: 8-pin.



Amplifier Push-Pull Voltage

Z-8351

SPECIFICATION

A general-purpose amplifier for driving a push-pull, Class A or AB1 power amplifier stage. This unit may be driven by a phase inverter-amplifier, Z-8354, when only a single-ended input is available.

Input Signal:
3 volts peak-to-peak, maximum, with a 300-volt plate supply.
Impedance: Approximately 470,000 ohms at each input.

Frequency Response:
±1 db from 0 to 100,000 cycles per second.

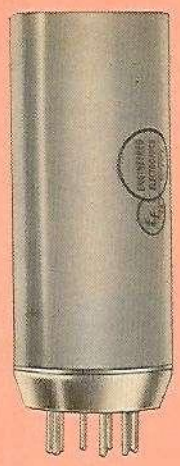
Voltage Amplification: 23 db.

Power Requirements:
200 volts dc to 400 volts dc (7.5 ma for 300-volt operation). Pin 1 to be positive with respect to pin 2.
6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and −90 volts of pin 2.

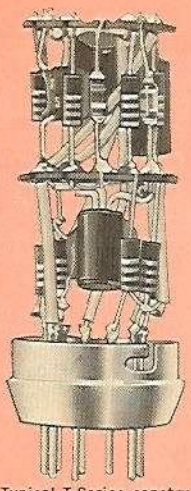
Tube Type: 12AU7.

Header: 8-pin.

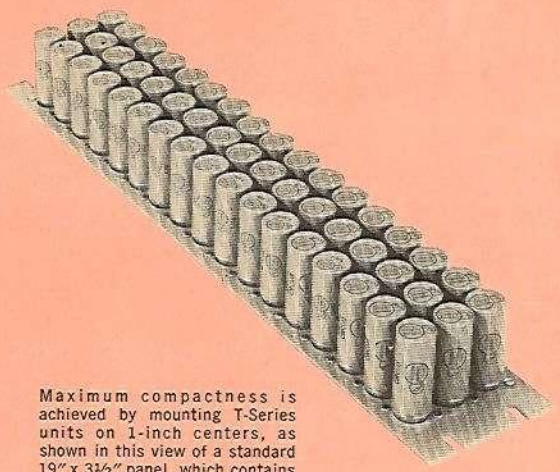
* Units furnished with uniform power connections (i.e., B+ at pin 2, Cathode return at pin 1) to simplify socket wiring. Other circuits have these connections interchanged.



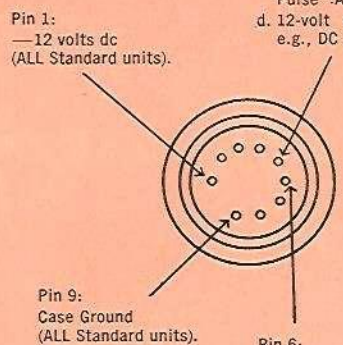
Typical T-Series plug-in package, actual size.



Typical T-Series construction details, actual size. (Pat. appl'd.)



Maximum compactness is achieved by mounting T-Series units on 1-inch centers, as shown in this view of a standard 19" x 3½" panel, which contains a total of 51 T-Series circuits.



Pin 5:
a. Miscellaneous on most units (set, input, output, tie point, etc.).
b. Unused on some units.
c. +12 volts dc on some units, e.g., Pulse "And" Gate T-410A.
d. 12-volt common on some units, e.g., DC Logic T-407.

Pin 6:
a. 12-volt common on most units.
b. +12 volts dc on some units, e.g., PNP emitter followers and DC Logic units.
c. Signal connection on some units, e.g., Shift Register Logic T-600.

T-SERIES

GERMANIUM TRANSISTOR

PACKAGED CIRCUITS

The T-Series is a *family* of transistorized digital circuits f service in compact systems and equipment. Featured in t T-Series are:

1. Compatible, standardized signal levels.
2. Consistently conservative electrical specifications.
3. Standard package outline.
4. Simple power requirements.
5. Electrical compatibility with N-Series decades and R-Seri "MINISIG"® indicators.
6. Choice of repairable modules, encapsulated modules for i dustry, and encapsulated modules for military application

In general, circuit design is based on *saturated* operation the transistors involved, except where fully reliable performan can be achieved using *unsaturated* operation. Each circuit desig is based on derated specifications for the components used; a the resulting circuit specifications are then further derated give reserve reliability. (For example, the guaranteed operati frequency range of a typical T-Series circuit may be derat by 50%.)

The usual *operating* temperature range for T-Series circui is —45°C to +65°C, with variations as noted on the individu specification sheets. Many circuits will operate over a range —54°C to +71°C. *Storage* temperature range is —55°C to +75° The specifications for each circuit apply throughout the opera ing temperature range, and are guaranteed *minimum* specific cations. As a result, if the ambient temperature is stabilize the frequency range, loading capability, etc., of the circui involved will generally be improved.

IMPORTANT: Although power and ground connections a generally compatible throughout the T-Series, all pins should checked in catalog schematics before wiring of sockets.

POWER CONNECTIONS

Power connections are standardized throughout the T-Series the greatest degree consistent with the most effective use of t number of pins available. For standard catalog circuits, t following uniform pin connections are used to simplify b wiring of sockets:

1. In all cases, *without exception:*
   Pin 1 = —12 volts dc
   Pin 9 = case ground
2. In most cases, *with typical exceptions* as noted:
   Pin 6 = —12-volt common
   EXCEPTIONS:
   a. PNP emitter followers and DC Logic units require bo a +12-volt dc and a —12-volt dc supply in contrast other units, which require —12 volts dc only. On the units:
      Pin 6 = +12 volts dc
      (Examples: PNP emitter followers T-111, T-112, a T-113; DC Logic units T-404, T-405, T-406, and T-407
   b. On units requiring an extra signal connection and 12-volt common:
      Pin 6 = Signal connection
      (Example: Shift Register Logic T-600.)
3. In some cases:
   Pin 5 = +12 volts dc
   (Example: Pulse "And" Gate T-410A.)

SPECIAL AND CUSTOM CIRCUITS

We invite quotation requests to produce special units tailored to your specific needs. Because of our package design and assembly methods, we can produce these specials at a cost favorably comparable to the cost of producing an equal number of standard items.

T-SERIES BLANK HARDWARE

Blank T-Series containers, as well as accessory hardware for companion equipment, are available in limited quantities for prototype development or for "one-of-a-kind" circuits. A complete listing of available hardware may be found in the price list.

CUSTOM CIRCUITS

In order to ensure complete system or equipment compatibility, EECO will package large or small quantities of any circuit of your design in T-Series plug-in containers. Prices on your special circuits may be estimated within 15% to 25% by comparing your circuit with similar circuits in the T-Series. When quotations are requested, or when orders are placed on an "advise-price" basis, the following is required:

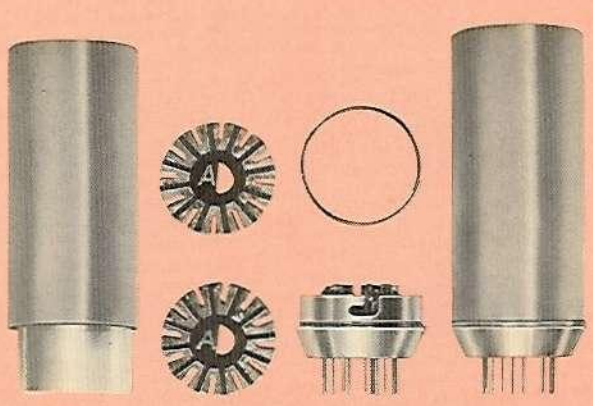
1. Circuit schematic
2. Bill of materials, with:
   - Transistor and/or diode type
   - Resistor values, tolerances, and wattages
   - Capacitor values, tolerances, and voltages

NOTE: Unless component values are otherwise specified, 5% resistors and 20% capacitors will be quoted.

UNIQUE BREADBOARD KIT

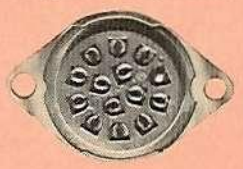
The EECO Breadboard Kit for use with T-Series plug-in circuits is a powerful systems-design tool for the engineer, and also is valuable as a training and educational aid. The breadboard panels have the necessary permanent wiring to accommodate any regular circuit and all other circuit interconnections are made by patch cords or plugs. Therefore, no soldering is needed, and experimental arrangements of T-Series units can be quickly set up, changed, or taken down without waste of time or materials.

The breadboarding system is designed around plastic circuit cards with circuit symbols showing input and output connections, power connections, part number, application notes, etc. These cards fit on the panel below sockets for the plug-in units, and match a pattern of banana jacks that are permanently wired to pins on the sockets. Holes in the circuit cards expose the appropriate socket pin connections. Power connections are made by shorting plugs, which also align the cards with the jack pattern and hold the cards in place. Signal connections are made by patching card-to-card in the circuit line-up being tried. All T-Series units *with pin 1 used for −12 volts*, whether 9-pin, 13-pin, or special units, can be used on the breadboard panels.

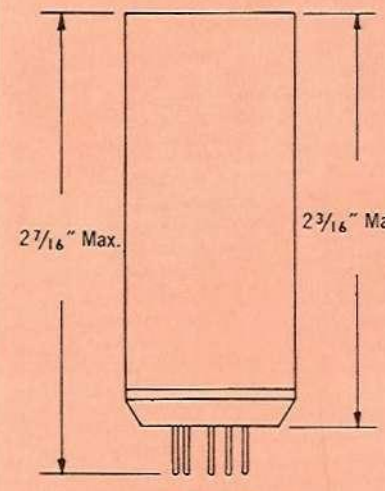


T-906 T-Series container parts include 13-pin header and two discs. Also available with three discs as T-908. (Pat. appl'd.)

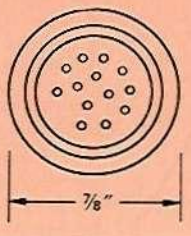
T-904 T-Series container is identical with T-906 (shown above), but is supplied with 9-pin header. (Pat. appl'd.)



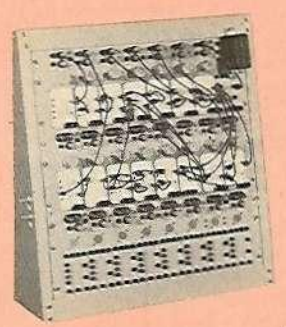
T-937 Socket, 14-pin, with pin 10 plugged for keyway orientation. Mates with T-906, T-908, or any T-600-Series logic unit.



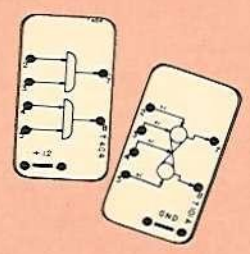
End view of typical T-Series unit. Mates with standard 9-pin miniature noval socket.



End view of typical T-600-Series unit. Mates with standard 14-pin miniature socket with pin 10 blanked for keyway orientation (EECO Part No. T-937).



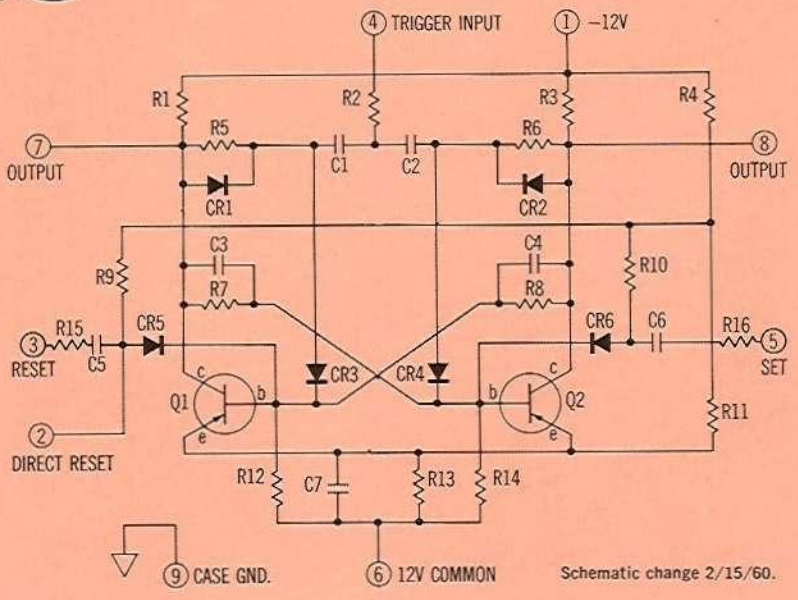
T-Series Breadboard.



Plastic circuit cards used with EECO T-Series Breadboard Kit.

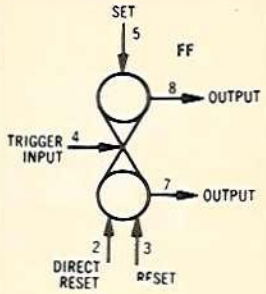
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



Schematic change 2/15/60.

RST FLIP-FLOP



T-101B

MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

• Specifications revised 2/15/60.

The T-101B is a general-purpose RST flip-flop; for service as a storage or memory device, or as a frequency divider. Also useful for pulse-width generation and scanning.

Standard operating frequency is 0 to 250 kc. Saturated operation of the transistors is employed at the sacrifice of higher-speed operation to obtain maximum independence of transistor parameter variations and to provide maximum stability and reliability. All inputs are diode isolated and are sensitive to positive polarity only.

The T-101B can be triggered in either of two modes:

1. In the T (trigger or binary) mode, each input pulse changes the state of the flip-flop.
2. In the RS (reset and set) mode, the circuit responds to *alternate* set and reset pulses; successive set pulses do not disturb the set state, for example.
   a) A pulse on the set input will drive output "7" to the "1" state (−3 volts), and output "8" to the "0" state (−11 volts).
   b) Reset inputs give the opposite effect.
   c) The direct reset input is for use when several flip-flops are to be synchronously reset by a dc reset generator.

ELECTRICAL SPECIFICATIONS

Input:

General Range: 6 to 9 volts between 0.1 and 1 microsecond rise time.

Inputs Available: Set, Reset, Trigger, and DC Reset.

Signal Frequency Range: Standard range is 0 to 250 kc in RS or in T mode. In the T mode, input signals to 400 kc are permissible with lighter loading, e.g., one emitter follower on each output and a minimum input of 7 volts at 0.4 microsecond rise time.

• In the RS mode, the minimum *separation* between a set pulse and the following reset pulse (or between a reset pulse and the following set pulse) is 3.3 microseconds. The minimum *recovery time* between the decay of a set pulse and the rise of the following set pulse (or between the decay of a reset pulse and the rise of the following reset pulse) is 5 microseconds.

Minimum Input Amplitude (R, S, or T input): The T-101B will *not* trigger on a positive-going pulse of 1½ volts or less, regardless of rise time. The T-101B will *always* operate on a positive-going pulse of 6 volts or greater at a rise time of 1 microsecond or faster.

Maximum Input Amplitude: 9 volts peak.

Rise Time: 0.1 to 1.0 microsecond. (Rise = positive-going; fall = negative-going.)

Input Impedance: Pin 4: 1.8 K resistive in series with 500 $\mu\mu$f capacitive. Pin 3 or pin 5: 470 $\mu\mu$f capacitive.

Output:

Outputs Available: Two, of opposite state: "0" output and "1" output.

Amplitude, Unloaded: 8-volt level shift from −11 volts dc to −3 volts dc, nominal.

Rise Time: 0.2 to 1.0 microsecond, depending on load and input signal.

Fall Time: Approximately 2.0 microseconds. (Rise = positive-going; fall = negative-going.)

Loading:

Typical load is a paralleled combination of 1 flip-flop, 1 emitter follower, and 50 $\mu\mu$f capacitance to ground.

Resistive Loading Effects:

a) dc load of 0.2 ma to a positive source or 1.0 ma to a negative source will cause a ½-volt level shift.

b) dc load of 0.4 ma to a positive source or 2.0 ma to a negative source will cause a 1-volt level shift.

Power Required:

−12 volts dc at 5 ma. Pin 1 to be negative with respect to pin 6.

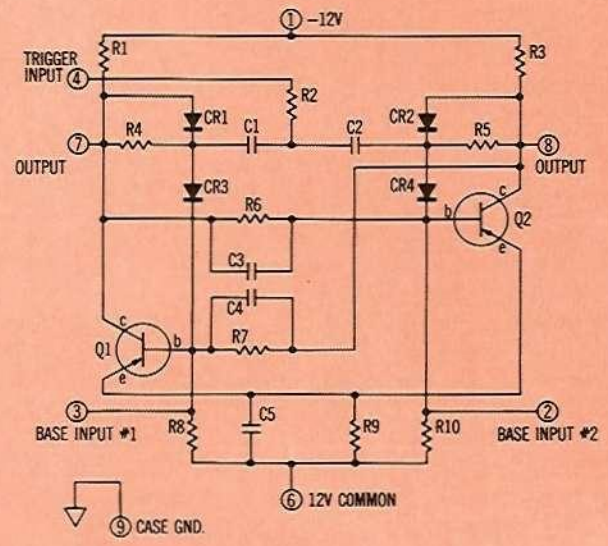
Supply voltage tolerance ±10%.

Operating Temperature Range: −45°C to +65°C.

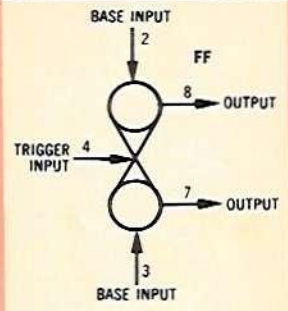
ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



T FLIP-FLOP



T-102A

MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

The T-102A is a T flip-flop; for service as a storage or memory device, and as a frequency divider. The T-102A is very similar to the general-purpose T-101A except that the diode-isolated set and reset inputs have been eliminated and replaced with a direct connection to the base of each transistor. For applications where a flip-flop will be used only with a binary or trigger input, a substantial cost saving is permitted.

The T-102A is basically intended to be triggered in the T (trigger or binary) mode, where each input pulse changes the state of the flip-flop. Standard operating range is 0 to 250 kc.

The units can also be used in set and reset operation where external circuitry contains the proper input circuit permitting set and reset connections to be made directly to the transistor base.

The base connections are normally used in conjunction with pulse logic circuits, to supply dc set and reset input pulses via diodes within the logic units.

ELECTRICAL SPECIFICATIONS

Input:

Trigger Input (pin 4):

General Range: 6 to 9 volts between 0.1 and 1 microsecond rise time.

Signal Frequency Range: 0 to 250 kc. Input signals to 400 kc are permissible with lighter loading, e.g., one emitter follower on each output and a minimum input of 7 volts at 0.4 microsecond rise time.

Minimum Input Amplitude: The T-102A will *not* trigger on a positive-going pulse of 1½ volts or less, regardless of rise time.

The T-102A will *always* operate on any positive-going pulse of 6 volts or greater at a rise time of 1 microsecond or faster.

Maximum Input Amplitude: 9 volts peak.

Rise Time: 0.1 to 1.0 microsecond.

Input Impedance: 3.6 K resistive, in series with 500 $\mu\mu$f capacitive.

ELECTRICAL SPECIFICATIONS (cont.)

Base Input (pins 2 and 3): The minimum pulse amplitude for these inputs should change from a nominal −3.5-volt dc level to a −1.0-volt dc level. Other conditions consistent with triggered input specifications listed above.

Output:

Outputs Available: Two, of opposite state: "0" output and "1" output.

Amplitude, Unloaded: 8-volt level shift from −11 volts dc to −3 volts dc, nominal.

Rise Time: 0.2 to 1.0 microsecond, depending on load and input signal.

Fall Time: Approximately 2.0 microseconds. (Rise = positive-going; fall = negative-going.)

Loading:

Typical load is a paralleled combination of 1 flip-flop, 1 emitter follower, and 50 $\mu\mu$f capacitance to ground.

Resistive Loading Effects:

a) dc load of 0.2 ma to a positive source or 1.0 ma to a negative source will cause a ½-volt level shift.

b) dc load of 0.4 ma to a positive source or 2.0 ma to a negative source will cause a 1-volt level shift.

Power Required:

−12 volts dc at 4.6 ma. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance ±10%.

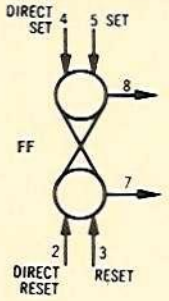
Operating Temperature Range: −45°C to +65°C.

ONE-HALF ACTUAL SIZE

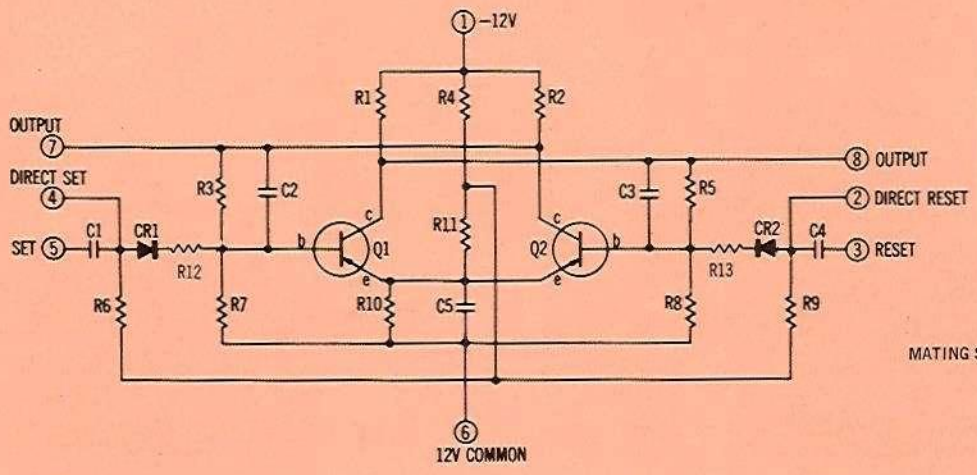
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

RS FLIP-FLOP



T-103



MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

● Specifications revised 2/15/60.

The T-103 is an RS Flip-Flop very similar to the general purpose T-101. It differs in that the binary or trigger input has been deleted with a substantial reduction in cost for applications where that input is not used. A direct set input has been added. Typical use for the T-103 would be for storage, memory, pulse width generation, or scanning.

The T-103 can be triggered in either the R or S (Reset and Set) modes, directly or through internally contained capacitors.

1. a) A pulse on the set input will change Output 7 to the "1" condition (−3 volts), and Output 8 to the "0" condition (−11 volts). There will be no change for a set input if the flip-flop is already in this condition.
   b) The inverse is true for the Reset input.
   c) The direct reset and direct set are for use when several flip-flops are to be set and reset in synchronism as when a dc reset generator is used.
2. The standard operating range for the T-103 is 0 to 300 kc.

ELECTRICAL SPECIFICATIONS

Input:

General Range: 6 to 9 volts between 0.1 and 1 microsecond rise time.

Inputs Available: Set, Reset, Direct Set, and Direct Reset.

● Signal Frequency Range: Effectively 0-300 kc with alternate pulses fed to the set and reset inputs. The minimum *separation* between a set pulse and the following reset pulse (or between a reset pulse and the following set pulse) is 3.3 microseconds. The minimum *recovery time* between the decay of a set pulse and the rise of the following set pulse (or between the decay of a reset pulse and the rise of the following reset pulse) is 5 microseconds.

Minimum Input Amplitude: The T-103 will *not* trigger on a positive-going pulse of 1½ volts or less, regardless of rise time.

The T-103 will *always* operate on any positive-going pulse of 6 volts or greater at a rise time of 1 microsecond or faster.

Maximum Input Amplitude: 9 volts peak.

Rise Time: 0.1 to 1.0 microsecond. (Rise = positive-going; fall = negative-going.)

Input Impedance: 270 μμf maximum, pins 3 and 5.

Output:

Outputs Available: Two, of opposite state: "0" output and "1" output.

Amplitude, Unloaded: 8-volt level shift from −11 volts dc to −3 volts dc, nominal.

Rise Time: 0.4 to 1.0 microsecond, depending on load and input signal.

Fall Time: Approximately 1½ microseconds.

Loading:

Typical load is a paralleled combination of 1 flip-flop, 1 emitter follower, and 50 μμf capacitance to ground.

Maximum resistive loading is:
0.2 ma to a positive source.
1.0 ma to a negative source.

Power Required:

−12 volts dc at 4 ma. Pin 1 to be negative with respect to pin 6.

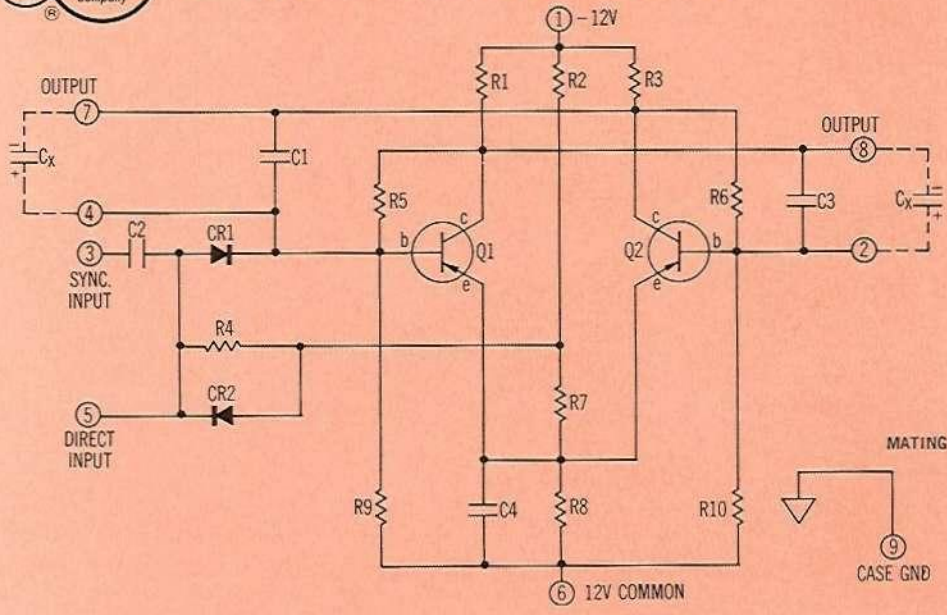
Supply voltage tolerance: ±10%.

Operating Temperature Range: −45°C to +65°C.

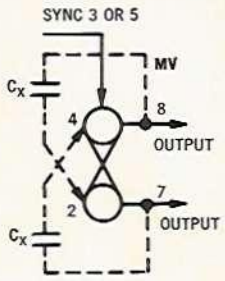
ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



MULTIVIBRATOR



T-104

MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

A general-purpose multivibrator, for use in generating square waves and time base frequencies, and for frequency division or multiplication. The operating frequency is determined by two external capacitors.

The T-104 can be used in either a free-running or synchronized mode. The free-running frequency may be in the range of 1 cycle per minute to 380 kc. The circuit may be synchronized by either a multiple or sub-multiple of the desired output frequency. Upper frequency limit for locked operation is 150 kc.

ELECTRICAL SPECIFICATIONS

Input: (Sync input; no input for free-running mode).

Frequency Range: 1 pulse per minute to 325 kc.

Amplitude: Maximum, 9 volts; minimum, 6 volts. Note: Circuit will *not* respond to signals smaller than 1.5 volts, regardless of rise time; and will *always* synchronize on a positive-going pulse or step of 6 volts with a rise time of 1.0 microsecond or better.

Rise Time: 0.1 to 1.0 microsecond (pin 3); for sync signals with poorer rise time, feed sync to pin 5 through a suitable external capacitor.

Input Impedance: 270 $\mu\mu$f (pin 3).

Output:

Outputs Available: Two of opposite polarity: "0" output and "1" output.

Amplitude: 8-volt level shift from −11 volts dc to −3 volts dc nominal.

Rise Time: 0.4 microsecond nominal under typical load.

Fall Time: Approximately 25% of period.

Period of Oscillation: Total period is determined by two external capacitors (C_x) connected between pins 2 and 8 and pins 4 and 7. The period is determined by the following formula:

$C_x = 45$ (T-2.6),

where C_x = Cap. in $\mu\mu$f, each capacitor and

T = Period in microseconds, free-running mode.

ELECTRICAL SPECIFICATIONS (cont.)

Minimum Period: 2.6 microseconds. ($C_x = 0$.) This corresponds to maximum free-running frequency of 380 kc, unloaded.

Maximum Period: 60 seconds. (The above formula applies only for periods up to 1 second.)

Loading: Typical loads are:

a) Below 100 kc: 2 flip-flops.

b) Above 100 kc: 1 flip-flop.

Synchronizing Frequency Range:

The T-104 can be locked to a frequency that is somewhat *higher* than its free-running frequency. The range over which positive synchronization is obtained for various locking harmonics is shown in the following table. (This table is valid for free-running frequencies up to 150 kc.)

HARMONIC	LOCKING RANGE
f	0 to +25%
2f*	0 to +12%
f/2	0 to +7%
f/3	0 to +4.5%
f/4	0 to +3.5%
f/5	0 to +2.5%

*When locked at 2f, output loading is restricted to pin 8 only.

Power Required:

−12 volts dc at 5.5 ma. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance ±10%.

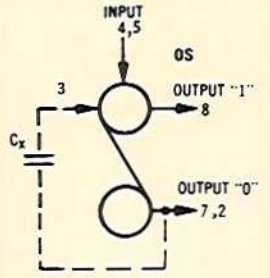
Operating Temperature Range: −45°C to +65°C.

ONE-HALF ACTUAL SIZE

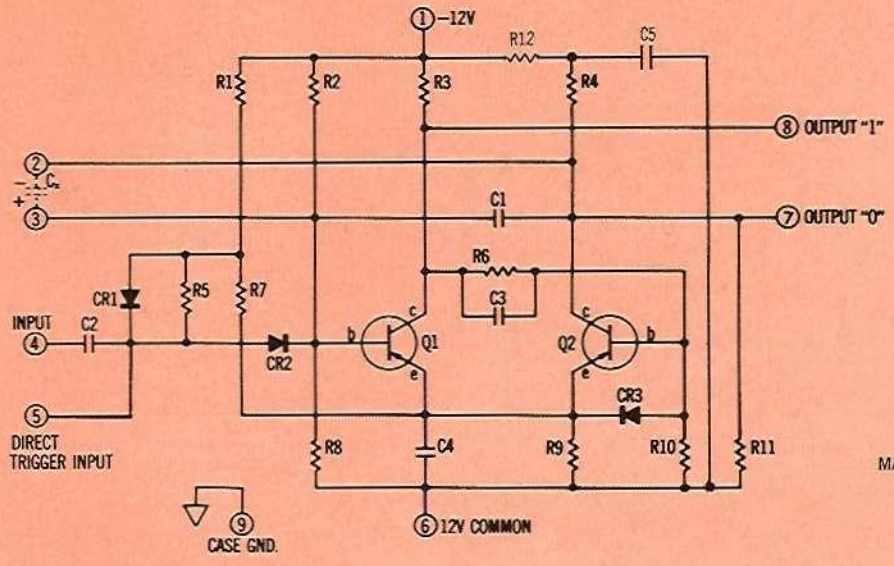
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

ONE-SHOT MULTIVIBRATOR



T-105



MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

The T-105 is a transistor One Shot for general application. It uses two PNP germanium transistors in saturated operation to obtain maximum independence of transistor parameter variations and therefore maximum stability and reliability. Typical uses for the T-105 include pulse width generation, time delay, and temporary digit storage.

The T-105 is triggered by a positive pulse or positive-going input step. Two outputs (rectangular pulses of opposite polarity) are available. Pulse widths from 2 microseconds ($C_x = 0$) to 50 milliseconds ($C_x = 2.5$ μf approximately) are obtainable at duty cycles up to 70%. Maximum pulse duration is approximately one second, with $C_x = 50$ μf. When using a polarized capacitor, the positive terminal should be connected to pin 3.

ELECTRICAL SPECIFICATIONS

Input:

Signal Frequency Range: 0 to 250 kc.

Trigger Input Amplitude (pin 4):

a) The T-105 will *not* trigger on a positive input pulse of 1.5 volts or less, regardless of rise time.

b) The T-105 will *always* operate on a positive input pulse of 5 volts with a rise time of 1 microsecond.

c) Sensitivity is correspondingly greater for sharper rise times.

d) Maximum trigger input is 9 volts peak.

e) Rise time range is from 0.1 microsecond to 1.0 microsecond.

Direct Trigger Input Amplitude (pin 5):

Minimum pulse amplitude for this input is −4.5 VDC level to −1 VDC level; other trigger characteristics consistent with Trigger Input above.

Output:

Outputs Available: Two of opposite polarity: "0" output (pin 7), "1" output (pin 8).

Amplitude, Unloaded: 8-volt level shift from −11 volts dc to −3 volts dc, nominal.

Rise Time: 0.4 microsecond nominal under typical load.

Fall Time (no load): Output "1," 1.5 microseconds; output "0," 20% to 30% of pulse duration, depending on input frequency.

Pulse Duration: The duration of the output pulse is primarily determined by an external capacitor connected between pins 2 and 3. The relation between capacity and duration is given by:

$$C_x = 50\ (t - 2)$$

where t is in microseconds, C_x is in $\mu\mu$f. When using polarized capacitor, pin 3 is positive.

The minimum pulse duration is 2 microseconds with no external capacitor used. The maximum pulse duration is 1 second with $C_x = 50$ μf.

Duty Cycle: Duty cycle is a maximum of 70% up to 50 kc; 60% up to 250 kc. Duty cycle may be varied from 20% to 50% with a variable resistance in series with C_x. For this type of service, an appropriate value of C_x is selected to give 50% duty cycle: then a 200K variable resistance in series with C_x will permit varying the duty cycle between limits of 20% and 50%.

Loading:

A typical load for the "0" output (pin 7) is 2 flip-flops for frequencies up to 125 kc and 1 flip-flop from 125 kc to 250 kc. A typical load for the "1" output (pin 8) is 2 flip-flops for all frequencies.

Power Required:

−12 volts dc at 5 ma. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance ±10%.

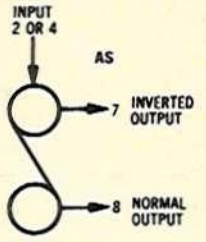
Operating Temperature Range: −45°C to +65°C.

ONE-HALF ACTUAL SIZE

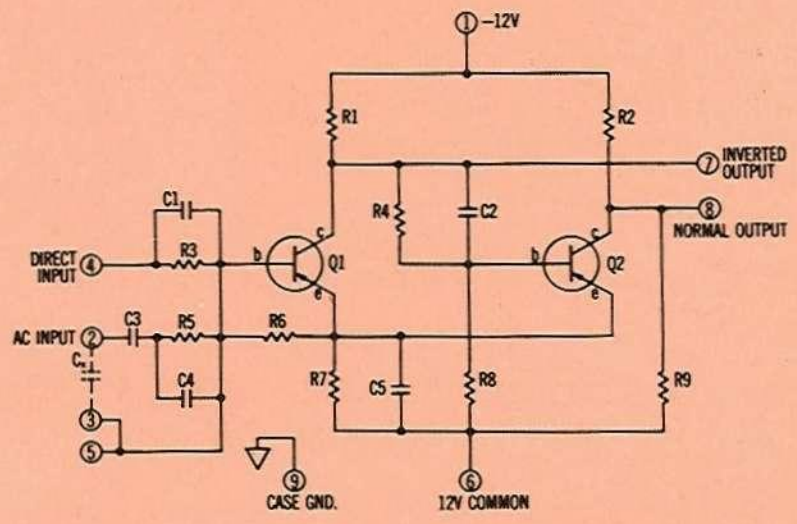
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

SQUARING AMPLIFIER



T-106



MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

The T-106 general-purpose Squaring Amplifier is typically used for such purposes as waveform restoration, signal level shifting, "Not" circuits, squaring sinusoidal or nonrectangular inputs, pulse amplification, and dc level detecting. Two outputs are available, (a normal and an inverted output), both of which are rectangular waveforms of opposite polarities.

The unit is a modified Schmidt Trigger which remains in one output state until the input exceeds the trigger level. At this time the output levels switch to the opposite condition.

The trigger level is adjustable. Without external connection (pin 5 floating), the threshold level is −2.5 volts dc. Suitable bias connected to pin 5 will establish different trigger levels to fit various applications. For example, in a system using our standard signal levels of −3 and −11 volts, a threshold of −6.5 volts is suggested to permit the T-106 to function as a "Not" circuit or signal restorer. The −6.5 volt threshold occurs when pin 5 is connected to our standard +12 volt dc supply through a 47,000-ohm resistor.

ELECTRICAL SPECIFICATIONS

Input:

Direct Input (pin 4): Signal must shift above and below the threshold level (−2.5 volts dc) by + .. volt and −2½ volts dc, which would be a dc level shift from −2 volts dc to −5 volts dc. A signal possessing this minimum level excursion can be shifted to encompass the desired range by suitable biasing on pin 5 (i.e., by connecting an external resistor to ±12 volts dc). Maximum ramp time for 3-volt signal excursion is 300 microseconds for an input signal with source impedance of 5.6 K maximum.

AC Input (pin 2): 4 volts peak-to-peak sine wave, minimum; 5 volts nominal; 12 volts maximum.

Operating Frequency Range: 0 to 500 kc (pin 4), and 50 kc to 500 kc (pin 2), nominally.

a) with sine wave inputs lower than 50 kc, pin 2 input is used, with external capacitor between pins 2 and 3:

1 kc to 5 kc – 0.1 μf
5 kc to 25 kc – 0.022 μf
25 kc to 50 kc – 0.0047 μf

b) operating frequency may be extended up to 1 mc/s with sine wave input of 6 volts peak-to-peak, (pin 2) and emitter follower loading.

ELECTRICAL SPECIFICATIONS (cont.)

Output:

Normal Output (pin 8): Rectangular signals of 8 volts peak-to-peak amplitude, unlcaded levels are −11 volts dc and −3 volts dc, nominal.

Rise Time Normal Output: 0.6 microsecond, nominal under loaded conditions.

Inverted Output (pin 7): Rectangular signal of 8 volts peak-to-peak amplitude, unloaded levels are −11 volts dc and −3 volts dc, nominal.

Rise Time Inverted Output: 0.8 microsecond, nominal under loaded conditions.

Loading:

Typical, up to 2 paralleled flip-flop inputs.

Power Required:

−12 volts dc at 5.0 ma. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance: ±10%.

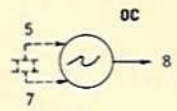
Operating Temperature Range: −45°C to +65°C.

ONE-HALF ACTUAL SIZE

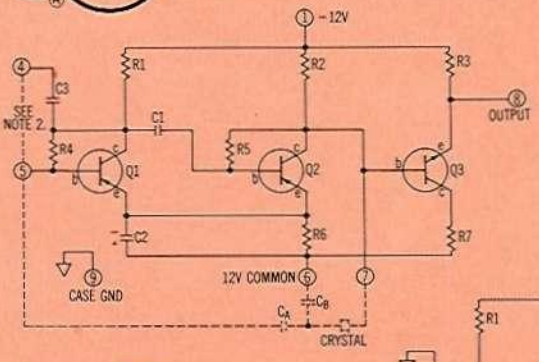
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

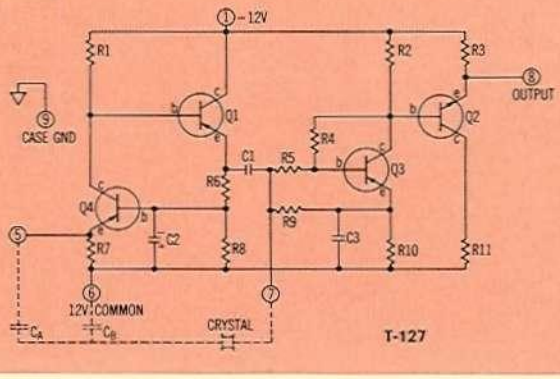
CRYSTAL OSCILLATORS



T-107, T-127



T-107



T-127

NOTES:
1) C_a and C_b are trimmer capacitors to adjust crystal frequency ±.001%. (See table.) If no trimming is required, omit C_a and C_b and connect crystal between pins 5 and 7.
2) Jumper pin 4 to pin 5 on T-107 for operation at 10 kc to 45 kc.

MATING SOCKET (BOTH UNITS): 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

• Specifications revised 2/15/60.

These units are transistorized crystal oscillators, the T-107 containing two germanium PNP transistors in a two-stage saturated feedback amplifier and one germanium NPN transistor connected in emitter follower configuration; the T-127 containing two germanium PNP transistors as a Butler crystal oscillator circuit, one germanium PNP transistor for squaring, and one germanium NPN transistor as emitter follower. The output of both units is a square wave at the crystal resonant frequency. Units are normally supplied without crystals, but may be supplied with crystals cut to specific frequencies. For maximum stability, an oven may be supplied in which is mounted both the unit and the crystal. (See crystal and oven specifications on reverse.)

The crystal is used in the series-resonance mode for maximum stability. In the T-107, the crystal acts as the coupling impedance between the output of the second stage and the input to the first stage; in the T-127, it acts as the coupling impedance between the two stages of the Butler circuit, with one stage as common collector and the other stage as common base. Since a full 360° phase shift occurs through two cascaded common emitter transistor amplifiers of the T-107 and 0° phase shift occurs through cascaded CC-CB stages of the T-127, both circuits will oscillate at a frequency that experiences neither phase shift nor appreciable attenuation through the crystal. This frequency is the series-resonant frequency of the crystal. The T-107 covers the frequency range of 10 kcs to 75 kcs; the T-127 covers the frequency range of 75 kcs to 250 kcs.

These assemblies are contained in cylindrical plug-in packages that insert into a standard 9-pin miniature tube socket. The crystal in each case is connected externally. It is recommended that the crystal be mounted alongside the electronic assembly in order to reduce shunt capacitance between the crystal leads.

ELECTRICAL SPECIFICATIONS

T-107

Output:
- Frequency Range: 10 kcs to 75 kcs. (For 10 kcs to 45 kcs, jumper pin 4 to pin 5.)
- Amplitude: 8 volts peak-to-peak, from −11 volts to −3 volts with respect to pin 6.
- Stability: Frequency ±.005%, amplitude ±10%. (Frequency stability ±.0005% with crystal and electronic unit in oven.)
- Output Impedance: 800 ohms.
- Rise Time: 0.1 to 1.0 microsecond.
- Frequency Trimming: ±.001% of nominal crystal frequency. (See Frequency Trimming Table.)
- Maximum DC Load: 2.7 K to −12 volts (at 71°C).

Power Requirements:
- −12 volts dc at 7.0 ma (800-ohm ac load).
- Supply voltage tolerance: ±10%.

T-127

Output:
- Frequency Range: 75 kcs to 250 kcs.
- Amplitude: 8 volts peak-to-peak, from −11 volts to −3 volts with respect to pin 6.
- Frequency Stability: ±.001% maximum, ±.0005%

(Continued)

ONE-HALF ACTUAL SIZE

● Crystal specifications added 2/15/60.

typical (under maximum combined variations of temperature, supply voltage, and load; with crystal in oven).
Output Impedance: 1000 ohms (ac loaded).
Rise Time: 1.0 microsecond maximum, 0.4 microsecond typical.
Frequency Trimming: ±.001% of nominal crystal frequency. (See Frequency Trimming Table.)
Maximum DC Load: 2.7 K to −12 volts (at 71°C).

Power Requirements:
−12 volts dc at 10 ma (1000-ohm ac load).
Supply voltage tolerance: ±10%.

SPECIFICATIONS
CRYSTAL OVEN ASSEMBLIES

MODEL NO.	DESCRIPTION	FREQUENCY RANGE	DIMENSIONS
H-143	Contains crystal holder for MC-6A, MC-13A, or MC-131A crystal. Works with T-107 or T-127 Crystal Oscillator (mounted separately)	10 kc to 250 kc, depending on crystal	Cylindrical; 1.28" OD x 3½" seated height
● H-149	Oven assembly for one MC-13A crystal and one T-107 Crystal Oscillator	10 kc to 45 kc	Rectangular; 2" x 2-1/2" x 3-5/16" seated height
● H-150	Oven assembly for one MC-6A, MC-13A, or MC-131A crystal and one T-107 or T-127 Crystal Oscillator	45 kc to 75 kc or 75 kc to 250 kc, depending on Crystal Oscillator and crystal	Rectangular; 2" x 2-1/2" x 3-5/16" seated height

NOTE: All above units mate with standard octal socket. Choice of 28-V or 115-V heater supply. Specify with order.

FREQUENCY TRIMMING TABLE
CAPACITANCE VS. FREQUENCY CHANGE
(typical, depending on crystal parameters)

CRYSTAL OSCILLATOR	△ F	SERIES	SHUNT
	(%)	C_A (μμf)	C_B (μμf)
T-107	+.0010	170	0
	+.0005	400	0
	+.0002	700	0
	.000	Jumper	0
	−.0002	Jumper	160
	−.0005	Jumper	300
	−.0010	Jumper	500
	(%)	C_A (μf)	C_B (μf)
T-127	+.0010	.003	0
	+.0005	.007	0
	.000	Jumper	0
	−.0005	Jumper	.003
	−.0010	Jumper	.005

Operating Temperature Range of both units is −54°C to +71°C.

OSCILLATOR

SPECIFICATIONS
T-107 CRYSTALS

● The H-145 is a quartz crystal unit to be used with the T-107 crystal oscillator. The crystal can be cut for any frequency within the range 10 kc to 75 kc and is available in several holder types. See Chart I for specific crystal parameters. A specific crystal is completely described by a dash number following the general designation H-145. For example, the H-145-1 unit is a 10-kc J-element mounted in an MC-13A holder. All H-145 crystal made for series resonant operation, with drive level of 0.1 milliwatt maximum motional resistance of 100k ohms.
For best frequency stability, the crystal should be operated in an oven as the H-149, H-150, or H-143.

CHART I

Dash No.	Frequency	Holder Type	Element	Type Cut	Calib. Accuracy	Max. Temp. Coeff. at Tr	Reference Temp. (Tr)
−1	10 kc	MC-13A	J	+5°X	±.001%	−4 PPM/°C	+70°C
−2	15 kc	MC-13A	J	+5°X	±.001%	−4 PPM/°C	+70°C
−3	16 kc	MC-13A	N	NT	±.001%	−4 PPM/°C	+70°C
−4	75 kc	MC-13A	N	NT	±.001%	−2.5 PPM/°C	+70°C

SPECIFICATIONS
T-127 CRYSTALS

● The H-146 is a quartz crystal unit to be used with the T-127 crystal oscillator. The crystal can be cut for any frequency within the range 75 kc to 250 kc and is available in several holder types. See Chart II for specific crystal parameters. A specific crystal is completely described by a dash number following the general designation H-146. For example, the H-146-1 unit is a 75-kc E-element mounted in an MC-131A holder. All H-146 crystal made for series resonant operation, with a drive level of 2 milliwatts a maximum motional resistance of 2.5k ohms.
For best frequency stability, the crystal should be operated in an oven as the H-150 or H-143.

CHART II

Dash No.	Frequency	Holder Type	Element	Type Cut	Calib. Accuracy	Max. Temp. Coeff. at Tr	Reference Temp. (Tr)
−1	75 kc	MC-131A	E	+5°X	±.001%	−2.5 PPM/°C	+70°C
−2	100 kc	MC-13A	E	+5°X	±.001%	−2.5 PPM/°C	+70°C
−3	175 kc	MC-6A	D	DT	±.001%	±1 PPM/°C	+70°C
−4	250 kc	MC-6A	D	DT	±.001%	±1 PPM/°C	+70°C

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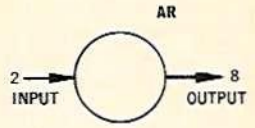
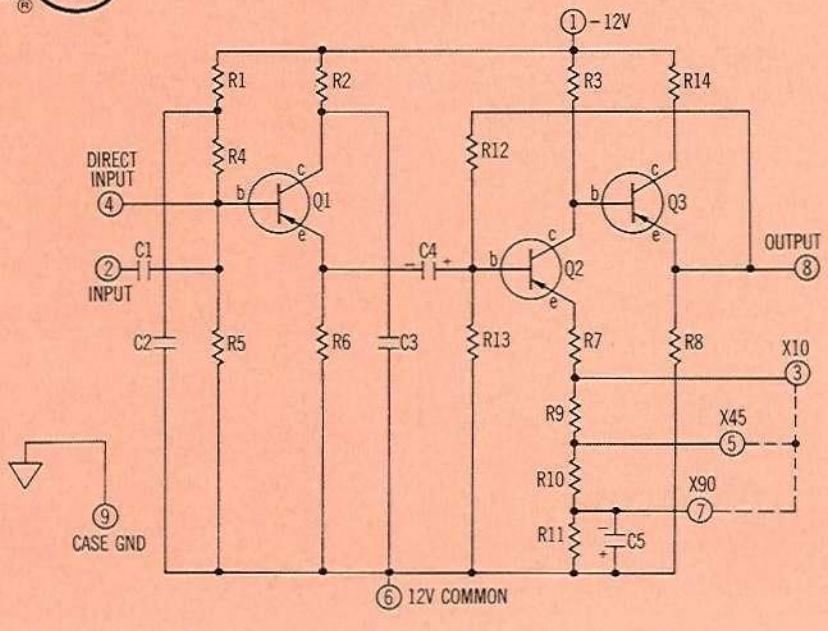
"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

LINEAR AMPLIFIER



T-108



MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

NOTES:
1. AMPLIFIER VOLTAGE GAINS OF X10, X45, X90 SELECTABLE BY JUMPERING PINS AS INDICATED.

CIRCUIT DESCRIPTION

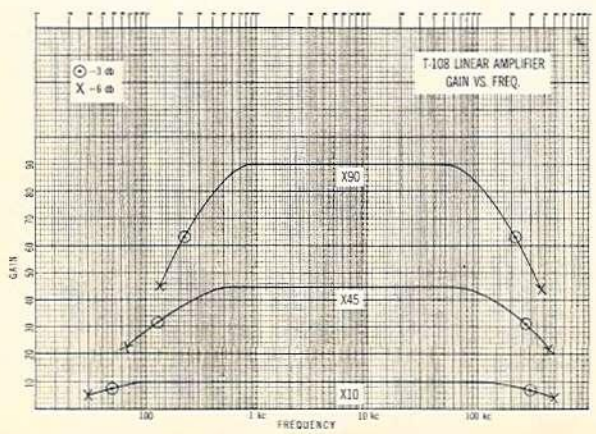
A linear amplifier circuit for small input signals. Input can be sine waves, square waves, pulses, or complex wave forms, provided the frequency components of the signal are within the response range of the amplifier. Input sources include voltage pick ups, low-level transducers, etc.

The T-108 offers good frequency response, high input impedance, low output impedance, good stability, and three selectable, fixed gains. Other features include provision for using external R-C components to give intermediate fixed or adjustable gain, and/or extended low-frequency response.

ELECTRICAL SPECIFICATIONS

Input:

General Range: 30 cps to 500 kc sine wave, or complex wave form with frequency components in this range: Low frequency response may be extended by coupling input through a large external capacitor to pin 4 and by additional external by-passing of R-11.



ELECTRICAL SPECIFICATIONS (Cont.)

Amplitude: 5 mv to 0.6 volts, peak to peak, depending on gain. This range will give linear operation. Maximum input amplitude is 12 volts, peak to peak.

Input Impedance (pin 2): Varies with frequency and gain. For example:
a. at 100 cps, 20 K to 41 K, approximately.
b. at 1 kc, 10 K to 33 K, approximately.
c. at 100 kc, 3 K to 18 K, approximately.

Output:

General Characteristics: Emitter follower output, with signal inverted (180° phase reversal) relative to input. DC level is —7.0 volts, nominal. Frequency response versus gain is shown on the chart. Low frequency response may be extended by the use of external capacitors. Capacitor polarity must be observed.

Amplitude: 6 volts, peak to peak, maximum undistorted.

Gain: 10, 45, or 90, selectable by jumpers; intermediate between 10 and 90, selectable by fixed or variable resistance connected between pins 3 and 7.

With *socket* jumpers:
a. Gain = 10: None.
b. Gain = 45: Jumper 3 and 5.
c. Gain = 90: Jumper 3 and 7.

Loading: Typical load is a squaring amplifier.

Random Noise: 20 mv, peak to peak.

Power Required:
—12 volts dc at 2.5 ma. Pin 1 to be negative with respect to pin 6.
Supply voltage tolerance ±10%.

Operating Temperature Range: —45°C to +65°C.

ONE-HALF ACTUAL SIZE

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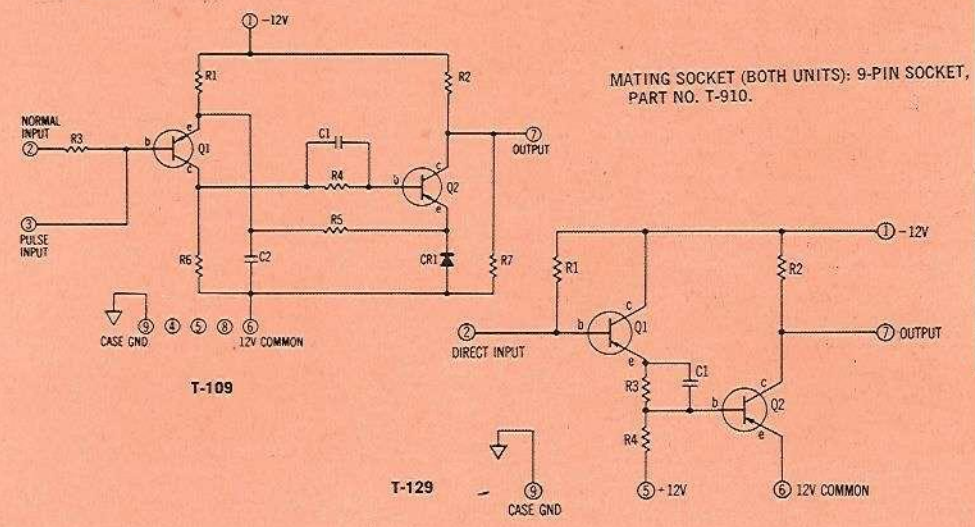
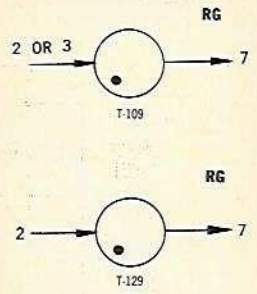
"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



MATING SOCKET (BOTH UNITS): 9-PIN SOCKET, PART NO. T-910.

RESET GENERATORS



T-109, T-129

T-129 symbol corrected 2/15/60.

CIRCUIT DESCRIPTION

These units are transistorized DC Reset Generators, the T-109 for the purpose of resetting (or setting) up to 15 flip-flops and the T-129 for the purpose of resetting up to 6 N-Series decades.

In use, the T-109 output is applied to the direct reset (or set) input of the flip-flops concerned. While the input to the T-109 is −3 volts, nominal, one of the transistors in each flip-flop is held in a cut-off condition, and normal flip-flop operation is suspended. When the input to the T-109 is −11 volts, nominal, the flip-flops will respond to their normal input signals.

The T-129 holds all decades continuously in the reset condition for the duration of an applied input signal. Upon removal of the input signal, all decades are immediately allowed to return to their normal operation condition. The T-129 is to be used when a negative pulse or level is required for resetting. If, during reset, the input to the decade is not gated and pulses are fed to the decade, the first stage N/2 in the decade will have an output, but this will not be coupled through the decade.

The standard input for either unit is an 8-volt dc level shift (−11 to −3 volts) such as would be obtained from a flip-flop, a one shot, or a gate. Pulse resetting may also be employed.

ELECTRICAL SPECIFICATIONS

T-109

Input:
- Minimum Input Amplitude: 5 volts dc level shift from −9 volts dc (reset "off") to −4 volts dc (reset "on").
- Maximum Input Voltage: Between −12 and zero volts dc.
- Maximum Reset Rate: 250 kc.
- Pulse Input: For optional operation with pulse inputs, a 7-volt P-P minimum pulse, positive-going, is applied to pin 3 through a capacitor. Rise time should be 0.1 to 0.6 microsecond. Additional external connections to be made are:
  - a. Connect a 33 K resistor between pins 3 and 6.
  - b. Jumper pins 1 and 2.
- Input Impedance: Greater than 15,000 ohms (pin 2).

Output (pin 7):
- DC Level Shift: From a nominal −5.5 volts dc (reset "off") to −0.3 volt dc (reset "on"). The exact value of the most negative level is determined by the number of flip-flop loads. It is −5.5 volts dc unloaded and approximately −4.5 volts dc loaded with 15 flip-flops.
- Duration: From 1 microsecond, minimum, to dc.
- Rise Time: 0.5 microsecond nominally.
- Fall Time: 0.5 microsecond nominally.

Loading:
- Up to a maximum of 15 flip-flops.

Power Required:
- −12 volts dc at 3.5 ma quiescent; 7 ma during reset period. Pin 1 to be negative with respect to pin 6.
- Supply voltage tolerance: ±10%.

Operating Temperature Range: −54°C to +71°C.

T-129

Input:
- Minimum Input Amplitude: 5.5-volt dc level shift from −9.5 volts dc to −4 volts dc.
- Maximum Reset Rate (service with N-Series): 50 kc.
- For optional operation with pulse inputs, a 7-volt P-P minimum positive level shift with rise time up to 1 microsecond is applied to pin 2 through a capacitor. A 470 $\mu\mu$f capacitor is recommended for approximately a 15-microsecond pulse output.
- Input Impedance: Greater than 25,000 ohms (pin 2).
- Maximum Input Amplitude: −12 volts dc to zero volts dc.
- Resetting is accomplished by a positive pulse or level shift.

Output:
- DC Level Shift: 0 to −12 volts dc (no load). The exact value of the lower level is determined by the number of decade loads. The lower level when operating into a maximum of 6 decades = −4 volts dc.
- Duration: From 15 microseconds, minimum, to dc.
- Rise Time: 0.5 microsecond nominally (dc input), approximately ¼ pulse width (ac input).

Loading:
- Up to a maximum of 6 decades. When loaded with less than 3 decades, insert a 1,000-ohm resistor in series with output.

Power Required:
- −12 volts dc at 20 ma quiescent; 13 ma maximum during reset period. Pin 1 to be negative with respect to pin 6.
- +12 volts dc at 1.5 ma. Pin 5 to be positive with respect to pin 6.
- Supply voltage tolerance: ±10%.

Operating Temperature Range: −54°C to +71°C.

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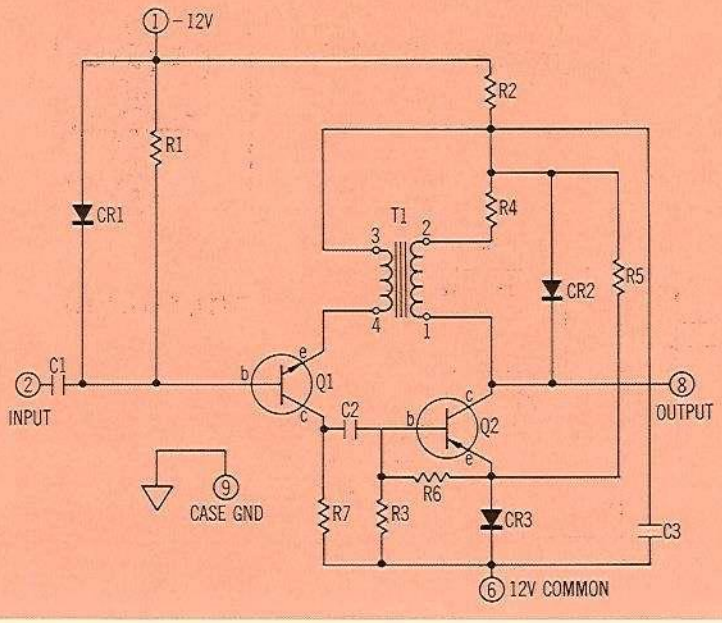
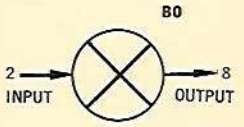
"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



BLOCKING OSCILLATOR



T-110

MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

• Specifications revised 2/15/60.

A transistorized blocking oscillator circuit, using two transistors in a monostable circuit. When triggered, the T-110 generates a positive pulse capable of driving a heavy load. The output pulse is approximately 1.0 microsecond wide, and will drive up to 20 paralleled flip-flop inputs.

ELECTRICAL SPECIFICATIONS

Input (Pin 2):
- Signal Frequency Range: 0 to 250 kc.
- Trigger Input Amplitude: Circuit will *always* operate on any positive-going pulse of 6 volts or greater, at a rise time up to 1 microsecond. Circuit will *not* trigger on any positive-going pulse of 1.5 volts or less, regardless of rise time.
- Maximum Trigger Input Amplitude: 9 volts peak.
- Rise Time: 0.1 to 1.0 microsecond.
- Input Impedance: 330 $\mu\mu$f, maximum.

Output (Pin 8):
- Amplitude: 7.5 V to 8 V unloaded, depending on frequency.
- Type: Positive pulse.
- Output Levels: Unloaded.
  - Upper Level, −3 VDC nominal.
  - Lower Level, −10.5 VDC to −11 VDC depending on frequency.
- Rise Time: 0.1 to 0.8 microsecond depending on capacitive load.
- Duration: 0.65 to 2.0 microseconds, depending on input amplitude. (Pulse duration becomes narrower with lower input amplitudes.)
- Capacitive Load: Up to 20 paralleled flip-flop inputs.
- Resistive Load: Minimum resistance is 5 K to ground or 1 K ohms to −12 volts.

Power Requirements:
- −12 VDC at 12 ma quiescent, 40 ma peak. Pin 1 negative with respect to pin 6.
- Supply voltage tolerance: ±10%.

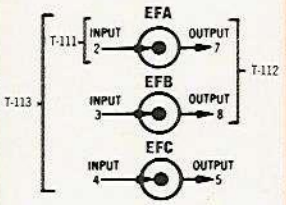
Operating Temperature Range: −45°C to +65°C.

ONE-HALF ACTUAL SIZE

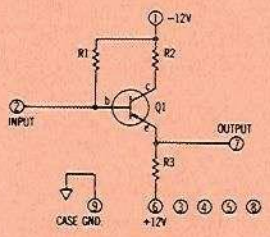
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

PNP EMITTER FOLLOWERS

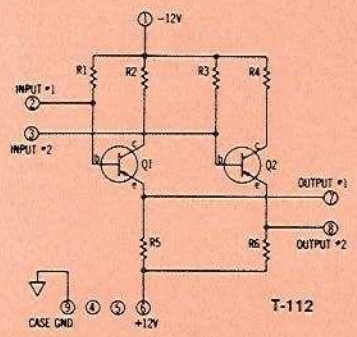


T-111, T-112, T-113

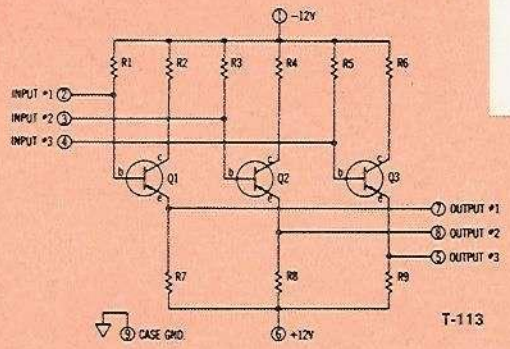


T-111

MATING SOCKET (ALL THREE UNITS): 9-PIN SOCKET, PART NO. T-910.



T-112



T-113

CIRCUIT DESCRIPTION

The T-111, T-112, and T-113 are arrangements of the same basic PNP Emitter Follower. Circuit details and performance are identical. The T-111 contains a single emitter follower. The T-112 contains two independent emitter followers, while the T-113 contains three independent emitter followers.

This series of emitter followers is used to provide current gain and circuit isolation, as well as to increase the load-driving capacity of an input signal. Probably the most general application is for operating into dc logic.

The PNP Emitter Follower has a minimum output impedance for negative-going signals. If minimum output impedance is needed for positive-going signals, the NPN Emitter Followers, T-114, T-115, or T-116, should be considered.

ELECTRICAL SPECIFICATIONS

Input:

Signal Frequency Range: 0 to 250 kc. (Frequency range can be extended to 500 kc with slightly reduced output signal.)

Signal Amplitude: The standard input is an 8-volt dc level shift within the range of −11 volts dc to −3 volts dc, such as from a flip-flop, one shot, etc. Maximum signal amplitude for pulse inputs is 12 volts P-P, applied through an external capacitor.

Input Impedance: 25,000 ohms minimum, depending on load and frequency.

Input Circuit Differentiation: Can be accomplished in a conventional fashion with a series capacitor and a resistor returned to a bias of proper value to establish the quiescent output voltage. Definite care should be taken to keep operating conditions within the maximum signal amplitude allowed.

Output:

Amplitude: Equal to input signal. Level shift is approximately ¼ volt in the positive direction.

Rise Time (unloaded): Essentially same as input.

ELECTRICAL SPECIFICATIONS (cont.)

Output Impedance: 150 ohms for a negative-going signal; 5,600 ohms maximum for a positive-going signal.

Loading:

Resistance: 3,300 ohms to ±12 volts, maximum resistive load for a signal shift of −3 to −11 volts dc.

Capacitance: 600 μμf maximum capacity to ground, or three paralleled flip-flops. When operating into pure capacitive loads, connect a 5,600-ohm external resistor from output to +12-volt supply.

Power Required (each Emitter Follower):

+12 volts dc and −12 volts dc, both at 3.9 to 11 ma, depending on load and input level. Pin 1 to be 24 volts negative with respect to pin 6.

Supply voltage tolerance: ±10%.

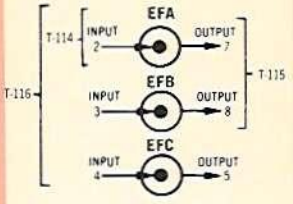
Operating Temperature Range: −45°C to +65°C.

ONE-HALF ACTUAL SIZE

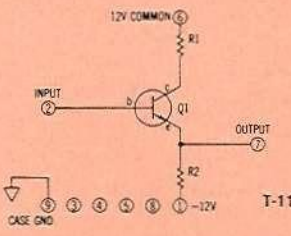
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

NPN EMITTER FOLLOWERS

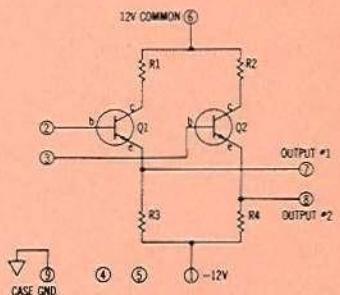


T-114, T-115, T-116

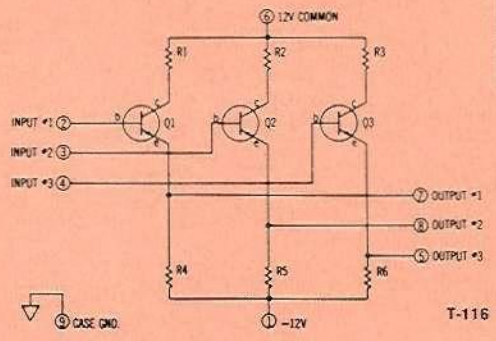


T-114

MATING SOCKET (ALL THREE UNITS): 9-PIN SOCKET, PART NO. T-910.



T-115



T-116

CIRCUIT DESCRIPTION

• Specifications revised 2/15/60.

The T-114, T-115, and T-116 are arrangements of the same basic NPN Emitter Follower. Circuit details and performance are identical. The T-114 contains a single emitter follower. The T-115 contains two independent emitter followers, while the T-116 contains three independent emitter followers.

This series of emitter followers is used to provide current gain and circuit isolation, as well as to increase the load-driving capacity of an input signal. Probably the most general application is for driving capacitive loads such as multiple flip-flops or one shots. NPN Emitter Followers should *not* be used for operating into dc logic.

The NPN Emitter Follower has a minimum output impedance for positive-going signals. If minimum output impedance is needed for negative-going signals, the PNP Emitter Followers, T-111, T-112, or T-113, should be considered.

ELECTRICAL SPECIFICATIONS

Input:

Signal Frequency Range: 0 to 250 kc. (Frequency range can be extended to 500 kc with slightly reduced output signal.)

Signal Amplitude: The standard input is an 8-volt dc level shift within the range of −11 volts dc to −3 volts dc. The maximum signal amplitude for pulse inputs is 12 volts P-P, applied through an external capacitor.

Input Impedance: 30,000 ohms minimum, depending on load and frequency.

Input Circuit Differentiation: Can be accomplished in a conventional fashion with a series capacitor and a resistor returned to a bias of proper value to establish the quiescent output voltage. Definite care should be taken to keep operating conditions within the maximum signal amplitude allowed.

ELECTRICAL SPECIFICATIONS (cont.)

Output:

Amplitude: Equal to input signal. Level shift is approximately ¼ volt in the negative direction.

Rise Time: Normally not deteriorated by more than 0.1 microsecond referred to input.

Output Impedance: 150 ohms for a positive-going signal; 1,800 ohms maximum for a negative-going signal.

Loading:

Either 600 $\mu\mu$f maximum capacity to ground or four flip-flops. (Greater capacitive loads may be imposed when correspondingly poorer rise times are allowable. Maximum should not exceed 5000 $\mu\mu$f.

Power Required (each Emitter Follower):

−12 volts at 1 to 7 ma, depending on load and input level. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance: ±10%.

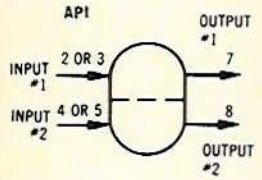
• Operating Temperature Range: −45°C to +71°C.

ONE-HALF ACTUAL SIZE

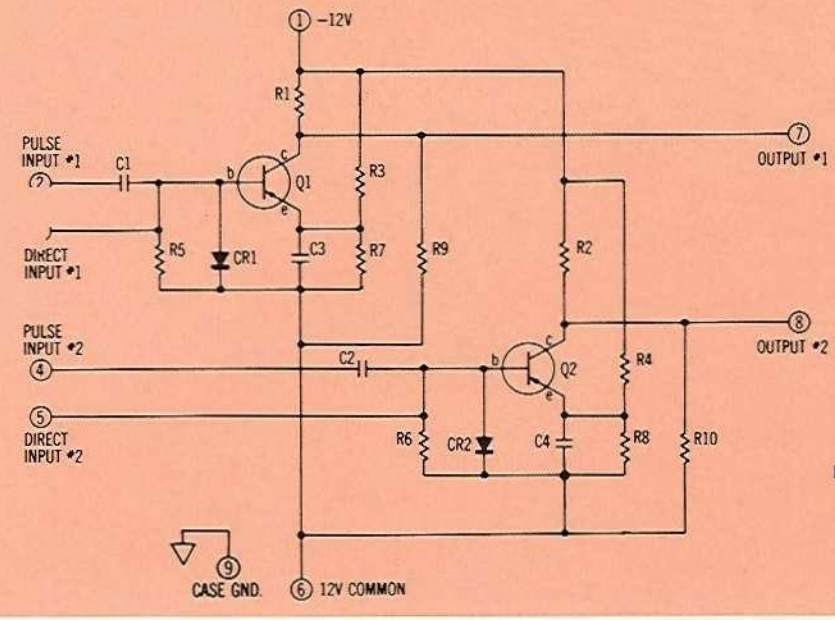
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

PULSE INVERTER, DUAL



T-117



MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

• Specifications revised 2/15/60.

The T-117 assembly contains two identical, independent Pulse Inverting Amplifiers. Each pulse inverter section produces a standard positive-going pulse of 1 to 2 microseconds duration for each negative-going input pulse or voltage step. The input is shaped to produce an output of improved rise time and standard amplitude.

ELECTRICAL SPECIFICATIONS

Input (each Pulse Inverter section):

Amplitude:

a) Minimum input is a 6.0 volt negative pulse or step to pin 2 or 4 with a rise time of 1 microsecond.

b) Circuit will not respond to inputs of less than 1½ volts, regardless of rise time.

Rise Time (pin 2 or 4): General range is 0.1 to 1.0 microsecond. Up to 1 microsecond at minimum input amplitude. More deteriorated rise times at correspondingly greater amplitudes may be regenerated.

Maximum Operating Frequency: 250 kc.

Direct Input (pins 3 and 5): For signals of very poor rise time, use Direct Input with an external capacitor of suitable size.

Input Impedance: 270$\mu\mu$f capacitance (pins 2 and 4).

Output (each Pulse Inverter section):

Amplitude (no load): 7.5 to 9 volts P-P (pins 7 and 8), depending on frequency.

Polarity: Positive.

Output level, unloaded:

a) Lower level, −11 volts dc, nominal.

b) Upper level, −2 volts dc to −3.5 volts dc, depending on frequency.

Rise Time: 0.15 to 0.5 microsecond, depending on capacitive load.

Duration: 1.5 to 2.0 microseconds, depending on input signal and load.

ELECTRICAL SPECIFICATIONS (cont.)

Loading:

• Typical load is two flip-flop inputs. For frequencies up to 125 kc, loading may be increased to five flip-flops.

Power Required:

−12 volts dc at 2.4 ma quiescent; 4 ma peak. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance: ±10%.

Operating Temperature Range: −45°C to +65°C.

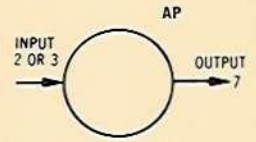
ONE-HALF ACTUAL SIZE

INVERTER

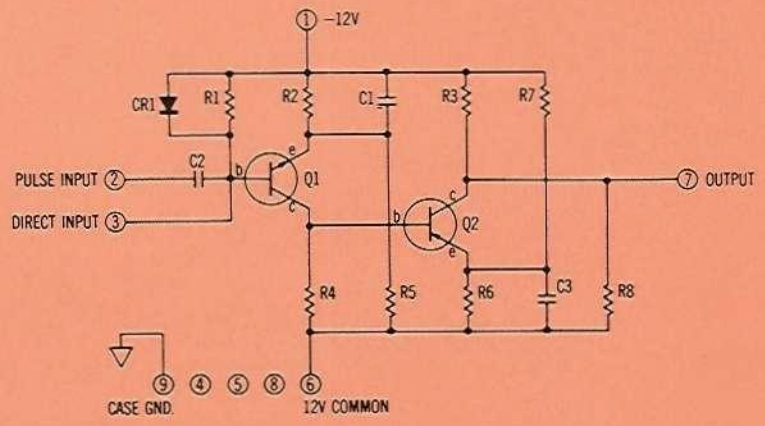
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

PULSE AMPLIFIER



T-118



CIRCUIT DESCRIPTION

● Specifications revised 2/15/60.

The T-118 is a Transistorized Pulse Amplifier used to produce standardized positive-going pulses with a duration of 0.5 to 3.5 microseconds and a sharp rise time. The input may be of deteriorated shape and low amplitude. The positive-going pulses result from an input of either a positive-going pulse or voltage step.

ELECTRICAL SPECIFICATIONS

Input:

Amplitude:

a) Minimum input is a 5.5-volt positive pulse or step at 1 microsecond rise time (pin 2).

b) Circuit will *not* respond to inputs of less than 1.5 volts, regardless of rise time.

Rise Time: From 0.1 to 1.0 microsecond.

Maximum Operating Frequency: 250 kc.

Direct Input (pin 3): For signals of very poor rise time, use Direct Input with an external capacitor of suitable size.

Input Impedance: 220 $\mu\mu$f capacitance (pin 2).

Output:

Amplitude: 8 volts peak-to-peak, unloaded.

Polarity: Positive.

Output Levels: −11 volts dc and −3 volts dc nominal.

Rise Time: 0.15 to 0.5 microsecond, depending on capacitive load.

Duration: 0.5 to 3.5 microseconds nominal.

Loading:

● Typical load is two flip-flops. For frequencies up to 125 kc, loading may be increased to eight flip-flops.

Power Required:

−12 volts dc at 2 ma quiescent, 10 ma peak. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance: ±10%.

Operating Temperature Range: −45°C to +65°C.

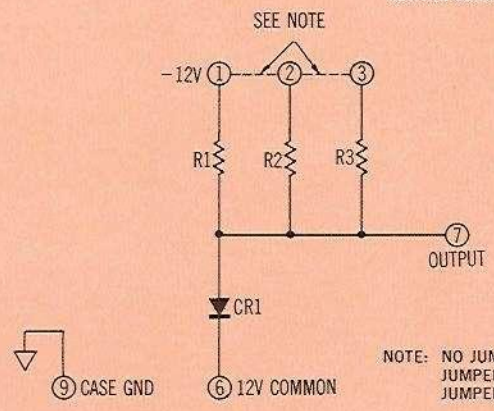
ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS Company

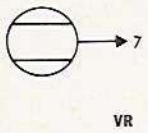
"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

VOLTAGE REGULATOR

MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.



NOTE: NO JUMPER, OUTPUT CURRENT 6 MA.
JUMPER 1 AND 2, OUTPUT CURRENT 12 MA.
JUMPER 1, 2, AND 3, OUTPUT CURRENT 18 MA.



T-123

CIRCUIT DESCRIPTION

• Load Table added 2/15/60.

The T-123 is a shunt-type regulated negative 7.5-volt supply. A medium-power zener diode is used and yields a low output impedance and good regulation. Three ranges of regulated current are provided for by means of an external jumper. The usual application for T-123 is to supply bias for Minisig Indicators (neon types) used with T-Series units, so the Minisig operating characteristics wll be shifted to accommodate the output signal levels of T-Series circuits.

ELECTRICAL SPECIFICATIONS

Input: −12 volts regulated.

Output:

Voltage Level: −7.5 volts ±1.0 volt.

Regulated output current:

No jumper: 0 to 6 ma.

Jumper between pins 1 and 2: 12 ma.

Jumper between pins 1, 2, and 3: 18 ma.

Impedance: Approximately 10 ohms.

Power Requirements:

−12 volts:

No jumper: 22 ma.

Jumper between pins 1 and 2: 44 ma.

Jumper between pins 1, 2, and 3: 66 ma.

Supply voltage tolerance ±10%.

Operating Temperature Range: −45°C to +65°C.

TABLE I

• Permissible load and connection guide for jumpering of T-123, when used with various models of neon Minisig Indicators:

	No Jumper	Jumper 1 & 2	Jumper 1, 2, & 3
R-101 R-121	6	13	20
R-201 R-221	3	6	10

Example I: To supply bias for 7 to 13 R-101's or R-121's (same circuit), jumper pins 1 and 2 on T-123.

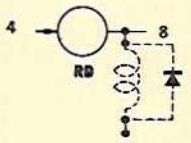
Example II: As a specific example, bias for 18 R-201's or R-221's (same circuit) can be supplied by using two T-123's with pins 1, 2, and 3 jumpered on each. Split the load so that each T-123 feeds a bias bus for 9 Minisigs.

ONE-HALF ACTUAL SIZE

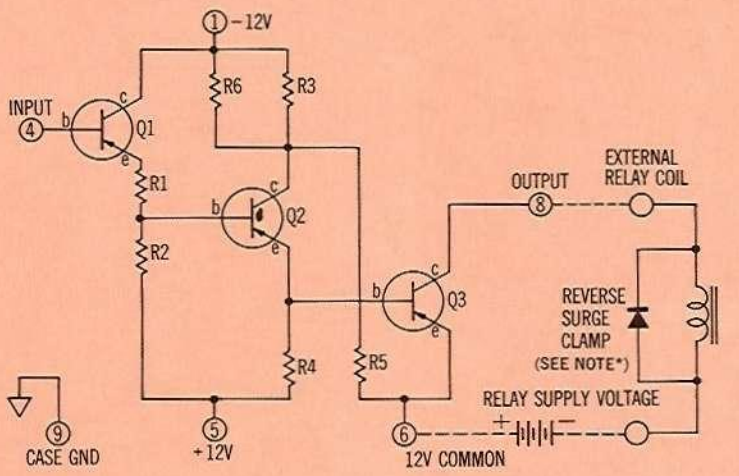
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

RELAY DRIVERS



T-120, T-121, T-128



MATING SOCKET (ALL THREE UNITS): 9-PIN SOCKET, PART NO. T-910.

● *NOTE: REVERSE SURGE CLAMP DIODE MUST PASS PEAK FORWARD CURRENT EQUAL TO THE RELAY "ON" CURRENT, AND MUST WITHSTAND PEAK INVERSE VOLTAGE EQUAL TO THE RELAY SUPPLY VOLTAGE.

● Note added 2/15/60.

CIRCUIT DESCRIPTION

● Specifications revised 2/15/60.

The T-120, T-121, and T-128 Relay Drivers are basically transistorized switches that may be operated directly from the output of T-Series digital circuits such as flip-flops, one shots, or squaring circuits. The input signal levels required are −3 volts and −11 volts. An external load circuit will be completed when the input signal is −11 volts and interrupted when the input signal is −3 volts. The most common application is control of general-purpose relays, but the units are also useful for signal inversion and level changing.

Each circuit uses three germanium switching transistors. The first two stages are alike in all models; the third stage is a power-switching transistor with its voltage rating the variable to consider in specifying the model required.

When operating a relay, these units require protection against reverse surge voltages generated by the relay. Diode clamping may be used across the relay for this purpose, as shown in the circuit schematic.

ELECTRICAL SPECIFICATIONS

Input:

Signal Frequency Range: T-120 and T-128: 0 - 1 kc (for 400 ma resistive load). T-121: 0 - 1 kc (for 500 ma resistive load). Maximum frequency with relay load depends on relay capabilities.

DC Signal Level to Actuate Relay: −11 volts nominal.

DC Signal Level to Release Relay: −3 volts nominal.

Input Current Requirements: 0.1 ma maximum to positive source at −11-volt level; 0.5 ma maximum to negative source at −3-volt level.

The sum of the input rise and fall times must not be greater than 25% of the total period. Absolute maximum rise or fall time: 1 second.

Output:

Maximum output current available is dependent upon the relay voltage used. (See Load Charts.)

Absolute Maximum Output Current: T-120 and T-128 · 400 ma. T-121: 500 ma.

Typical Rise Time:

T-120 and T-128: 13 microseconds (for 400 ma load), or one-tenth the input fall time, whichever is greater.

T-121: 6 microseconds (for 500-ma load), or one-tenth the input fall time, whichever is greater.

Typical Fall Time:

T-120 and T-128: 13 microseconds (for 400-ma load), or one-tenth the input rise time, whichever is greater.

T-121: 6 microseconds (for 500-ma load), or one-tenth the input rise time, whichever is greater.

Leakage current through load in "OFF" condition (input at −3 volts) and at 71°C: T-120 and T-128: 10 ma maximum; 2 ma typical. T-121: 5 ma maximum; 1 ma typical.

Power Required:

B+ (+12 volts ±10% at 14 ma).

● B− (−12 volts ±10% at 30 ma to 45 ma).

Relay Coil Supply Voltage:

T-128: −24 volts absolute maximum.

T-120: −48 volts absolute maximum.

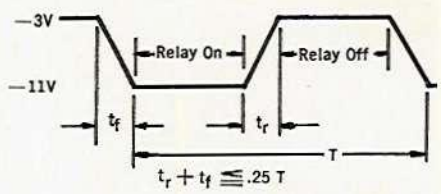
T-121: −90 volts absolute maximum.

(Continued)

ONE-HALF ACTUAL SIZE

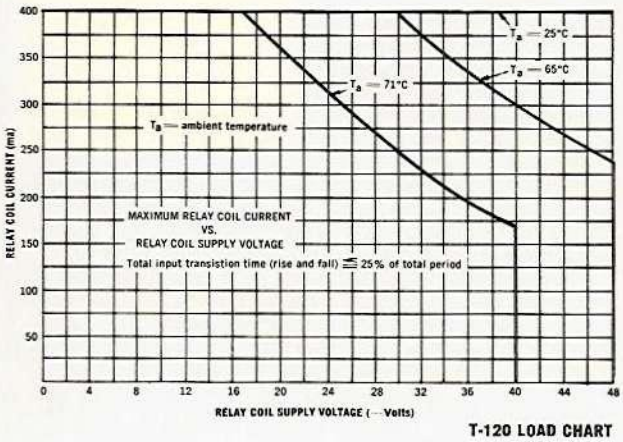
Operating Temperature Range:
T-121 and T-128: −54°C to +71°C maximum.
T-120: −54°C to +65°C. (May be operated at +71°C maximum for relay voltages up to 40 volts.)

INPUT WAVEFORM

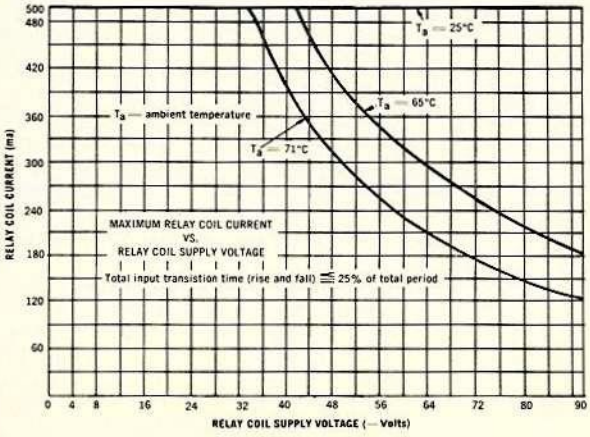


Absolute maximum value for t_r or t_f = 1 second.

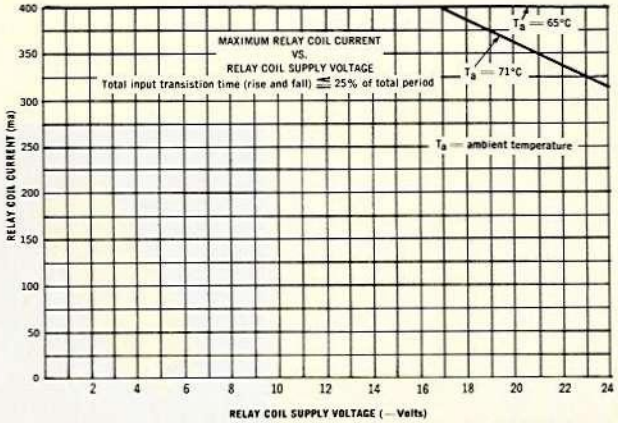
t_f = fall time
t_r = rise time



T-120 LOAD CHART



T-121 LOAD CHART



T-128 LOAD CHART

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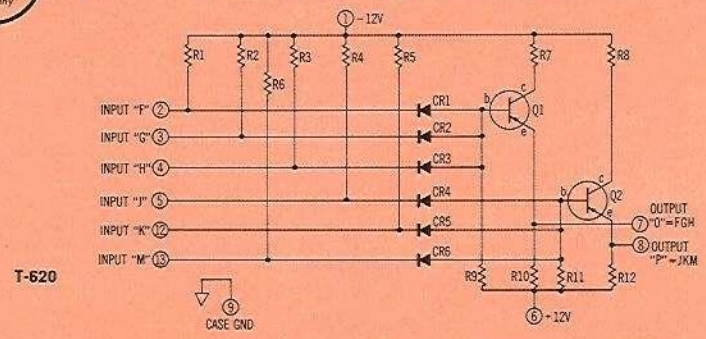
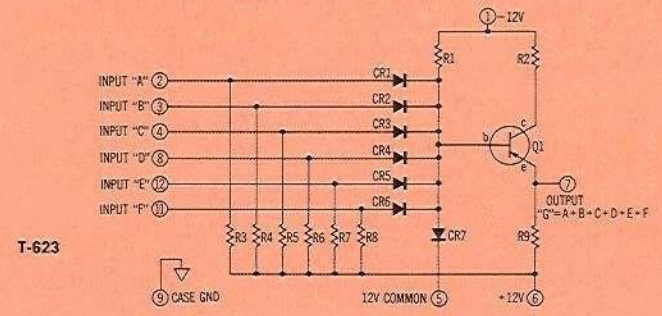
"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

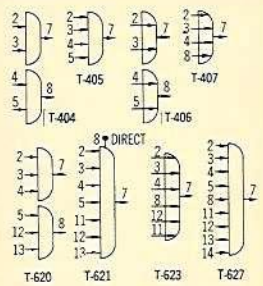


T-620



T-623

DC LOGIC



T-404, T-405, T-406, T-407, T-620, T-621, T-623, T-627

MATING SOCKET:
T-400 SERIES: 9-PIN SOCKET, PART NO. T-910.
T-600 SERIES: 14-PIN SOCKET WITH PIN 10 BLOCKED FOR KEYWAY ORIENTATION, PART NO. T-937.

DC

GENERAL

● Specifications revised 2/15/60.

This group of logic circuits for the T-Series system has been developed on the principle that it contains an integral emitter follower on the output of each "And" or "Or" gate. This provides superior isolation and the ability to cascade logic in any combination. For example, the usual limitation that "Or" circuits cannot drive "And" circuits is overcome in this system.

The cost of adding the emitter follower to the logic is very small and can save substantial amounts in space and cost when compared to the use of external emitter followers to accomplish the same purpose.

Our logic circuits are supplied in either a 9-pin or 13-pin package, depending on circuit complexity. (The mating T-937 socket is supplied at no charge with each 13-pin unit.)

A few representative samples of DC logic are specified on this page. These basic circuits and many more can be supplied as standard items. Custom-built logic can be furnished readily at a small premium over a standard logic of comparable complexity. We can work from either a schematic or a logic equation.

CIRCUIT DESCRIPTION

The DC Logic circuits use diodes to perform the basic switching functions for "AND" and "OR" operations. The matrix outputs feed a PNP emitter follower, which provides drive capability for subsequent logic. Representative logic formulae for cataloged circuits follow:

AND	OR
T-404: K=FG, L=HJ	T-406: K=F+G, L=H+J
T-405: K=FGHJ	T-407: K=F+G+H+J
T-620: O=FGH, P=JKM	T-623: G=A+B+C+D+E+F
T-621: H=ABCDEFG	
T-627: R=FGHJKLMNP	

ELECTRICAL SPECIFICATIONS

"AND" CIRCUITS

Input:

Frequency Range: 0 to 250 kc.

Amplitude: 0 to −12 volts.

Typical Signal Input: −3 volts to −11 volts.

Input Impedance: Function of load and transistor beta. Nominally 20 K for maximum load and minimum beta.

- Signal Driving Levels:
- ON (Binary "1"): −3 volts at .8 ma to positive
- source (full load).
- OFF (Binary "0"): −11 volts at 1.2 ma to positive
- source (full load).

Unused input pins must be returned to ground.

Output:

Amplitude: Essentially equal to input signal. Level shift, approximately +0.4 volts.

Rise Time, unloaded, positive-going signal: Essentially equal to input signal rise time.

Rise Time Degradation, 3-flip-flop load: 0.5 to 1.0 microsecond, depending on input rise time.

Resistive Loading Effect: Maximum resistive load is determined by input level and allowable transistor dissipation of 71.5 mw at 65°C. For a typical signal input of −3 volts to −11 volts, maximum allowable resistive load is 3.3 K to ±12 volts.

(Continued)

ONE-HALF ACTUAL SIZE

Output Impedance: 150 ohms for negative-going signal; 5.6 K for positive-going signal.
For purely capacitive loading, connect a 5.6 K resistor externally from output to +12-volt supply.

Typical Loading:
Two typical logic loads for the "AND" gate are as follows:
(1) 7 "AND" gates in parallel, each of which is loaded by one similar "AND" gate, for a total logic load of 14 "AND" gates.
(2) 3 "AND" gates in parallel, each of which is loaded by 3 similar "AND" gates for a total logic load of 12 "AND" gates.
These units are typically driven by PNP emitter followers or DC logic.

Power Requirements (per output channel):
+12 volts at 3.9 ma to 11 ma, depending upon load.
−12 volts at 3.9 ma to 11 ma, depending upon load.
(Pin 1 to be 24 volts negative with respect to pin 6.)
Supply Voltage Tolerance: ±10%.

- Operating Temperature Range: −45°C to +65°C.

"OR" CIRCUITS

Input:
Frequency Range: 0 to 250 kc.
Amplitude: 0 to −12 volts.
Typical Signal Input: −3 volts to −11 volts.
Input Impedance: 4,000 ohms.
- Signal Driving Levels:
- ON (Binary "1"): −3 volts at .6 ma to negative
- source (full load).
- OFF (Binary "0") −11 volts at 1.5 ma to positive
- source (full load).

Unused input pins are to be connected to −12 volts (pin 1).

Output:
Amplitude: Essentially equal to input signal. Level shift, approximately +0.1 volt.
Rise Time, unloaded, positive-going signal: Essentially equal to input signal rise time.
Rise Time Degradation, 3-flip-flop load: 0.5 to 1.0 microsecond, depending on input rise time.
Resistive Loading Effect: Maximum resistive load is determined by input level and allowable transistor dissipation of 71.5 mw at 65°C. For a typical signal input of −3 volts to −11 volts, maximum allowable resistive load is 3.3 K to ±12 volts.
Output Impedance: 150 ohms for negative-going signal; 5.6 K for positive-going signal.
For purely capacitive loading, connect a 5.6 K resistor externally from output to +12-volt supply.

Typical Loading:
Two typical logic loads for the "OR" gate are as follows:
(1) 3 "AND" gates in parallel, each of which is loaded by 3 similar "AND" gates for a total logic load of 12 "AND" gates.
(2) 2 "OR" gates in parallel, each of which is loaded by 2 similar "OR" gates for a total logic load of 6 "OR" gates.
These units are typically driven by PNP emitter followers or DC logic.

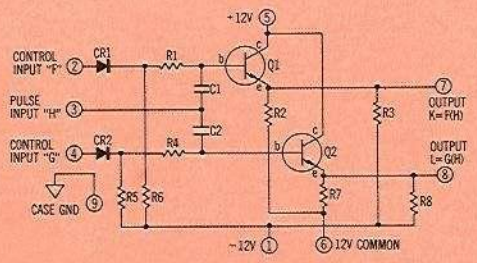
Power Requirements (per output channel):
+12 volts at 3.9 to 11 ma, depending upon load.
−12 volts at 3.9 to 11 ma, depending upon load. (Pin 1 to be 24 volts negative with respect to pin 6.)
Supply Voltage Tolerance: ±10%.

- Operating Temperature Range: −45°C to +65°C.

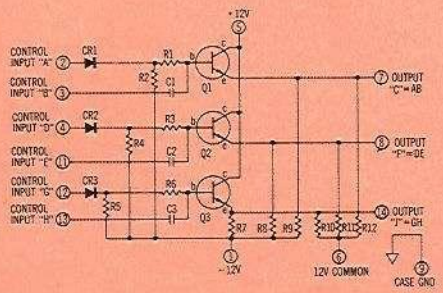
ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

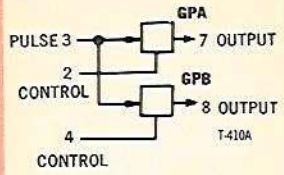
T-410A

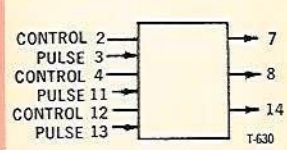


T-630



PULSE "AND" GATES





T-410A, T-630

MATING SOCKET:
T-410A: 9-PIN SOCKET, PART NO. T-910.
T-630: 14-PIN SOCKET WITH PIN 10 BLOCKED FOR KEYWAY ORIENTATION, PART NO. T-937.

T-630 Schematic and Symbol added 2/15/60.

CIRCUIT DESCRIPTION

• Specifications revised 2/15/60.

• Pulse AND gates, for transmission of pulses to a load
• when a control signal is present. T-630 has three control
• inputs and three independent pulse inputs; T-410A has
• two control inputs, but the pulse input is common to
• both AND gates.

These circuits have inherent delays in the control properties, which make them useful in applications where trigger and logic operations occur at the same time. The specifications give "enable" and "disable" delay referenced to the time at which a "turn on" or "turn off" signal is applied at the control input, assuming the waveform of the control signal has a fast rise time. If the control signal has a poor waveform, these specifications on delay will not apply. The outputs may be OR mixed, but should not be cascaded.

ELECTRICAL SPECIFICATIONS

• Control Input (T-410A, pin 2 or 4; T-630, pin 2, 4,
• or 12):
• Amplitude: DC level shift; —3 VDC "ON"; —11
• VDC "OFF."
Rise Time: 0.1 to 1.0 microsecond.
Enable Time: 2.0 microseconds.
Disable Time: 4.0 microseconds.
Input Impedance: 2.2 K, 220 $\mu\mu$f in series.
Input Current: 0.9 ma to negative source.
Source: Output of flip-flop, squaring amplifier, one shot, etc.

Pulse Input (pin 3):
Amplitude: Minimum, 7.5 volts; maximum, 9 volts.
Rise Time: 0.25 μs or less.
Frequency: 250 kc, maximum.
Input Impedance: 440 $\mu\mu$f.
Source: Output of pulse amplifier, squaring amplifier, blocking oscillator, NPN emitter follower, or pulse inverter.

• Output: (T-410A, pin 7 or 8; T-630, pin 7, 8, or 14):
Type: Positive pulse.
Amplitude: 4.5 volts with typical input and load.
Rise Time: Essentially equal to rise time of pulse input for 0.25 microsecond or less waveform. Note: The amplitude of the output is below the nominal minimum specified for T-Series input; but these gates give satisfactory drive because of the fast rise time of the output signal waveform.
Pulse Duration: 1.1 microseconds, nominal.
• Typical Load from each output: 2 flip-flop inputs (T or RS).

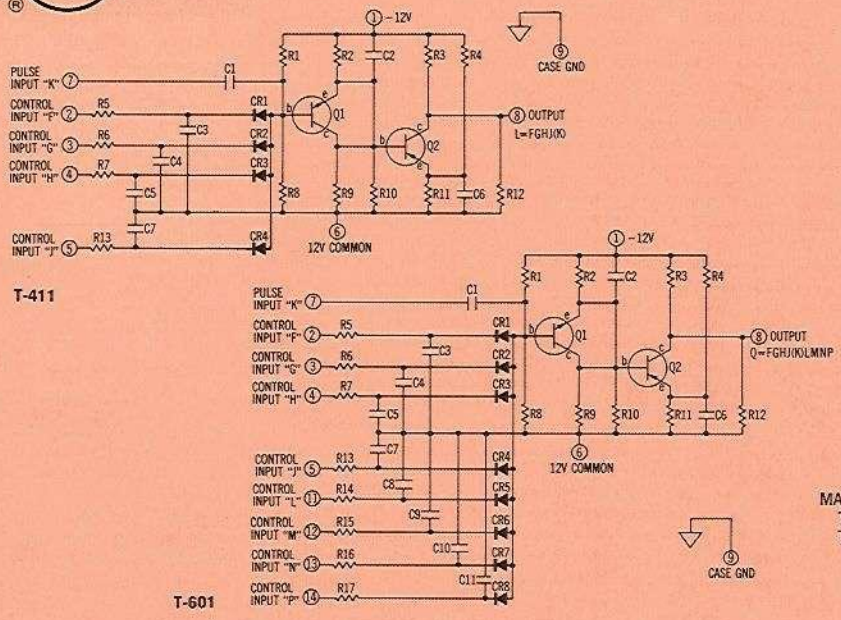
Power Required (each gate):
—12 volts at 1.8 ma (pin 1).
+12 volts at 0.4 ma (pin 5).
Tolerance: ±10%.

Operating Temperature Range: —45°C to +65°C.

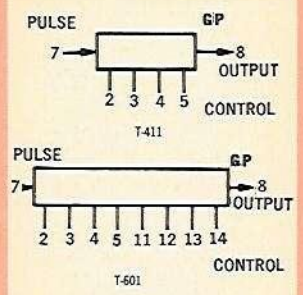
ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



PULSE "AND" GATES, MULTIPLE INPUT



T-411, T-601

MATING SOCKET:
T-411: 9-PIN SOCKET, PART NO. T-910.
T-601: 14-PIN SOCKET WITH PIN 10 BLOCKED FOR KEYWAY ORIENTATION, PART NO. T-937.

CIRCUIT DESCRIPTION

Multiple-input pulse AND gates, for transmission of pulses to a load when *all* control inputs are present. The circuits are identical except for the number of control inputs available: T-411 has four; T-601 has eight. The gates are enabled 3.0 microseconds after *all* control inputs shift to −3 volts; and are disabled 4.0 microseconds after *any* control input shifts to −11 volts. The specifications give "enable" and "disable" delay referenced to the time at which a "turn on" or "turn off" signal is applied at the control input, assuming the waveform of the control signal has a fast rise time. If the control signal has a poor waveform, these specifications on delay will not apply. While the gates are enabled, input pulses may be transmitted to the load. An integral pulse amplifier insures standardized output pulses.

Maximum input pulse repetition rate is 250 kc. All control inputs can be supplied direct from flip-flops, one-shots, etc. Pulse inputs can be supplied by a pulse amplifier, squaring amplifier, blocking oscillator, or NPN emitter follower.

ELECTRICAL SPECIFICATIONS

Control Inputs:
- Number of Inputs: T-411, 4; T-601, 8.
- Amplitude: 8 volt level shift from −11 volts dc to −3 volts dc nominal.
- Rise Time: 0.1 to 1.0 microsecond.
- Gate Enabling Time: 3.0 microseconds.
- Gate Disabling Time: 4.0 microseconds.
- Input Impedance: Series RC of 5.6 K and 220 $\mu\mu$f.
- Input Current: 0.6 ma maximum to a positive voltage.

Pulse Input (Pin 7):
- Amplitude: 6 volts minimum; 9 volts maximum.
- Frequency: 250 kc maximum.
- Rise Time: 0.1 to 1.0 microsecond.
- Input Impedance: 150 $\mu\mu$f capacitive.

ELECTRICAL SPECIFICATIONS (cont.)

Output (T-411, T-601):
- Amplitude: 8 volts (Pin 8).
- Type: Positive pulse.
- Output Levels: −11 volts dc and −3 volts dc nominal.
- Rise Time: 0.4 microsecond maximum into a capacitive load.
- Duration: 0.5 to 1.0 microsecond nominal.

Loading:
- Typical: Up to 3 paralleled flip-flop inputs. For operating frequency to 125 kc, loading may be increased to 4 flip-flops.

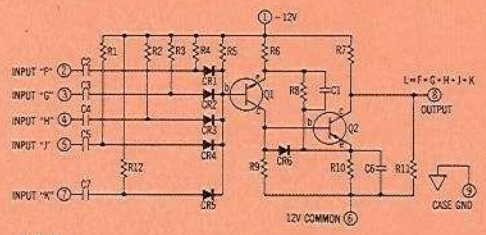
Power Required (T-411, T-601):
- −12 volts dc at 2.8 ma quiescent, 6 ma peak. Pin 1 negative with respect to pin 6.
- Supply voltage tolerance: ±10%.

Operating Temperature Range: −45°C to +65°C.

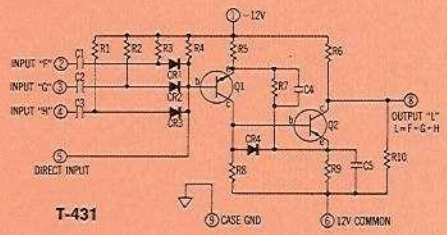
ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS Company

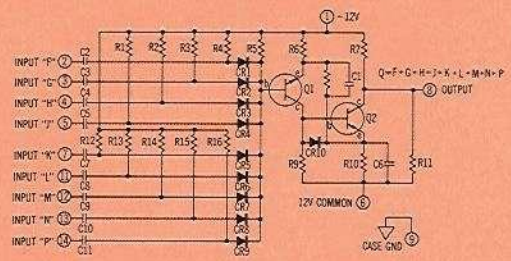
"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



T-412

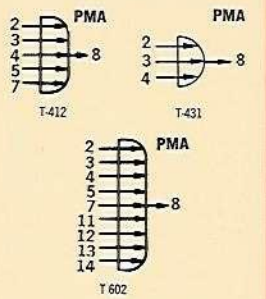


T-431



T-602

PULSE MIXER AMPLIFIERS, MULTIPLE INPUT



T-412, T-431, T-602

MATING SOCKET:
T-400 SERIES: 9-PIN SOCKET, PART NO. T-910.
T-600 SERIES: 14-PIN SOCKET WITH PIN 10 BLOCKED FOR KEYWAY ORIENTATION, PART NO. T-937.

CIRCUIT DESCRIPTION

Multiple input pulse mixers or OR gates, with integral pulse amplifier to produce standardized output pulses. The T-412, T-431, and T-602 differ only in the number of inputs available: T-412 has five inputs; T-431 has three; and T-602 has nine. External R-C Networks and blocking diodes may be connected to the pin 5 input of T-431 to give additional mixing capability.

ELECTRICAL SPECIFICATIONS

Input:
- Number of Inputs: T-412, 5; T-431, 3; T-602, 9.
- Amplitude: Minimum input is 7.0 volts positive pulse or step at rise time up to 0.8 microsecond. Circuit will *not* respond to inputs of less than 1.5 volts regardless of rise time.
- Rise Time: 0.1 to 0.8 microsecond.
- Signal Frequency Range: 250 kc maximum.
- Input Impedance (Each Input Terminal): 270 $\mu\mu$f, approximately.

Output:
- Amplitude: 8.5 volts peak-to-peak (pin 8).
- Type: Positive pulse.
- Output Levels: —11 volts dc and —2.5 volts dc nominal.
- Rise Time: 0.4 microsecond maximum into a capacitive load.
- Duration: 0.5 to 2.0 microsecond nominal.

Loading:
- Typical, up to 2 paralleled flip-flop inputs. For operating frequency to 125 kc, loading may be increased to 4 flip-flops.

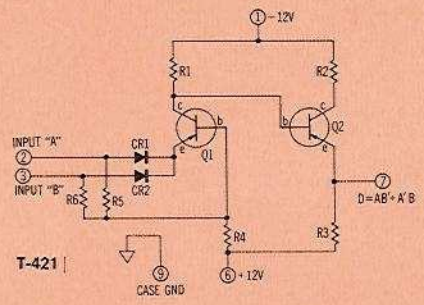
Power Required:
- —12 volts dc at 2 ma quiescent, 10 ma peak. Pin 1 negative with respect to pin 6.
- Supply voltage tolerance: ±10%.

Operating Temperature Range: —45°C to +65°C.

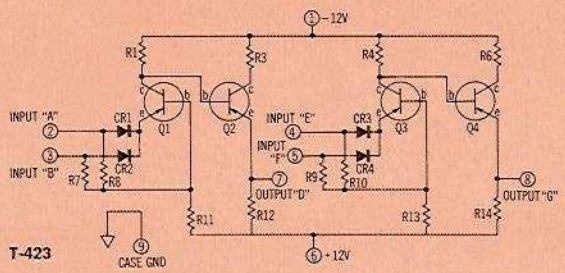
ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

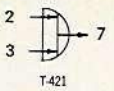


T-421

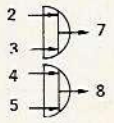


T-423

"EXCLUSIVELY-OR" GATES



T-421



T-423

T-421, T-423

MATING SOCKET (BOTH UNITS): 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

The T-421 is an "exclusively-OR" gate containing two transistors and two diodes. The T-423 is a pair of "exclusively-OR" gates (T-421's), each containing two transistors and two diodes. The purpose of an "exclusively-OR" gate is to provide an output when one, and only one, input is present. The logic equations are as follows:

T-421	T-423
$D = AB' + A'B$	$D = AB' + A'B$
	$G = EF' + E'F$

Each circuit consists of a conventional OR gate whose output is supplied to the emitter of a transistor gate (Q_1). The base of the transistor is supplied by a summing network of which the summed voltage is a function of the number of OR-gate input signals that are OFF. When more than one input is ON, the summed voltage is sufficiently low to cut off the transistor gate.

If one input is held at −11 volts (OFF), the remaining input can be switched ON and OFF to produce a similar signal at the output. The output rise time is a function of the input rise time and the B of Q_1.

The circuit can also be used as a DC inverter by holding one input at −3 volts (ON) while a second input is switched ON and OFF by the signal that is to be inverted. The output rise time is now a function of the input fall time and the B of Q_1.

A recommended driving unit for each input is a T-111 PNP emitter follower.

ELECTRICAL SPECIFICATIONS

Input:
- Frequency Range: 0 to 250 kc.
- Signal Driving Levels:
  - OFF (Binary "0"): −11 volts at 1.7 ma to a positive source.
  - ON (Binary "1"): −3 volts at 2.4 ma to a negative source.
- Recommended Driving Unit: PNP emitter follower (T-111).

Output:
- Amplitude: Essentially equal to input signal. Level shift at −3-volt level is −0.4 volt nominal.
- Signal Levels: −3 volts to −11 volts.
- Rise Time: 0.1 to 1.0 microsecond if input rise and fall times are less than 2 microseconds.
- Typical Load: One "OR" gate and one "AND" gate on each output.
- Maximum Load at 71°C: 8K to +12 volts, 2K to ground, or 4.7K to −12 volts on each output.

Power Requirements:

	T-421	T-423
+12 volts DC at	4 ma	8 ma
−12 volts DC at	4 ma	8 ma

Supply voltage tolerance ±10%.

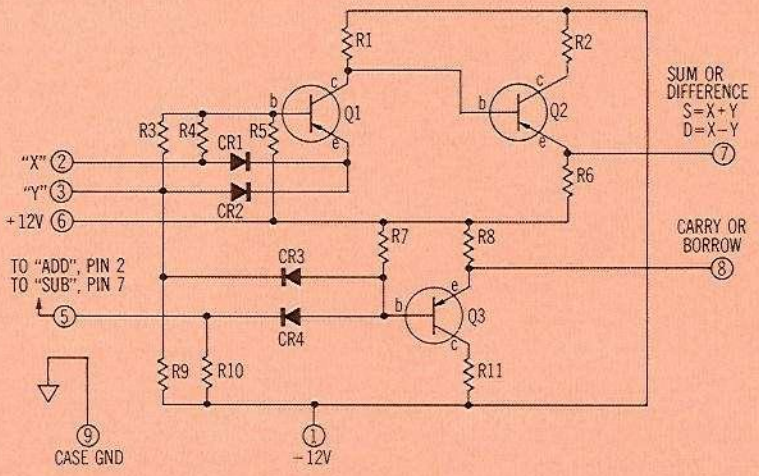
Operating Temperature Range: −54°C to +71°C.

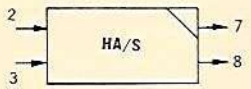
ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

HALF ADDER/SUBTRACTOR





T-424

MATING SOCKET: 9-PIN SOCKET, PART NO. T-910.

CIRCUIT DESCRIPTION

● Specifications revised 2/15/60.

The T-424 Half-Adder/Subtractor is a transistorized assembly containing three PNP germanium transistors, two of which are emitter followers, and four germanium diodes. The unit can be used as a half-adder or a half-subtractor, depending on the connection of an external jumper.

The purpose of a half-adder is to provide sum (S) and carry (C) outputs from two single-digit inputs (X plus Y). The logic equations for a half-adder are:

S (sum) = XY′ + X′Y

C (carry) = XY

Full addition is performed when a third input, "carry" from adder of next lowest significant digit, is added to (X plus Y). Two half-adders and an "OR" gate make up a full-adder. (See Truth Tables I and II.)

The purpose of a half-subtractor is to provide difference (D) and borrow (B) outputs from two single-digit inputs (X minus Y). The logic equations for a half-subtractor are:

D (difference) = XY′ + X′Y

B (borrow) = DY

Full subtraction is performed when a third input, "borrow" from subtractor of next lowest significant digit, is subtracted from (X minus Y). Two half-subtractors and an "OR" gate make up a full-subtractor. (See Truth Table III and IV.)

The sum and difference equations are exactly alike; thus, either can be performed by an "exclusively-OR" gate. Carry and borrow equations have similar form, but different inputs. Either can be performed by an "AND" gate if one of the inputs is connected to X for addition or to D for subtraction. (The other input is always connected to Y.)

The T-424 contains one "exclusively-OR" gate and one "AND" gate. One of the "AND" gate inputs is terminated at pin 5, which is jumpered to pin 2 (X) for addition or pin 7 (D) for subtraction.

ELECTRICAL SPECIFICATIONS

Input:

Frequency Range: 0 to 250 kc.

Signal Driving Levels:

OFF (Binary "0"): −11 volts at 2.5 ma to a positive source.

ON (Binary "1"): −3 volts at 2.5 ma to a negative source.

Recommended Driving Unit: PNP emitter follower (T-112).

Output:

Amplitude: Essentially equal to input signal.

Level shift at −3-volt level:

Pin 7: −0.4 volt nominal.

Pin 8: +0.4 volt nominal.

Signal Levels: −3 volts to −11 volts.

Rise Time: 0.1 to 1.0 microsecond, depending on input rise and fall time.

Typical Load: One half-adder/subtractor and one "OR" gate.

Maximum Load at 71°C: 8K to +12 volts, 2K to ground, or 4.7K to −12 volts.

Power Requirements:

+12 volts DC at 8 ma.

−12 volts DC at 8 ma.

Supply voltage tolerance ±10%.

Operating Temperature Range: −54°C to +71°C.

Truth Table I
Half-Adder X+Y=S

X	0	0	1	1
Y	0	1	0	1
S	0	1	1	0
C	0	0	0	1

Truth Table II
Full-Adder X+Y+C=S

X	0	1	0	0	1	1	0	1
Y	0	0	1	0	1	0	1	1
C	0	0	0	1	0	1	1	1
S	0	1	1	1	0	0	0	1
C	0	0	0	0	1	1	1	1

Truth Table III
Half-Subtractor X−Y=D

X	0	1	0	1
Y	0	0	1	1
D	0	1	1	0
B	0	0	1	0

Truth Table IV
Full-Subtractor X−Y−B=D

X	0	1	0	0	1	1	0	1
Y	0	0	1	0	1	0	1	1
B	0	0	0	1	0	1	1	1
D	0	1	1	1	0	0	0	1
B	0	0	1	1	0	0	1	1

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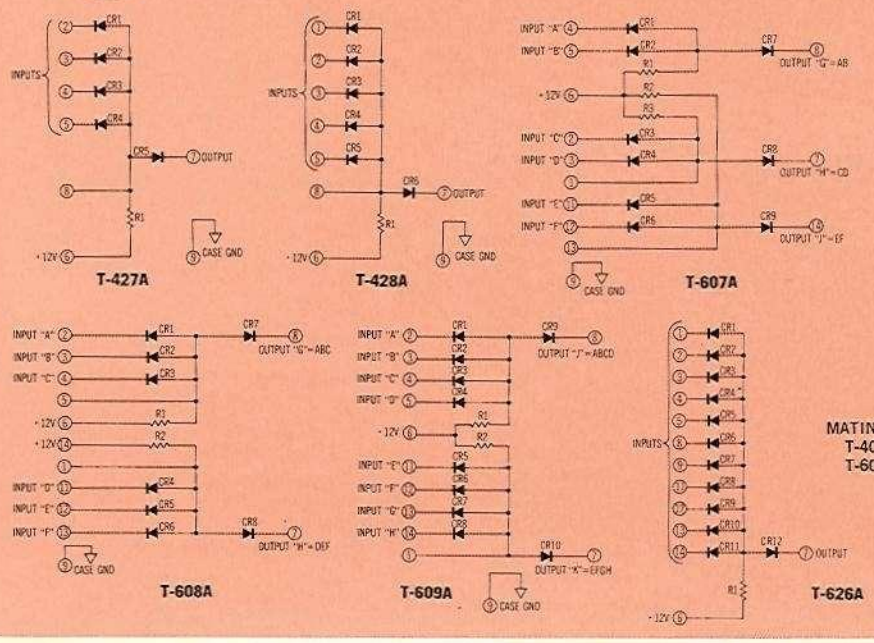
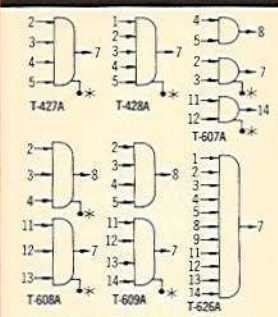
"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



BUFFERED "AND" GATES



T-427A, T-428A, T-607A
T-608A, T-609A, T-626A

MATING SOCKET:
T-400 SERIES: 9-PIN SOCKET, PART NO. T-910.
T-600 SERIES: 14-PIN SOCKET WITH PIN 10 BLOCKED FOR KEYWAY ORIENTATION, PART NO. T-937.

CIRCUIT DESCRIPTION

● Specifications revised 2/15/60.

These circuits are "buffered" diode AND gates for use in simple logical networks. The "buffer" diode in each output line facilitates OR mixing of several circuits. The outputs cannot be cascaded, however, because these packages do not include an output emitter follower (as do T-404, T-405, T-620, T-621, etc.). Generally the outputs from these units will be amplified before they are fed to a following circuit. However, the output can be used to drive a flip-flop or one-shot without amplification. Where an extra terminal is available, the circuits may be interconnected externally to build up AND Gates with additional input terminals. This terminal is available only on the gates marked with (*) in the above diagrams.

ELECTRICAL SPECIFICATIONS

Input:

Standard T-Series signals; −3 volts for "1," −11 volts for "0," supplied from a PNP emitter follower (such as T-111, T-112, or T-113) or from a T-Series unit with PNP emitter follower output.

Frequency Range: 0 to 250 kc.

Output:

Terminate with 8.2 K resistor, returned to −12 volts. (Where outputs are OR mixed, use only one terminating resistor and connect resistor common to all OR terminals.) Output signal is −3 volts for "1," −11 volts for "0" and rise time is a function of the input signals.

ELECTRICAL SPECIFICATIONS (cont.)

Loading:

Any *one* of the following units: T-104, T-105, T-106, T-108, T-109, T-110, T-117, T-118, or any T-Series flip-flop. All inputs to the AND gate must have a rise time of 1 μs or less.

Power Required (each gate):

+12 volts dc ±10% at 3.0 ma approximately.
−12 volts dc ±10% at 1.5 ma approximately.

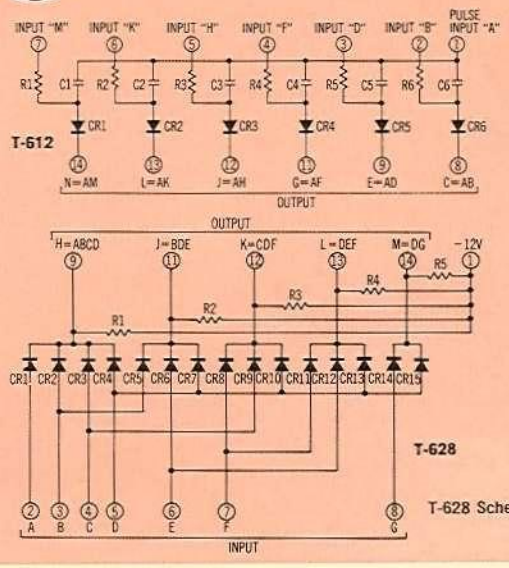
Operating Temperature Range: −45°C to +65°C.

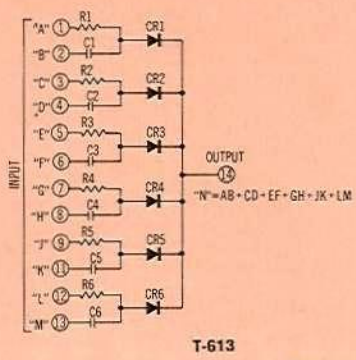
ONE-HALF ACTUAL SIZE

● NOTE: Of the above units, only T-427A can be used with the T-927 System Development Panels, because pin 1 on the T-927 sockets is prewired to −12 volts.

ENGINEERED ELECTRONICS Company

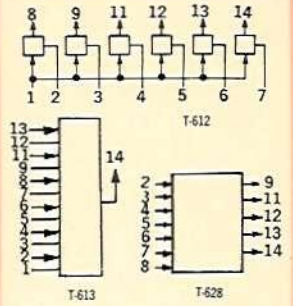
"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS





T-628 Schematic change 2/15/60.

LOGIC



T-612, T-613, T-628

MATING SOCKET (ALL THREE UNITS):
14-PIN SOCKET WITH PIN 10 BLOCKED FOR KEYWAY ORIENTATION, PART NO. T-937.

CIRCUIT DESCRIPTION

● Specifications revised 2/15/60.

The T-612 Multiple Pulse "And" Gate is a low-frequency, diode pulse gate assembly containing six gate circuits. Each gate has an independent control input, but all gates have a common pulse input. The outputs of a large number of the gates may be connected together, because of the high back impedance of the silicon diode used.

The T-613 Multiple Pulse "And" Gate is also a low-frequency, diode pulse gate assembly containing six gate circuits. Each gate has independent control and pulse inputs, but all gates have common output. The outputs of several T-613 units may be connected together because of the high back impedance of the silicon diode used.

Either the T-612 or T-613 pulse gate may be used to drive the base inputs of a T-102A directly; or, by biasing the output to −3 volts, either may be used to drive capacitive inputs.

The T-628 is a diode matrix intended for use in pairs to convert a 1-2-4-2 or 1-2-4-8 binary-coded decimal input to a 10-line decimal output (0-9) for driving relay drivers. The matrix is arranged so that emitter followers are not required on either input or output. Relay Drivers (T-120, T-121, or T-128) may be loaded on all outputs simultaneously.

The operating temperature range of all three units is −45°C to +65°C.

ELECTRICAL SPECIFICATIONS (T-628 only):

Input (pins 2, 3, 4, 5, 6, 7, and 8):

Type: Negative level shift.
Frequency Range: DC to 1 kc.
DC Levels: −3 volts dc to −11 volts dc. (−4 volts dc to −10 volts dc minimum.)
DC Input Current: 0 to 1.9 ma to −12 volts, depending on count and input.

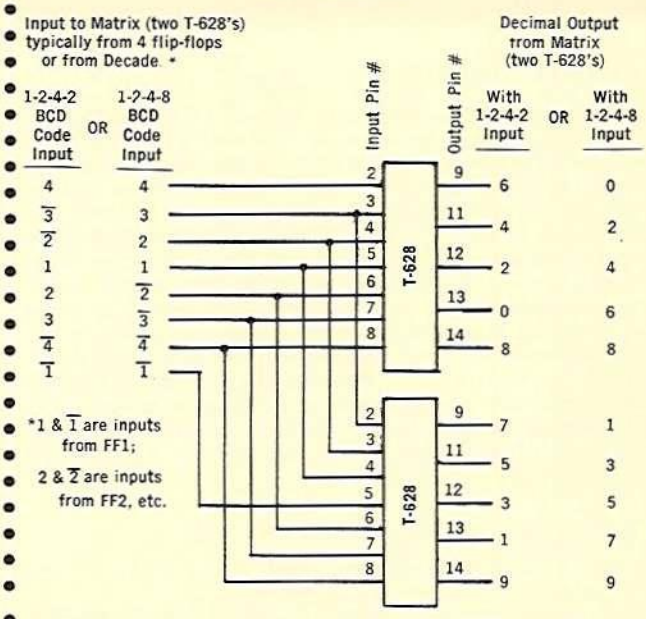
Output (pins 9, 11, 12, 13, and 14):

Type: Negative level shift. (Particularly designed for Relay Drivers T-120, T-121, T-128.)
DC Levels: −4 volts dc to −10.5 volts dc when driven by a decade made up of T-101B flip-flops and loaded by a relay driver.
Duration: Duration of negative level is essentially equal to period of decade input frequency.
Loading: One relay driver maximum on each output.

Power Requirements:

−12 volts at 3.6 ma maximum.
Supply voltage tolerance: ±10%.

APPLICATION NOTE



NOTE: None of the above units can be used with the T-927 System Development Panels, because pins 1 and 9 of the T-927 sockets are prewired to −12 volts and ground, respectively. However, T-639 and T-640 (not catalogued) can be used with the T-927 System Development Panels. These two circuits are identical with T-612 and T-613, respectively, except that they have 5 inputs instead of 6.

● Application Note added 2/15/60.

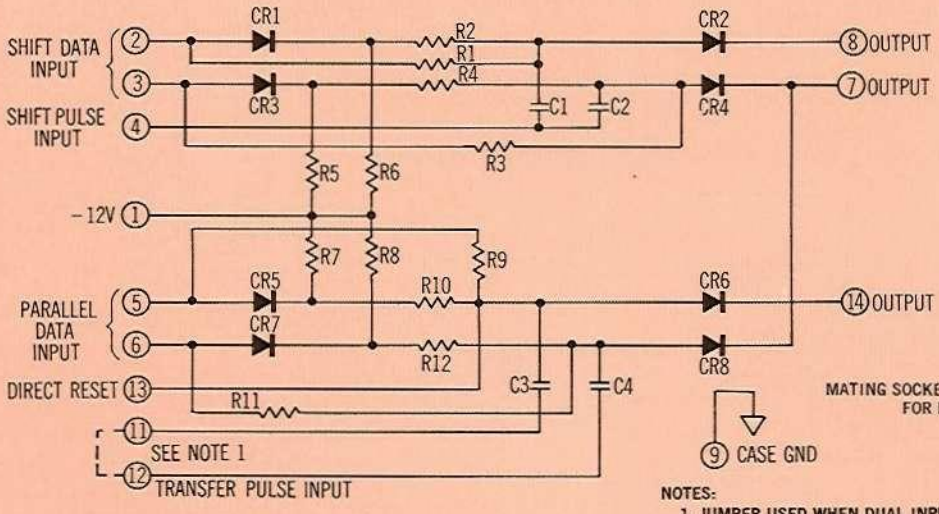
ONE-HALF ACTUAL SIZE

DC

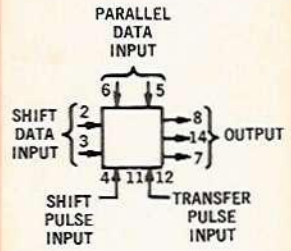
PULSE

ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS



SHIFT REGISTER LOGIC



T-600

MATING SOCKET: 14-PIN SOCKET WITH PIN 10 BLOCKED FOR KEYWAY ORIENTATION, PART NO. T-937.

NOTES:
1. JUMPER USED WHEN DUAL INPUT PARALLEL DATA APPLIED.
2. KEYWAY LOCATION: PIN 10 (OMITTED FROM HEADER).

CIRCUIT DESCRIPTION

A shift register logic element for use with T-102A flip-flops in shift register systems. The T-600 contains four pulse AND gates and two pulse OR gates, arranged to transfer stored data from input flip-flops to an output flip-flop. In shift registers, a T-600 and a T-102A are arranged in series: one pair for each data digit. The "Shift data inputs" are outputs from the preceding T-102A; the "outputs" are fed to the base inputs of the next T-102A in the series. Each "shift pulse" is gated to the R or S base input of the following T-102A in accordance with the control voltages present at the outputs of the previous T-102A. Parallel data are gated *into* the shift register system through similar circuitry. The T-600 is a flexible inter-stage logic circuit for application in shift registers. Details are given in Applications Notes.

ELECTRICAL SPECIFICATIONS

Control Inputs: Shift Data Input (pins 2 and 3) and Parallel Data Input (pins 5 and 6).
- Type: DC level shift as obtained from flip-flop outputs.
- Amplitude: Level shift of 8 volts amplitude, from −11 volts to −3 volts nominal.
- Rise Time: 0.1 to 1.0 microsecond.
- Frequency: 0 to 125 kc.
- Input Current: 0.9 ma to negative voltage.

Pulse Inputs: Shift Pulse Input (pin 4) and Transfer Pulse Input (pins 11 and 12).
- Type: Positive pulse. Normally obtained from a Pulse Amplifier, Blocking Oscillator, or NPN Emitter Follower.
- Minimum Amplitude: 7.5 volts.
- Maximum Amplitude: 9 volts.
- Rise Time: 0.4 microsecond or better.
- Frequency: 0 to 250 kc.
- Input Impedance: 440 $\mu\mu$f capacitive (pin 4); 220 $\mu\mu$f capacitive (pin 11); 220 $\mu\mu$f capacitive (pin 12).

Reset Input: (pin 13).
- When Reset operation is used, a Reset Generator T-109 is connected to pin 13. A resistor should be connected from pin 13 to 12-volt common

$$\text{Value} = \frac{10{,}000}{n}$$

where n is the number of SR elements connected to the T-109.

Output: (pins 7, 8, and 14).
- Type: Positive pulse. Three output connections for applying set and reset signals to base inputs of a T-102A Flip-Flop. Pulse signals are present on pin 7, pin 8, or pin 14. For most shift register applications, pin 14 is jumpered to pin 8.

Minimum Amplitude, Loaded: 2-volt pulse, level shift from −3.5 volts to −1.5 volts.

Rise Time: Essentially equal to pulse input rise time (0.4 microsecond or better).
- Duration: Nominally 0.75 microsecond.
- Load: Typical load is a direct base input of T-102A Flip-Flop or a direct trigger input of T-102A Flip-Flop.

Power Requirements:
- −12 volts at 1.8 ma maximum. Pin 1 to be negative with respect to the 12-volt common.
- Supply voltage tolerance ±10%.

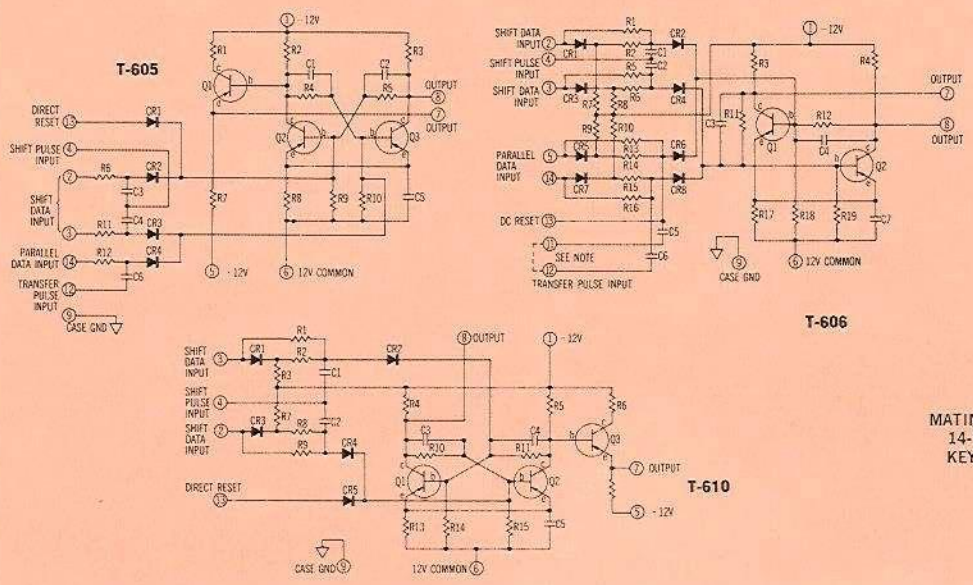
Operating Temperature Range: −45°C to +65°C.

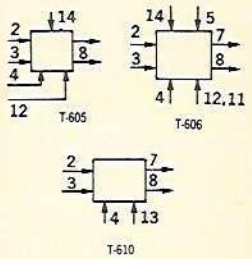
ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

SHIFT REGISTER FLIP-FLOP





T-605, T-606, T-610

MATING SOCKET (ALL THREE UNITS); 14-PIN SOCKET WITH PIN 10 BLOCKED FOR KEYWAY ORIENTATION, PART NO. T-937.

CIRCUIT DESCRIPTION

These shift register flip-flops are complete shift elements, containing the storage and gating circuits within a single package. One of the models, T-606, is a general-purpose element for flexible application. (This circuit is a combination of the T-102A flip-flop and the T-600 logic.) The T-605 and T-610 units each include an output emitter follower to facilitate parallel loading into DC logic.

The usual areas of application for these circuits are:

T-605 – Parallel-in, parallel-out.

T-606 – Serial-in, serial-out; or parallel-in, serial-out.

T-610 – Serial-in, parallel-out.

The T-605 is a slow-speed element that will work at speeds up to 25 kc. The T-606 and T-610 are both medium-speed devices that will work at speeds up to 250 kc.

ELECTRICAL SPECIFICATIONS

T-605

Control Inputs: Shift Data Input (pins 2 and 3), and Parallel Data Input (pin 14):

Type: DC Level shift as obtained from shift register or flip-flop outputs.

Amplitude: Level shift of 8 volts amplitude, from −11 volts DC to −3 volts DC, nominal.

Rise Time (for full-rated speed): 0.1 to 1.0 microsecond.

Frequency: 0 to 12.5 kc.

Pulse Inputs: Shift Pulse Input (pin 4), and Transfer Pulse Input (pin 12):

Type: Positive pulse. Normally obtained from a Pulse Amplifier, Blocking Oscillator, or NPN Emitter Follower.

Minimum Amplitude: 6.0 volts peak-to-peak.

Maximum Amplitude: 9 volts peak-to-peak.

Rise Time: 0.1 to 1.0 microsecond.

Frequency: 0 to 25 kc.

Input Impedance: 300 $\mu\mu$f capacitive (pin 4); 150 $\mu\mu$f capacitive (pin 12).

Reset Input (pin 13): When reset operation is used, a Reset Generator, T-109, is connected to pin 13.

Output (pins 7 and 8):

Type: 2 outputs of opposite polarity: "0" and "1." The pin 7 output is supplied from an emitter follower and is in the "0" state (−11 volts) when the unit is reset.

Amplitude (unloaded): 8-volt level shift from −11 volts DC to −3 volts DC, nominally.

Rise Time: 0.2 to 1.0 microsecond, depending upon load.

Load: Typical load is a control input to a shift register. Maximum resistive loading on pin 7 is 3.3 K to ±12 volts. This output may be used to drive DC logic units directly.

Power Requirements:

−12 volts at 8.9 to 16 ma, depending upon load. Pin 1 to be negative with respect to pin 6.

+12 volts at 3.9 to 11 ma, depending upon load. Pin 5 to be positive with respect to pin 6.

Supply voltage tolerance: ±10%.

Operating Temperature Range: −45°C to +65°C.

T-606

Control Inputs: Shift Data Input (pins 2 and 3), and parallel Data Input (pins 5 and 14):

Type: DC level shift as obtained from a shift register or a flip-flop output.

(Continued)

ONE-HALF ACTUAL SIZE

Amplitude: Level shift of 8 volts amplitude, from −11 volts DC to −3 volts DC, nominal.
Rise Time (for full-rated speed): 0.1 to 1.0 microsecond.
Frequency: 0 to 125 kc.
Input Current: 0.9 ma to negative voltage.

Pulse Inputs: Shift Pulse Input (pin 4), and Transfer Pulse Input (pins 11 and 12):
Type: Positive pulse. Normally obtained from a Pulse Amplifier, Blocking Oscillator, or NPN Emitter Follower.
Minimum Amplitude: 7.5 volts peak-to-peak.
Maximum Amplitude: 9 volts peak-to-peak.
Rise Time: 0.4 microsecond or better.
Frequency: 0 to 250 kc.
Input Impedance: 440 $\mu\mu$f capacitive (pin 4); 220 $\mu\mu$f capacitive (pin 11); 220 $\mu\mu$f capacitive (pin 12).

Reset Input (pin 13): When reset operation is used, a Reset Generator, T-109, is connected to pin 13. A resistor should be connected from pin 13 to 12-volt common. Value $= \frac{10{,}000}{n}$, where n is the number of shift register elements.

Output (pins 7 and 8):
Type: 2 outputs of opposite polarity: "0" and "1." The pin 7 output is in the "0" state (−11 volts) when the unit is reset.
Amplitude: 8-volt level shift from −11 volts DC to −3 volts DC nominally.
Rise Time: 0.2 to 1.0 microsecond, depending on load and input signal.
Loads: Typical load is a parallel combination of one control input to a shift register flip-flop, 1 flip-flop, and 1 Minisig indicator. Note that this output cannot feed DC logic units directly.
Maximum resistive loading: For ½-volt level shift, 0.2 ma to a positive source; 1 ma to a negative source. For 1-volt level shift, 0.4 ma to a positive source; 2.0 ma to a negative source.
Fall Time: Approximately 2.0 microseconds.

Power Requirements:
−12 volts at 6.6 ma maximum. Pin 1 to be negative with respect to pin 6.
Supply voltage tolerance: ±10%.

Operating Temperature Range: −54°C to +71°C.

Control Inputs: Shift Data Input (pins 2 and 3):
Type: DC level shift as obtained from register or flip-flop outputs.
Amplitude: Level shift of 8 volts amplitude, from −11 volts DC to −3 volts DC, nominal.
Rise Time (for full-rated speed): 0.1 to 1.0 microsecond.
Frequency: 0 to 125 kc.
Input Current: 0.9 ma to negative voltage.

Pulse Inputs: Shift Pulse Input (pin 4):
Type: Positive pulse. Normally obtained from a Pulse Amplifier, Blocking Oscillator, or NPN Emitter Follower.
Minimum Amplitude: 7.5 volts peak-to-peak.
Maximum Amplitude: 9 volts peak-to-peak.
Rise Time: 0.4 microsecond or better.
Frequency: 0 to 250 kc.
Input Impedance: 440 $\mu\mu$f capacitive.

Reset Input (pin 13): When reset operation is used, a Reset Generator, T-109, is connected to pin 13.

Output (pins 7 and 8):
Type: 2 outputs of opposite polarity: "0" and "1." The pin 7 output is supplied from an emitter follower and is in the "0" state (−11 volts) when the unit is reset.
Amplitude (unloaded): 8-volt level shift from −11 volts DC to −3 volts DC, nominally.
Rise Time: 0.2 to 1.0 microsecond, depending upon load.
Load: Typical load is a control input to a shift register. Maximum resistive loading on pin 7 is 3.3 K to ±12 volts. The output may be used to feed DC logic units directly.

Power Requirements:
−12 volts at 9.8 to 16.9 ma, depending upon load. Pin 1 to be negative with respect to pin 6.
+12 volts at 3.9 to 11 ma, depending upon load. Pin 5 to be positive with respect to pin 6.
Supply voltage tolerance: ±10%.

Operating Temperature Range: −45°C to +65°C.

ENGINEERED ELECTRONICS Company

"T-SERIES" GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

NEW CIRCUITS

NEW CIRCUITS UNDER DEVELOPMENT AND/OR PRESENTLY AVAILABLE, BUT NOT FULLY CATALOGUED. ADDITIONAL INFORMATION AVAILABLE ON REQUEST.

T-134 DUAL 0-28V RELAY AND INDICATOR DRIVER

A transistorized driver to provide power to operate moderately sensitive relays and indicator elements.

Frequency Range: 0-50 kc.
Input Level: To Activate —11V DC.
To Deactivate —3V DC.
Maximum Load: —28V @ 50 ma (each output).

T-135 DUAL 35V RELAY AND INDICATOR DRIVER

Similar to T-134 but the output is capable of handling —35V @ 100 ma.

T-136 DUAL INVERTER

A transistorized inverter for the purpose of logic inversion with level restoration.

Frequency Range: 0-250 kc.
Loading (each circuit): One T-136 or 10 K resistive to ground or 4.7 K to —12V.

T-137 BUFFERED INVERTER

For logic inversion with level restoration. Emitter follower output to permit loading into DC Logic.

Frequency Range: 0-250 kc.
Loading: Up to 10 T-137 or 1 K resistive to ground or 5.6 K to —12V.

T-138 INVERTER & BUFFERED INVERTER

A combination of ½ T-136 and a T-137, which may be used individually or series connected for DC squaring or level restoration without logic inversion.

Frequency Range: 0-250 kc.
Loading: (Inverter) one T-136
(Buffered Inverter) up to 10 T-137.

T-302 CAPACITY DRIVER (0-1 MC)

A squaring amplifier with complemented emitter follower output. Anti-saturation techniques are used to extend upper frequency response. The primary purpose of this unit is to drive high capacity loads without appreciable logic level loss or phase shift. DC loading is also permissible.

Loading: Up to 20 T-301 or 20 T-801 Pulse inputs at 1 mc.

T-434 DC LOGIC (F = AB + CD)

A dual, two input "AND" gate with an "OR'D" emitter follower output. The buffered output provides input isolation and facilitates heavy loading. The T-434 is typically driven by PNP emitter followers or by DC logic.

Frequency Range: 0-250 kc.
Output Level Shift: Approximately +.3V.
Output Impedance: 150 ohms for negative signal; 5.6 K for positive.
Loading (maximum): 3 "AND" gates in parallel, each loaded with 3 similar "AND" gates; or 2 "OR" gates in parallel, each loaded with 2 similar "OR" gates.

T-304 EMITTER FOLLOWER – HEAVY DUTY (0-1 MC)

A PNP-NPN complemented emitter follower configuration to provide current gain, circuit isolation, or for increasing load driving capabilities of an input signal.

Loading: 1 K to ±12V resistive load.
Output Impedance: 100 ohms maximum.

T-305 VIDEO AMPLIFIER (30 CPS to 10 MC)

A transistorized video amplifier with emitter follower output, for the amplification of low level input signals. Input source can be a voltage pick-up or a low level transducer. The gain is adjustable from X10 (30 cps to 10 mc) to X100 (60 cps to 5 mc) using an external shunt resistor. The output is in phase with the input.

Input: 5 mv to .6VPP, with 6VPP maximum output.

T-306 SQUARING AMPLIFIER (0-5 MC)

A modified Schmitt Trigger similar to the general purpose T-106. Typically used for waveform restoration, squaring of sine waves and for pulse amplification. A normal output is available with a nominal level shift of from —3V to —11V. Typical output loading would be one T-303 or one N-109 decade.

T-801 GATED FLIP-FLOP (0-1 MC)

Similar to, but more versatile than T-301 for use as a storage memory device, a frequency divider and as a shift register element for serial and/or parallel input with serial and/or parallel output. With an externally gated trigger input, AC set and reset inputs and a direct reset input, maximum versatility is provided.

Input: Control —3 to —11V (—3V to enable) Pulse 9VPP at 1 mc from T-302 or T-304.
Loading: A PNP emitter follower driving up to eight "AND" gate inputs.

(Continued)

ONE-HALF ACTUAL SIZE

T-301 GATED FLIP-FLOP (0-1 MC)

Used as a storage element for shift registers requiring serial input with parallel output. The unit is enabled by the preceding stage and triggered by a common shift pulse.

Input: Shift data −3V to −11V (−3V to enable) (0-500 kc).
Shift Pulse 6 to 9VPP at 1 mc from T-302 or T-304.

Loading: A PNP emitter follower driving up to eight "AND" gate inputs.

T-303 TRIGGER FLIP-FLOP (0-5 MC)

A T flip-flop similar to the T-102A, but with an extended high frequency operating range. It is generally used as a storage or memory device and as a frequency divider. The base connections are brought out to provide DC set and reset inputs when used in conjunction with logic circuits.

Input: To be driven from T-303 or T-306 squaring amplifier.

Loading: 1 N-109 or N-110 or 1 T-303.

T-633 RST FLIP-FLOP

Containing all the features of the T-101B, the T-102A and the T-103. The use of a 13-pin header provides terminals for all possible combinations of input signals. Diode isolation is provided between DC set and reset and AC set and reset for ease of use.

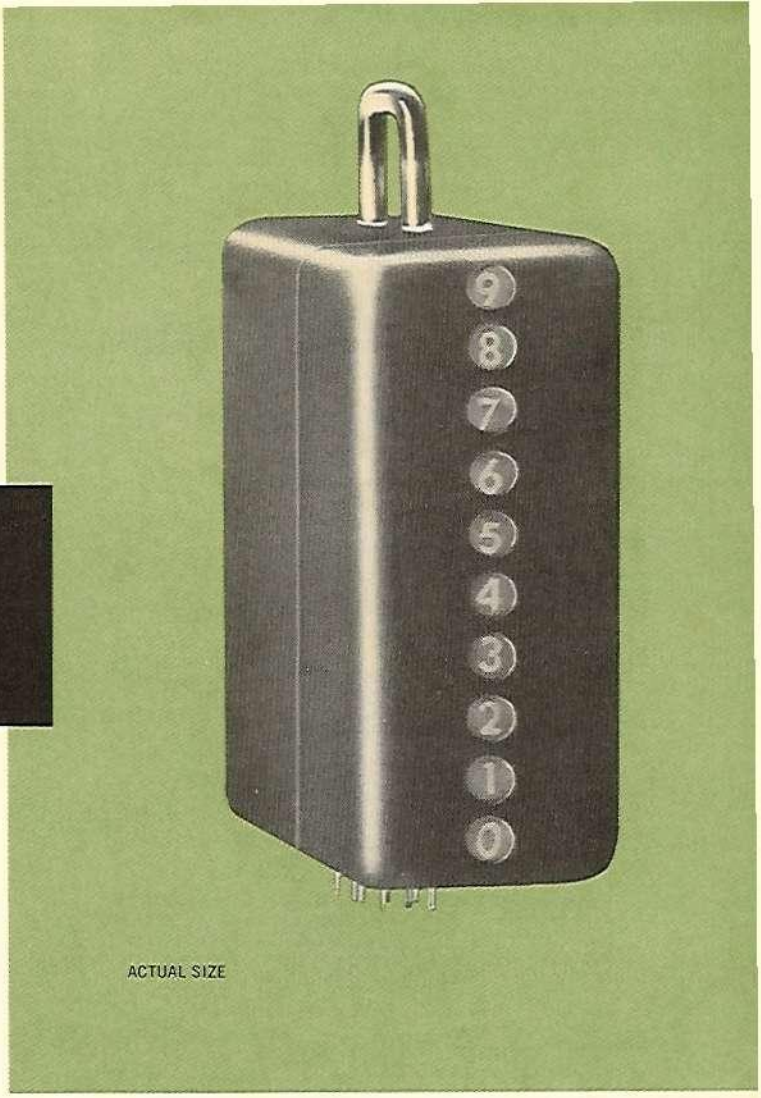
The primary purpose of this unit is for use as a storage or memory device, and as a frequency divider. When used as a memory with DC logic circuitry, the flip-flop should operate first into an emitter follower and then into the logic.

Frequency Range: 0-250 kc.

Loading: Typical load is a parallel combination of 1 flip-flop and 1 emitter follower plus 50 mmf.

N-SERIES

TRANSISTORIZED DECADES



ACTUAL SIZE

GENERAL

The EECO N-Series family of miniaturized and transistorized plug-in decimal counters features high operating speed, simple power-supply requirements, low power consumption, and *reserve* reliability. The standard *conservative* counting rates are 0-250 kcs and 0-5 mcs, and these units will work dependably even under adverse conditions of environment and power supply variations. N-Series decades are completely compatible with EECO T-Series plug-in digital circuits, and may be intermixed with T-Series circuits as required to build up equipment and systems.

The standard N-Series unit is slightly larger than a cigarette pack, and will plug into either a 13-pin or 29-pin socket, depending on model. The mating socket is supplied with each N-Series unit.

N-Series units are repairable, since the case can be opened for access to the one or two etched-circuit board sub-assemblies. A competent technician can generally effect repair using stock parts. No special test equipment is needed.

CIRCUIT DESCRIPTION

The counting circuits of the decades use four flip-flop stages with feedback. The circuits were designed using saturation techniques, along with consistent derating of component tolerances. The feedback used in most of the 250-kcs decades develops a 1-2-4-2 code; the 5-mcs decades use a special feedback scheme to give reliable counting at high speed. These basic counting circuits may be combined with several types of readout matrix for build-up of the various decade models.

CUSTOM CIRCUITS

We routinely furnish made-to-order circuits in the N-Series package. Often this can be done by making minor modifications to standard circuitry. Therefore, if our standard counters do not meet your requirements, please favor us with the opportunity to quote on special counters for your equipment, either in a standard N-Series case or in a special package, as appropriate to the problem.

WIDE SELECTION

N-Series plug-in Transistorized Decades are available in a wide range of models. The counting circuitry is standardized, and visual readout and/or preset controls are provided in typical decades as follows:*

MODEL	DESCRIPTION
N-101	No readout.
N-102	Incandescent readout.
N-104	Incandescent readout (remote). Typically an N-901 projection readout module.
N-105	Nixie readout. (Can be cabled to remote Nixie up to 25 feet away.)
N-106	Preset decade with Nixie readout. (Can be cabled to remote Nixie up to 25 feet away.) Preset control switch included.
N-109	No readout. (5-mcs counting rate.)
N-110	Incandescent readout. (5-mcs counting rate.)
N-111	No readout, but with code 1-2-4-2 outputs; no staircase output.
N-112	Incandescent readout and code 1-2-4-2 outputs; no staircase output.
N-901	Industrial Electronic Engineers' projection readout (numerals 0 through 9) for use with N-104.

*Many other non-catalogued decades for specialized applications are available. Specific inquiries are invited.

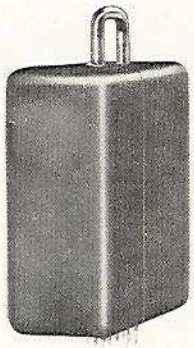
SUMMARY CHART (PARTIAL LIST)

N-SERIES	ELECTRICAL SPECIFICATIONS									READ-OUT				SOCKET		MISCELLANEOUS	
MODEL NUMBER	0-250 kc	0-5 mc	N/10, N-10 OUTPUT	N/2, N/2 OUTPUT	STAIRCASE OUTPUT	1-2-4-2 CODE	GATED OUTPUT	—12 V REQUIRED	—75 V REQUIRED	NONE	0-9 VERTICAL	0-9 IN LINE	0-9 NIXIE	13-PIN EECO #1937	23-PIN CONTINENTAL #MIK-23-23	EXTERNAL RESET NOT SUPPLIED	EXTERNAL SWITCH NOT SUPPLIED
N-101	■			■				■		■				■			
N-102	■			■				■			■			■			
N-104	■			■				■				■		■	■	■	
N-105	■			■				■	■					■			
N-106	■			■			■	■	■					■			
N-109		■						■		■				■			
N-110		■						■			■			■			
N-111	■			■		■		■		■				■			
N-112	■			■				■			■			■			

NOTES:

1. The N-Series decades are compatible with T-Series plug-in circuits and admixtures of N-Series and T-Series are permissible.
2. A reset connection is provided on all N-Series units. This input is ordinarily driven by a T-129 DC Reset Generator, which will reset six N-Series decades. The N-Series units require negative reset signals, and may be reset either by pulses or DC levels.
3. Permissible power supply tolerance is 10% on all input power.
4. Rated operating temperature range is −54°C to +71°C, unless otherwise specified.
5. The staircase output appears between two terminals. A 25-μa meter and series resistor can be connected between these terminals to give an economical visual readout.

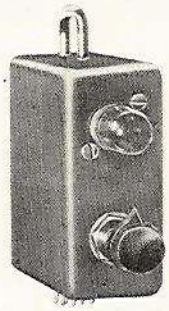
APPLICATION GUIDE FOR REPRESENTATIVE UNITS



N-101
N-109
N-111

Non-Indicating Decades

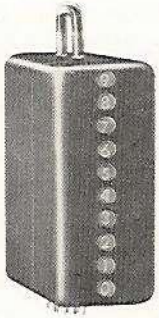
The main use of non-indicating decades is straight N/10 counting operations where visual readout is not required or not practicable because of counting speed. Model N-111 is useful in control applications, since 1-2-4-2 code outputs are available.



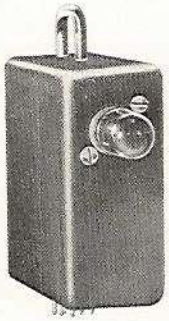
N-106

Presettable Decade

The presettable decade (N-106) offers a visual NIXIE readout and standard electrical outputs, plus a gated output signal at any count from 0 through 9, as determined by the setting of the switch. The gated signal is a positive voltage step (−11 v to −3 v) and its duration is equal to the period of the decade input signal.



N-102
N-110
N-112



N-105

N-104

N-901

Indicating Decades

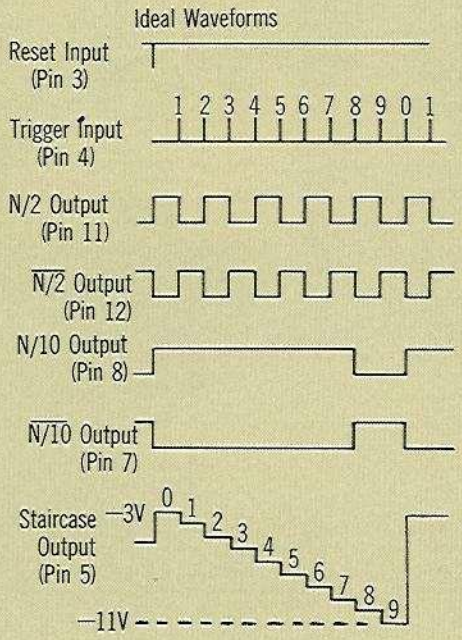
The indicating decades are general-purpose units. Three types of readout displays are available as shown in the illustrations. The vertical display uses 10 incandescent lamps (plug-in type); the in-line displays available are NIXIE and the projection-type manufactured by Industrial Electronic Engineers, and cataloged by EECO as N-901.

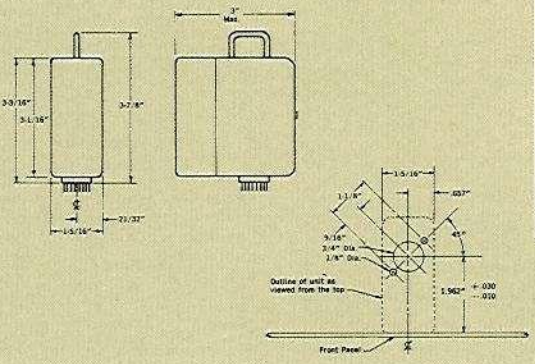
PHYSICAL SPECIFICATIONS

Outline, chassis layout, and full dimensional data are included on each specification sheet. Case is anodized aluminum, finished in black, baked enamel.

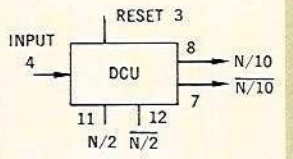
ENGINEERED ELECTRONICS Company

"N-SERIES" TRANSISTORIZED DECADES





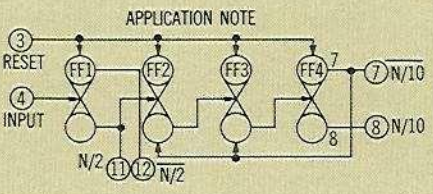
DECADE

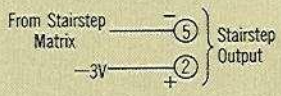


N-101

CONNECTOR KEYING NOTE: Pin 1 is toward front cover of decade.

POWER CONNECTIONS:
Pin 1: −12 volts
Pin 6: 12-volt common
Pin 9: Case ground





CIRCUIT DESCRIPTION

• Specifications revised 2/15/60.

The N-101 is a transistorized decimal counter employing four binary stages operating in a 1-2-4-2 code. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 250 kcs under adverse conditions of environment and power supply variations, but can be operated to 500 kc under limited conditions as stated below. The N-101 has no visual read-out, but it does have the following electrical outputs: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$, and a ten-level stairstep. The stairstep output may be adapted for a visual display by means of an emitter follower (T-111) and DC voltmeter.

The input and output signal characteristics are similar to those of the T-Series. The T-Series and N-Series thus form a compatible family of transistorized modules. The total power consumption of the N-101 is approximately one-half watt.

ELECTRICAL SPECIFICATIONS

Input:

Trigger Input:

(0 to 250 kcs): 6-volt minimum positive pulse or step at 1.0 microsecond maximum rise time.

(0 to 500 kcs): 7.5-volt minimum positive pulse or step at 0.2 microsecond maximum rise time (500-kc operation limited to −54° C to +50° C).

Maximum Operating Frequency: 250 kcs. (500 kcs under limited conditions as stated above.)

Input Impedance: 500 $\mu\mu$f capacitance, maximum, in series with 2.2 K.

Maximum Input Amplitude: 9 volts peak.

Unit will not trigger on a positive-going signal of less than 1.5 volts peak, regardless of rise time.

Reset: The N-101 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator.

Output (no load; 250 kc input):

Type: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$, and ten-level stairstep.

Amplitude: 8 volts peak to peak.

Output Levels: (N/10), $\overline{(N/10)}$, (N/2), and $\overline{(N/2)}$: −11 volts DC and −3 volts DC, nominal. Stairstep: −11 volts DC to −3 volts DC in nine steps.

Rise Time: (N/10), (N/2): 0.5 microsecond. $\overline{(N/10)}$, $\overline{(N/2)}$: 0.5 microsecond. Fall Time: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$: 1.5 microseconds.

Loading:

Typical: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$: Two N-Series decades or two T-Series flip-flops.

Maximum DC Load:

(N/10), $\overline{(N/10)}$: 4 ma to a negative source, which will shift −3-volt level ½ volt or less. (N/2), $\overline{(N/2)}$: 2 ma to a negative source, which will shift −3-volt level ½ volt or less.

(N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$: 0.5 ma to a positive source, which will shift −11-volt level ½ volt or less.

Maximum AC Load: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$: 1,200 $\mu\mu$f capacitance.

Note: The (N/10), $\overline{(N/10)}$ outputs may be loaded the same at 500 kc as at 250 kc, but the (N/2), $\overline{(N/2)}$ outputs are limited to one decade or one T-Series flip-flop.

Power Required:

−12 volts at 50 ma. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance ±10%.

PHYSICAL SPECIFICATIONS

Dimensions: This unit is contained within a rectangular package 1-5/16" wide x 2-31/32" deep x 3-7/8" seated height (including handle).

Mounting: Assembly is mounted by inserting into a 14-pin miniature socket with pin 10 blanked for keyway orientation. Socket is EECO Part No. T-937, furnished with each N-101 unit.

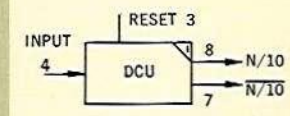
Pin connections are so arranged that power and grounds may be in-line wired.

• Operating Temperature Range: −54° C to +71° C.

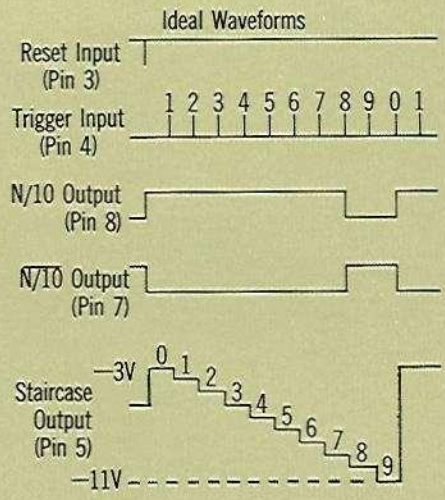
ENGINEERED ELECTRONICS Company

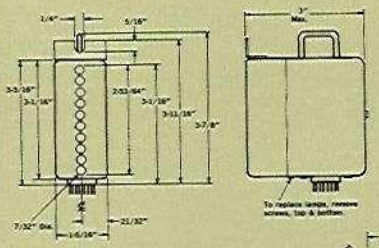
"N-SERIES" TRANSISTORIZED DECADES

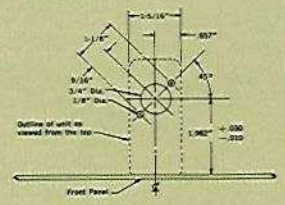
DECADE



N-102



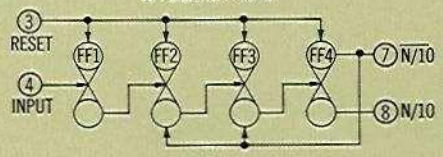


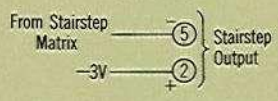


CONNECTOR KEYING NOTE: Pin 1 is toward front cover of decade.

POWER CONNECTIONS:
Pin 1: —12 volts
Pin 6: 12-volt common
Pin 9: Case ground

APPLICATION NOTE





DECADE COUNTER

CIRCUIT DESCRIPTION

The N-102 is a transistorized decimal counter employing four binary stages operating in a 1-2-4-2 code. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 250 kcs under adverse conditions of environment and power supply variations, but can be operated to 500 kc under limited conditions as stated below. The N-102 has a vertical incandescent read-out, plus the following electrical outputs: (N/10), $\overline{(N/10)}$, and a ten-level stairstep. The stairstep output may be adapted for a visual display by means of an emitter follower and DC voltmeter.

The input and output signal characteristics are similar to those of the T-Series. The T-Series and N-Series thus form a compatible family of transistorized modules. The total power consumption of the N-102 is approximately one watt.

ELECTRICAL SPECIFICATIONS

Input:
- Trigger Input:
  - (0 to 250 kcs): 6-volt minimum positive pulse or step at 1.0 microsecond maximum rise time.
  - (0 to 500 kcs): 7.5-volt minimum positive pulse or step at 0.2 microsecond maximum rise time (500-kc operation limited to —54° C to +50° C).
- Maximum Operating Frequency: 250 kcs. (500 kcs under limited conditions as stated above.)
- Input Impedance: 500 $\mu\mu$f capacitance, maximum, in series with 2.2 K.
- Maximum Input Amplitude: 9 volts peak.
- Unit will not trigger on a positive-going signal of less than 1.5 volts peak, regardless of rise time.
- Reset: The N-102 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator.

Output (no load):
- Type: (N/10), $\overline{(N/10)}$, and ten-level stairstep.
- Amplitude: 8 volts peak to peak.
- Output Levels: (N/10) and $\overline{(N/10)}$: —11 volts DC and —3 volts DC, nominal. Stairstep: —11 volts DC to —3 volts DC in nine steps.
- Rise Time: (N/10): 0.5 microsecond. $\overline{(N/10)}$: 0.5 microsecond. Fall Time: (N/10) and $\overline{(N/10)}$: 1.5 microseconds.

Loading:
- Typical: Two N-Series decades or two T-Series flip-flops.
- Maximum DC Load:
  - 4 ma to a negative source, which will shift —3-volt level ½ volt or less.
  - 0.5 ma to a positive source, which will shift —11-volt level ½ volt or less.
- Maximum AC Load: 1,200 $\mu\mu$f capacitance.

Power Required:
- —12 volts at 90 ma. Pin 1 to be negative with respect to pin 6.
- Supply voltage tolerance ±10%.

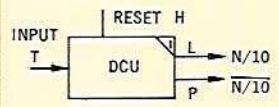
PHYSICAL SPECIFICATIONS

- Dimensions: This unit is contained within a rectangular package 1-5/16″ wide x 2-31/32″ deep x 3-7/8″ seated height (including handle).
- Mounting: Assembly is mounted by inserting into a 14-pin miniature socket with pin 10 blanked for keyway orientation. Socket is EECO Part No. T-937, furnished with each N-102 unit.
- Pin connections are so arranged that power and grounds may be in-line wired.
- Operating Temperature Range: —54° C to +71° C.

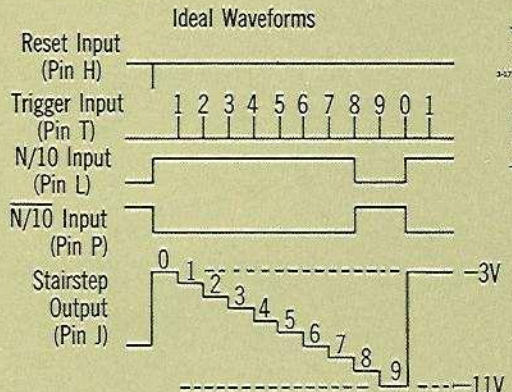
ENGINEERED ELECTRONICS Company

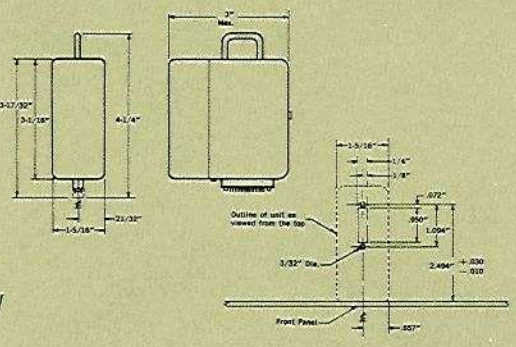
"N-SERIES" TRANSISTORIZED DECADES

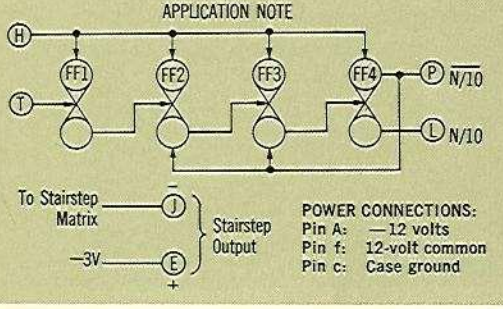
DECADE



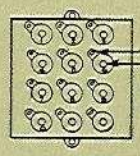
N-104





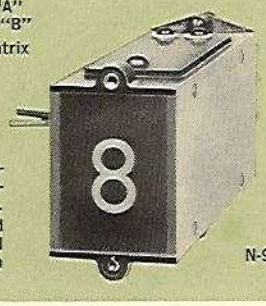


POWER CONNECTIONS:
Pin A: —12 volts
Pin f: 12-volt common
Pin c: Case ground



Outer connection = "A"
Center connection = "B"
Connect to decade matrix per table.

NOTES:
1. Ground is split return, i. e., matrix output is in bi-quinary form, requiring separate ground for each pair of five outputs.
2. Connect ground returns to even and odd "A" terminals on indicator; and signal outputs to appropriate "B" terminals on indicator.



N-901

DECADE COUNTER

CIRCUIT DESCRIPTION

● Specifications revised 2/15/60.

The N-104 is a transistorized decimal counter employing four binary stages operating in a 1-2-4-2 code. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 250 kcs under adverse conditions of environment and power supply variations, but can be operated to 500 kc under limited conditions as stated below. The N-104 has a remote incandescent read-out, plus the following electrical outputs: (N/10), $\overline{(N/10)}$, and a ten-level stairstep. The stairstep output may be adapted for a visual display by means of an emitter follower (T-111) and DC voltmeter. Remote read-out is accomplished by use of in-line projection-type display unit manufactured by Industrial Electronic Engineers (cataloged by EECO as N-901).

The input and output signal characteristics are similar to those of the T-Series. The T-Series and N-Series thus form a compatible family of transistorized modules. The total power consumption of the N-104 is approximately 2.5 watts, including remote read-out.

ELECTRICAL SPECIFICATIONS

Input:

Trigger Input:

(0 to 250 kcs): 6-volt minimum positive pulse or step at 1.0 microsecond maximum rise time.

(0 to 500 kcs): 7.5-volt minimum positive pulse or step at 0.2 microsecond maximum rise time (500-kc operation limited to —54° C to +50° C).

Maximum Operating Frequency: 250 kcs. (500 kcs under limited conditions as stated above.)

Input Impedance: 500 $\mu\mu$f capacitance, maximum, in series with 2.2 K.

Maximum Input Amplitude: 9 volts peak.

Unit will not trigger on a positive-going signal of less than 1.5 volts peak, regardless of rise time.

Reset: The N-104 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator.

Output (no load):

Type: (N/10), $\overline{(N/10)}$, and ten-level stairstep.

Amplitude: 8 volts peak to peak.

Output Levels: (N/10) and $\overline{(N/10)}$: —11 volts DC and —3 volts DC, nominal. Stairstep: —11 volts DC to —3 volts DC in nine steps.

Rise Time: (N/10): 0.5 microsecond. $\overline{(N/10)}$: 0.5 microsecond. Fall Time: (N/10) and $\overline{(N/10)}$: 1.5 microseconds.

Loading:

Typical: Two N-Series decades or two T-Series flip-flops.

Maximum DC Load:

4 ma to a negative source, which will shift —3-volt level ½ volt or less.

0.5 ma to a positive source, which will shift —11-volt level ½ volt or less.

Maximum AC Load: 1,200 $\mu\mu$f capacitance.

Power Required:

—12 volts at 225 ma. Pin A to be negative with respect to pin F.

Supply voltage tolerance ±10%.

PHYSICAL SPECIFICATIONS

Dimensions:

The N-104 Decade Counter is contained within a rectangular package 1-5/16" wide x 2-31/32" deep x 4-1/4" seated height (including handle).

The N-901 Remote Indicator is contained within a rectangular package 1-9/16" wide x 5-1/8" long x 2-5/8" high.

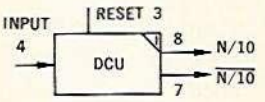
Mounting: Decade Counter is mounted by inserting into a standard 29-pin socket (Continental No. MM-29-22S) furnished with each N-104 unit. Remote Indicator is mounted by two 10-32 screws in the front.

● Operating Temperature Range: —54° C to +65° C.

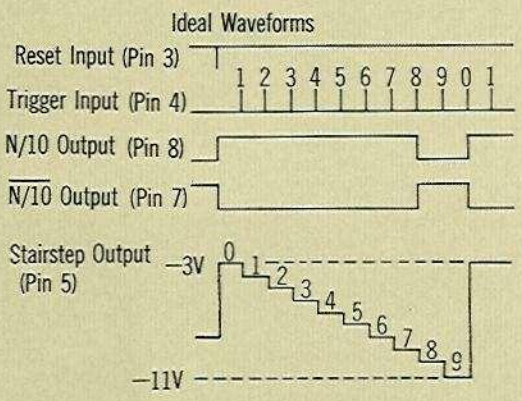
ENGINEERED ELECTRONICS Company

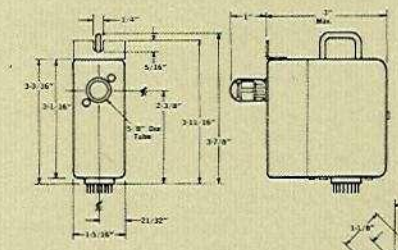
"N-SERIES" TRANSISTORIZED DECADES

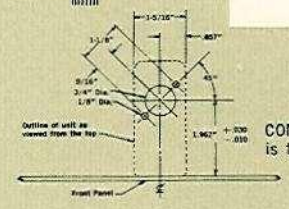
DECADE



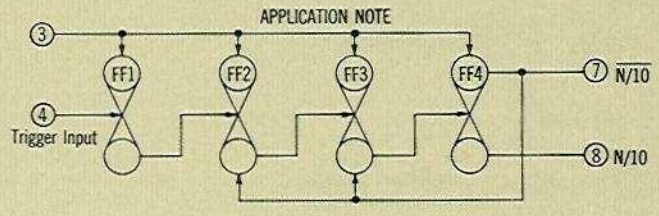
N-105



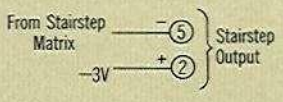




CONNECTOR KEYING NOTE: Pin 1 is toward front cover of decade.



POWER CONNECTIONS:
Pin 1: −12 volts
Pin 6: 12-volt common
Pin 9: Case ground
Pin 11: +150 volts



DECADE COUNTER

CIRCUIT DESCRIPTION

The N-105 is a transistorized decimal counter employing four binary stages operating in a 1-2-4-2 code. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 250 kcs under adverse conditions of environment and power supply variations, but can be operated to 500 kc under limited conditions as stated below. The N-105 has a miniature (Nixie) read-out, plus the following electrical outputs: (N/10), $(\overline{N/10})$, and a ten-level stairstep. The stairstep output may be adapted for a visual display by means of an emitter follower (T-111) and DC voltmeter.

The input and output signal characteristics are similar to those of the T-Series. The T-Series and N-Series thus form a compatible family of transistorized modules. The total power consumption of the N-105 is approximately three watts.

ELECTRICAL SPECIFICATIONS

Input:

Trigger Input:

(0 to 250 kcs): 6-volt minimum positive pulse or step at 1.0 microsecond maximum rise time.

(0 to 500 kcs): 7.5-volt minimum positive pulse or step at 0.2 microsecond maximum rise time (500-kc operation limited to −54° C to +50° C).

Maximum Operating Frequency: 250 kcs. (500 kcs under limited conditions as stated above.)

Input Impedance: 500 μμf capacitance, maximum, in series with 2.2 K.

Maximum Input Amplitude: 9 volts peak.

Unit will not trigger on a positive input signal of less than 1.5 volts, regardless of rise time.

Reset: The N-105 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator.

Output (no load):

Type: (N/10), $(\overline{N/10})$, and ten-level stairstep.

Amplitude: 8 volts peak to peak.

Output Levels: (N/10) and $(\overline{N/10})$: −11 volts DC and −3 volts DC, nominal. Stairstep: −11 volts DC to −3 volts DC in nine steps.

Rise Time: (N/10): 0.5 microsecond. $(\overline{N/10})$: 0.5 microsecond. Fall Time: (N/10) and $(\overline{N/10})$: 1.5 microseconds.

Loading:

Typical: Two N-Series decades or two T-Series flip-flops.

Maximum DC Load:

4 ma to a negative source, which will shift −3-volt level ½ volt or less.

0.2 ma to a positive source, which will shift −11-volt level ½ volt or less.

Maximum AC Load: 1,200 μμf capacitance.

Power Required:

−12 volts at 50 ma; +150 volts at 17 ma. Pin 1 to be negative with respect to pin 6 and pin 11 positive with respect to pin 6.

Supply voltage tolerance ±10%.

PHYSICAL SPECIFICATIONS

Dimensions: This unit is contained within a rectangular package 1-5/16″ wide x 2-31/32″ deep x 3-7/8″ seated height (including handle).

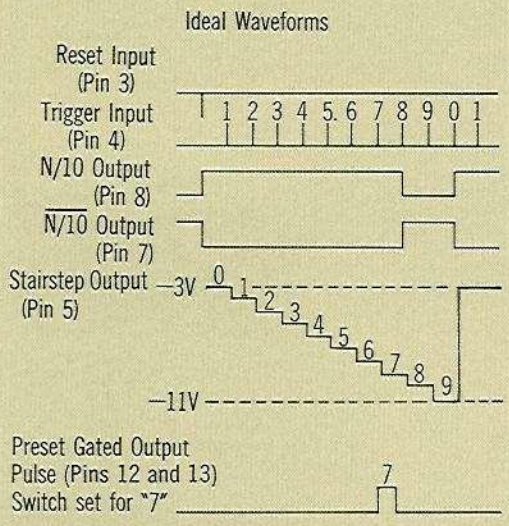
Mounting: Assembly is mounted by inserting into a 14-pin miniature socket with pin 10 blanked for keyway orientation. Socket is EECO Part No. T-937, furnished with each N-105 unit.

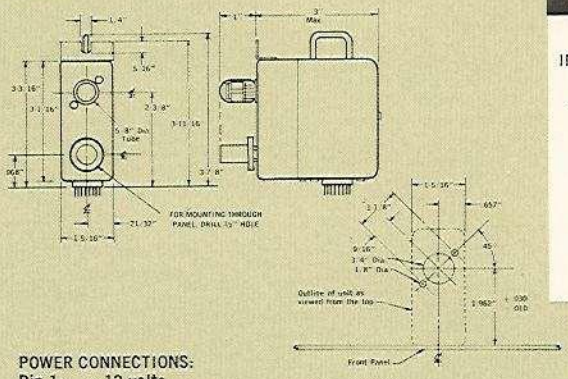
Pin connections are so arranged that power and grounds may be in-line wired.

Operating Temperature Range: −54° C to +65° C.

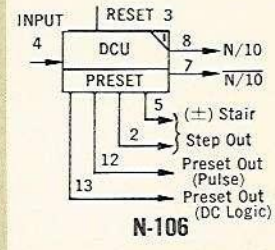
ENGINEERED ELECTRONICS Company

"N-SERIES" TRANSISTORIZED DECADES





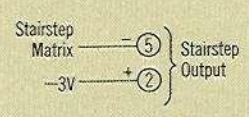
DECADE



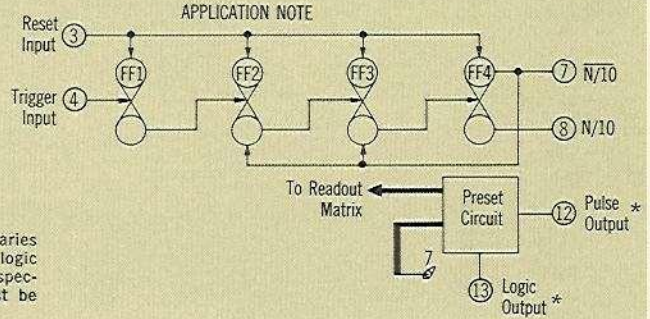
N-106

CONNECTOR KEYING NOTE: Pin 1 is toward front cover of decade.

POWER CONNECTIONS:
Pin 1: —12 volts
Pin 6: 12-volt common
Pin 9: Case ground
Pin 11: +150 volts
Pin 14: +12 volts



APPLICATION NOTE



* NOTE: The preset outputs are delayed with respect to the input pulse train. This delay varies with switch setting and may typically be as long as 2 microseconds. The pulse output and logic output have the same waveform, and are for application with capacity and DC logic loads, respectively. Where the preset output is to be used with coincidence circuitry, the delay must be accommodated to prevent false coincidence outputs.

CIRCUIT DESCRIPTION

The N-106 is a transistorized decimal counter employing four binary stages operating in a 1-2-4-2 code. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 250 kcs under adverse conditions of environment and power supply variations. The N-106 has a miniature (Nixie) read-out, plus the following electrical outputs: (N/10), $\overline{(N/10)}$, and a ten-level stairstep. The stairstep output may be adapted for a visual display by means of an emitter follower (T-111) and DC voltmeter. The N-106 also has a preset gated pulse output and preset gated logic output. Thus, a pulse or logic output can be obtained at any preset digit from 0 to 9.

The input and output signal characteristics are similar to those of the T-Series. The T-Series and N-Series thus form a compatible family of transistorized modules. The total power consumption of the N-106 is approximately three watts.

ELECTRICAL SPECIFICATIONS

Input:

Trigger Input:
(0 to 250 kcs): 6-volt minimum positive pulse or step at 1.0 microsecond maximum rise time.
Maximum Operating Frequency: 250 kcs.
Input Impedance: 500 $\mu\mu$f capacitance, maximum, in series with 2.2 K.
Maximum Input Amplitude: 9 volts peak.
Unit will not trigger on a positive input signal of less than 1.5 volts, regardless of rise time.
Reset: The N-106 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator.

Output (no load):

Type: (N/10), $\overline{(N/10)}$, ten-level stairstep, preset gated pulse and logic outputs.
Amplitude: 8 volts peak to peak.
Output Levels: (N/10), $\overline{(N/10)}$, preset gated pulse and logic outputs: —11 volts DC and —3 volts DC, nominal. Stairstep: —11 volts DC to —3 volts DC in nine steps.
Rise Time: (N/10), $\overline{(N/10)}$: 0.5 microsecond. Fall Time: (N/10), $\overline{(N/10)}$: 1.5 microseconds.
Preset Gated Pulse Output Rise Time: 0.3 microsecond. Fall Time: 1.5 microseconds.
Preset Gated Logic Output Rise Time: 0.5 microsecond. Fall Time: 1.5 microseconds.

Loading:

Typical: Two N-Series decades or two T-Series flip-flops, for (N/10), $\overline{(N/10)}$, and preset pulse outputs.
Maximum DC Load:
4 ma to a negative source, which will shift —3-volt level ½ volt or less, (N/10) and $\overline{(N/10)}$ outputs.
0.2 ma to a positive source, which will shift —11-volt level ½ volt or less, (N/10) and $\overline{(N/10)}$ outputs.
1 ma to a negative source for preset logic output.
4 ma to a positive source for preset logic output.
4 ma to a negative source for preset pulse output.
0.4 ma to a positive source for preset pulse output.
Maximum AC Load: 1,200 $\mu\mu$f capacitance for (N/10), $\overline{(N/10)}$, and preset pulse output.
The duration of the preset pulse output is the period of the input frequency.

Power required:

—12 volts at 60 ma; +150 volts at 20 ma. Pin 1 to be negative with respect to pin 6 and pin 11 positive with respect to pin 6. (If logic output is used, +12 volts at 2 to 5 ma, depending on load.)
Supply voltage tolerance ±10%.

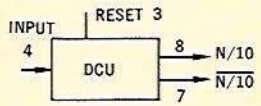
PHYSICAL SPECIFICATIONS

Dimensions: This unit is contained within a rectangular package 1-5/16" wide x 2-31/32" deep x 3-7/8" seated height (including handle).
Mounting: Assembly is mounted by inserting into a 14-pin miniature socket with pin 10 blanked for keyway orientation. Socket is EECO Part No. T-937, furnished with each N-106 unit.
Pin connections are so arranged that power and grounds may be in-line wired.
Operating Temperature Range: —54° C to +65° C.
The "Nixie" tube and preset switch are located on the face of the decade.

ENGINEERED ELECTRONICS Company

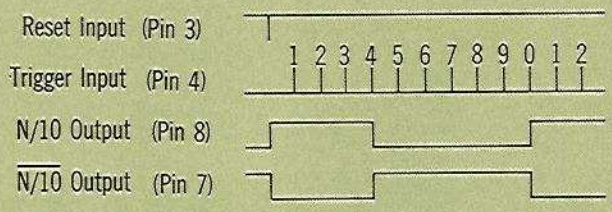
"N-SERIES" TRANSISTORIZED DECADES

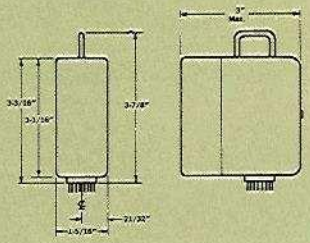
DECADE

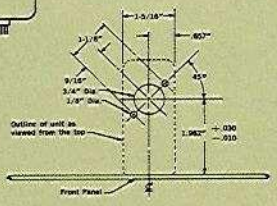


N-109

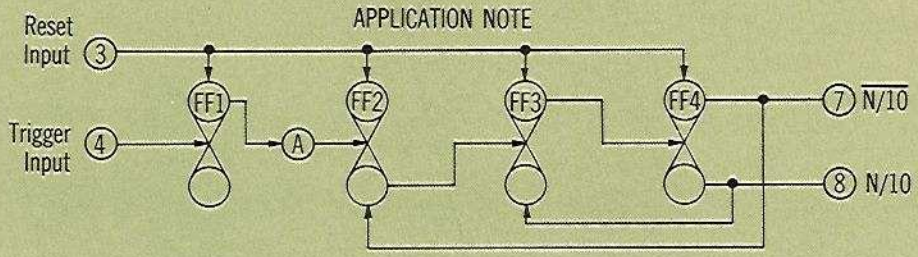
Ideal Waveforms







APPLICATION NOTE



CONNECTOR KEYING NOTE: Pin 1 is toward front cover of decade.

POWER CONNECTIONS:
Pin 1: —12 volts
Pin 6: 12-volt common
Pin 9: Case ground

DECADE COUNTER

CIRCUIT DESCRIPTION

The N-109 is a transistorized decimal counter employing four binary stages, with feed back. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 5 mcs, under adverse conditions of environment and power supply variation. This unit has no visual read-out, but (N/10) and $\overline{(N/10)}$ outputs are available.

The output characteristics of the N-109 are similar to the input characteristics of the N-Series low-speed decades (250 kcs), which makes them a compatible family of transistorized modules. The total power consumption of the N-109 is approximately 0.75 watt.

ELECTRICAL SPECIFICATIONS

Input:
- Trigger Input:
  - (0 to 5 mcs) : 7-volt minimum step or pulse at .02 microsecond maximum rise time.
  - (0 to 1 mcs) : 7-volt minimum step or pulse at .05 microsecond maximum rise time.
- Maximum Operating Frequency: 5 mcs.
- Input Impedance: 270 $\mu\mu$f capacitance, maximum, in series with 1 K.
- Maximum Input: 10 volts peak.
- Unit will not trigger on a positive-going signal of 1.5 volts or less, regardless of rise time.
- Reset: The N-109 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator. When the reset input (pin 3) is not used, it must be returned to 12-volt common.

Output (no load):
- Type: (N/10), $\overline{(N/10)}$.
- Amplitude: 8 volts peak to peak.
- Output Levels: —11 volts DC and —3 volts DC, nominal.
- Rise Time: (N/10) and $\overline{(N/10)}$ outputs: .05 microsecond rise time; 1.0 microsecond fall time.

Loading:
- Typical: One N-Series decade (250 kcs or 5 mcs).
- Maximum DC Load:
  - 5 ma to a negative source, which will shift —3-volt level ½ volt or less.
  - 0.5 ma to a positive source, which will shift —11-volt level ½ volt or less.
- Maximum AC Load: 82 $\mu\mu$f capacitance.

Power Required:
- —12 volts at 65 ma. Pin 1 to be negative with respect to pin 6.
- Supply voltage tolerance ±10%.

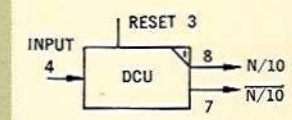
PHYSICAL SPECIFICATIONS

- Dimensions: This unit is contained within a rectangular package 1-5/16″ wide x 2-31/32″ deep x 3-7/8″ seated height (including handle).
- Mounting: Assembly is mounted by inserting into a 14-pin miniature socket with pin 10 blanked for keyway orientation. Socket is EECO Part No. T-937, furnished with each N-109 unit.
- Pin connections are so arranged that power and grounds may be in-line wired.
- Operating Temperature Range: —54°C to +71°C.
- *Note:* When using these plug-in modules, high-frequency pulse techniques must be observed in external wiring.

ENGINEERED ELECTRONICS Company

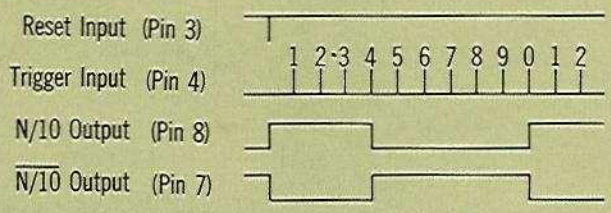
"N-SERIES" TRANSISTORIZED DECADES

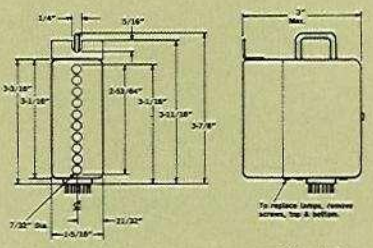
DECADE

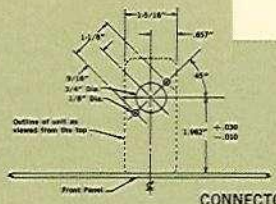


N-110

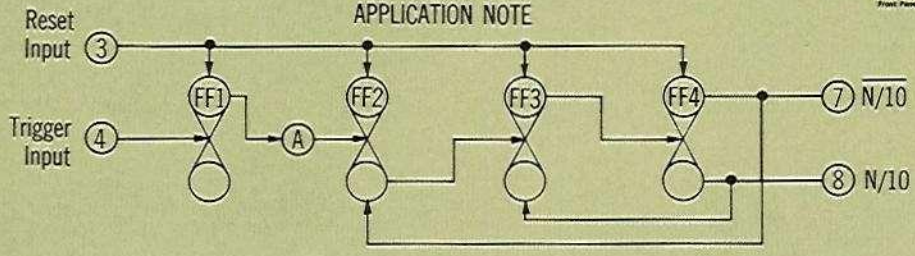
Ideal Waveforms







APPLICATION NOTE



CONNECTOR KEYING NOTE: Pin 1 is toward front cover of decade.

POWER CONNECTIONS:
Pin 1: —12 volts
Pin 6: 12-volt common
Pin 9: Case ground

CIRCUIT DESCRIPTION

The N-110 is a transistorized decimal counter employing four binary stages, with feed back. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 5 mcs, under adverse conditions of environment and power supply variations. (N/10) and $\overline{(N/10)}$ outputs are available. This unit also employs a vertical incandescent visual display, which is self-contained in the package.

The output characteristics of the N-110 are similar to the input characteristics of the N-Series low-speed decades (250 kcs), which makes them a compatible family of transistorized modules. The total power consumption of the N-110 is approximately 1.25 watts.

ELECTRICAL SPECIFICATIONS

Input:
- Trigger Input:
  - (0 to 5 mcs): 7-volt minimum step or pulse at .02 microsecond maximum rise time.
  - (0 to 1 mcs): 7-volt minimum step or pulse at .05 microsecond maximum rise time.
- Maximum Operating Frequency: 5 mcs.
- Input Impedance: 270 $\mu\mu$f capacitance, maximum, in series with 1 K.
- Maximum Input: 10 volts peak.
- Unit will not trigger on a positive-going signal of 1.5 volts or less, regardless of rise time.
- Reset: The N-110 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator. When the reset input (pin 3) is not used, it must be returned to 12-volt common.

Output (no load):
- Type: (N/10), $\overline{(N/10)}$, vertical incandescent display.
- Amplitude: 8 volts peak to peak.
- Output Levels: —11 volts DC and —3 volts DC, nominal.
- Rise Time: (N/10) and $\overline{(N/10)}$ outputs: .05 microsecond rise time; 1.0 microsecond fall time.

Loading:
- Typical: One N-Series decade (250 kcs or 5 mcs).
- Maximum DC Load:
  - 5 ma to a negative source, which will shift —3-volt level ½ volt or less.
  - 0.4 ma to a positive source, which will shift —11-volt level ½ volt or less.
- Maximum AC Load: 82 $\mu\mu$f capacitance.

Power Required:
- —12 volts at 105 ma. Pin 1 to be negative with respect to pin 6.
- Supply voltage tolerance ±10%.

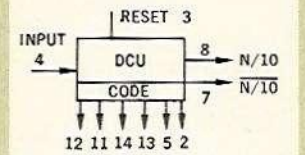
PHYSICAL SPECIFICATIONS

- Dimensions: This unit is contained within a rectangular package 1-5/16″ wide x 2-31/32″ deep x 3-7/8″ seated height (including handle).
- Mounting: Assembly is mounted by inserting into a 14-pin miniature socket with pin 10 blanked for keyway orientation. Socket is EECO Part No. T-937, furnished with each N-110 unit.
- Pin connections are so arranged that power and grounds may be in-line wired.
- Operating Temperature Range: —54° C to +71° C.
- *Note:* When using these plug-in modules, high-frequency pulse techniques must be observed in external wiring.

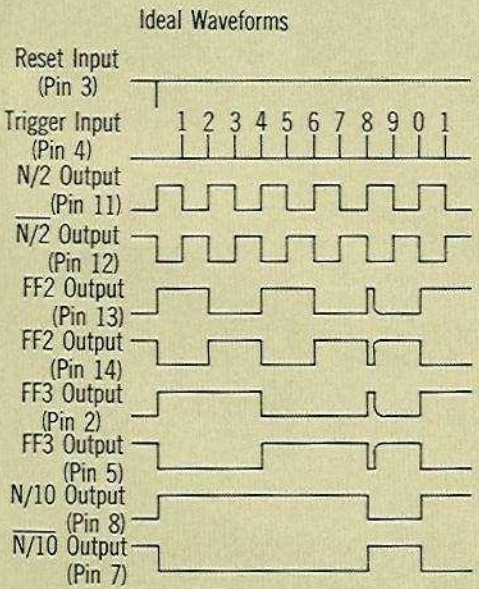
ENGINEERED ELECTRONICS Company

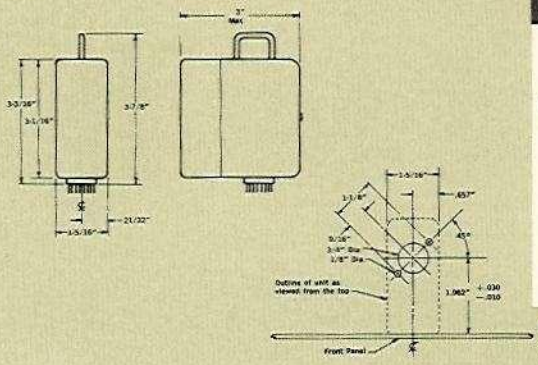
"N-SERIES" TRANSISTORIZED DECADES

DECADE



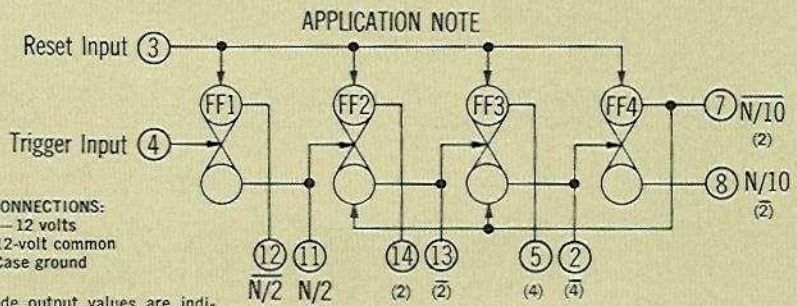
N-111





CONNECTOR KEYING NOTE: Pin 1 is toward front cover of decade.

APPLICATION NOTE



POWER CONNECTIONS:
Pin 1: —12 volts
Pin 6: 12-volt common
Pin 9: Case ground

NOTE: Code output values are indicated by numbers in parentheses ( ).

DECADE

CIRCUIT DESCRIPTION

The N-111 is a transistorized decimal counter employing four binary stages operating in a 1-2-4-2 code. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 250 kcs, under adverse conditions of environment and power supply variations, but can be operated to 500 kc under limited conditions as stated below. The N-111 has no visual read-out, but it does have the following electrical outputs: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$, and the normal and complimented outputs of the other two stages in the four-stage decade.

Note: Since this unit has 1-2-4-2 code output, T-Series Unit T-628 can be used in pairs to convert the coded output to a 10-line decimal output where required.

The input and output signal characteristics are similar to those of the T-Series. The T-Series and N-Series thus form a compatible family of transistorized modules. The total power consumption of the N-111 is approximately one-half watt.

ELECTRICAL SPECIFICATIONS

Input:

Trigger Input:

(0 to 250 kcs): 6-volt minimum positive pulse or step at 1.0 microsecond maximum rise time.

(0 to 500 kcs): 7.5-volt minimum positive pulse or step at 0.2 microsecond maximum rise time (500-kc operation limited to —54° C to +50° C).

Maximum Operating Frequency: 250 kcs. (500 kcs under limited conditions as stated above.)

Input Impedance: 500 $\mu\mu$f capacitance, maximum.

Maximum Input Amplitude: 9 volts peak.

Unit will not trigger on a positive-going signal of less than 1.5 volts, regardless of rise time.

Reset: The N-111 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator.

Output (no load; 250 kc input):

Type: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$, and the normal and complemented outputs of the other two stages in the four-stage decade.

Amplitude: 8 volts peak to peak, all outputs.

Output Levels: —11 volts DC and —3 volts DC, nominal, all outputs.

Rise Time: 0.5 microsecond or less, all outputs. Fall Time: 1.5 microseconds, all outputs.

Loading:

Typical: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$, two N-Series decades or two T-Series flip-flops.

Maximum DC Load:

(N/10), $\overline{(N/10)}$: 4 ma to a negative source, which will shift —3-volt level ½ volt or less. All other outputs: 2 ma to a negative source, which will shift —3-volt level ½ volt or less.

(N/10), $\overline{(N/10)}$: 0.5 ma to a positive source, which will shift —11-volt level ½ volt or less. All other outputs: 0.4 ma to a positive source, which will shift —11-volt level ½ volt or less.

Maximum AC Load (all outputs): 1,200 $\mu\mu$f capacitance.

Note: The (N/10), $\overline{(N/10)}$ outputs may be loaded the same at 500 kc as at 250 kc, but the other outputs are limited to one decade or one T-Series flip-flop.

Power Required:

—12 volts at 50 ma. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance ±10%.

PHYSICAL SPECIFICATIONS

Dimensions: This unit is contained within a rectangular package 1-5/16" wide x 2-31/32" deep x 3-7/8" seated height (including handle).

Mounting: Assembly is mounted by inserting into a 14-pin miniature socket with pin 10 blanked for keyway orientation. Socket is EECO Part No. T-937, furnished with each N-111 unit.

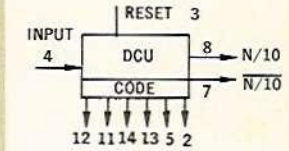
Pin connections are so arranged that power and grounds may be in-line wired.

Operating Temperature Range: —54° C to +71° C.

ENGINEERED ELECTRONICS Company

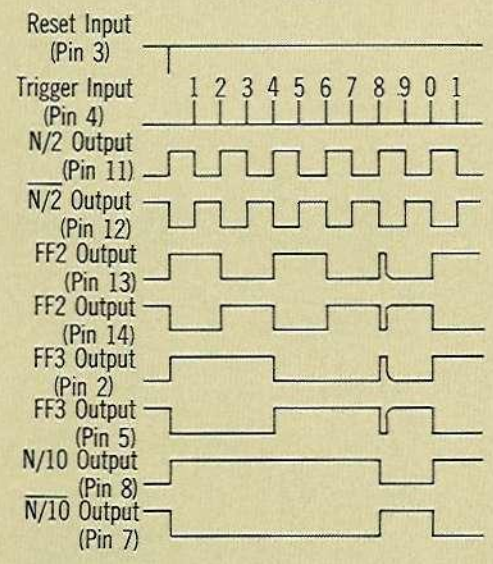
"N-SERIES" TRANSISTORIZED DECADES

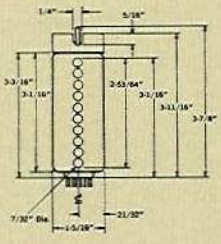
DECADE

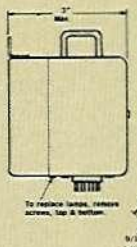


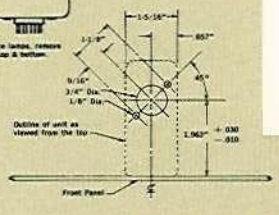
N-112

Ideal Waveforms





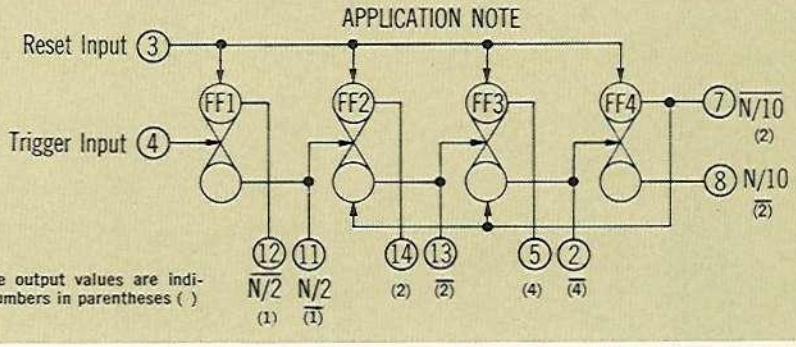




POWER CONNECTIONS:
Pin 1: —12 volts
Pin 6: 12-volt common
Pin 9: Case ground

CONNECTOR KEYING NOTE: Pin 1 is toward front cover of decade.

APPLICATION NOTE



NOTE: Code output values are indicated by numbers in parentheses ( )

CIRCUIT DESCRIPTION

The N-112 is a transistorized decimal counter employing four binary stages operating in a 1-2-4-2 code. Features emphasized and contained in the design are extreme reliability (achieved through saturation techniques as well as derating component tolerances), low power consumption, and small size. The counter is conservatively rated for operation from 0 to 250 kcs under adverse conditions of environment and power supply variations, but can be operated to 500 kc under limited conditions as stated below. The N-112 has visual read-out and the following electrical outputs: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$, and the normal and complimented outputs of the other two stages in the four-stage decade.

Note: Since this unit has 1-2-4-2 code output, T-Series Unit T-628 can be used in pairs to convert the coded output to a 10-line decimal output where required.

The input and output signal characteristics are similar to those of the T-Series. The T-Series and N-Series thus form a compatible family of transistorized modules. The total power consumption of the N-112 is approximately one watt.

ELECTRICAL SPECIFICATIONS

Input:

Trigger Input:

(0 to 250 kcs): 6-volt minimum positive pulse or step at 1.0 microsecond maximum rise time.

(0 to 500 kcs): 7.5-volt minimum positive pulse or step at 0.2 microsecond maximum rise time (500-kc operation limited to —54° C to +50° C).

Maximum Operating Frequency: 250 kcs. (500 kcs under limited conditions as stated above.)

Input Impedance: 500 $\mu\mu$f capacitance, maximum.

Maximum Input Amplitude: 9 volts peak.

Unit will not trigger on a positive-going signal of less than 1.5 volts peak, regardless of rise time.

Reset: The N-112 is reset by a negative pulse or DC level shift supplied by the T-129 Reset Generator.

Output (no load; 250 kc input):

Type: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$, and the normal and complemented outputs of the other two stages in the four-stage decade.

Amplitude: 8 volts peak to peak, all outputs.

Output Levels: —11 volts DC and —3 volts DC, nominal, all outputs.

Rise Time: 0.5 microsecond or less, all outputs. Fall Time: 1.5 microseconds, all outputs.

Loading:

Typical: (N/10), $\overline{(N/10)}$, (N/2), $\overline{(N/2)}$, two N-Series decades or two T-Series flip-flops.

Maximum DC Load:

(N/10), $\overline{(N/10)}$: 4 ma to a negative source, which will shift —3-volt level ½ volt or less. All other outputs: 2 ma to a negative source, which will shift —3-volt level ½ volt or less.

(N/10), $\overline{(N/10)}$: 0.5 ma to a positive source, which will shift —11-volt level ½ volt or less. All other outputs: 0.4 ma to a positive source, which will shift —11-volt level ½ volt or less.

Maximum AC Load (all outputs): 1,200 $\mu\mu$f capacitance.

Note: The (N/10), $\overline{(N/10)}$ outputs may be loaded the same at 500 kc as at 250 kc, but the other outputs are limited to one decade or one T-Series flip-flop.

Power Required:

—12 volts at 90 ma. Pin 1 to be negative with respect to pin 6.

Supply voltage tolerance ±10%.

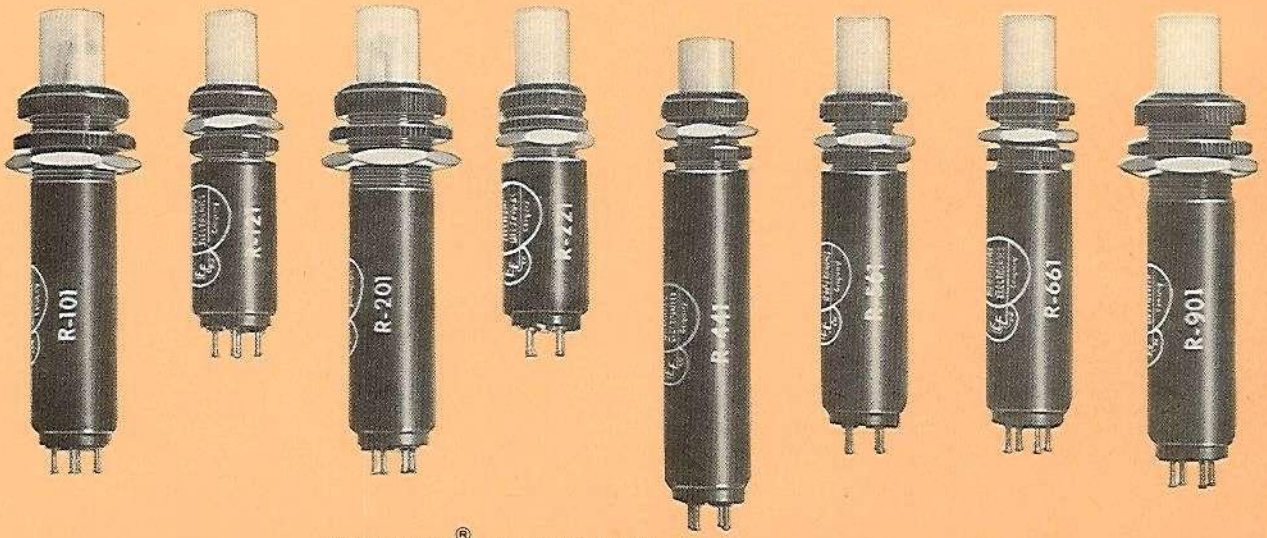
PHYSICAL SPECIFICATIONS

Dimensions: This unit is contained within a rectangular package 1-5/16" wide x 2-31/32" deep x 3-7/8" seated height (including handle).

Mounting: Assembly is mounted by inserting into a 14-pin miniature socket with pin 10 blanked for keyway orientation. Socket is EECO Part No. T-937, furnished with each N-112 unit.

Pin connections are so arranged that power and grounds may be in-line wired.

Operating Temperature Range: —54° C to +71° C.



TYPICAL MINISIG® SENSITIVE INDICATORS
(ACTUAL SIZE)

MINISIG® SENSITIVE TRANSISTORIZED INDICATORS

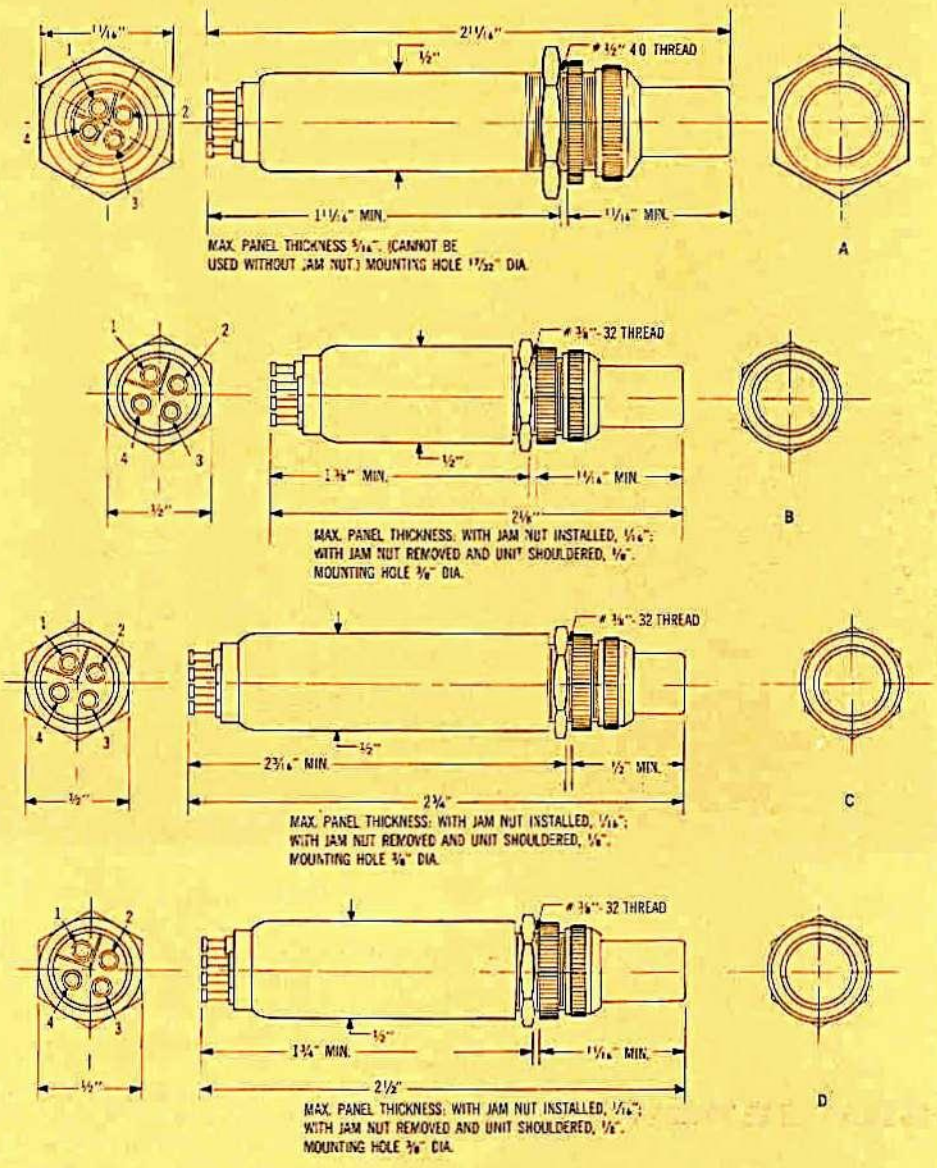
EECO Minisig Indicators are sensitive indicator devices designed to operate directly from low-level signals. Their principal use is to indicate signal levels or the state of flip-flops, switching circuits, and storage elements.

Many different models are available, with a wide range of application. Most Minisig Indicators incorporate a built-in *high-sensitivity* transistorized driver circuit to give "on-off" indication where the signal excursion is too small for direct operation of neon or incandescent lamps, and can therefore be applied effectively to any system designed for small signal excursions. For example, they are ideal for use in systems or equipment incorporating EECO T-Series, W-Series, or Y-Series plug-in circuits, which are designed for the following signal voltage swings:

		P-P Excursion
T-Series:	"1"= −3 volts; "0"= −11 volts	8 volts
W-Series:	"1"= +6 volts; "0"= +16 volts	10 volts
Y-Series:	"1"= −20 volts; "0"= 0 volts	20 volts

Minisig Indicators are available in a wide variety of models, including neon-type, filament-type, high-temperature-type, memory-type (thyratron), and plug-in type units, as well as miniature and subminiature designs. Most models have adjustable operating characteristics controlled by external bias voltage and will accommodate a wide range of input signal conditions.

DIMENSIONS OF TYPICAL MINISIG® INDICATORS



The following summary chart covers several typical Minisig Indicator models for which individual specification sheets are included in this catalog:

SUMMARY CHART

MODEL NO.	TYPE	TRANSISTOR TYPE	SIGNAL "ON"	DIMENSIONS (SEE DRAWINGS)
R-101	Neon	Germanium	Positive-Going	A
R-121	Neon	Germanium	Positive-Going	B
R-201	Neon	Germanium	Negative-Going	A
R-221	Neon	Germanium	Negative-Going	B
R-341	Incand.	Germanium	Positive-Going	C
R-342	Incand.	Germanium	Positive-Going	C
R-441	Incand.	Germanium	Negative-Going	C
R-561	Neon	Silicon	Positive-Going	D
R-661	Neon	Silicon	Negative-Going	D
R-901	Thyratron	—	Positive-Going	A
R-902	Thyratron	—	Positive-Going	A

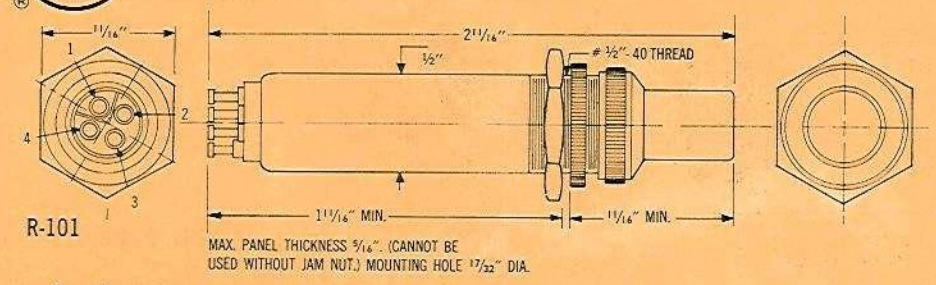
Other models are also available, including plug-in types such as the Model R-1004 assembly. This assembly is composed of an outer shell and an R-1005 encapsulated plug-in insert for easy servicing. It provides the basic flexibility of application of the R-101 and R-201. Physically, it extends only 1¼" behind the panel and mounts in a ½" hole.

Specifications on non-cataloged models are available upon request. In addition, we are always ready to work on specials to meet your exact requirements.

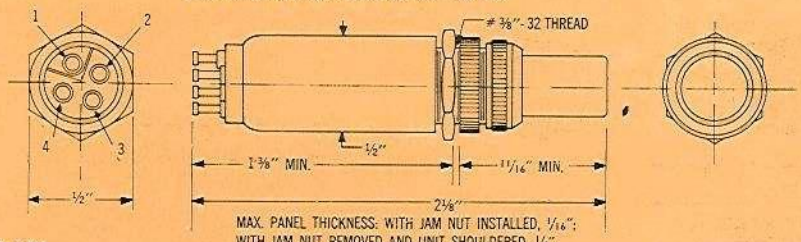
ENGINEERED ELECTRONICS Company

"R-SERIES" MINISIG® SENSITIVE TRANSISTORIZED INDICATORS

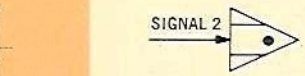
NEON INDICATOR



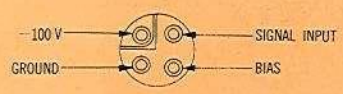
R-101



R-121



R-101, R-121



CIRCUIT DESCRIPTION

The R-101 and R-121 Minisig Indicators are high-gain, transistorized neon indicators, useful for a visual display of various signal levels. They are designed to accommodate small- or medium-amplitude signal excursions (3 volts peak-to-peak to 45 volts peak-to-peak or greater), and yield a visual indication for the more positive of two signal levels. A typical application of these devices would be to indicate the static state of a flip-flop or other information storage element by a visual display.

ELECTRICAL SPECIFICATIONS

Input:

See Operating Characteristics chart for areas of operation.

Maximum loads imposed upon input signal:

Neon on: —120μa.

Neon off: ≥ +35μa, the limit being determined by the lower operating point. (See chart.)

Maximum negative input: —50 volts.

Output: A visual display is given for the more positive of two signal levels to the input of the R-101 or R-121.

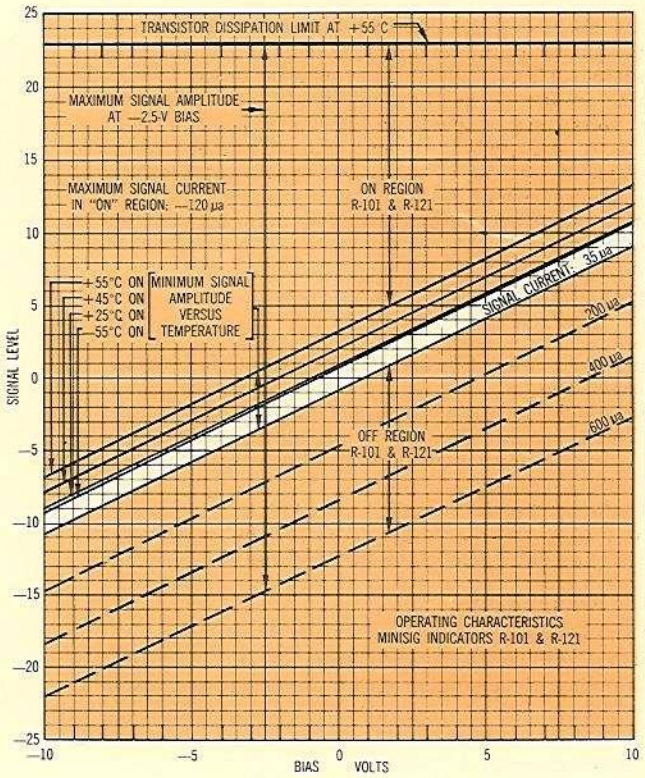
Power Requirements:

—100 volts at 0.7 ma.

Bias (see chart for voltage level): At 3.5 ma, maximum, depending on input signal level and bias voltage. When used with T-Series, with bias at —7.5 volts from T-123 bias regulator, current is approximately 0.9 ma.

Supply voltage tolerance: ±5%.

Pin Connections: See drawing.



PHYSICAL SPECIFICATIONS

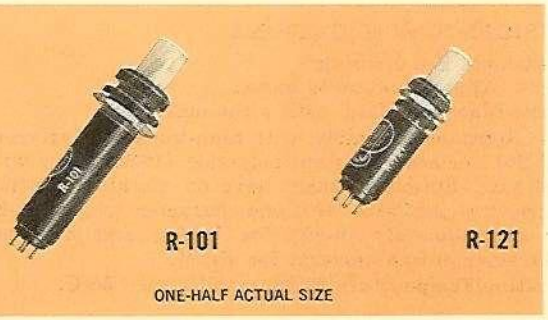
Dimensions: See drawing.

Weight: Approximately ½ ounce.

Finish: Black anodized, with white marking.

Lens: Rotatable assembly, with high-impact polystyrene (R-101) or heat-resistant polymide (R-121) lens with flat face. Standard lenses have no marking. Marked lenses are available with one character (+, —, A-Z) or two numerals (0-99) for R-101; and with one character or one numeral for R-121.

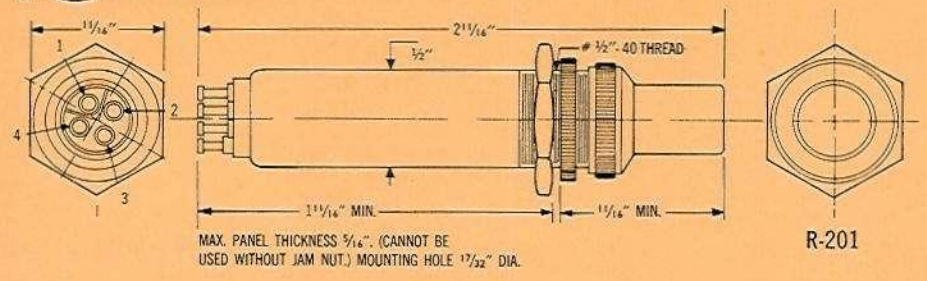
Operating Temperature Range: —55°C to +55°C.

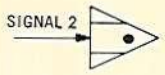


ENGINEERED ELECTRONICS Company

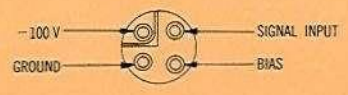
"R-SERIES" MINISIG® SENSITIVE TRANSISTORIZED INDICATORS

NEON INDICATOR





R-201, R-221



CIRCUIT DESCRIPTION

The R-201 and R-221 Minisig Indicators are high-gain, transistorized neon indicators, useful for a visual display of various signal levels. They are designed to accommodate small- or medium-amplitude signal excursions (5.0 volts peak-to-peak to 40 volts peak-to-peak or greater), and yield a visual indication for the more negative of two signal levels. A typical application of these devices would be to indicate the static state of a flip-flop or other information storage element by a visual display.

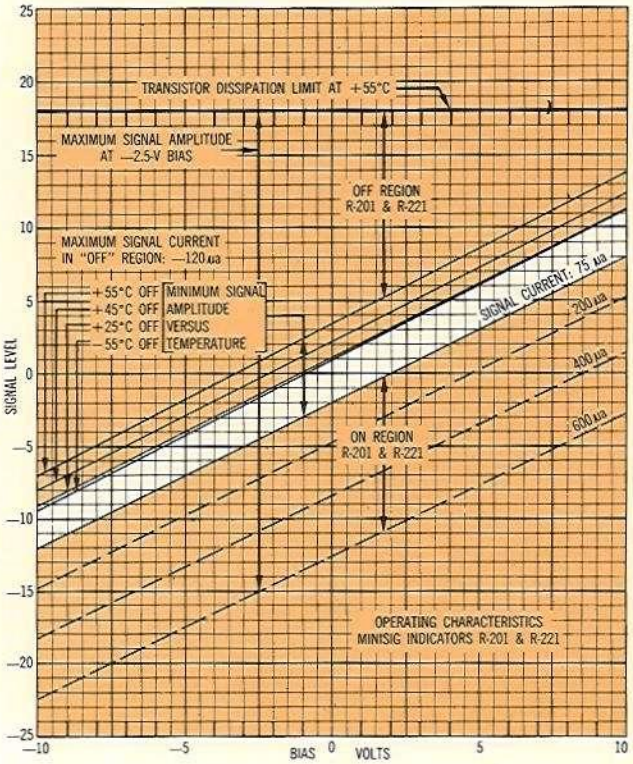
ELECTRICAL SPECIFICATIONS

Input:
- See Operating Characteristics chart for areas of operation.
- Maximum loads imposed upon input signal:
  - Neon on: ≥ +75 μa, the limit being determined by the lower operating point. (See chart.)
  - Neon off: −120 μa.
- Maximum negative input is −50 volts.

Output: A visual display is given for the more negative of two signal levels to the input of the R-201 or R-221.

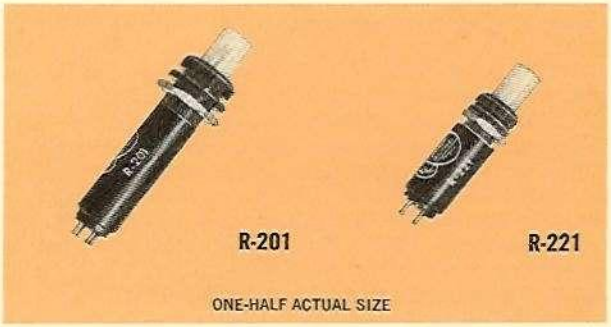
Power Requirements:
- −100 volts at 1.6 ma.
- Bias (see chart for voltage level): At 4.0 ma, maximum, depending on input signal level and bias voltage. When used with T-Series, with bias at −7.5 volts from T-123 bias regulator, current is approximately 1.8 ma.
- Supply voltage tolerance: ±5%.

Pin Connections: See drawing.



PHYSICAL SPECIFICATIONS

Dimensions: See drawing.
Weight: Approximately ½ ounce.
Finish: Black anodized, with white marking.
Lens: Rotatable assembly, with high-impact polystyrene (R-201) or heat-resistant polymide (R-221) lens with flat face. Standard lenses have no marking. Marked lenses are available with one character (+, −, A-Z) or two numerals (0-99) for R-201; and with one character or one numeral for R-221.
Operating Temperature Range: −55°C to +55°C. .

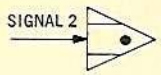


INDICATOR

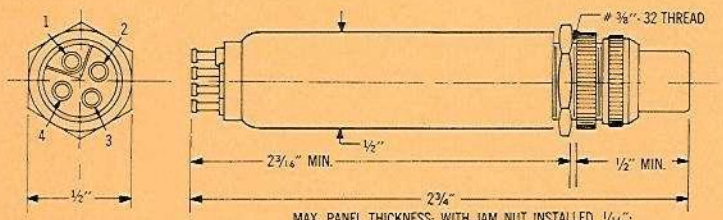
ENGINEERED ELECTRONICS Company

"R-SERIES" MINISIG® SENSITIVE TRANSISTORIZED INDICATORS

LAMP INDICATOR

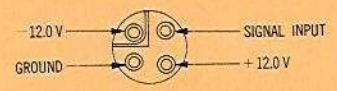


R-341, R-342, & R-441



MAX. PANEL THICKNESS: WITH JAM NUT INSTALLED, 1/16"; WITH JAM NUT REMOVED AND UNIT SHOULDERED, 1/8". MOUNTING HOLE 3/8" DIA.

R-341, R-342, & R-441



CIRCUIT DESCRIPTION

• Specifications revised 2/15/60 (R-342 added).

The R-341, R-342, and R-441 Lamp Minisig Indicators are high-gain, transistorized, low-voltage lamp indicators, useful for a visual display of the T-Series signal levels. The circuits employ a low-voltage incandescent lamp of high luminosity. The R-341 and R-342 yield a visual indication for the —3-volt level; the R-441 yields a visual indication for the —11-volt level. A typical application of these devices would be to indicate the static state of a flip-flop or other information storage element by a visual display.

As shown in the table at the right, the power drain from ±12-volt supplies required for indication in a system may easily be balanced by suitable combinations of these units.

ELECTRICAL SPECIFICATIONS

Input:

Amplitude: T-Series levels (—3.0 volts, —11.0 volts).
Maximum load imposed upon input signal: Less than 0.1 ma under normal conditions.

Output:

R-341 and R-342: A visual display is given for the —3-volt level.

R-441: A visual display is given for the —11-volt level.

Power Requirements:

R-341:
+12.0 volts at 0.3 ma.
—12.0 volts at 43.0 ma.
Supply voltage tolerance: ±10%.

R-342:
+12.0 volts at 42.0 ma.
—12.0 volts at 0.7 ma.
Supply voltage tolerance: ±10%.

R-441:
+12.0 volts at 1.6 ma.
—12.0 volts at 43.0 ma.
Supply voltage tolerance: ±10%.

Pin Connections: See drawing.

PHYSICAL SPECIFICATIONS

Dimensions: See drawing.
Weight: Approximately ½ ounce.
Finish: Black anodized, with white marking.
Lens: Rotatable assembly, heat-resistant polymide lens with flat face. Standard lens has no marking. On special order, lenses with arabic numerals 0-9, letters A-Z, or characters + or — can be furnished.
Operating Temperature Range: —45°C to +71°C.

TABLE I • Table added 2/15/60.

TYPICAL POWER REQUIRED FOR "ON"—"OFF" INDICATION

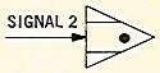
R-341	OFF	—11V	1 ma at —12V	.255 ma at +12V
	ON	— 3V	41 ma at —12V	.32 ma at +12V
R-342	OFF	—11V	2 ma at —12V	2 ma at +12V
	ON	— 3V	.65 ma at —12V	42 ma at +12V
R-441	ON	—11V	42.8 ma at —12V	1.5 ma at +12V
	OFF	— 3V	1.25 ma at —12V	1.25 ma at +12V

R-341, R-342, & R-441
ONE-HALF ACTUAL SIZE

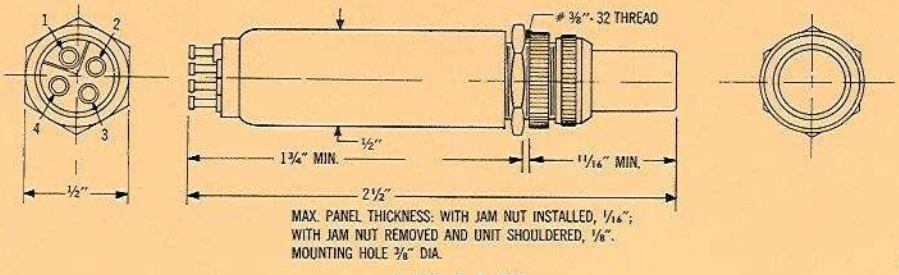
ENGINEERED ELECTRONICS Company

"R-SERIES" MINISIG SENSITIVE TRANSISTORIZED INDICATORS

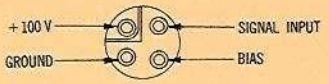
NEON INDICATOR



R-561, R-661



R-561 & R-661



CIRCUIT DESCRIPTION

The R-561 and R-661 Minisig Indicators are high-gain, transistorized neon indicators, useful for a visual display of various signal levels over the temperature range −55°C to +100°C. The devices are designed to accommodate small or medium amplitude signal excursions (R-561: 6.0 volts peak-to-peak to 45 volts peak-to-peak or greater; R-661: 5.0 volts peak-to-peak to 40 volts peak-to-peak or greater). The R-561 yields a visual indication for the more positive of two signal levels. The R-661 yields a visual indication for the more negative of two signal levels. A typical application of these devices would be to indicate the static state of a flip-flop or other information storage element by a visual display.

ELECTRICAL SPECIFICATIONS

Input:
- See R-561 Operating Characteristics chart and R-661 Operating Characteristics chart for respective areas of operation.
- Maximum loads imposed upon input signal:
  - R-561:
    - Neon on: ≥ +200 μa, the limit being determined by the operating point. (See R-561 Operating Characteristics chart.)
    - Neon off: −160 μa.
  - R-661:
    - Neon on: −135 μa.
    - Neon off: ≥ +150 μa, the limit being determined by the operating point. (See R-661 Operating Characteristics chart.)

Output:
- R-561: A visual display is given for the more *positive* of two signal levels.
- R-661: A visual display is given for the more *negative* of two signal levels.

Power Requirements:
- R-561:
  - +100 volts at 1.25 ma.
  - Bias voltage at 1.5 ma for signal current of 200 μa. The voltage level is derived from Operating Characteristics chart for R-561.
  - Supply voltage tolerance: ±5%.
- R-661:
  - +100 volts at 0.8 ma.
  - Bias voltage at 1.0 ma for signal current of 200 μa. The voltage level is derived from Operating Characteristics chart for R-661.
  - Supply voltage tolerance: ±5%.

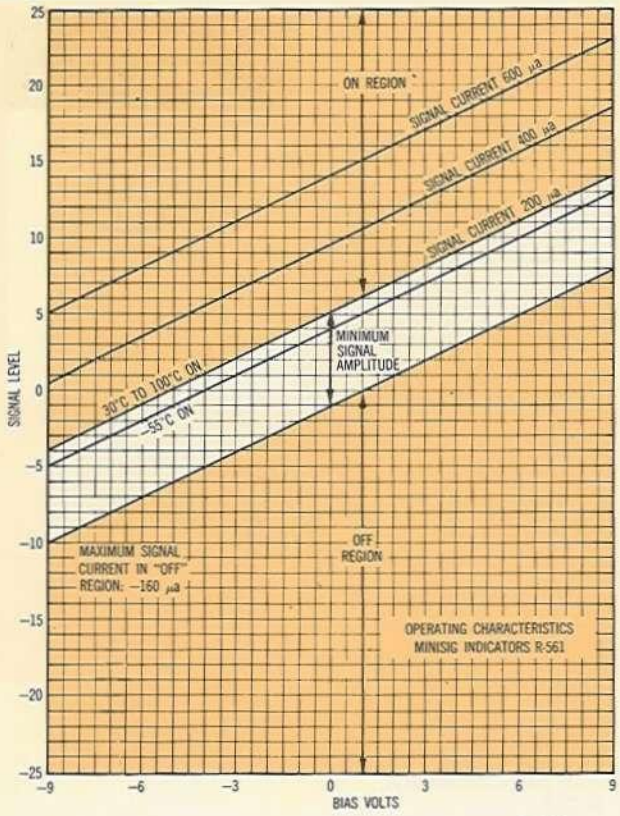
PHYSICAL SPECIFICATIONS

Dimensions: See drawing.
Weight: Approximately ½ ounce.
Finish: Black anodized, with white marking.
Lens: Rotatable assembly, heat-resistant polymide lens with flat face. Standard lens has no marking. On special order, lenses with arabic numerals 0-9, letters A-Z, or characters + or − can be furnished.
Operating Temperature Range: −55°C to +100°C.

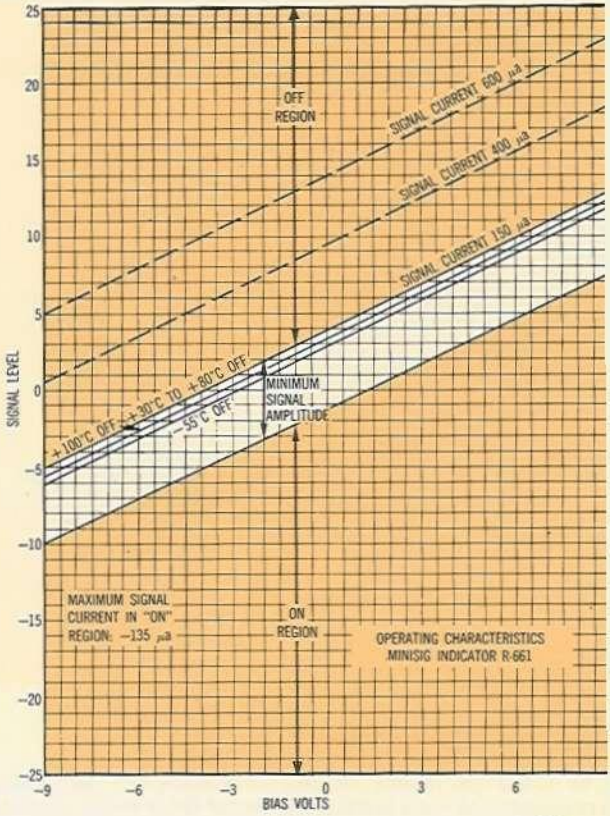
(Continued)

R-561 & R-661

ONE-HALF ACTUAL SIZE


ON REGION
SIGNAL CURRENT 600 μa
SIGNAL CURRENT 400 μa
SIGNAL CURRENT 200 μa
MINIMUM SIGNAL AMPLITUDE
30°C TO 100°C ON
-55°C ON
MAXIMUM SIGNAL CURRENT IN "OFF" REGION: -160 μa
OFF REGION
OPERATING CHARACTERISTICS MINISIG INDICATORS R-561
SIGNAL LEVEL
BIAS VOLTS
25
20
15
10
5
0
-5
-10
-15
-20
-25
-9
-6
-3
0
3
6
9

R-561

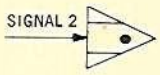

OFF REGION
SIGNAL CURRENT 600 μa
SIGNAL CURRENT 400 μa
SIGNAL CURRENT 150 μa
MINIMUM SIGNAL AMPLITUDE
+100°C OFF
+30°C TO +80°C OFF
-55°C OFF
MAXIMUM SIGNAL CURRENT IN "ON" REGION: -135 μa
ON REGION
OPERATING CHARACTERISTICS MINISIG INDICATOR R-661
SIGNAL LEVEL
BIAS VOLTS
25
20
15
10
5
0
-5
-10
-15
-20
-25
-9
-6
-3
0
3
6

R-661

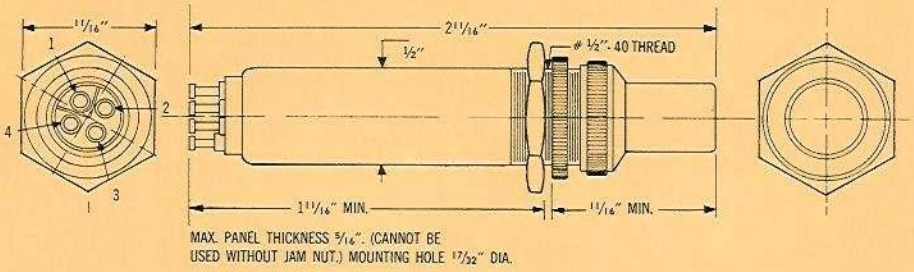
ENGINEERED ELECTRONICS Company

"R-SERIES" MINISIG® SENSITIVE TRANSISTORIZED INDICATORS

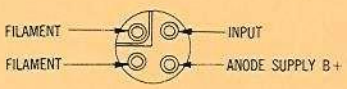
THYRATRON INDICATOR



R-901, R-902



R-901 & R-902



CIRCUIT DESCRIPTION

The R-901 and R-902 Minisig Indicators are subminiature thyratrons, with negative control grid characteristics. Because of their minute triggering requirements, they can be driven directly from transistor circuitry without the necessity of intermediate driving circuits. They can be used either as memory devices or as visual displays of the static state of a flip-flop or other information storage element. When used as a visual indicator, the R-901 and R-902 yield a visual indication, several times brighter than a neon, for the more positive of two signal levels. Their small size and low power requirements make them ideal indicators for transistorized systems. The only difference between these two Minisig Indicators is that the R-901 employs a Raytheon CK 1050 thyratron and the R-902 employs a Chatham/Tung-Sol 7323. By the addition of an external series anode resistor, either of these circuits may be used as a memory device (i.e., once the thyratron is turned on, it can be extinguished only by interrupting the anode supply).

ELECTRICAL SPECIFICATIONS

Input:

See Control Characteristics chart for areas of operation.

Maximum load imposed on input circuit: $\prec 20\ \mu a$ to a positive source.

Minimum input pulse width for memory operation: 5 microseconds.

Minimum input pulse amplitude: 5 volts, −5 to 0 volts dc.

When used as a visual display, a visual display is prescnted for the more positive of two signal levels.

When used as a memory device, the thyratron will fire upon the input of a positive pulse of the required levels and pulse width, and will remain on until the anode supply is momentarily interrupted. When used in this application, a 22 K, ½-watt resistor must be placed in series with the anode supply of 90 volts dc.

Power Requirements:

1.25 volts ac rms at 280 ma.

65 volts ac rms at 2 ma, when used as a visual indicator.

90 volts dc at 2.5 ma, when used as a memory device.

Supply voltage tolerance: ±10%.

Pin Connections: See drawing.

PHYSICAL SPECIFICATIONS

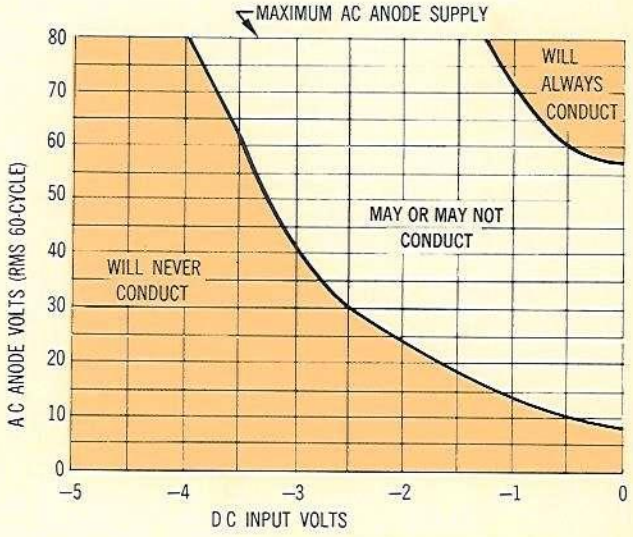
Dimensions: See drawing.

Weight: Approximately ½ ounce.

Finish: Black anodized, with white marking.

Lens: Rotatable assembly, high-impact polystyrene lens with flat face. Standard lens has no marking. On special order, lenses with arabic numerals 0-99, letters A-Z, or characters + or − can be furnished.

Operating Temperature Range: −45°C to +71°C.



R-901 & R-902

ONE-HALF ACTUAL SIZE

ENGINEERED ELECTRONICS COMPANY

506 EAST FIRST STREET
SANTA ANA, CALIFORNIA

TELEPHONE
Kimberley 7-5651

STANDARD SERIES PRICE LIST
Effective Date: February 15, 1960

Terms, FOB point, and footnotes, e.g., (1) (23), etc., will be found at the end of the price lists.

PART NUMBERS	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
Z-8309 *	Cathode Follower	8.60	8.20	7.80	7.60	7.25	6.95
Z-8318 *	One Shot	9.65	9.30	8.60	7.90	6.90	6.70
Z-8324 or Z-90408 *	Linear Amplifier	10.10	9.60	9.25	8.90	8.45	8.15
Z-8327 *	Pulse Gate	7.65	7.25	7.00	6.75	6.45	6.15
Z-8336 or Z-90399 *	Flip-Flop	11.30	10.90	10.10	9.30	8.05	7.90
Z-8339 or Z-90400 *	Flip-Flop	11.50	11.10	10.25	9.45	8.20	8.00
Z-8342 or Z-90401 *	Flip-Flop	11.55	11.15	10.30	9.50	8.25	8.05
Z-8351 or Z-90411 *	Push Pull Amplifier	7.90	7.45	7.20	6.95	6.60	6.35
Z-8354 or Z-90410 *	Phase Inverter	7.90	7.50	7.20	7.00	6.65	6.35
Z-8489 *	Pulse Amplifier	9.85	9.40	9.10	8.75	8.35	8.00
Z-8762 or Z-90409 *	Amplifier	9.20	8.80	8.50	8.15	7.80	7.45
Z-8889 *	One Shot	7.65	7.40	6.85	6.30	5.45	5.35
Z-90001 or Z-90407 *	Squaring Circuit	9.90	9.55	8.85	8.15	7.05	6.90
Z-90002 or Z-90405 *	Gate Circuit	10.35	10.00	9.25	8.50	7.40	7.25
Z-90009 or Z-90412 *	Crystal Oscillator (12)	11.80	11.40	10.55	9.70	8.45	8.25
Z-90015 *	Blocking Oscillator	18.45	17.80	17.30	16.70	16.00	15.30
Z-90020 *	Reset Generator	12.30	11.45	11.05	10.50	10.10	9.70
Z-90021 *	Squaring Circuit	9.40	8.95	8.60	8.30	7.95	7.60
Z-90023 *	Pentagrid Gate	8.00	7.60	7.30	7.05	6.70	6.45
Z-90030 *	Pulse Amplifier	11.05	10.65	9.85	9.05	7.90	7.70
Z-90036 *	Multivibrator	7.60	7.20	7.00	6.70	6.40	6.15
Z-90049 *	Squaring Circuit	12.70	12.05	11.60	11.15	10.70	10.20
Z-90052*	Flip-Flop	10.80	10.30	9.90	9.50	9.10	8.70
Z-90053 *	Cathode Follower	12.75	12.20	11.85	11.40	10.90	10.45
Z-90059 or Z-90402 *	Flip-Flop	11.50	11.10	10.25	9.45	8.20	8.00
Z-90166 *	Flip-Flop	11.70	11.25	10.50	9.60	8.30	8.10
Z-90392	Flip-Flop	30.15	28.95	28.10	27.10	25.95	24.80
Z-90399 see Z-8336							
Z-90400 see Z-8339							
Z-90401 see Z-8342							
Z-90402 see Z-90059							
Z-90405 see Z-90002							

*See Footnote (1) at end of price lists.

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STANDARD SERIES PRICE LIST
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Terms, FOB point, and footnotes, e.g., (1) (23), etc., will be found at the end of the price lists.

PART NUMBER	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
Z-90407 see Z-90001							
Z-90408 see Z-8324							
Z-90409 see Z-8762							
Z-90410 see Z-8354							
Z-90411 see Z-8351							
Z-90412 see Z-90009							

HARDWARE AND ACCESSORY CROSS REFERENCE (8)

Power Supplies	See Z-95091, Z-95091-1, Z-95091-2, Z-95098, Z-95098-1, Z-95098-2, Z-95098-3.
Container Hardware and Parts	See 95026-1, 95026-3, 95030-1-2-3-4-5-6, 95052-1-2-3.
Hold Down Clamps and Screws	See 95018-19-27, 95024-1-2.
Sockets	Purchase standard octal socket from local jobber. For 11-pin socket, see H-151, or purchase locally.
Breadboard Panels, etc.	See 95101, 95103, 95104.
Crystals for Crystal Oscillator	See H-143, H-146.
Drafting Template for Plug-in Symbols	See H-144.

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RUGGEDIZED SERIES PRICE LIST
Effective Date: February 1, 1960

Terms, FOB point, and footnotes, e.g., (1) (23), etc., will be found at the end of the price lists.

PART NUMBERS	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
Z-92000/8336 or Z-92001 *	Flip-Flop	14.55 Same	14.10	13.25	12.35	10.95	10.70
Z-92002/8339 or Z-92003 *	Flip-Flop	14.75 Same	14.30	13.40	12.50	11.10	10.80
Z-92004/8342 or Z-92005 *	Flip-Flop	14.80 Same	14.35	13.45	12.55	11.15	10.85
Z-92007/90052*	Flip-flop	14.05	13.50	13.05	12.55	12.00	11.50
Z-92008/90059 or Z-92009 *	Flip-Flop	14.75 Same	14.30	13.40	12.50	11.10	10.80
Z-92010/90166 *	Flip-Flop	14.95	14.45	13.65	12.65	11.20	10.90
Z-92011/90015 *	Blocking Oscillator	21.70	21.00	20.45	19.75	18.90	18.10
Z-92012/8318 *	One Shot	12.90	12.50	11.75	10.95	9.80	9.50
Z-92013/8889 *	One Shot	10.90	10.60	10.00	9.35	8.35	8.15
Z-92018/90002 or Z-92019 *	Gate Circuit	13.60 Same	13.20	12.40	11.55	10.30	10.05
Z-92022/90023 *	Pentagrid Gate	11.25	10.80	10.45	10.10	9.60	9.25
Z-92023/8327 *	Pulse Gate	10.90	10.45	10.15	9.80	9.35	8.95
Z-92024/90001 or Z-92025 *	Squaring Circuit	13.15 Same	12.75	12.00	11.20	9.95	9.70
Z-92026/90021 *	Squaring Circuit	12.65	12.15	11.75	11.35	10.85	10.40
Z-92027/90049 *	Squaring Circuit	15.95	15.25	14.75	14.20	13.60	13.00
Z-92029/8489 *	Pulse Amplifier	13.10	12.60	12.25	11.80	11.25	10.80
Z-92030/90030 *	Pulse Amplifier	14.30	13.85	13.00	12.10	10.80	10.50
Z-92031/8324 or Z-92032 *	Linear Amplifier	13.35 Same	12.80	12.40	11.95	11.40	10.95
Z-92033/8762 or Z-92034 *	Amplifier	12.45 Same	12.00	11.65	11.20	10.70	10.25
Z-92035/8354 or Z-92036 *	Phase Inverter	11.15 Same	10.70	10.35	10.05	9.55	9.15
Z-92037/8351 or Z-92038 *	Push Pull Amplifier	11.15 Same	10.65	10.35	10.00	9.50	9.15
Z-92039/8309 *	Cathode Follower	11.85	11.40	10.95	10.65	10.15	9.75

*See footnote (1) at end of price lists.

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RUGGEDIZED SERIES PRICE LIST
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PART NUMBERS	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
Z-92040/90053 *	Cathode Follower	16.00	15.40	15.00	14.45	13.80	13.25
Z-92041/90036 *	Multivibrator	10.85	10.40	10.15	9.75	9.30	8.95
Z-92042/90009 or Z-92043*	Crystal Oscillator (12)	15.05 Same	14.60	13.70	12.75	11.35	11.05
Z-92044/90020 *	Reset Generator	15.55	14.65	14.20	13.55	13.00	12.50
Z-92086/90392*	Flip-flop	33.40	32.15	31.25	30.15	28.85	27.60

HARDWARE AND ACCESSORY CROSS REFERENCE (8)

Power Supplies	Same as Standard Series
Container Hardware and Parts	See 95026-1, 95026-3, 95289-1 through 12
Hold Down Clamps and Screws	See 95424-19-27, 95024-1-2
Sockets	Same as Standard Series
Breadboard Panels, etc.	Same as Standard Series
Crystals for Crystal Oscillator	Same as Standard Series
Drafting Template for Plug-in Symbols	Same as Standard Series

*See Footnote (1) at end of price lists.

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GENERAL HARDWARE AND ACCESSORY PRICE LIST

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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	"FAMILY" USE (5)			1-9	10-Up
• ZA-720	Dual 12-volt DC 5 amp Regulator Power Supply	N	R	T	995.00	995.00
• ZA-721	12-volt DC 1 amp Regulated Power Supply	N	R	T	215.00	215.00
95018-19	Holddown Clamp with 2 ea. 19/32" Screw			Z	.50	.50
95018-27	Holddown Clamp with 2 ea. 27/32" Screw			Z	.50	.50
95022-1	Blank 8-diode plug-in container. Covers male Amphenol plug #26-159-16. (Not included). Mates with Amphenol socket #26-190-16. (Not included).	Q			1.60	1.40
95022-2	Blank 12-diode plug-in container. Covers male Amphenol plug #26-159-24. (Not included). Mates with Amphenol socket #26-190-24. (Not included).	Q			1.60	1.40
95022-3	Blank 16-diode plug-in container. Covers male Amphenol plug #26-159-32.(Not included). Mates with Amphenol socket #26-190-32. (Not included).	Q			1.60	1.40
95024-1	19/32" Screw	Q	Z	Zr	.25	.25
95024-2	27/32" Screw	Q	Z	Zr	.25	.25
95026-1	Dummy plug for octal socket		Z	Zr	1.25	1.15
95026-3	Dummy plug for 11-pin socket		Z	Zr	1.25	1.15
95030-1	Standard Series Container, 7-pin tube, octal header.		Z		2.35	2.25
95030-2	Standard Series Container, 9-pin tube, octal header.		Z		2.35	2.25
95030-5	Standard Series Container, 7-pin tube, 11-pin header.		Z		2.35	2.25
95030-6	Standard Series Container, 9-pin tube, 11-pin header.		Z		2.35	2.25
95052-1	Network package, octal header.		Z		1.95	1.85
95052-3	Network package, 11-pin header.		Z		1.95	1.85
95063-19	Diode Holddown Clamp with 2 ea. 19/32" long Screws. Two clamps required per diode plug-in.	Q			.80	.80
95063-27	Diode Holddown Clamp with 2 ea. 27/32" long Screws. Two clamps required per diode plug-in.	Q			.80	.80
Z-95091	Chassis single Power Supply - no bias.		Z	Zr	128.00	128.00
Z-95091-1	Panel Mounted Single Power Supply - no bias.		Z	Zr	145.00	145.00
Z-95091-2	Panel Mounted Dual Power Supply - no bias.		Z	Zr	260.00	260.00

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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	"FAMILY" USE (5)		1-9	10-Up
Z-95098	Chassis Single Power Supply with bias	Z	Zr	153.00	153.00
Z-95098-1	Panel Mounted Single Power Supply with bias	Z	Zr	170.00	170.00
Z-95098-2	Panel Mounted Dual Power Supply with bias	Z	Zr	310.00	310.00
Z-95098-3	Panel Mounted Dual Power Supply - one with bias, one without bias.	Z	Zr	285.00	285.00
95101	Systems Development Rack - consists of 1 each Z-95102 Rack, 1 each Z-95103 Blank Panel, and 2 each Z-95104 Socket Panels. Less Power Supply and Cabling. (4)	Z	Zr	121.60	121.60
95102	Rack only	Z	Zr	21.00	21.00
95103	Blank Panel 1-3/4" x 19", Gray	Z	Zr	5.00	5.00
95104	Panel 5-1/4" x 19", Gray, with 10 octal and 2 11-pin sockets. Filament wiring installed. (4)	Z	Zr	47.80	47.80
95289-1	Ruggedized Container: 7-pin short tube, octal header.		Zr	4.40	4.35
95289-2	Ruggedized Container: 7-pin medium tube, octal header		Zr	4.40	4.35
95289-3	Ruggedized Container: 7-pin tall tube, octal header		Zr	4.40	4.35
95289-4	Ruggedized Container: 7-pin short tube, 11-pin header		Zr	4.40	4.35
95289-5	Ruggedized Container: 7-pin medium tube, 11-pin header		Zr	4.40	4.35
95289-6	Ruggedized Container: 7-pin tall tube, 11-pin header		Zr	4.40	4.35
95289-7	Ruggedized Container: 9-pin short tube, octal header		Zr	4.40	4.35
95289-8	Ruggedized Container: 9-pin medium tube, octal header		Zr	4.40	4.35
95289-9	Ruggedized Container: 9-pin tall tube, octal header		Zr	4.40	4.35
95289-10	Ruggedized Container: 9-pin short tube, 11-pin header		Zr	4.40	4.35
95289-11	Ruggedized Container: 9-pin medium tube, 11-pin header		Zr	4.40	4.35
95289-12	Ruggedized Container: 9-pin tall tube, 11-pin header		Zr	4.40	4.35
95424-19	Holddown Clamp with 3 each 19/32" Screws		Zr	.60	.60
95424-27	Holddown Clamp with 3 each 27/32" Screws		Zr	.60	.60

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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	USED WITH	1-9	10-Up
H-101	Black Patch Cord, 4" long	T (7)	1.30	1.30
H-106	Black Patch Cord, 8" long	T (7)	1.30	1.30
H-107	Red Patch Cord, 8" long	T (7)	1.30	1.30
H-108	Blue Patch Cord, 8" long	T (7)	1.30	1.30
H-109	Green Patch Cord, 8" long	T (7)	1.30	1.30
H-110	Yellow Patch Cord, 8" long	T (7)	1.30	1.30
H-111	Black Patch Cord, 12" long	T (7)	1.30	1.30
H-112	Red Patch Cord, 12" long	T (7)	1.30	1.30
H-113	Blue Patch Cord, 12" long	T (7)	1.30	1.30
H-114	Green Patch Cord, 12" long	T (7)	1.30	1.30
H-115	Yellow Patch Cord, 12" long	T (7)	1.30	1.30
•H-116	Black Patch Cord, 18" long	T (7)	1.30	1.30
•H-117	Red Patch Cord, 18" long	T (7)	1.30	1.30
•H-118	Blue Patch Cord, 18" long	T (7)	1.30	1.30
•H-119	Green Patch Cord, 18" long	T (7)	1.30	1.30
•H-120	Yellow Patch Cord, 18" long	T (7)	1.30	1.30
H-143	Oven only - to contain crystal only for T-107, T-127, Z-90009. 10 kc to 250 kc.	T, Z, Zr (12)	Price on Request	
H-144	Drafting Template for plug-in symbols	D N Q R T Z Zr	3.70	3.70
H-145	10 kc crystal for T-107 crystal oscillator	T (12)	59.30	59.30
•H-146	100 kc crystal for T-127 crystal oscillator	T Z Zr (12)	23.60	23.60
H-147	Burroughs Nixie Lamp #7009	N	Price on Request	
H-148	Socket for Burroughs Nixie Tube(for H-147 remote).	N	1.50	1.50
H-149	Oven only - to contain T-107 and matching crystal, 10 kc to 45 kc only	T (12)	Price on Request	
H-150	Oven only - to contain T-107 or T-127 and matching crystal,45 kc to 250 kc.	T (12)	Price on Request	
H-151	11-pin Socket for Standard and Ruggedized Series (Amphenol 77MIP11)	Z Zr	.20	.20

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H-SERIES HARDWARE PRICE LIST
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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	USED WITH	1-9	10-Up
H-152	Octal Socket for Standard and Ruggedized Series (Amphenol 77MIP-8)	Z Zr	.20	.20
H-201	Filament Lamp for N-Series Decades	N	1.55	1.55
H-202	Filament Lamp for Minisigs	R	1.55	1.55

- NOTE:

- N-Series Sockets, Hardware, and Accessories, etc.:
- See N-Series Price List (Green).

- T-Series Sockets, Hardware, Breadboard, and Accessories, etc.:
- See T-Series Price List (Red).

- W-Series Sockets, Hardware, and Accessories, etc.:
- See W-Series Price List (Salmon).

- Y-Series Sockets, Mounting Frames, and Accessories, etc.:
- See Y-Series Price List (Salmon).

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T-SERIES PRICE LIST

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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
T-101B	Flip-Flop (RST)	42.85	39.50	37.10	36.10	35.20	34.65
T-102A	Flip-Flop (T)	33.70	31.10	29.20	28.40	27.75	27.35
T-103	Flip-Flop (RS)	33.15	30.55	28.65	27.90	27.20	26.80
T-104	Multivibrator	32.25	29.75	27.95	26.95	26.15	25.80
T-105	One Shot	34.75	32.05	30.15	29.30	28.60	27.95
T-106	Squaring Amplifier	26.10	24.05	22.55	21.95	21.40	21.05
T-107	Crystal Oscillator (10kc - 75kc) (12)	32.25	29.75	27.95	26.95	26.15	25.80
T-108	Linear Amplifier	43.10	39.60	36.25	34.15	32.05	31.45
T-109	Reset Generator (T-Series)	23.85	22.05	20.75	20.15	19.70	19.35
T-110	Blocking Oscillator	54.35	49.35	43.20	41.50	37.80	37.15
T-111	Emitter Follower, Single (PNP)	10.70	9.85	9.25	8.95	8.75	8.65
T-112	Emitter Follower, Dual (PNP)	15.85	14.60	13.70	13.35	13.00	12.70
T-113	Emitter Follower, Triple (PNP)	21.35	19.70	18.50	18.00	17.30	16.85
T-114	Emitter Follower, Single (NPN)	12.05	11.15	10.45	10.20	9.95	9.80
T-115	Emitter Follower, Dual (NPN)	17.40	16.10	15.15	14.75	14.40	14.10
T-116	Emitter Follower, Triple (NPN)	23.40	21.70	20.45	19.90	19.30	18.90
T-117	Inverting Pulse Amplifier, Dual	31.50	29.10	27.35	26.55	25.85	25.25
T-118	Pulse Amplifier	23.75	21.95	20.55	19.95	19.40	19.00
T-120	Relay Driver (0 - 48V)	27.40	25.45	24.00	21.85	18.95	18.70
T-121	Relay Driver (0 - 90V)	42.80	40.00	37.85	35.40	27.15	26.75
T-123	Bias Regulator (-7.5V)	19.05	17.75	16.75	16.35	13.60	13.40
T-127	Crystal Oscillator (75kc - 250kc) (12)	38.25	35.40	33.35	32.50	31.70	31.25
T-128	Relay Driver (0 - 24V)	24.90	23.05	21.75	19.65	17.70	17.45
T-129	Reset Generator (N-Series)	23.85	22.05	20.75	20.15	19.70	19.35
• T-134	Indicator Driver	27.00	25.10	23.65	20.10	19.60	19.35
• T-135	Relay and Indicator Driver	32.45	30.15	28.45	24.80	24.20	23.80
• T-136	Dual Inverter	Price on Request					
• T-137	Buffered Inverter	"	"	"			
• T-138	Inverter and Buffered Inverter	"	"	"			
• T-301	Gated Flip-flop, 0-1 mc	47.95	44.35	41.70	36.20	35.30	34.80
• T-302	Capacity Driver, 0-1 mc	66.60	61.95	51.65	50.30	47.00	46.35
• T-303	5 mc Flip-flop	49.00	45.50	42.90	41.80	40.80	40.25
• T-304	Emitter Follower Heavy Duty, 0-1 mc	Price on Request					
• T-305	Video Amplifier, 30 cps to 10 mc	"	"	"			
• T-306	Squaring Amplifier, 5 mc	59.95	59.75	52.65	40.95	39.95	39.40

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T-SERIES PRICE LIST
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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
T-404	DC "AND" (K= FG, L=HJ)	30.95	28.60	26.30	25.60	24.90	24.30
T-405	DC "AND" (K= FGHJ)	24.95	23.05	21.25	20.70	19.95	19.65
T-406	DC "OR" (K= F+G , L= H+J)	30.95	28.60	26.30	25.60	24.90	24.30
T-407	DC "OR" (K= F+G+H+J)	24.95	23.05	21.25	20.70	19.95	19.65
● T-410A	Pulse "AND" (K= FH, L= GH)	30.05	27.70	26.10	25.30	24.80	24.40
T-411	Pulse "AND" (L= FGHJK)	46.40	42.75	39.45	38.20	37.00	36.40
T-412	Pulse "OR" (L= F+G+H+J+K)	47.75	44.00	40.50	39.20	38.15	37.40
T-421	DC "Exclusive OR" ($D= AB^1+A^1B$)	21.55	19.85	18.65	18.10	17.65	17.40
T-423	DC "Exclusive OR" ($D= AB^1+A^1B$, $G= EF^1+E^1F$)	36.75	33.80	31.75	30.90	30.15	29.70
T-424	DC Half-Adder/Subtractor	34.95	32.15	30.15	29.30	28.60	28.20
● T-427A	Buffered "AND" (4-input)	15.00	13.85	13.00	12.65	12.35	12.20
● T-428A	Buffered "AND" (5-input)	16.75	15.45	14.55	14.15	13.80	13.60
T-431	Pulse "OR" (L= F+G+H)	33.85	31.15	29.25	28.40	27.70	27.35
● T-434	"AND-OR" Gate	33.55	30.95	29.10	28.30	25.30	24.95

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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3), (13)	1-9	10-24	25-49	50-99	100-199	200-499
T-600	Shift Register Logic (for T-102A)	40.35	37.20	34.95	33.95	33.15	32.50
T-601	Pulse "AND" (Q= FGHJKLMNP)	65.90	60.75	55.75	53.75	51.75	50.35
T-602	Pulse "OR" (Q=F+G+H+J+K+L+M+N+P)	66.60	61.35	56.20	54.40	52.85	51.75
T-605	Shift Register (E.F. output, 25 kc.)	43.00	39.55	37.10	36.10	35.20	34.70
T-606	Shift Register (250 kc.)	53.05	48.75	45.65	44.40	43.30	42.70
•T-607A	Buffered "AND" (Triple, 2-input)	24.80	22.90	21.45	20.90	20.40	20.15
•T-608A	Buffered "AND" (Dual, 3-input)	21.95	20.25	19.00	18.50	18.05	17.85
•T-609A	Buffered "AND" (Dual, 4-input)	25.80	23.75	22.35	21.75	21.25	20.95
T-610	Shift Register (E.F. output, 250 kc.)	46.70	42.95	40.30	39.15	38.20	37.70
•T-612	6-input Pulse "AND", 10 kc	40.50	37.50	31.40	30.55	29.70	28.15
•T-613	6-input Pulse "AND-OR", 5 kc	40.50	37.50	31.55	30.70	29.95	28.40
T-620	DC "AND" (K= FGH, L= JKM)	33.10	30.60	28.80	27.90	27.20	26.80
T-621	DC "AND" (H= ABCDEFG)	32.95	30.35	28.45	27.55	26.70	26.30
T-623	DC "OR" (G= A+B+C+D+E+F)	31.70	29.15	27.35	26.60	25.85	25.25
•T-626A	Buffered "AND" (11-input)	28.75	26.55	24.95	24.25	23.70	23.40
T-627	DC "AND" (R= FGHJKLMNP)	37.25	34.25	32.10	31.25	30.45	30.05
T-628	DC Logic (Decimal Converter)	38.25	35.25	33.10	32.20	31.45	31.00
•T-630	Pulse "AND" (C= AB, F= DE, J= GH)	40.35	37.25	35.05	34.10	33.30	32.85
•T-633	Flip-flop (RST)	44.85	43.05	41.80	40.20	38.55	36.85
•T-639	5-input Pulse "AND", 10 kc	34.50	32.00	26.85	26.15	25.40	24.10
•T-640	5-input Pulse "AND-OR", 5 kc	34.50	32.00	26.85	26.15	25.40	24.10
•T-801	Flip-flop	52.20	48.20	45.30	39.65	38.70	38.25

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T-SERIES PRICE LIST
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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	1-9	10-Up
T-901	Panel, 51 socket holes, w/o sockets, 3-1/2" x 19". Gray finish, Amateur notch.	20.35	19.85
T-902	Panel, 51 socket holes, w/9-pin sockets, 3-1/2" x 19". Gray finish, Amateur notch. (4)	48.40	46.55
T-903	Panel, 51 socket holes, w/9-pin sockets and bus wired for power, 3-1/2" x 19". Gray finish, Amateur notch. (4)	58.90	56.35
T-904	T-Series Container, 9-pin, w/2 discs.	2.50	2.40
T-906	T-Series Container, 13-pin, w/2 discs.	2.60	2.55
T-908	T-Series Container, 13-pin, w/3 discs.	3.00	2.95
T-909	T-Series 13-pin socket (Cinch #54A14775 with keying plug-in pin #10) for 1/8" panel.	(2)	.45 (2)
T-910	T-Series 9-pin socket (EBY #9713-32) for 18-gauge chassis.	(6)	.25 (6)
T-913	T-Series Standard Pattern Disc (use w/T-904, T-906, T-908 if extra discs are needed).	(2)	.60 (2)
T-914	System Development Panel, 5-1/4" x 19" w/8 sockets and associated banana jacks. Gray finish, Amateur notch.	Replaced by T-927	
T-915	Indicator Panel, 1-3/4" x 19", w/16 R-1010 Minisig Indicators (Neon) and banana jacks for input signals. Indicators light when input signal is -3V. Gray finish, Amateur notch. (7)	178.00	178.00
T-916	Indicator and Tie Point Panel, 1-3/4" x 19", w/8 R-1010 Minisig Indicators (Neon), plus 8 dual binding posts for external parts such as resistors, diodes, capacitors, etc. T-916 is similar to T-915. Indicators light when input signal is -3V. Binding posts will accept T-920 and also standard banana plug patch cords. Gray, Amateur notch. (7)	126.00	126.00
T-917	Indicator Panel. Same as T-915 except uses R-341 Minisig Indicators (Filament). (7)	238.00	238.00
T-918	Indicator and Tie Point Panel. Same as T-916 except uses R-341 Minisig Indicators (Filament). (7)	146.00	146.00
T-919/xxx	Circuit Symbol Card. Plastic encased. Holes are punched in card to match field of banana jacks on T-927 panel. Order by T-Series circuit number in place of xxx. For example: T-919/105 is card for T-105 One-Shot. (7)	.50	.50

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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	1-9	10-Up
T-920	Power Plug. Black. Dual banana plug with shorting bar between pins. Used w/T-927 panels and T-919/xxx circuit symbol cards. (7)	1.35	1.35
T-927	System Development Panel, 5-1/4" x 19" w/8 nine-pin sockets and 8 thirteen-pin sockets. Used with T-919/xxx circuit symbol cards and T-920 power plugs for breadboarding T-Series systems; using either 9-pin or 13-pin units. Panel will accept up to 8 circuits at one time.	111.00	111.00
T-928	Component Plug. Red. Similar to T-920 power plug but w/o shorting bar. Used with T-916 and T-918. Holds resistor, capacitor, or diode, and plugs into dual binding post. (7)	1.70	1.70
T-929	Component Plug. Yellow. Same as T-928 except color. (7)	1.70	1.70
T-930	Component Plug. Blue. Same as T-928 except color. (7)	1.70	1.70
T-931	Panel, 45 socket holes, w/o sockets. Holes are spaced to accept tube shield bases. Panel is 3-1/2" x 19". Gray finish, Amateur notch.	18.10	17.60
T-932	Panel, 45 socket holes, similar to T-931. Includes 9-pin sockets and tube shield bases, mounted. Uses quantity 45 IERC shield base #T-6-1025-3H. (4)	143.90	140.30
T-933	Panel, 45 socket holes, similar to T-931. Includes 9-pin sockets and tube shield bases, mounted. Uses quantity 45 ELCO shield base #195V. (4)	69.05	66.90
T-934	Panel, 70 socket holes, w/o sockets. Size is 5-1/4" x 19". Gray finish, Amateur notch.	22.45	21.70
T-935	Panel, 70 socket holes, w/sockets. Otherwise same as T-934. (4)	52.50	50.15
T-936	Panel, 70 socket holes, w/9-pin sockets and bus wired for power. Otherwise, same as T-934. (4)	63.45	60.40
• T-937	T-Series 13-pin socket, T-909, with T-959 spacer for 18 gauge chassis. (13)	(2)	.60
• T-959	Spacer. Adapts T-109 socket for use with 18-gauge chassis.	(2)	.15

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HARDWARE AND ACCESSORY CROSS REFERENCE (8)

Container Hardware and Parts	See T-904, T-906, T-908, T-913
Hold Down Clamps	Purchase from local jobber vacuum tube shields and bases for nine-pin miniature tall vacuum tubes. They fit all T-Series.
Sockets (13)	See T-909, T-910, T-937
Panels for Production Equipment	See T-901, T-902, T-903, T-931, T-932, T-933, T-934, T-935, T-936, T-937.
Breadboard Panels, etc.	See T-915, T-916, T-917, T-918, T-919, T-920, T-927, T-928, T-929, T-930, H-101-H120.
Crystals and Ovens for Crystal Oscillator	See H-141, H-142, H-143, H-145, H-146.
Drafting Template for Plug-In Symbols	See H-144.

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N-SERIES PRICE LIST
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Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3), (11)	1-49	50-99	100-199	200-399
N-101	Counter (no readout, 250 kc.)	119.00	118.00	116.00	114.00
N-102	Counter (0-9 readout, 250 kc.)	198.00	196.00	194.00	192.00
N-104	Counter (N-901 readout, 250 kc.)	231.00	227.00	223.00	219.00
N-105	Counter (Nixie readout, 250 kc.)	268.00	264.00	257.00	253.00
N-106	Preset Counter (Nixie readout, 250 kc.)	287.00	283.00	278.00	274.00
N-109	Counter (no readout, 5 mc.)	222.00	220.00	218.00	216.00
N-110	Counter (0-9 readout, 5 mc.)	306.00	303.00	299.00	296.00
N-111	Counter/Code Generator (no readout, 250 kc.)	129.00	127.00	125.00	123.00
N-112	Counter/Code Generator (0-9 readout, 250 kc.)	212.00	209.00	205.00	202.00
N-901	Readout (projection type)	25.00	25.00	25.00	25.00
N-902	Socket, 29-pin Continental #MM-29-22S or equivalent. (11)	4.35	4.35	4.35	4.35

HARDWARE AND ACCESSORY CROSS REFERENCE (8)

Sockets (11)	See T-909 T-937, N-902
Drafting Template for Plug-In Symbols	See H-144

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R-SERIES PRICE LIST
•Effective Date: February 15, 1960

Terms, FOB point, and footnotes, e.g. (1) (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	1-9	10-24	25-199	200-499
R-101	Neon indicator (positive signal) (9)	6.55	6.10	5.75	5.60
R-121	Neon indicator (miniaturized, positive signal) (10)	7.55	7.10	6.75	6.60
R-201	Neon indicator (negative signal) (9)	6.55	6.10	5.75	5.60
R-221	Neon indicator (miniaturized, negative signal) (10)	7.55	7.10	6.75	6.60
R-341	Filament indicator (T-Series, positive signal) (10)	12.00	11.20	10.55	10.20
•R-342	Filament indicator (T-Series, positive signal) (10)	13.85	12.85	11.90	11.60
R-441	Filament indicator (T-Series, negative signal) (10)	13.40	12.55	11.90	11.60
R-561	Neon indicator (positive signal, +100°C) (9)	32.50	30.60	29.10	20.40
R-661	Neon indicator (negative signal, +100°C) (9)	31.50	29.70	28.20	19.55
R-901	Thyratron indicator (Raytheon CK1050) (9)	10.00	9.35	8.90	8.65
R-902	Thyratron indicator (Chatham/Tung-Sol 7323) (9)	7.15	6.70	6.35	6.20

HARDWARE AND ACCESSORY CROSS REFERENCE (8)

Drafting Template for Plug-In Symbols — See H-144

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W-SERIES PRICE LIST
Effective Date: February 1, 1960

Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
W-100	Flip-Flop	121.55	117.60	114.50	110.50	105.90	99.10
W-101	Emitter Follower (NPN)	28.95	28.15	27.50	24.95	22.90	21.95
W-102	Emitter Follower (Dual NPN)	43.45	42.20	41.20	37.65	35.65	34.10
W-105	One Shot	128.65	124.70	121.55	115.80	106.00	99.85
W-106	Squaring Amplifier	104.65	101.50	98.95	92.50	86.30	82.45
W-108	Linear Amplifier	71.65	69.55	67.90	58.60	54.70	52.35
W-109	Reset Generator	65.10	63.30	61.35	54.85	50.65	48.45
W-112	Neon Driver (Dual)	99.20	96.80	94.70	67.05	63.55	60.65
W-114	Neon Driver (Quad)	184.40	180.00	127.55	121.70	115.70	110.80
W-901	Blank Board	8.35	8.15	7.15	6.50	5.55	5.35

HARDWARE AND ACCESSORY CROSS REFERENCE (8)

Blank Board	See W-901
Sockets	Purchase from local jobber Winchester #KKM-12SJ or equal
Drafting Template for Plug-In Symbols	See H-144

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Y-SERIES PRICE LIST

Effective Date: February 1, 1960

Terms, FOB point, and footnotes, e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
Y-100	Flip-Flop	60.90	58.45	54.10	51.50	48.00	45.85
Y-101	Flip-Flop	57.30	55.10	50.90	48.40	45.00	43.05
Y-102	Flip-Flop	63.20	60.80	56.40	53.75	50.15	47.95
Y-103	Shift Register Element	89.35	86.05	81.00	77.75	72.90	69.70
Y-104	One Shot	51.60	49.65	45.65	43.35	40.20	38.40
Y-105	Cathode Follower (Quadruple)	33.90	32.50	28.95	27.25	24.75	23.65
Y-106	Heavy Duty Cathode Follower (Quad)	36.30	35.00	31.35	29.60	27.00	25.80
Y-107	Neon Driver	37.30	35.75	32.00	30.20	27.60	26.35
Y-108	One Digit Adder Matrix	120.30	116.50	110.25	105.80	99.80	95.50
Y-109	One Digit Subtractor Matrix	95.25	92.05	86.85	83.35	78.50	75.10
Y-110	DC "NOT" Circuit	67.95	65.55	61.10	58.35	56.80	52.20
Y-111	Delay Unit	79.70	76.90	72.20	69.00	64.75	61.95
Y-112	Pulse Mixer Amplifier	67.65	65.00	60.45	57.60	53.85	51.45
Y-113	High Speed Flip-Flop	94.15	90.30	80.05	74.35	69.50	66.20
Y-115	Tape Write Amplifier	50.95	48.90	43.75	41.50	38.15	36.45
Y-116	Tape Read Amplifier	98.25	95.20	79.45	63.65	58.45	55.90
Y-118	Flip-Flop	77.75	74.80	72.60	70.00	67.05	64.15
Y-119	Flip-Flop	84.95	81.35	72.95	67.50	62.90	59.95
Y-124	-25V Bias Regulator	57.70	51.75	43.95	40.25	36.45	34.80
Y-400	Diode Logic	63.90	61.70	57.50	54.85	51.20	48.95
Y-401	Diode Logic	50.70	48.90	44.95	42.75	39.60	37.90
Y-402	Diode Logic	90.60	87.65	82.80	79.30	74.65	71.40
Y-403	Diode Logic	60.45	58.40	54.25	51.75	48.25	46.10
Y-404	Diode Logic	62.80	62.25	57.95	55.30	51.65	49.40
Y-405	Diode Logic	50.70	48.90	44.95	42.75	39.60	37.90
Y-406	Diode Logic	73.15	70.70	66.20	63.20	59.25	56.65
Y-407	Diode Logic	53.20	51.35	47.35	45.05	41.85	40.00
Y-408	Diode Logic	59.75	57.65	53.45	51.00	47.50	45.45
Y-409	Diode Logic	58.45	56.40	52.30	49.85	46.40	44.35

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Terms, FOB point, and footnotes e.g., (1), (23), etc., will be found at the end of the price lists.

PART NOS.	DESCRIPTION (3)	1-9	10-24	25-49	50-99	100-199	200-499
Y-410	Diode Logic	62.40	60.25	56.05	53.45	49.85	47.70
Y-411	Diode Logic	59.10	57.10	52.95	50.45	47.00	44.95
Y-412	Diode Logic	59.50	57.50	53.30	49.75	47.30	45.25
Y-413	Diode Logic	42.25	39.50	37.00	35.05	32.25	30.85
Y-414	Diode Logic	120.85	117.15	111.60	107.10	101.35	96.95
Y-415	Diode Logic	47.60	45.90	42.05	39.95	36.90	35.30
Y-416	Diode Logic	73.50	71.05	66.60	63.65	59.65	57.05
Y-417	Diode Logic	58.76	56.75	52.60	50.10	46.70	44.65
Y-418	Diode Logic	63.80	61.65	57.35	54.70	51.10	48.85
Y-419	Diode Logic	51.10	49.30	45.30	43.10	39.95	38.20
Y-420	Diode Logic	72.20	69.75	65.25	62.15	58.20	55.65
Y-421	Diode Logic	64.10	61.90	57.65	55.00	51.35	49.10
Y-422	Diode Isolation	92.70	90.40	86.05	81.25	77.15	73.90
Y-423	Diode Logic	57.50	55.55	51.45	49.00	46.65	43.65
Y-424	Diode Logic	51.80	50.00	46.10	43.85	40.65	38.90
Y-425	Diode Logic	58.60	56.60	52.45	50.00	46.55	44.50
Y-426	Diode Logic (One Tube)	55.40	53.30	49.15	46.80	43.45	41.55
Y-427	Diode Logic	58.25	56.25	52.10	49.65	46.25	44.20
Y-900	Mounting Frame			70.15		66.80	
Y-906	Female 15-pin connector (H.H. Buggie #4316)			1.10		1.10	
Y-907	In Circuit Test Fixture, 15-pin			26.45		26.20	
Y-909	Diode Logic Plug-in - blank - Matrix only. 15-pin connector (H.H. Buggie #4317)			21.95		19.65	
Y-910	Blank plug-in unit - 2 filament leads, 1 ground pad, 12 turret lugs - no socket - 15-pin connector (H.H. Buggie #4317)	Qty. 1-9		21.95	Qty. 10-Up	19.65	
Y-911	Same as Y-910 but has 1 9-pin socket			23.00		20.60	
Y-912	Same as Y-910 but has 2 9-pin sockets			24.00		21.55	

HARDWARE AND ACCESSORY CROSS REFERENCE

Power Supplies	See Y-124
Container Hardware and Parts	See Y-909, Y-910, Y-911, Y-912
Mounting Frames and Accessories	See Y-900, Y-907
Sockets	See Y-906
Drafting Template for Symbols	See H-144

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FOOTNOTES TO PRICE LIST
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FOOTNOTES

(1) Indicates that circuit is supplied with uniform B+ and Ground Connections - i.e., B+ at pin 2, ground at pin 1. Select circuits marked (*) to simplify socket wiring.

(2) Minimum order quantity 10.

(3) Description information listed does not necessarily correspond to the actual markings on parts. When ordering, use the part number and a brief parts description. For example, order as "T-101B Flip-Flop"; "95030-2 Standard Series Container"; "Z-95098-1 Power Supply"; "H-143 Crystal Oven", etc.

(4) May be supplied with other combinations of sockets on special order. Must be quoted by factory.

(5) The application (or family with which they are used) for hardware and accessory items is indicated by the following letter code:

- N Transistorized Decades (N-Series)
- Q Diode Containers
- R Minisig Indicators
- T Germanium Plug-in Circuits (T-Series)
- W Silicon Plug-in Circuits (W-Series)
- Y Two-tube Plug-in Circuits (Y-Series)
- Z Standard One-tube Plug-in Circuits (Standard Series)
- Zr Ruggedized One-tube Plug-in Circuits (Ruggedized Series Z-92000)

(6) Minimum order quantity 20.

(7) Used with T-Series System Development Panels T-927, etc.

(8) Other miscellaneous hardware may be found in the General Hardware 95000 and 96000 Section, or in the H-Series Hardware Section.

(9) All Minisigs are supplied with no markings on the lens. Lenses with one letter (A-Z) or 2 decimal digits (0-99) are available separately. Price of such lenses is $.05 each.

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FOOTNOTES TO PRICE LIST
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FOOTNOTES

(10) All Minisigs are supplied with no markings on the lens. Lenses with one letter (A-Z) or 1 decimal digit (0-9) are available separately. Price of such lenses is 5 cents each.

(11) Note: All N-Series decades are furnished with the mating connector included in the decade price. If additional connectors are required, check the decade specs to determine the part number for the proper connector.

(12) When ordering crystal oscillators and accessory parts: give the required operating frequency and "spot" tolerance, frequency stability, ambient temperature range, and required heater voltage rating on ovens (28 v and 115 v available).

(13) Note: All T-600 Series plug-in circuit modules are furnished with the mating 13-pin connector (T-937) included in the plug-in price. See listings for T-937 and T-909 if additional sockets and/or different mounting style sockets are required.

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TERMS AND CONDITIONS
Effective Date: February 1, 1960

TERMS AND CONDITIONS

1% 10 days, net 30 days. Prices are FOB Santa Ana, California. Prices and specifications are subject to change without notice. EECO assumes no obligation to incorporate production changes into previously delivered equipment.

LOANER POLICY

Because our experience indicates that engineers become regular customers once they have used Engineered Electronics Company plug-in units, we are prepared to loan you, without obligation, a reasonable quantity of EECO Plug-In Units for a 30-day trial period. If, at the end of the loan period, you wish to retain the loaned plug-ins, an invoice in the amount of the catalog price will be rendered. Should you so desire, you may return the loaners at any time prior to the expiration of the 30-day loan period without charge. Write for further details.

WARRANTY

We warrant all products manufactured or sold by us to be free from defects in materials and workmanship, excluding vacuum tubes, transistors, and other semi conductors; our obligations under this warranty being generally limited to repairing or replacing with reasonable promptness any of our products which shall, within four (4) months after delivery to the original purchaser, prove to be defective and which are returned to us; provided, however, that the purchaser shall have reasonably inspected products received and notified us of any apparent defects discovered within fifteen (15) days of receipt of shipment.

This warranty does not extend to any of our products which have been subjected to misuse, neglect, accident, or improper installation or application, nor shall it extend to units which have been repaired or altered outside of our factory. This warranty is in lieu of all other warranties.

Transportation charges covering any product returned shall be at our expense only if such product is proved defective. Prices include taxes payable by seller, but not taxes payable by or chargeable to buyer, which seller is required to collect.

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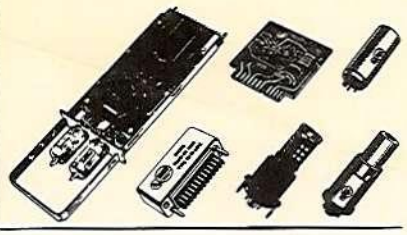

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LOADING MANUAL FOR T-SERIES GERMANIUM TRANSISTOR CIRCUIT MODULES

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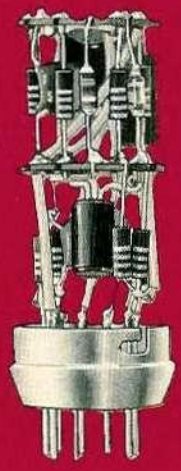
Typical T-Series plug-in package, actual size



Typical T-Series construction details, actual size

This manual provides loading rules and a loading chart for the T-Series germanium transistor circuit modules. It supplements the circuit diagrams, specifications, and application notes contained in EECO Catalog 859.

The manual will be of particular value to the systems planner and design engineer, although it will also be useful in system check-out and troubleshooting.

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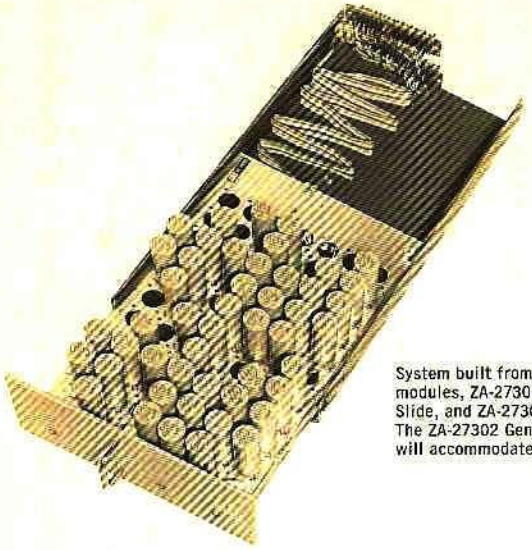
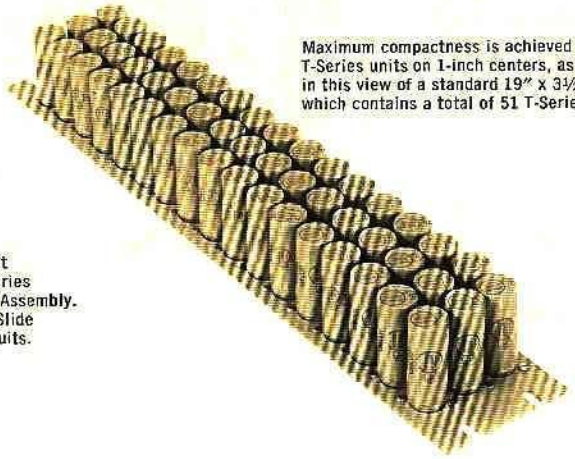


System built from T-Series plug-in circuit modules, ZA-27302 General-Purpose T-Series Slide, and ZA-27303 Mounting Hardware Assembly. The ZA-27302 General-Purpose T-Series Slide will accommodate up to 77 T-Series circuits.



Maximum compactness is achieved by mounting T-Series units on 1-inch centers, as shown in this view of a standard 19" x 3½" panel, which contains a total of 51 T-Series circuits.

A. GENERAL INFORMATION

The loading chart shows the maximum load each T-Series unit will drive under the worst temperature conditions at the maximum rated frequency for the driver-load combination (see paragraph C on frequency). The column at the left of the chart, "Drive Unit," lists the units which are to drive the loads. The heading at the top of the chart, designated "Load Unit," lists the plug-ins which are to be used as loads. The output of the drive unit is connected to the indicated input of the load unit, i.e., trigger, pulse, etc.

B. COMBINATION LOADS

The drive unit will drive a number of different types of load simultaneously as long as the combination does not exceed the load driving capacity of the drive unit. To determine what combinations may be driven by any given drive unit, first determine the percentage of a full load that each load unit presents to the driver. For example: one T-101B Flip-Flop drives 4 T-105 One-shots, *or* 2 T-110 Blocking Oscillators, *or* 5 T-111 Emitter Followers. Therefore, one T-105 is 25% of a full load, one T-110 is 50% of a full load, and one T-111 is 20% of a full load for the T-101B. The drive unit will drive a total of 100% of a full load. Therefore, the T-101B will drive 2 T-105 (50%) and 1 T-110 (50%) for a total load of 100%. Among other load combinations for the T-101B are: 2 T-105 (50%) and 2 T-111 (40%) for a total of 90% or 1 T-110 (50%) and 2 T-111 (40%) for a total of 90%. The drive units will drive a heavier load at lower frequencies (see paragraphs C and D on frequency). Therefore, the percentages will change at lower frequencies.

Frequency	Drive Unit	Load Combinations Which May Be Driven by the Drive Unit	Percent of Full Load
250 kc	T-101B	2 T-105 (50%) and 1 T-110 (50%)	100%
250 kc	T-101B	2 T-105 (50%) and 2 T-111 (40%)	90%
250 kc	T-101B	2 T-111 (40%) and 1 T-110 (50%)	90%
250 kc	T-101B	1 T-111 (20%) and 1 T-105 (25%) and 1 T-110 (50%)	95%
125 kc	T-101B	2 T-111 and 2 T-105 and 2 T-110 (See Paragraph D)	Approx. 100%
10 kc	T-612	1 T-102 (50%) and 1 T-105 (50%)	100%
10 kc	T-612	1 T-104 (50%) and 1 T-118 (50%)	100%

C. FREQUENCY

The frequency noted for each unit is the specified maximum frequency for that unit. *The loading chart figures were obtained with a frequency of 250 kc into the drive unit* in all cases except those where it was necessary to use a lower frequency because the specified maximum frequency of the drive unit or the load unit is less than 250 kc. The specified maximum frequency of the T-404 DC "AND" Gate is 250 kc. The specified maximum frequency of the T-410A (control input) Pulse "AND" Gate is 125 kc. Therefore, the test frequency into the drive unit was 125 kc with the T-404 driving the T-410A (control input).

The output of flip-flops is ½ the frequency of the input. Therefore, when a flip-flop is the driving unit, the load unit is actually running at ½ its rated frequency in most cases. For example, with 250 kc into the trigger input, the T-102A may be used to drive the control input of the T-410A because the output of the T-102A will be only 125 kc.

D. MORE LOAD AT LOWER FREQUENCIES

All T-Series units will drive heavier loads at frequencies lower than their specified maximum frequency. For a frequency into the drive unit of one half the specified maximum frequency of the drive unit, or lower, the unit will drive 50% to 100% more load than it will at maximum frequency. (Some units do even better than this — see paragraph E.)

EXAMPLES:

Frequency	Drive Unit	Permissible Load	Comments
250 kc 125 kc or lower	T-101B T-101B	4 T-101B 6-8 T-101B	The drive unit will drive from 50% to 100% more at frequencies lower than one half the specified maximum frequency.
250 kc 125 kc	T-105 T-105	2 T-118 3-4 T-118	
10 kc 5 kc	T-612 T-612	1 T-630 (Pulse Input) 2 T-630 (Pulse Input)	
125 kc 62 kc or lower	T-404 T-404	3 T-410A (Control Input) 3 T-410A (Control Input)	The drive unit is already at half its specified maximum frequency or less, therefore, there is no increase in driving ability by a further drop in frequency.
5 kc 1 kc	T-605 T-605	6 T-612 (Control Input) 6 T-612 (Control Input)	

E. EXCEPTIONS TO PARAGRAPH D

The T-118, T-411 or T-601 will each drive 8 to 10 flip-flops (T-101B, T-102A, T-103) at frequencies of 125 kc, or less. At 250 kc, they would drive 2 to 4 flip-flops.

Typical R-Series Minisig® sensitive indicators. Models include neon, filament, high-temperature, and memory (thyratron), packaged in miniature, subminiature, and plug-in designs. Ideal for compatible use with T-Series circuit modules.

F. EMITTER FOLLOWERS

To use emitter followers, connect the output of the drive unit to the input of the emitter follower. Connect the ouput of the emitter follower to the input of the load unit. The emitter follower is used to increase the load-driving capacity of the drive unit or to provide better circuit isolation between the drive unit and the load unit. (Note that transistor emitter followers unlike vacuum tube cathode followers, still "reflect" the load back to the input – roughly in the ratio of 1/Beta.)

The *PNP Emitter Followers* T-111, T-112, T-113 are generally used to drive DC logic such as "AND" and "OR" gates or other resistive loads. *CAUTION:* When driving a *capacitive load* with *PNP emitter followers* connect a 5.6 k resistor from the *output of the emitter follower to +12 volts*. This is done to lower the output impedance of the emitter follower for positive-going signals and thus increase its driving ability for positive pulses.

The *NPN Emitter Followers* T-114, T-115, T-116 are generally used to drive *capacitive loads.* (See explanation below.) They have a minimum output impedance for positive pulses or positive-going signals. They are also good for driving control inputs of Pulse "AND" Gates and control inputs of Shift Registers and Gated Flip-Flops.

A capacitive load is one that has a capacitor in series with its input and therefore requires a pulse to drive it. Typical examples of a capacitive load are: flip-flops, pulse inverters, pulse amplifiers, and the pulse input of pulse gates.

G. INCREASED DRIVE ABILITY USING EMITTER FOLLOWERS

When using an emitter follower (T-111, T-112, T-113, T-114, T-115, or T-116) as indicated in F above, the drive unit (through the emitter follower) will drive 2 to 2½ times the load that it will drive without the emitter follower.

EXAMPLES:

Frequency	Drive Unit	Emitter Follower	Permissible Load
250 kc	T-101B	None	4 T-102A
250 kc	T-101B	T-114	8 to 10 T-102A
250 kc	T-104	None	2 T-106 (Direct Input)
250 kc	T-104	T-111	4 T-106 (Direct Input)
125 kc	T-104	T-111	6 to 8 T-106 (Direct Input)

This formula does not apply to drive units that already have an emitter follower output such as T-404, T-107, etc. Note in the previous example, that at frequencies of ½ the specified maximum or less, *and* using an emitter follower, the drive unit will drive 3 to 4 times what the permissible load would be at the maximum frequency without an emitter follower.

H. USE OF THE T-410A OR THE T-630 PULSE "AND" GATES

The T-410A and the T-630, due to their low output amplitudes, are poor driving units. Therefore, when used as drivers, the units which the T-410A or the T-630 are *driving* have only ½ of *their* normal driving ability.

Frequency	Drive Unit	Permissible Load	Permissible Load for each T-101B
250 kc	T-410A or T-630	2 T-101B	2 T-102A

For example, the usual permissible load for the T-101B at this frequency is 4 T-102A, but when the T-101B is driven by a T-410A (or a T-630) the driving ability of the T-101B is reduced to ½ its normal driving ability. Therefore, it will drive only 2 T-102A.

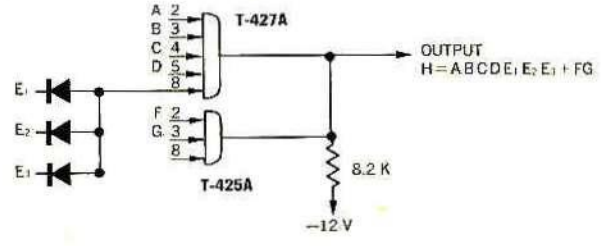
J. USE OF T-107 OR THE T-127 CRYSTAL OSCILLATORS

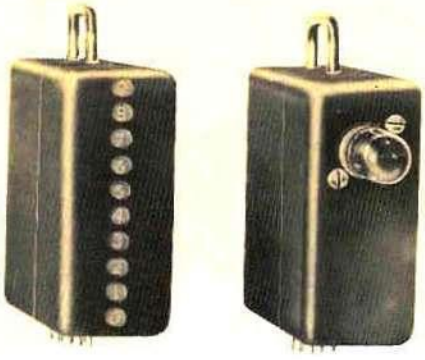
The T-107 and T-127 Crystal Oscillators have NPN emitter follower outputs providing a good driving source for positive-going signals. When driving only capacitive loads (no resistive load) the driving ability of the Crystal Oscillators is increased by about 50% by connecting a 2.2 k resistor from the output to −12 volts. This increases the drive ability by lowering the driving source impedance. This 2.2 k resistor was used to obtain the values on the load chart for the Crystal Oscillators driving capacitive loads. Do not use this resistor when driving resistive loads since it is unnecessary and may cause the Crystal Oscillator to be overloaded. (See paragraph F for definition of capacitive load.)

K. USE OF BUFFERED "AND" GATES T-425A, T-426A, T-427A, T-428A, T-607A, T-608A, T-609A, T-625A, T-626A, and T-631A.

Each of these units has a "buffer" diode in the output line. Because of this diode it is possible to connect the output of as many as 24 units together to get a single "OR'd" output. For most applications, regardless of how many of these "AND" Gates are "OR'd" together, the output must be returned to −12 volts through *one* common 8.2 k ohm resistor.

However, when the output is used to drive control inputs of gated flip-flops or shift register flip-flops, do not use this external 8.2 k ohm resistor because the input to these units is already returned to −12 volts.





Typical N-Series transistorized plug-in decade counters. These units, available in a wide variety of models, are electrically compatible with T-Series circuit modules and measure only slightly larger than a cigarette pack.

Model ZA-721 transistorized 12-volt DC, 1-Amp Regulated Power Supply plugs into modified 14-pin miniature tube socket. Seated height is identical with T-Series plug-in circuit package (2-3/16").

L. USE OF T-109 RESET GENERATOR

The T-109 is used for the *direct set* (where this terminal is available) or the *direct reset* of up to 15 of the following units: T-600, T-604, T-605, T-606, T-610, T-629, T-633, T-101B, T-102A (base input), T-103. With a nominal —3 volts DC into the input of the T-109, the output of the T-109 is approximately 0 volts DC. This level is used for resetting.

When the T-109 is connected to the direct reset input of the above units, with a nominal —3 volts DC into the T-109, the pin 8 output of the units being reset will be reset and held at —3 volts DC. However, if pulses are applied to the unit while it is being held reset, pulses will appear at the pin 7 output which may trigger subsequent circuits.

When the T-109 is used for resetting the T-102A, or the T-604, an external diode must be used. Connect the anode of the diode to the T-109 output. Connect the cathode of the diode to the base input of the T-102A or the direct reset input of the T-604. This diode is internal on the other units and is necessary to isolate the T-109 from the unit being reset, at times other than "reset time."

If the input noted in the table below is used *in addition* to the direct reset, then it is necessary to use an isolating diode between the T-109 and the direct reset of these units. Otherwise a pulse at this input will see a low impedance path through the T-109 and hence not trigger the load unit properly.

Unit	Input
T-101B	AC reset
T-103	AC reset
T-600	parallel data input pin 5, and/or transfer pulse input pin 11.
T-606	parallel data input pin 5, and/or transfer pulse input pin 11.

Connect the anode of the diode to the T-109 output.

M. USE OF THE T-129 RESET GENERATOR

The T-129 Reset Generator is used to reset as many as 6 N-Series Decades, 30 T-102A Flip-Flops, or 30 T-604 Gated Flip-Flops. *When resetting less than 3 decades or less than 10 T-102A or T-604, connect a 1000 ohm resistor in series with the output of the T-129.* This resistor is necessary to limit the reset current for light loads.

To use the T-129 to reset T-102A Flip-Flops, or T-604 Gated Flip-Flops, connect a diode between the output of the T-129 and the base input of the T-102A or the direct reset input of the T-604, with the *cathode* end of the diode connected to the T-129. (This diode is internal in the decades.) With a nominal —3 volts DC level into the T-129 input, the output of the T-129 is approximately —4 volts DC when loaded with 1 to 6 decades or 1 to 30 T-102A or T-604. This —4 volts DC level is used for resetting.

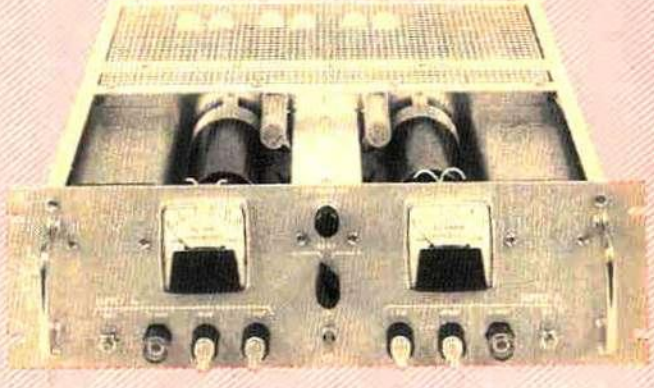
When the T-129 is connected (through the diode) to base input #1 of the T-102A or to the direct reset input of the T-604, *with a nominal —3 volts level into the T-129, the pin 7 output of the T-102A or the T-604 will be reset and held to —3 volts.* (Note that this is the opposite of the T-109.) However, if a signal is put into the trigger input of the T-102A or the T-604 while it is held reset, a small pulse may result at the pin 8 output which may be of sufficient amplitude to trigger a succeeding flip-flop. The T-129 will hold N-Series Decades reset even with pulses going into the trigger input of the decade, so N/10 outputs will not occur. (If the N-Series unit has code outputs, however, the first stage output will show effects similar to T-Series.)

N. USE OF EMITTER FOLLOWER TO DRIVE LOGIC CIRCUITS

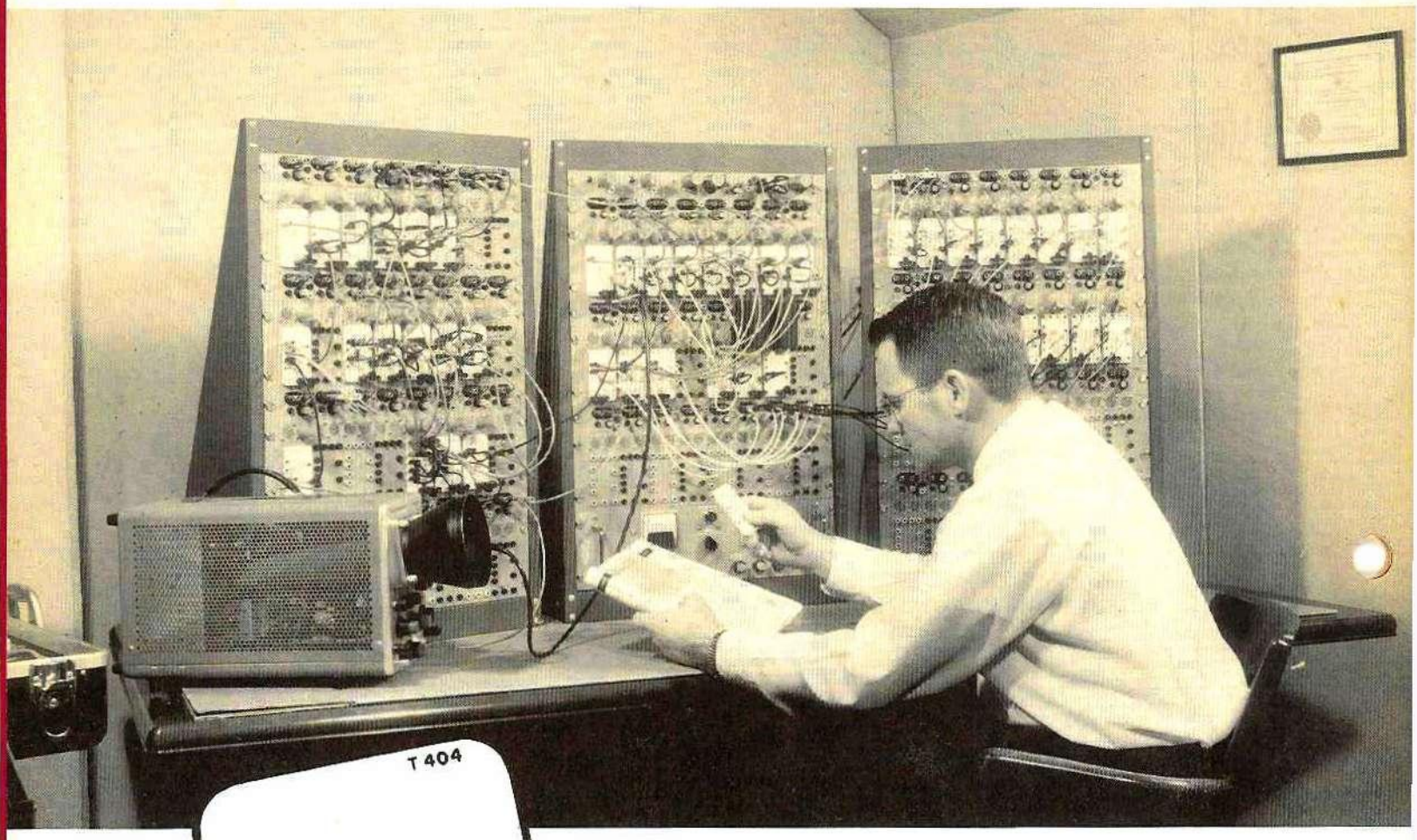
The column headed "Logic" under T-111-113 load units is used when the emitter follower being driven is in turn used to drive DC logic or control inputs of pulse logic. The lighter loading is necessary so that the driving circuit output levels are not detrimentally lowered in amplitude. Otherwise this could create problems because when a heavily loaded unit with a 6 volts output and a lightly loaded unit with an 8 volts output are both connected into the same logic circuit, it is possible to get an undesirable 2 volts pedestal which may trigger succeeding circuits.

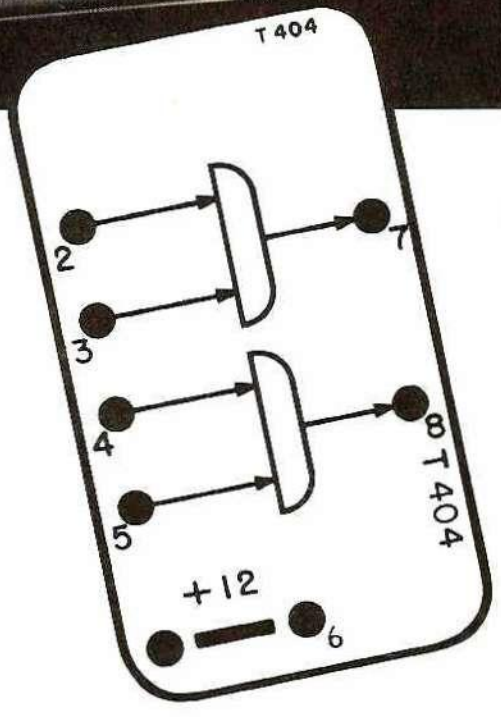
O. LOAD ON BOTH OUTPUTS OF FLIP-FLOPS

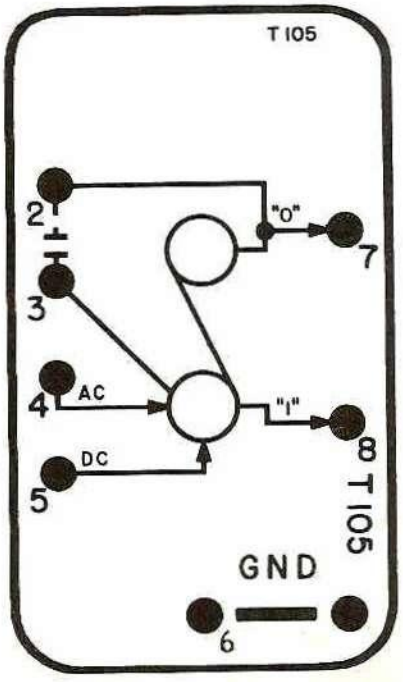
When the drive unit is a flip-flop, without an emitter follower built in on the output, the number shown on the load chart is the total combined load that can be driven by both outputs of the flip-flop. This total load can also be driven by either output singly.



Model ZA-720 transistorized Dual 12-volt DC, 5-Amp Regulated Power Supply, designed to provide the power source for systems and equipment employing EECO T-Series circuit modules. Convection cooled.







EECO T-Series Digital System Breadboard Equipment can be built up in stages to any degree of complexity. Compatible interconnections between racks permit expanding equipment into a complete systems development console.

Plastic circuit cards, showing circuit symbols, input and output connections, power connections, part number, application notes, etc., provide a convenient guide to patchcord wiring of signal connections; facilitate drawing a circuit diagram and determining cost of the system.

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DRIVE UNIT (A) ↓		LOAD UNIT → (A) (B)	SQUARING AMPLIFIER		FLIP-FLOPS		GATED FLIP-FLOPS			SHIFT REGISTER FLIP-FLOPS			
			T-106		T-101B T-102A T-633	T-101B T-103 T-633	T-604, T-629			T-606, T-610		T-605	
		INPUT →	AC	DIRECT	TRIGGER	SET, RESET	PULSE	TRIGGER	CONTROL	PULSE	CONTROL	PULSE	CONTROL
		MAX. FREQ. → (C) ↓ (D)	500 KC	500 KC	250 KC	300 KC	250 KC	250 KC	125 KC	250 KC	125 KC	25 KC	12.5 KC
LINEAR AMPLIFIER	T-108	30 cps to 500 kc	1	1	X	X	X	X	X	X	NNA	X	NNA
SQUARING AMPLIFIER	T-106	500 kc	2	2	3	4	1**	3	1	1**	1	1	2
FLIP-FLOP	T-103 (O)	300 kc	2	2	4	2	1**	4	1	1**	1	1	2
FLIP-FLOPS	T-101B, T-102A, T-633 (O)	250 kc	2	2	4	3	1**	4	1	1**	1	1	2
GATED FLIP-FLOPS	T-604, T-629 (O)	250 kc											
SHIFT REGISTER FLIP-FLOPS	T-606, T-610 (Pin 8 out) (O)	250 kc											
	T-610 (Pin 7 out)	250 kc	4	4	8	4	1	8	2	1	2	2	4
SHIFT REGISTER FLIP-FLOPS	T-605 (Pin 7 out)	25 kc	6	6	12	7	2	12	3	2	3	3	4
	T-605 (Pin 8 out)	25 kc	3	3	8	5	1	8	1	1	1	2	3
MULTIVIBRATOR (FREE RUNNING)	T-104	325 kc	2	2	4	6	1**	4	1	1**	1	1	2
ONE SHOT MULTIVIBRATOR	T-105 (Pin 7 out)	250 kc	1	1	1	3	1**	1	1	1**	1	1	1
	T-105 (Pin 8 out)	250 kc	1	1	1	3	1**	1	1	1**	1	1	2
CRYSTAL OSCILLATOR	T-107 (J)	10 kc - 75 kc	7	7	15	12	3	15	3	3	3	5	4
CRYSTAL OSCILLATOR	T-127 (J)	75 kc - 250 kc	4	4	8	10	1	8	2	1	2	X	X
BLOCKING OSCILLATOR	T-110	250 kc	12	7	20	15	5	20	X	5	X	8	X
PULSE INVERTER	T-117	250 kc	2	1	2	2	1**	2	X	1**	X	1	X
PULSE AMPLIFIER (NON-INVERTING)	T-118 (E)	250 kc	1	1	2	6	1	2	X	1	X	1	X
PULSE "AND" GATES	T-410A, T-630 (H)	250 kc	1	1	2	2	X	2	X	X	X	X	X
	T-411, T-601 (E)	250 kc	3	2	4	8	1	3	X	1	X	1	X
PULSE "AND" GATE	T-612	10 kc	1	X	2	2	1*	2	X	1*	X	1*	X
PULSE "AND" GATE	T-613	5 kc											
PULSE "OR" GATES (MIXER AMPLIFIERS)	T-412, T-430, T-431, T-602	250 kc	1	1	3	6	1	2	X	1	X	1	X
DC "AND" GATES	T-404, T-405, T-620, T-621, T-622, T-627	250 kc	2	2	3	4	1	3	3	1	3	1	4
DC "OR" GATES	T-406, T-407, T-614, T-623, T-634, T-635	250 kc											
DC "AND"/"OR" GATE	T-433	250 kc											
DC DUAL "AND" GATE, "OR'd" OUTPUT	T-434	250 kc											
DC "EXCLUSIVE-OR" GATE	T-421, T-423	250 kc	1	1	3	3	1	2	2	1	1	1	2
DC HALF ADDER/SUBTRACTOR	T-424	250 kc											
DC "AND"/"EXCLUSIVE-OR" GATE	T-432	250 kc											
DC BUFFERED "AND" GATES	T-425A, T-426A, T-427A, T-428A, T-607A, T-608A, T-609A, T-625A, T-626A, T-631A (K)	250 kc	1	1	1	1	1**	1	2	1**	2	1**	2
EMITTER FOLLOWERS	T-111, T-112, T-113, T-114, T-115, T-116	500 kc	See Notes (F), (G), (M)										
RESET GENERATORS	T-109, T-129		See Notes (L), (M)										

LOAD CHART

FOR T-SERIES GERMANIUM TRANSISTOR CIRCUIT MODULES

RESET GENERATORS			MULTI-VIBRATOR	ONE SHOT MULTI-VIBRATOR	BLOCKING OSCILLATOR	PULSE INVERTER	PULSE AMPLIFIER	PULSE "AND" GATES								PULSE "OR" GATE (MIXER AMP.)	DC BUFFERED "AND" GATES	DC "AND" GA
T-109		T-129	T-104	T-105	T-110	T-117	T-118	T-410A	T-411 T-601	T-630	T-410A T-411 T-601 T-630	T-612		T-613		T-412 T-430 T-431 T-602	T-425A T-608A T-426A T-609A T-427A T-625A T-428A T-626A T-607A T-631A	T-404 T T-405 T T-620 T
NORMAL	PULSE							PULSE	PULSE	PULSE	CONTROL	PULSE	CONTROL	PULSE	CONTROL	PULSE		
250 KC	250 KC	50 KC	325 KC	250 KC	250 KC	250 KC	250 KC	250 KC	250 KC	250 KC	125 KC	10 KC	5 KC	5 KC	2.5 KC	250 KC	250 KC	250 K
X	X	X	NNA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14	2	3	2	3	2	3	3	1	2	1	1	1**	6*	6**	6*	1	1*	4*
15	2	2	3	3	1	2	3	1**	3	1	1	1**	6*	6**	6*	2	1*	4*
15	3	3	3	4	2	3	4	1	4	2	1	1**	6*	6**	6*	4	1*	4*
30	6	6	4	6	4	6	8	2	8	4	2	1	6	6	6	8	1	4
30	8	7	10	12	7	10	15	3	15	5	3	1	6	6	6	15	1	4
20	5	3	6	8	4	4	8	1	8	2	1	1**	6*	6**	6*	7	1*	4*
15	3	3	4	4	2	3	4	1	4	2	1	1**	6*	6**	6*	3	1*	4*
4	1	3	1	1	1	1	1	1**	1	1	1	1**	6*	6**	6*	1	1*	4*
9	2	3	2	2	2	1	2	1**	1	1	1	1**	6*	6**	6*	2	1*	4*
30	10	7	7	15	7	10	15	3	15	6	3	1	X	X	X	15	1*	4*
10	6	3	4	8	4	6	8	1	8	2	1	X	X	X	X	8	1*	4*
30	12	12	15	20	8	12	20	5	15	10	X	2**	X	12**	X	15	NNA	NNA
10	3	2	2	4	1	2	3	1**	2	1	X	2**	X	12**	X	2	1*	4*
10	1	2	1	2	1	X	2	1**	1	1	X	2**	X	12**	X	1	1*	4*
X	2		2	2	1	X	2	X	1	X	X	X	X	X	X	1	X	X
10	3	2	3	4	2	NNA	2	1	4	1	X	1**	X	6**	X	2	1*	4*
X	2	1	2	2	1	NNA	2	X	1	1	X	X	X	X	X	1	X	X
10	2	2	2	2	2	NNA	3	1	3	2	X	1**	X	6**	X	2	1*	4*
15	2	6	3	4	2	NNA	3	NNA	3	1	3	1	6	6	6	3	1	4
10	1	2	2	2	1	NNA	2	NNA	2	1	1	1	6	6	6	2	1	2
5	1	2	1	1	1	1	1	1**	1	1	2	1**	4*	4**	4*	1	X	X

NOTES

* Indicates that the loading figures were obtained by using a PNP emitter follower (T-111, T-112, or T-113) between the driving unit and the load unit. (See note on emitter followers.)

** Indicates that the loading figures were obtained by using an NPN emitter follower (T-114, T-115, or T-116) between the driving unit and the load unit. (See note on emitter followers.)

NNA Not a normal application. Tests have not been made to indicate whether or not this combination will work.

✕ This combination is not recommended.

ALPHABET REFERENCES: Letters in colored circles refer to paragraphs in the preceding text.

DC "OR" GATES	DC "EXCLUSIVE-OR" GATES	DC "AND"/"EXCLUSIVE-OR" GATE		DC "AND"/"OR" GATE		DC DUAL "AND" GATE "OR'd" OUTPUT	HALF ADDER/ SUBTRACTOR		RELAY DRIVERS		CODE CONVERTER MATRIX	EMITTER FOLLOWERS		
T-406 T-623 T-407 T-634 T-614 T-635	T-421 T-423	T-432		T-433		T-434	T-424		T-120 T-121 T-128	T-130	T-628	T-111 T-112 T-113 (PNP)	T-111 T-112 T-113 (PNP) N (LOGIC)	T-114 T-115 T-116 (NPN)
		PIN 2, 3	PIN 4, 5	PIN 2, 3	PIN 4, 5		PIN 5	PIN 2, 3						
250 KC	250 KC	250 KC	250 KC	250 KC	250 KC	250 KC	250 KC	250 KC	1 KC	1 KC	1 KC	500 KC	250 KC	500 KC
✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	4	NNA	4
3*	1*	4*	1*	4*	3*	4*	4*	1*	4	3	1	5	1	8
3*	1*	4*	1*	4*	3*	4*	4*	1*	2	1	1	4	1	7
3*	1*	4*	1*	4*	3*	4*	4*	1*	4	3	1	5	1	8
3	1	4*	1	4*	3	4*	4	1	8	6	2	6	5	8
3	2	4	2	4	4	4	4	2	8	6	2	6	5	8
3*	1*	4*	1*	4*	3*	4*	4*	1*	4	3	2	6	1	8
3*	1*	4*	1*	4*	3*	4*	4*	1*	4	3	2	6	1	6
3*	1*	4*	1*	4*	3*	4*	4*	1*	4	3	1	2	1	3
3*	1*	4*	1*	4*	3*	4*	4*	1*	4	3	1	3	1	4
3*	1*	4*	1*	4*	3*	4*	4*	1*	✕	✕	✕	8	5	8
3*	1*	4*	1*	4*	3*	4*	4*	1*	✕	✕	✕	6	5	8
NNA	NNA	NNA	NNA	NNA	NNA	NNA	NNA	NNA	✕	✕	✕	10	10	15
3*	1*	4*	1*	4*	3*	4*	4*	NNA	✕	✕	1	2	1	5
3*	1*	4*	1*	4*	3*	4*	4*	1*	✕	✕	1	2	1	6
✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
3*	1*	4*	1*	4*	3*	4*	4*	1*	✕	✕	2	3	2	5
✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	2	✕	✕
3*	1*	4*	1*	4*	3*	4*	4*	1*	✕	✕	✕	2	1	4
3	1	4*	1	4*	3	4*	4	1	4	3	1	6	5	4
3	1	2	1	2	3	2	2	1	4	3	1	8	5	4
✕	✕	✕	✕	✕	✕	✕	✕	✕	1	1	NNA	✕	✕	2

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