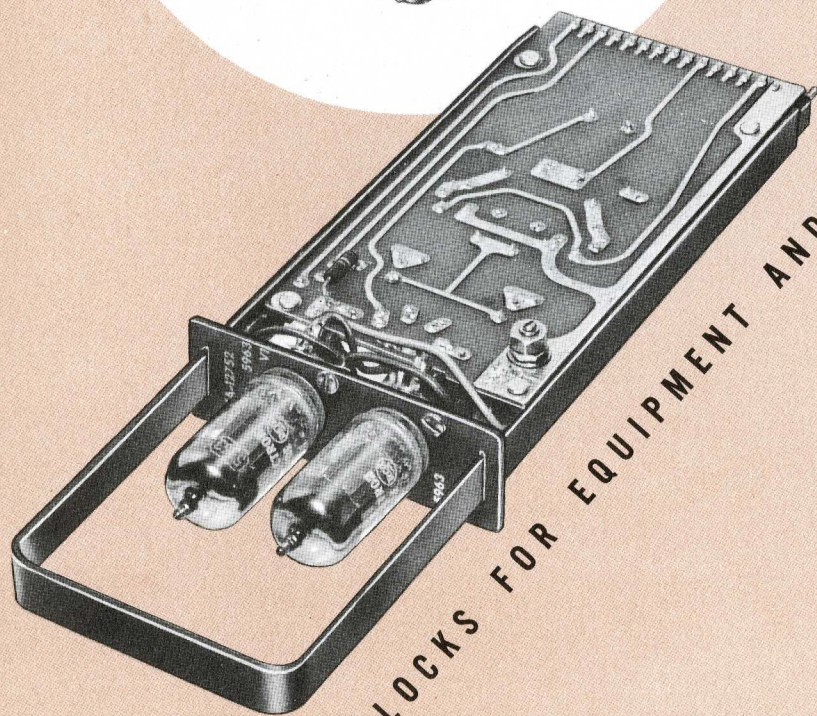




Engineered Electronics



BUILDING BLOCKS FOR EQUIPMENT AND SYSTEMS

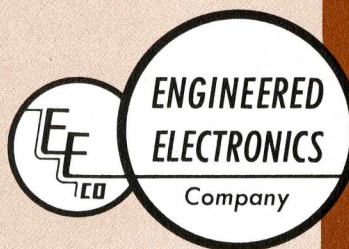


Table of Contents

Section One

Standard-Series Plug-in Units	
Introduction	2
Usage Chart	4
Specifications and Schematic Circuits	6-22
Diode Plug-in Units	23
Mechanical Specifications	24
Special Circuits	24
Custom Plug-in Containers	25
Equipment Design and Fabrication	25
Standard-Series Plug-in Applications	26-33

Section Two

Power Supplies and Accessories	34
--------------------------------------	----

Section Three

Computer-Series Plug-in Units	
Introduction	36
Specifications and Schematic Circuits	38-50
Diode Logic Plug-in Units	
Specifications and Schematic Circuits	51
Representative Circuit Equations	53
Accessory Equipment	54
Mechanical Specifications	55
Computer-Series Plug-in Applications	56-63

Section Four

Chopper Stabilized D-C Amplifiers	64
---	----

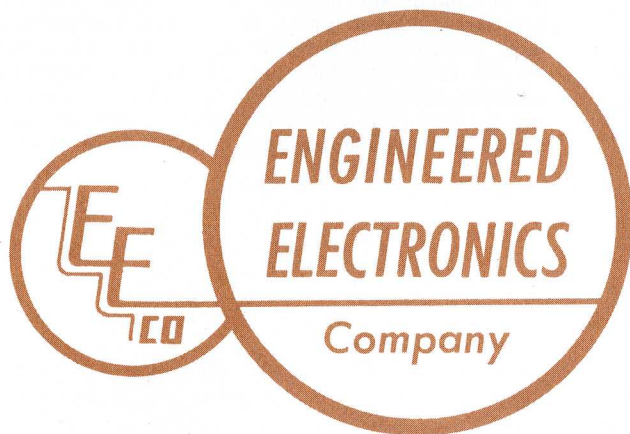
Section Five

General: Systems Components	66
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Section Six

Price List and Ordering Instructions	68
Index	72-73

About Engineered Electronics



THE ENGINEERED ELECTRONICS COMPANY (formerly the EECO Production Company) devotes its major effort to the *production* of highly engineered, reliable, electronic equipment. We are wholly owned by the Electronic Engineering Company of California, which specializes in the *design and development* of high-quality electronic systems for both military and industrial use.

Most of our products are modular in nature, designed to form building blocks for automation, instrumentation, data handling, computing, timing, telemetering, calibrating, testing, and other equipment and systems.

The majority of our products fall into either our Standard-Series or Computer-Series of plug-in units. These units are actually proven functional circuits, multi-diodes, or diode logics packaged in handy, compact, plug-in form. Equally important among our products, however, are power supplies, D-C amplifiers, accessory equipment, and general systems components, practically all of which are compatible with one or the other of our two series of plug-ins.

We have developed a system of symbols to represent our plug-ins. Use of these symbols as a shorthand saves design and drafting time and helps reduce wiring errors. Skilled engineers can spend their time on system design problems or unusual circuit requirements, while less highly trained people can assemble our units to provide the more normal or detailed requirements. Because detailed schematic circuit diagrams are eliminated, drafting time is minimized. Shop personnel soon learn the standard power connections and can then wire finished equipment directly from the shorthand symbol diagram.

Wherever possible in this catalog, the appropriate EECO symbol or symbolic diagram has been included along with the conventional schematic diagram it represents. This applies both to those pages devoted to the specifications of individual units and to the pages describing the typical application possibilities of Standard-Series and Computer-Series plug-in circuits. It is hoped that this arrangement will serve the engineer as a visual aid in familiarizing himself with this modern, time-saving technique. The engineering of these units has been done, and is available to all who wish to use it.

Standard-Series Plug-in Units

Section One



INTRODUCTION

MORE AND MORE DESIGN ENGINEERS are discovering the advantages of using Engineered Electronics Company plug-in circuits as building blocks in systems and equipment development work. By employing EECO standard symbols to represent established and proven circuits, the engineer reduces design time to a minimum. He gains a new freedom by becoming a "block diagram" man instead of a routine circuit detailer.

Then, with an EECO Systems Development Rack, a minimum of socket-to-socket wiring, and the proper combination of Standard-Series plug-ins, he is able to test out his system design. His "breadboard" or prototype equipment has a professional appearance that can be carried over into actual production runs with no change in wiring or layout.

The actual production of systems and equipment incorporating EECO Standard-Series plug-in units is stepped up, because technicians can cut fabrication time when only basic wiring is required.

And in operation, these systems and equipment offer the advantage of simplified maintenance. "Down time" is reduced to a minimum, because faulty units can be readily located and new ones plugged in with the ease of replacing vacuum tubes. What's more, EECO Standard-Series plug-in units can be taken apart and reassembled without tools. They are completely repairable — and this makes them economical, low-priced units as compared with costly "throw-away" circuits.

The extreme reliability of EECO Standard-Series plug-ins results both from sturdy mechanical construc-

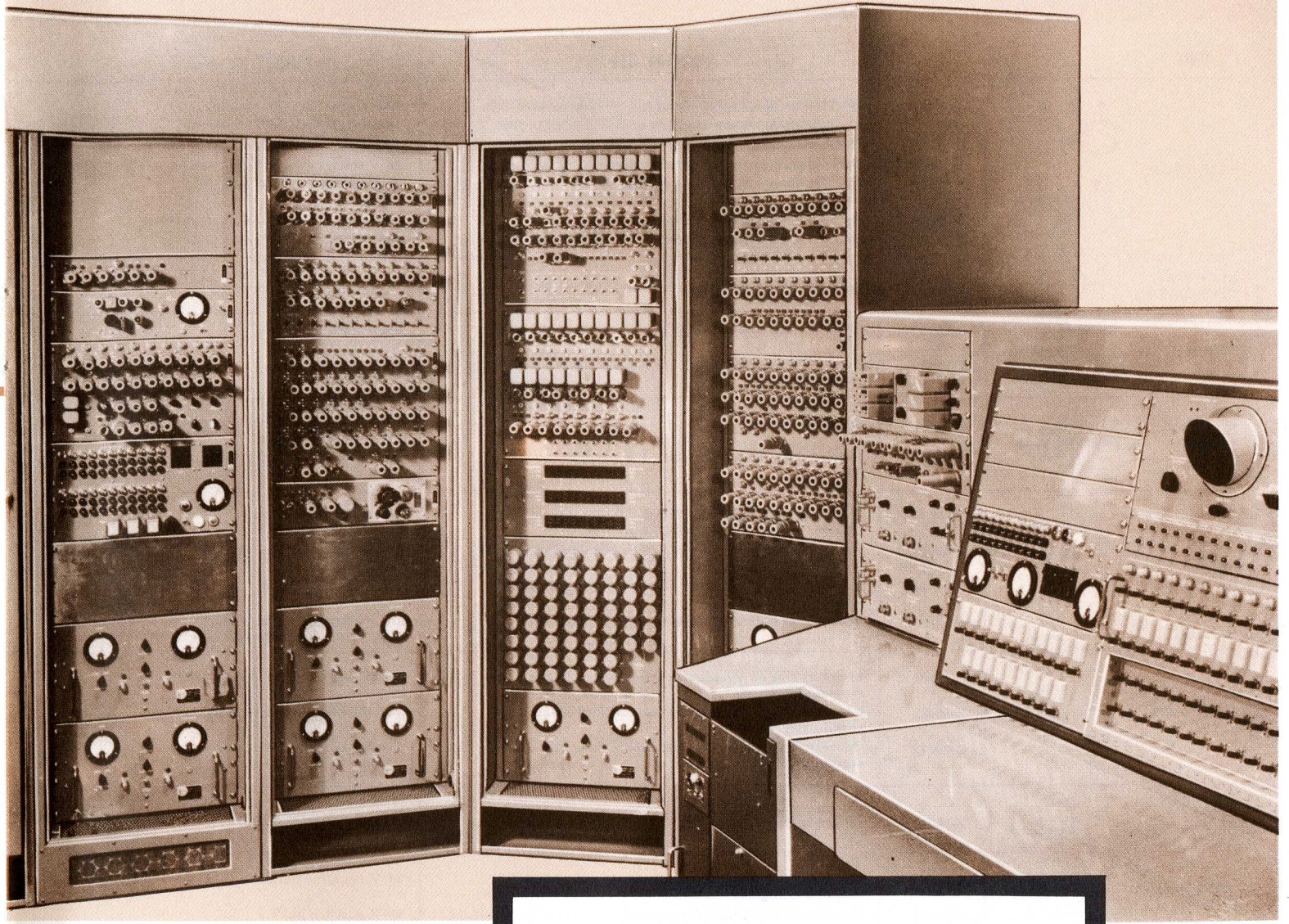
tion and from the fact that premium components are used throughout. All units are moisture- and fungus-proofed for optimum performance under even the most adverse conditions. Each plug-in is housed in a die-cast aluminum, baked enameled container, with an 8- or 11-pin header.

Standard-Series plug-in units containing any of our tested and proven circuits can be delivered from stock. These circuits include pulse and linear amplifiers, squaring circuits, flip-flops, one shots, multivibrators, oscillators, gates, diodes, and many others. The EECO symbol, schematic wiring diagram, and specifications for the majority of these circuits are given on pages 6 through 22. In addition, the Usage Chart on pages 4 and 5 lists the primary use, output, input, frequency range, gain, and power requirements of each unit in easy reference form for comparison purposes.

Some of the typical applications of EECO Standard-Series plug-in circuits are described in pages 26 through 33. These include counting and frequency division (both digital and analog), pulse and sweep generators, time selection, squaring circuits, pulse amplifiers, and linear amplifiers.

In the interest of ensuring the complete compatibility of equipment and systems incorporating EECO Standard-Series plug-in units, Engineered Electronics Company stands ready to build any special circuits specified by the design engineer in our regular containers. In addition, custom plug-ins can be produced, wired according to customer drawings. Where parts are on hand, two-week deliveries can be made on these units.

Engineered Electronics Company Standard-Series Plug-in units have found their way into many types of commercial and military systems and equipment during the seven years since they were first introduced. They have consistently proven themselves to be highly reliable, even under varying conditions of shock, vibration, temperature, and humidity.

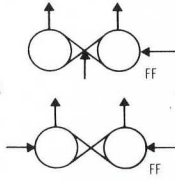

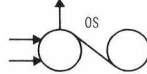
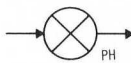
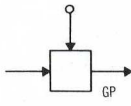

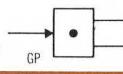
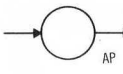
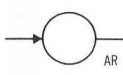
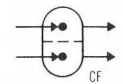
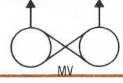

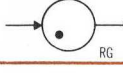



TYPICAL APPLICATION OF
STANDARD-SERIES PLUG-IN UNITS

EECO Standard-Series Plug-in "Loaner" Policy

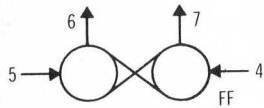
Because our experience indicates that engineers become regular customers once they have used Engineered Electronics Company plug-in units, we are prepared to loan you, without obligation, a reasonable quantity of EECO Standard-Series plug-in units for a 30-day trial period. If, at the end of the loan 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.

Usage Chart

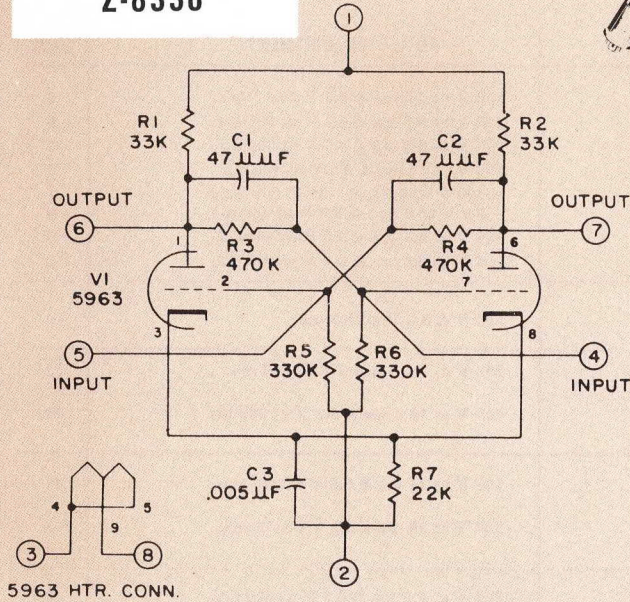
UNIT	PRIMARY USE	OUTPUT (no load)
FLIP-FLOPS  <ul style="list-style-type: none"> Z-8336 Z-8339 Z-8342 Z-90048 Z-90052 Z-90059 Z-90166 	<p>Medium-speed counting, frequency division, switching.</p> <p>Medium-speed binary counting or feedback counting.</p> <p>Medium-speed binary or linear counting.</p> <p>High-speed counting, frequency division, switching.</p> <p>Medium-speed applications driving logical "and" and "or" circuits.</p> <p>Medium-speed binary counting.</p> <p>Medium-speed counting, frequency division, and switching.</p>	<p>100-V square or rectangular wave.</p> <p>100-V square or rectangular wave.</p> <p>100-V square or rectangular wave.</p> <p>80-V square or rectangular wave.</p> <p>40-V square or rectangular wave.</p> <p>100-V square or rectangular wave.</p> <p>100-V square or rectangular wave.</p>
BLOCKING OSCILLATOR  <ul style="list-style-type: none"> Z-90015 	<p>Generate a fast-rise-time, short-duration pulse.</p>	<p>34-V to 88-V positive pulse.</p>
ONE SHOTS  <ul style="list-style-type: none"> Z-8318 Z-8889 	<p>Generate a fixed positive pulse of fixed duration, delay application.</p> <p>Generate a positive pulse of adjustable duration with fast recovery time.</p>	<p>100-V positive pulse.</p> <p>60-V positive pulse.</p>
PHANTAS-TRONS  <ul style="list-style-type: none"> Z-8771 Z-90018 	<p>Sweep or delay.</p> <p>Divider or sweep application.</p>	<p>30-V negative step, 70-V negative sweep, & 130-V positive pulse.</p> <p>17-V negative pulse, 25-V negative step, & 65-V to 100-V negative sweep.</p>
GATES  <ul style="list-style-type: none"> Z-90002 Z-90007 Z-90023 Z-8327 	<p>Pulse gate controllable by flip-flop or one shot with 28-microsecond gate opening time.</p> <p>Pulse gate similar to Z-90002, with 10-microsecond gate opening time.</p> <p>Pentagrid pulse gate with 10-microsecond gate opening time.</p> <p>Coincidence gate operating as a cathode follower.</p>	<p>100-V negative pulse.</p> <p>92-V p-p, maximum.</p> <p>180-V negative pulse.</p> <p>Coincidence signal 92 V negative.</p> <p>Anti-coincidence signal 10 V negative.</p>
SQUARING CIRCUITS  <ul style="list-style-type: none"> Z-90001 Z-90021 Z-90049 	<p>Converts sine or complex waveforms into square or rectangular waves.</p> <p>Converts sine or complex waveforms into square or rectangular waves.</p> <p>Converts sine or complex waveforms into square or rectangular waves.</p>	<p>100-V p-p square or rectangular wave.</p> <p>130-V p-p square or rectangular wave.</p> <p>110-V p-p square or rectangular wave up to 200 kc and 85-V to 1 mc.</p>
GENERATOR, PULSE (THYRATRON)  <ul style="list-style-type: none"> Z-90063 	<p>Pulse generator, amplifier, and/or gate.</p>	<p>80-V negative or positive spike; or 60-V p-p square wave.</p>
AMPLIFIERS, PULSE  <ul style="list-style-type: none"> Z-8489 Z-90030 	<p>Improves rise time and amplitude of weak signals, isolation amplifier.</p> <p>Regenerative amplifier for producing standard pulse output.</p>	<p>85-V negative pulse.</p> <p>90-V positive pulse.</p>
AMPLIFIERS, LINEAR  <ul style="list-style-type: none"> Z-8324 Z-8762 Z-8354 Z-8351 	<p>General-purpose resistance-coupled amplifier.</p> <p>General-purpose resistance-capacity-coupled amplifier.</p> <p>General-purpose phase inverter with single-ended input and double-ended output.</p> <p>General-purpose driver with double-ended input and output.</p>	
CATHODE FOLLOWERS (DUAL)  <ul style="list-style-type: none"> Z-8309 Z-90053 	<p>Impedance matching or isolation amplifier.</p> <p>Drives logical diode (1N191) circuits "and" and "or."</p>	<p>25-V p-p, maximum.</p> <p>39-V p-p.</p>
MULTI-VIBRATOR  <ul style="list-style-type: none"> Z-90036 	<p>Generates square or rectangular waves; locked-in multivibrator application.</p>	<p>170-V square or rectangular wave.</p>
OSCILLATORS (SINE WAVE)  <ul style="list-style-type: none"> Z-90134 Z-90009 	<p>Fixed- or variable-frequency audio oscillator.</p> <p>Crystal oscillator for applications requiring an accurate frequency.</p>	<p>13-V to 23-V p-p.</p> <p>40-V p-p.</p>
RESET GENERATOR  <ul style="list-style-type: none"> Z-90020 	<p>Resets decade scalars and flip-flops. May also be used as a low-impedance pulse source.</p>	<p>90-V to 170-V p-p positive pulse.</p>
POWER SUPPLY REGULATORS  <ul style="list-style-type: none"> Z-90016 Z-90005 	<p>DC amplifier for use in 200-V series-regulated supply.</p> <p>Shunt regulator using 2 high-mu triodes for low current applications.</p>	<p>See specifications.</p> <p>50, 100, or 150 V positive or negative.</p>

INPUT	FREQ. RANGE	GAIN	POWER REQUIREMENTS	PAGE
55-V to 100-V negative pulse or square wave.	0 to 100 kc		200 V at 3.5 ma & 6.3 V at 300 ma.	6
55-V to 100-V negative pulse or square wave.	0 to 100 kc		200 V at 3.5 ma & 6.3 V at 300 ma.	6
55-V to 100-V negative pulse or square wave.	0 to 100 kc		200 V at 3.5 ma & 6.3 V at 300 ma.	7
55-V to 80-V negative pulse or square wave.	0 to 1 mc		200 V at 14 ma & 6.3 V at 450 ma.	7
40-V to 80-V negative pulse or square wave.	0 to 100 kc		+100 V at 6.8 ma; -40 V at 4.4 ma; -200 V at 8 ma; & 6.3 V at 450 ma.	8
55-V to 100-V negative pulse or square wave.	0 to 100 kc		200 V at 3.5 ma & 6.3 V at 300 ma.	8
55-V to 100-V negative pulse or square wave.	0 to 100 kc		200 V at 3.5 ma & 6.3 V at 300 ma.	9
40-V positive pulse.	0.5 to 5 kc		200 V & 6.3 V at 300 ma.	9
50-V negative pulse.	0 to 10 kc		200 V at 5 ma & 6.3 V at 300 ma.	10
27-V positive pulse or 35-V negative pulse.	0 to 100 kc		200 V at 12.5 ma & 6.3 V at 300 ma.	10
40-V negative pulse.	0 to 10 kc		200 V at 10 ma & 6.3 V at 175 ma.	11
20-V negative pulse.	0 to 10 kc		200 V at 10 ma & 6.3 V at 175 ma.	11
20-V negative pulse.			200 V at 2.5 ma & 6.3 V at 300 ma.	12
Negative pulse.			200 V at 9 ma & 6.3 V at 300 ma.	12
53-V positive pulse.			200 V at 2 ma; 70 V at 14 ma; -50 V bias & 6.3 V at 300 ma.	13
100-V negative pulse or square wave.			200 V at 2 ma & 6.3 V at 300 ma.	13
30-V pulse or sine wave.	0 to 100 kc		200 V at 3.5 ma & 6.3 V at 300 ma.	14
20-V pulse or sine wave.	0 to 200 kc		200 V at 7 ma; -150 V bias; & 6.3 V at 300 ma.	14
25-V pulse or sine wave.	0 to 1 mc		200 V at 12 ma; -200 V at 1 ma; & 6.3 V at 300 ma.	15
35-V p-p positive pulse, minimum.			+200 V at 0.7 ma; -200 V at 0.1 ma; & 6.3 V at 600 ma.	15
30-V negative pulse.			200 V at 1.2 ma; -50 V bias; & 6.3 V at 300 ma.	16
20-V negative pulse or square wave.			200 V at 3 ma; -50 V bias; & 6.3 V at 300 ma.	16
0.3-V p-p maximum signal.	9 to 200 kc ± 1 db	40 db	200 V at 2.5 ma & 6.3 V at 300 ma.	17
2.8-V p-p maximum signal.	5 to 50 kc ± 1 db	34 db	200 V at 5 ma & 6.3 V at 300 ma.	17
2-V p-p maximum signal.	0 to 100 kc ± 1 db	22 db	200 to 300 V with 7 ma at 250 V & 6.3 V at 300 ma.	18
3-V p-p maximum signal.	0 to 100 kc ± 1 db	23 db	200 to 400 V with 7.5 ma at 300 V & 6.3 V at 300 ma.	18
Normally driven by a flip-flop. 40-V p-p.			200 V at 9 to 18 ma & 6.3 V at 300 ma. +100 V at 5.5 to 10 ma; -100 V at 5.5 to 10 ma; & 6.3 V at 900 ma.	19 19
Negative 15-V pulse for locked-in operation.	0 to 100 kc		200 V at 2 ma & 6.3 V at 300 ma.	20
	Audio		200 V at 4 ma & 6.3 V at 300 ma.	20
	90 to 250 kc		200 V at 3.5 ma & 6.3 V at 300 ma.	21
25-V p-p positive pulse, minimum.			200 V; -150 V; & 6.3 V at 600 ma.	21
See specifications.		60	200 V at 4 ma & 6.3 V at 300 ma. 200 V & 6.3 V at 300 ma.	22 22

Flip-Flop



Z-8336



5963 HTR. CONN.

SPECIFICATION

The Z-8336 is a medium-speed, bistable multivibrator circuit designed for use in counting, frequency division, switching, and time selection applications. The output of one Z-8336 may be capacity-coupled into another Z-8336 without the use of amplifiers.

Output Signal (pin 6 and pin 7) :

Amplitude: 100 volts (no load), 93 volts (maximum load).

Rise Time (Negative going) : 2 microseconds.

Decay Time (Positive going) : 8 microseconds.

Input Signal (pin 4 and pin 5) when coupling into pin 4 and pin 5 with 10 μf .

Frequency Range: 0 to 100,000 cycles per second.

Amplitude: Negative pulse or square wave with a minimum amplitude dependent upon frequency and load as follows:

1. No load (13 μf 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 another Z-8336:
 - 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 60 μf) :
 - A. 60 volts (0 to 10 kc).
 - B. 80 volts (10 kc to 50 kc).
 - C. 120 volts (50 kc to 100 kc).

Minimum Duration: 7 microseconds.

Rise Time: 0.5 microseconds to 3 microseconds.

Power Requirements:

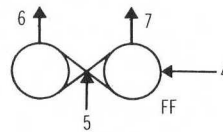
200 volts dc at 3.5 ma. Pin 1 to be positive with respect to pin 2.

6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and -25 volts of pin 2.

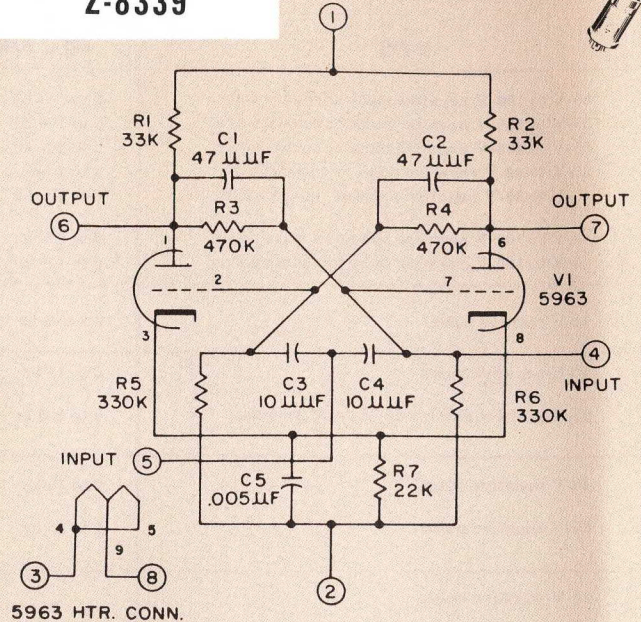
Tube Type: 5963.

Header: 8-pin.

Flip-Flop



Z-8339



5963 HTR. CONN.

SPECIFICATION

The Z-8339 is a medium-speed, bistable multivibrator circuit designed for use in counting, frequency division, switching, and time selection applications. The output of one Z-8339 may be directly coupled into another Z-8339 without the use of amplifiers. The Z-8339 contains internal 10- μf coupling capacitors for binary or feedback counting applications.

Output Signal (pin 6 and pin 7) :

Amplitude: 100 volts (no load), 93 volts (maximum load).

Rise Time (Negative going) : 2 microseconds.

Decay Time (Positive going) : 8 microseconds.

Input Signal (pin 4 and pin 5) :

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 μf 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 another Z-8339:
 - 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 60 μf) :
 - A. 60 volts (0 to 10 kc).
 - B. 80 volts (10 kc to 50 kc).
 - C. 150 volts (50 kc to 100 kc).

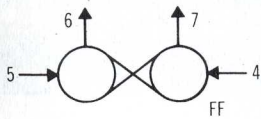
Power Requirements:

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 -25 volts of pin 2.

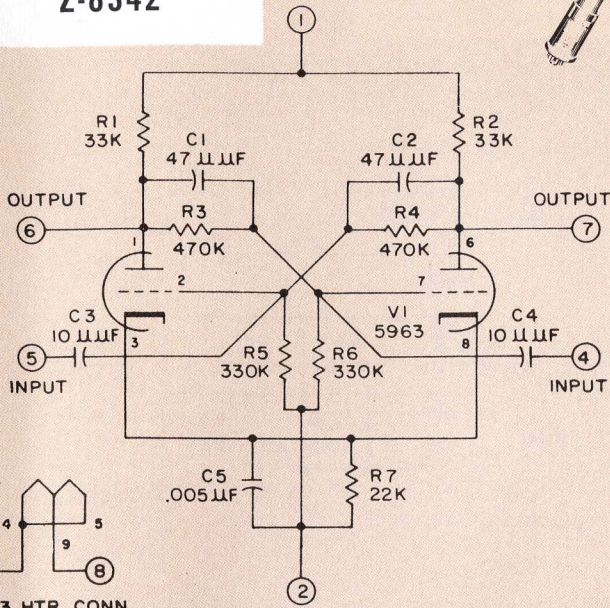
Tube Type: 5963.

Header: 8-pin.



Flip-Flop

Z-8342



5963 HTR. CONN.

SPECIFICATION

The Z-8342 is a medium-speed, bistable multivibrator circuit designed for use in counting, frequency division, switching, and time selection applications. The output of one Z-8342 may be directly coupled into another Z-8342 without the use of amplifiers. The Z-8342 contains internal 10- μf coupling capacitors for use in linear counting applications.

Output Signal (pin 6 and pin 7):

Amplitude: 100 volts (no load), 93 volts (maximum load).

Rise Time (Negative going): 2 microseconds.

Decay Time (Positive going): 8 microseconds.

Input Signal (pin 4 and pin 5):

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 μf 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 another Z-8342:
 - 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 60 μf):
 - A. 60 volts (0 to 10 kc).
 - B. 80 volts (10 kc to 50 kc).
 - C. 120 volts (50 kc to 100 kc).

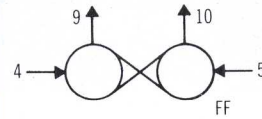
Power Requirements:

200 volts dc at 3.5 ma. Pin 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 -25 volts of pin 2.

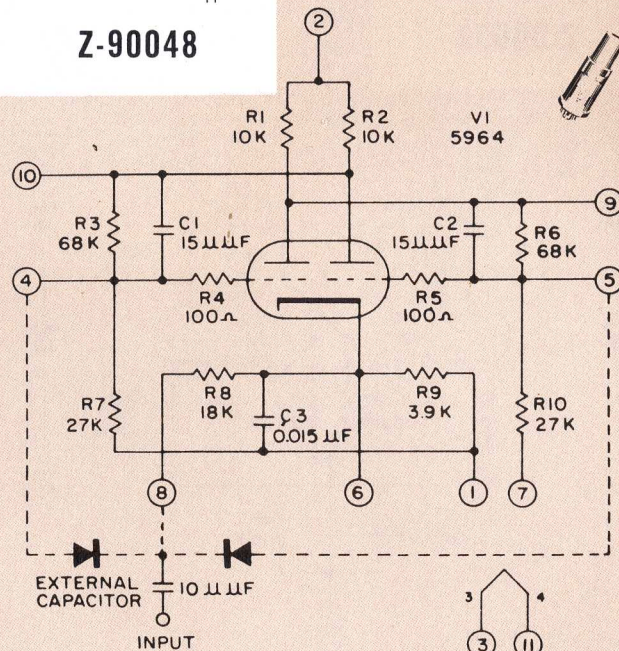
Tube Type: 5963.

Header: 8-pin.



Flip-Flop (0 to 1 mc)

Z-90048



5964 HTR. CONN.

SPECIFICATION

The Z-90048 flip-flop is a high-speed, bistable multivibrator designed for use in counting and frequency division applications. It will operate in binary fashion to above 1 megacycle. An 11-pin base has been used in order to increase the flexibility of the unit so that binary counting, counting employing feedback, and resetting may be readily accomplished. The output of one Z-90048 may be used to drive a following Z-90048 without the use of amplifiers.

Output Signal (pin 9 and pin 10) (no load):

Amplitude: 80 volts; plate swing is from +100 volts to +180 volts with respect to pin 1.

Rise Time (Negative going): 0.4 microsecond (no load).

Decay Time (Positive going): 1 microsecond (no load).

Maximum Load: 90 μf in parallel with 33,000 ohms.

Input Signal:

The input is a negative pulse or square wave normally coupled into pin 8 through an external 10- μf capacitor. Pins 4 and 5 are coupled to pin 8 through external point contact crystal diodes as indicated in the schematic. The following is the requirement for the signal at the input to the 10- μf capacitor with no load on the flip-flop. Large loads will require slightly greater trigger amplitude.

Amplitude: 80 volts minimum for input frequencies of 500 kc to 1 megacycle. 55 volts minimum for input frequencies of 0 to 500 kc.

Rise Time: 0.1 to 0.5 microsecond.

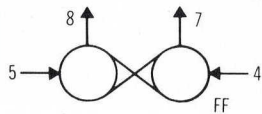
Power Requirements:

200 volts dc at 14 ma. Pin 2 to be positive with respect to pin 1.

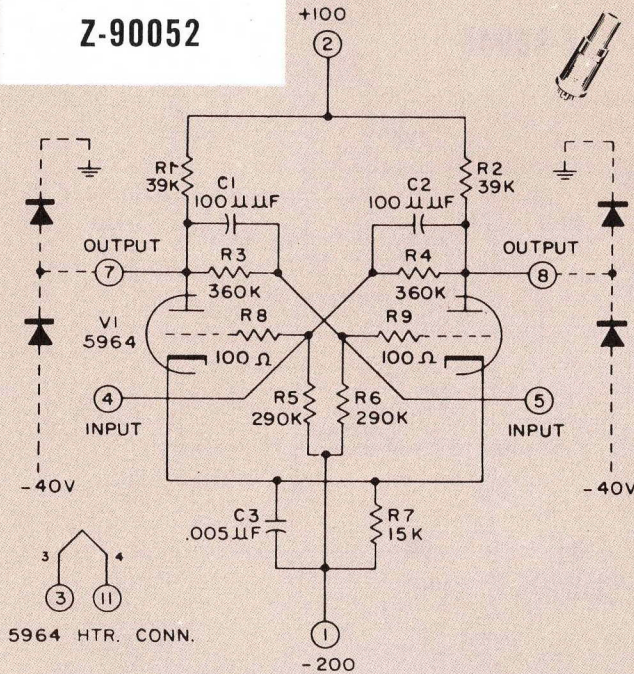
6.3 volts at 450 ma. DC potential on heaters to be between +90 volts and -40 volts of pin 1.

Tube Type: 5964.

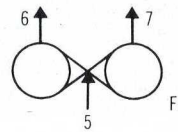
Header: 11-pin.



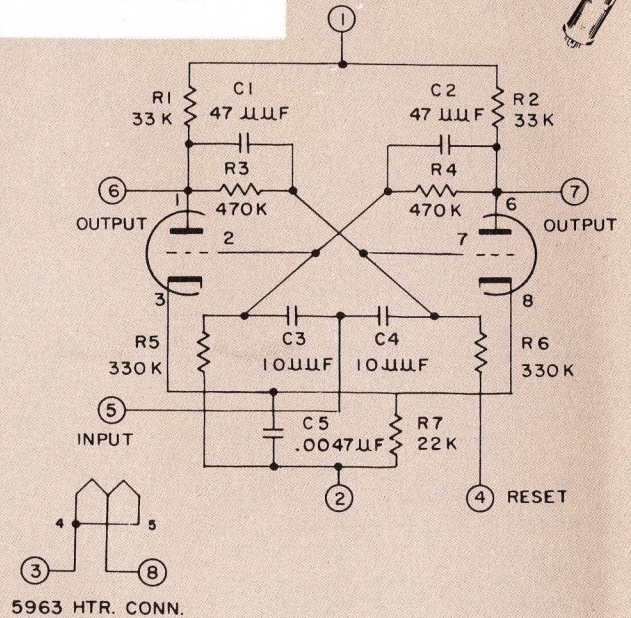
Z-90052



Flip-Flop



Z-90059



Flip-Flop

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 $\mu\mu\text{f}$ (to ground or -40 volts).

Input Signal (pin 4 and pin 5) :
 When used as a binary counter with 33- $\mu\mu\text{f}$ coupling to each grid and light flip-flop loads, the following is the minimum input signal requirement to the 33- $\mu\mu\text{f}$ capacitors:
 Amplitude: 40-volt negative pulse or square wave.*
 Rise Time: Less than 3 microseconds.
 For maximum load and 33- $\mu\mu\text{f}$ 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. Plates of clamping diodes to be negative with respect to ground.
 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-90059 is a medium-speed, bistable multivibrator circuit designed for use in counting, frequency division, switching, and time selection applications. The output of one Z-90059 may be directly coupled into another Z-90059 without the use of amplifiers. The Z-90059 contains internal 10- $\mu\mu\text{f}$ coupling capacitors connected for binary operation. Resetting of the unit may be accomplished by momentarily opening a normally closed switch connected to pins 2 and 4 or by Reset Generator Z-90020.

Output Signal (pin 6 and pin 7) :
 Amplitude: 100 volts (no load), 93 volts (maximum load).
 Rise Time (Negative going) : 2 microseconds.
 Decay Time (Positive going) : 8 microseconds.

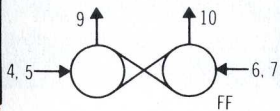
Input Signal (pin 5) :
 Frequency Range: 0 to 100 kc.
 Minimum Duration: 7 microseconds.
 Rise Time: 0.5 microsecond to 3 microseconds.
 Amplitude: Negative pulse or square wave with a minimum amplitude dependent upon frequency and load as follows:

1. No load (13 $\mu\mu\text{f}$ 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 another Z-90059:
 - 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 60 $\mu\mu\text{f}$) :
 - A. 60 volts (0 to 50 kc).
 - B. 80 volts (10 kc to 50 kc).
 - C. 120 volts (50 kc to 100 kc).

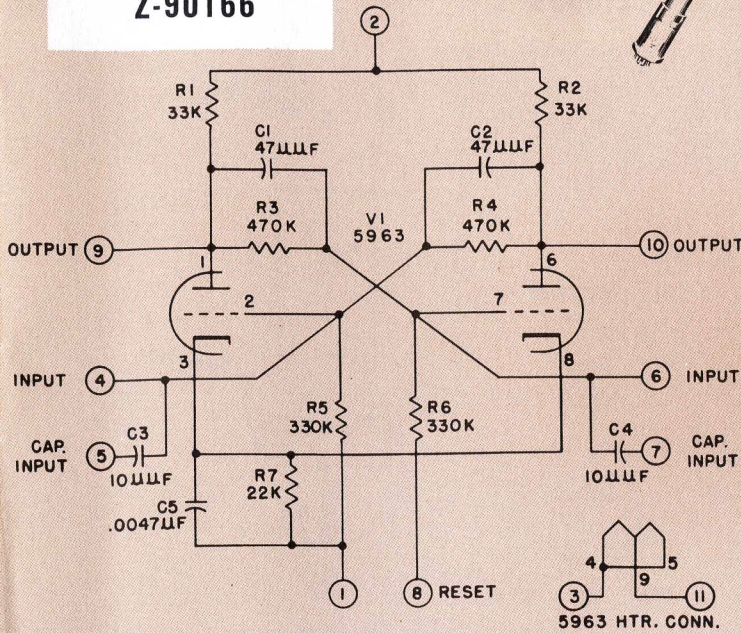
Power Requirements:
 200 volts dc at 3.5 ma. Pin 1 to be positive with respect to pin 2.
 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and -25 volts of pin 2.

Tube Type: 5963.
 Header: 8-pin.

Flip-Flop



Z-90166



SPECIFICATION

The Z-90166 is a medium-speed, bistable multivibrator circuit designed for use in counting, frequency division, switching, and time-selection applications. The output of one Z-90166 may be directly coupled into another Z-90166 without the use of amplifiers. Inputs to the Z-90166 may be applied through external coupling capacitors and/or internal coupling capacitors. Resetting of the unit may be accomplished by momentarily opening a normally closed switch connected to pins 1 and 8 or by Reset Generator Z-90020.

Output Signal (pins 9 and 10):

- Amplitude: 100 volts (no load); 93 volts (maximum load).
- Rise Time (Negative going): 2 microseconds.
- Decay Time (Positive going): 8 microseconds.

Input Signal (pins 5 and 7, or when coupling into pins 4 and 6 with 10 µF capacitors):

- Frequency Range: 0 to 100,000 cycles per second.
- 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 µF 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 another Z-90166:
 - 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 60 µF):
 - A. 60 volts (0 to 10 kc).
 - B. 80 volts (10 kc to 50 kc).
 - C. 120 volts (50 kc to 100 kc).

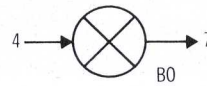
Power Requirements:

- 200 volts dc at 3.5 ma. Pin 2 to be positive with respect to pin 1.
- 6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and -25 volts of pin 1.

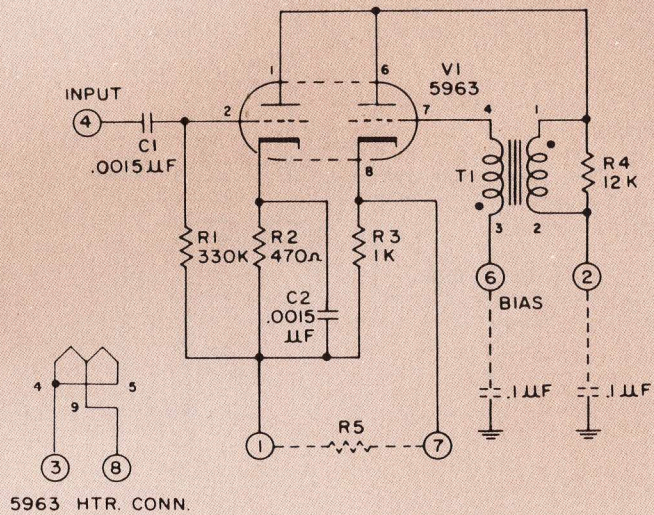
Tube Type: 5963.

Header: 11-pin.

Blocking Oscillator



Z-90015



SPECIFICATION

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:

	$R_0 = 92 \text{ Ohms}$	$R_0 = 1,000 \text{ Ohms}$
Amplitude	34 volts	88 volts
Pulse Width	2.3 microseconds	1.0 microsecond
Bias	-30 volts	-27 volts
Rise Time	.04 microsecond or less	.04 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: 500 to 5,000 pulses per second.
- Rise Time: 1 microsecond, maximum.

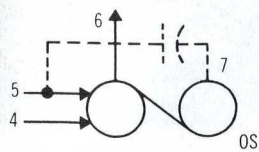
Power Requirements:

- 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.

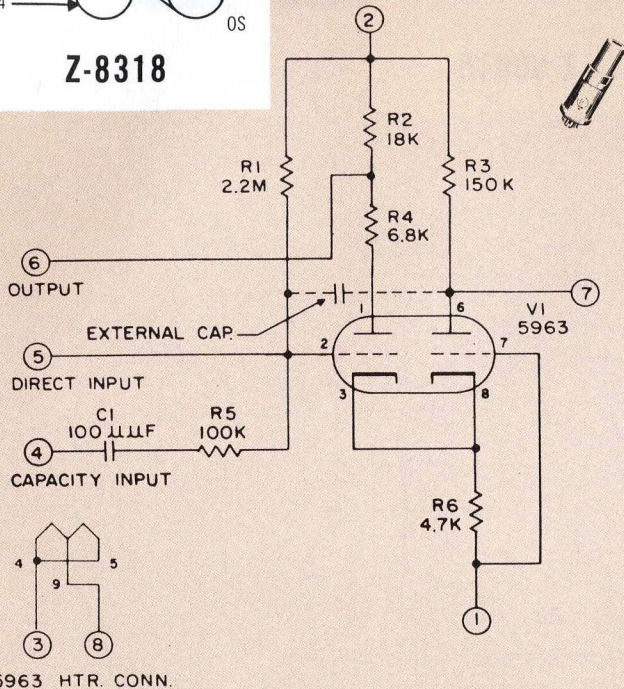
Tube Type: 5963.

Header: 8-pin.

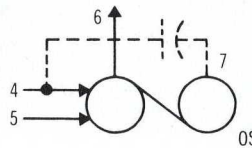
One Shot



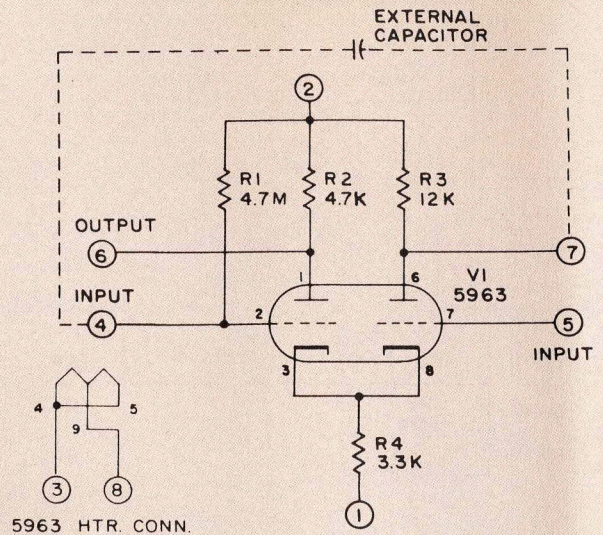
Z-8318



One Shot



Z-8889



SPECIFICATION

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) can be approximated by:

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

Minimum Duration: 50 microseconds.

Rise Time: 4 microseconds.

Decay Time: 2.5 microseconds.

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

Maximum Duty Cycle: 60%.

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 μmf in series with 220,000 ohms.

Amplitude: 50-volt negative pulse minimum.

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.

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 μmf) 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:

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

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 μmf .

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.

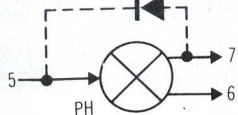
6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and -45 volts of pin 1.

Tube Type: 5963.

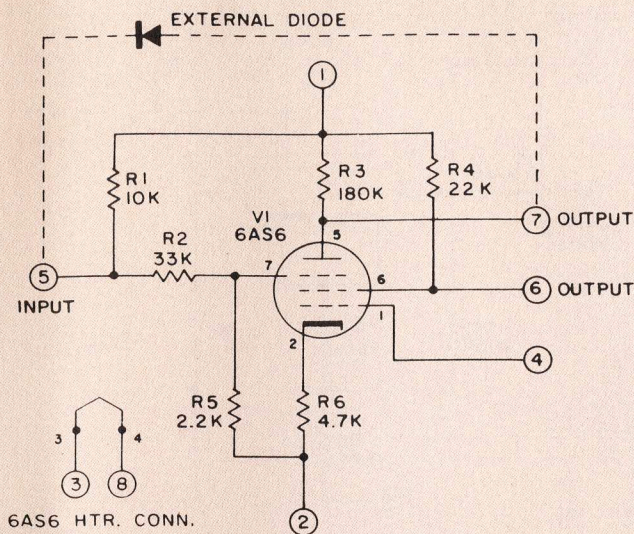
Header: 8-pin.

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

Phantastron



Z-8771



6AS6 HTR. CONN.

SPECIFICATION

The phantastron is a flexible circuit which may be adapted to sweep, divider, or delay service at output rates up to 10 kc. The time base is derived from a linear timing waveform instead of an exponential, as in the case of the one shot, and consequently has greater timing stability. An external diode is connected between pins 5 and 7 (cathode to 5 and plate to 7). Trigger pulses are applied to pin 5 through an external capacitor. The duration is controlled by an external capacitor from pin 4 to pin 7 and an external resistor from pin 4 to pin 1. An output may be taken from pin 6 as a positive pulse or pin 7 as a negative sweep.

For optimum sweep linearity, a vacuum diode is recommended between pins 5 and 7, although a crystal diode with a high-peak inverse voltage rating and high back resistance may be used.

Output Signal (pin 7) (no load):

Amplitude: 100-volt plate swing; 30-volt initial negative step and a 70-volt negative sweep.

Clamping Potential: Pin 5 is 160 volts positive with respect to pin 2.

Duration: 50 microseconds, minimum.

Maximum Duty Cycle: 60%. By using a cathode follower for coupling the timing capacitor from pin 7 to pin 4, the maximum duty cycle can be greatly increased.

Output Signal (pin 6) (no load):

Amplitude: 130-volt positive pulse.

Rise Time: 2 microseconds; coincides in time with step at pin 7 output.

Decay Time: 2 microseconds; coincides in time with end of sweep at pin 7 output.

Input Signal (pin 5):

Amplitude: 40-volt negative pulse, minimum.

NOTE: Above Input and Output specifications are based on a circuit using one diode section of a 6AL5 between pins 7 and 5 and a 1-megohm resistor between pins 4 and 1.

Power Requirements:

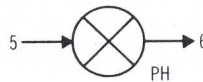
200 volts dc at 10 ma. Pin 1 to be positive with respect to pin 2.

6.3 volts at 175 ma. DC potential on heater to be between -60 volts and +90 volts with respect to pin 2.

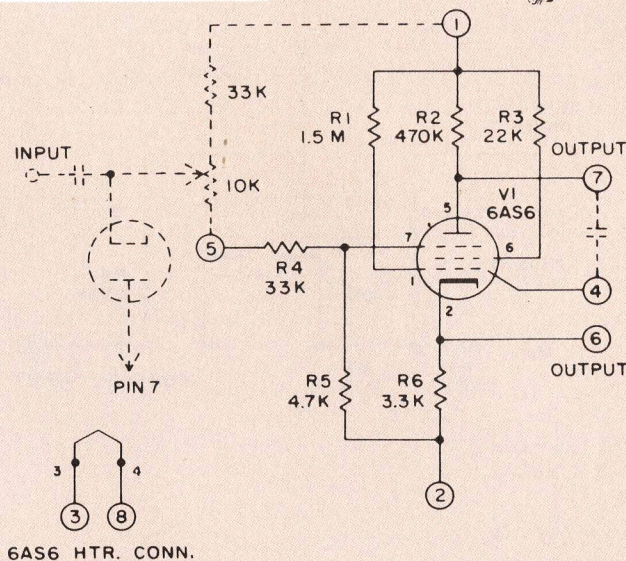
Tube Type: 6AS6.

Header: 8-pin.

Phantastron



Z-90018



6AS6 HTR. CONN.

SPECIFICATION

The Z-90018 phantastron is designed for operation as a fixed-frequency divider and as a sweep generator at output rates up to 10 kc. Negative trigger pulses are injected by means of an external diode, and a negative rectangular output is taken from pin 6. The pin 6 negative output allows phantastrons to be cascaded in divider applications without use of amplifiers. Output duration is controlled by an external capacitor and potentiometer. The Z-90018 phantastron may also be adapted to sweep service.

Output Signal (pin 6) (no load):

Amplitude: 17-volt negative pulse.

Duration: 50 microseconds, minimum; determined by external capacitor and diode clamping voltage as set by external potentiometer. The value of external capacitor (C in μmf) to use for a desired pulse duration (T in microseconds) may be approximated by:

$$C = 1.6 T$$

Maximum Duty Cycle: 60%. By using a cathode follower for coupling the timing capacitor from pin 7 to pin 4, the maximum duty cycle can be greatly increased.

Impedance: Less than 2,000 ohms.

Output Signal (pin 7):

Amplitude: 90-volt to 125-volt plate swing, depending on setting of external potentiometer (25-volt negative step and a 65-volt to 100-volt negative sweep).

Input Signal: (Applied through external diode to pin 7):

Amplitude: 20-volt negative pulse, minimum, with rise time of 1.5 microseconds, maximum. 40-volt minimum pulse (with rise time of 6 microseconds, maximum).

Impedance: Approximately 18,000 ohms.

Power Requirements:

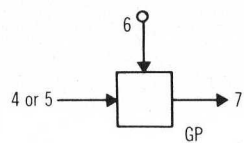
200 volts dc at 10 ma. Pin 1 to be positive with respect to pin 2.

6.3 volts at 175 ma. DC potential on heater to be between +90 volts and -75 volts of pin 2.

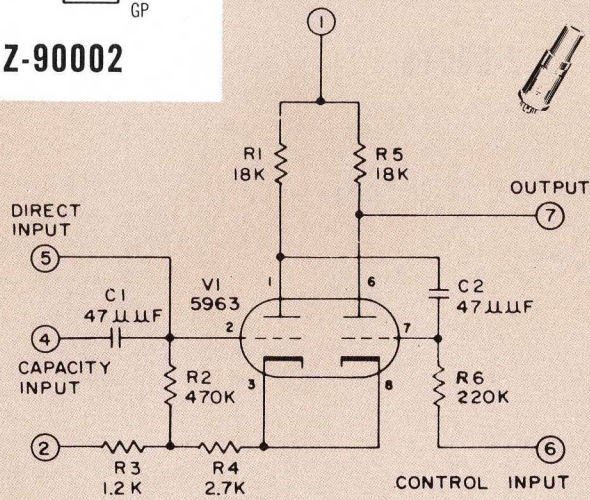
Tube Type: 6AS6.

Header: 8-pin.

Gate Circuit

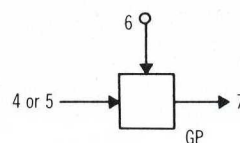


Z-90002

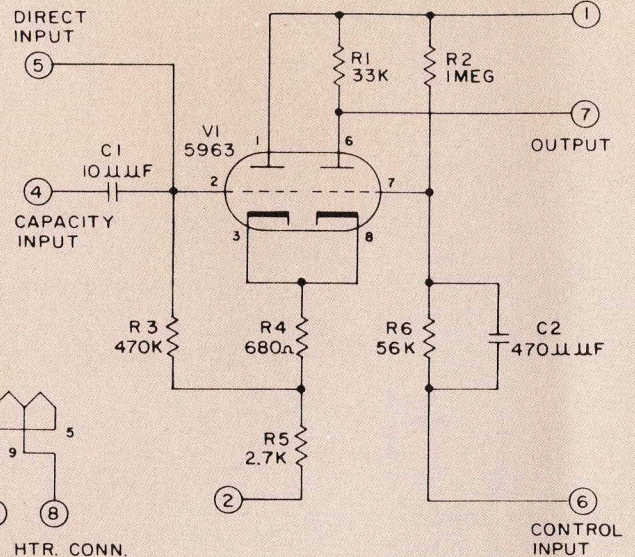


5963 HTR. CONN.

Gate Amplifier



Z-90007



5963 HTR. CONN.

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: 4.5 microseconds.
- 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.

SPECIFICATION

This unit is a gated amplifier designed to accept negative pulses at pin 4 or pin 5. The output is pin 7, with pin 6 used for the gating input.

Output Signal (pin 7) (no load):

- Amplitude: From 1 to 1.5 times the amplitude of the signal on pin 4. (92 volts peak-to-peak, maximum.)
- Rise Time: 3 microseconds (no load).
- Decay Time: 5 microseconds (no load).

Input Signal (pin 4):

- Negative pulse with rise time of 3 microseconds or less.

Input Signal (pin 5):

Pin 5 may be used with an external coupling capacitor instead of pin 4 for input signal having poor rise time.

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: 10 microseconds.
- Impedance: Approximately 1 megohm.

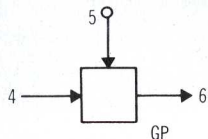
Power Requirements:

- 200 volts dc at 9 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.

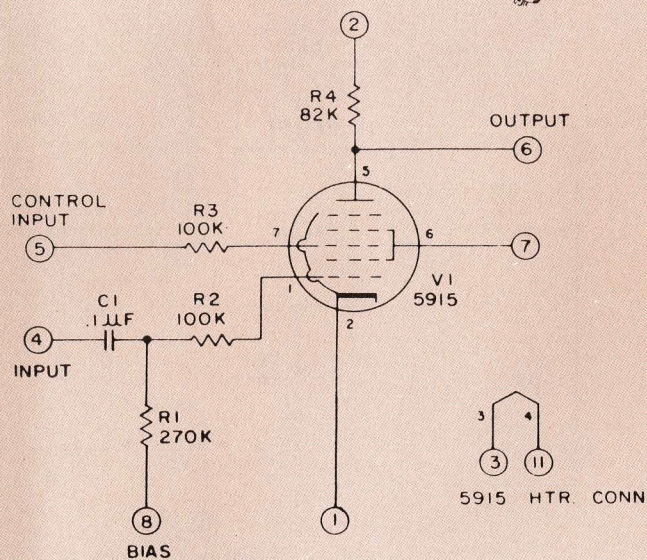
Tube Type: 5963.

Header: 8-pin.

Pentagrid Gate



Z-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 heater to be between +90 volts and -90 volts of pin 1.

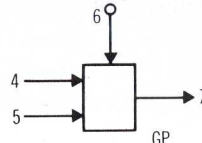
Tube Type: 5915.

Header: 11-pin.

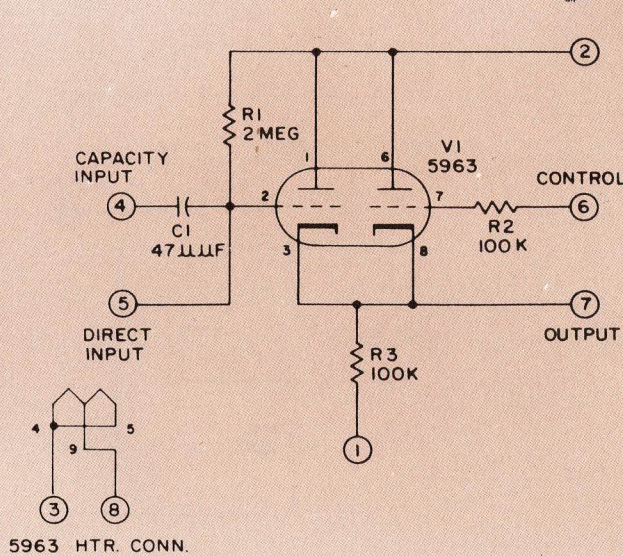
*External resistance may be connected between pins 2 and 6 for shorter rise times.

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

Pulse Gate



Z-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: 92-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):

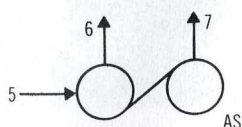
- Gate Closed: Pin 6 to be 10 volts negative with respect to pin 2.
- Gate Open: Pin 6 to be 100 volts negative with respect to pin 2.
- Gate Opening Time: 10 microseconds.

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.

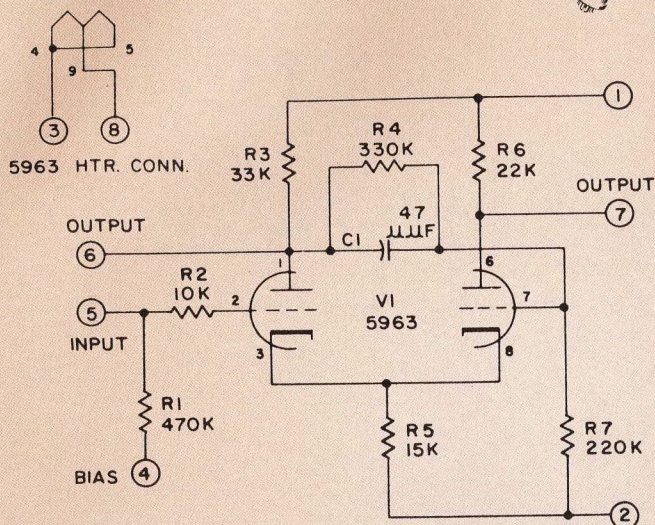
Tube Type: 5963.

Header: 8-pin.



Z-90001

Squaring Circuit (0 to 100 kc)



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 ± 5 -volt peak-to-peak pulse or square wave.

Duration: Function of input wave form and external bias on pin 4.

Rise Time (Negative going): 1 microsecond.

Decay Time (Positive going): 3 microseconds.

Output Impedance: Less than 22,000 ohms.

Output Signal (pin 6) (no load):

Amplitude: 120 ± 5 volts.

Rise Time (Negative going): 2 microseconds.

Decay Time (Positive going): 5 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 +75 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.

For DC trigger operation (pin 4 tied to pin 2), the trigger levels are approximately +45 volts and +65 volts.

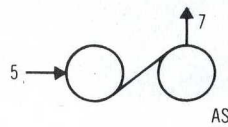
Power Requirements:

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.

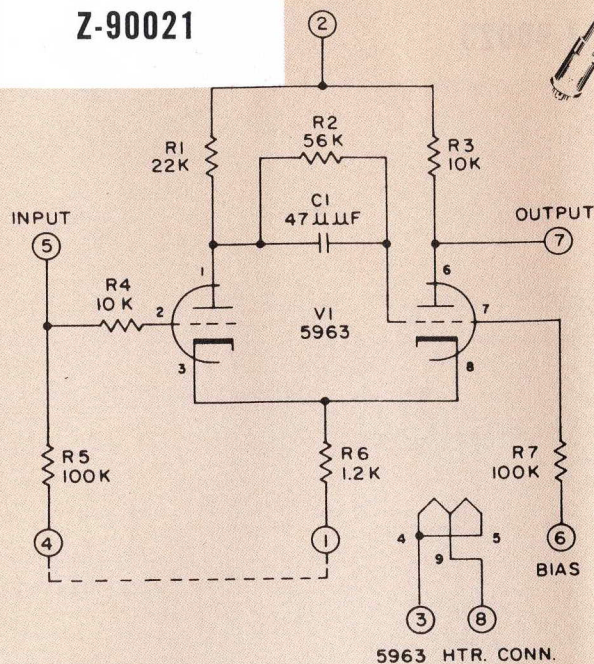
Tube Type: 5963.

Header: 8-pin.



Z-90021

Squaring Circuit (0 to 200 kc)



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.

Decay Time (Positive going): 1.2 microseconds.

Rise Time (Negative going): 0.8 microsecond.

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:

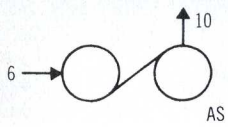
+200 volts dc at 7 ma. Pin 2 to be positive with respect to pin 1.

-150 volts dc at 0.5 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.

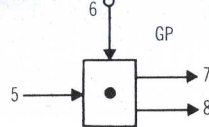
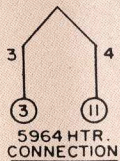
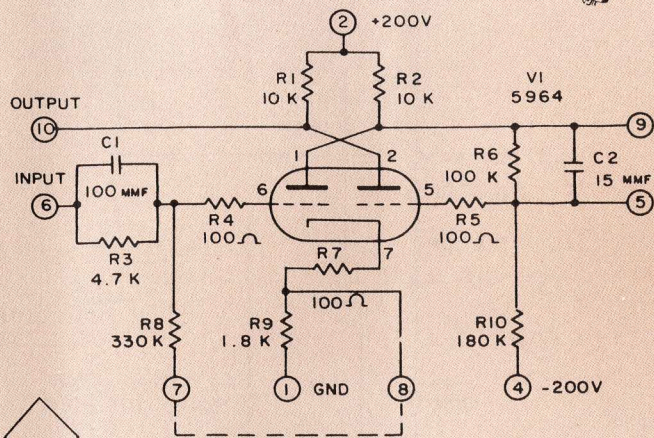
Tube Type: 5963.

Header: 8-pin.



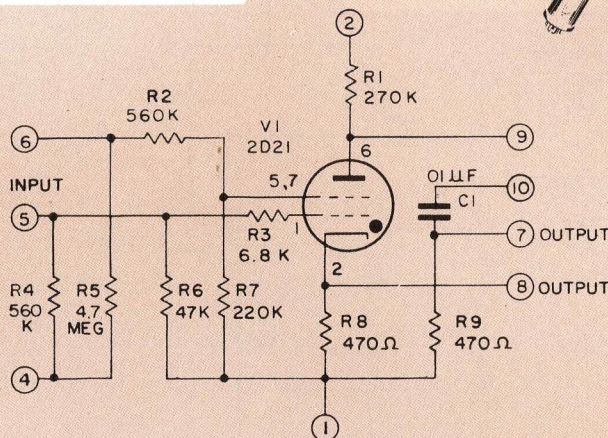
Z-90049

Squaring Circuit (0 to 1 mc)



Z-90063

Thyatron Pulse Generator



2D21 HTR. CONN.

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 Z-90048 high-speed flip-flop. It 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.

SPECIFICATION

This unit is designed to provide positive and/or negative pulses with sharp rise times at low impedances at rates up to 150 pulses per second. It may be used as a gate and/or an amplifier. Outputs may be in the form of a spike or square wave, depending upon the particular application.

Output Signal:

Unit Connected for Spike Output (pin 9 connected to pin 10):

Pin 7: 80-volt peak negative spike.
 Pin 8: 80-volt peak positive spike.
 Rise Time: Less than 0.2 microsecond.
 Duration: 30 microseconds at base of spike.
 Impedance: 300 ohms.

Unit Connected for Square Wave Output (delay line, unterminated, connected to pin 9; ground connection to pin 1): (Following values are typical, but depend on the particular delay line used.)

Pin 8: 60-volt peak, positive.
 Rise Time: Less than 0.2 microsecond.
 Decay Time: Less than 1 microsecond.
 Duration: Equal to twice the delay of the connected line.

Input Signal (pin 5):

Amplitude: 35-volt peak positive, minimum.
 Duration: 10 microseconds, minimum.
 Impedance: 40,000 ohms.

Control Signal (pin 6):*

Gate Open: 8 volts negative.
 Gate Closed: 50 volts or more negative.

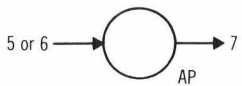
Power Requirements:

+200 volts at 0.7 ma. Pin 2 to be positive with respect to pin 1.
 -200 volts at 0.1 ma. Pin 4 to be negative with respect to pin 1.
 6.3 volts at 600 ma. DC potential on heater to be between +90 volts and 0 volts with respect to pin 1.

Tube Type: 2D21.

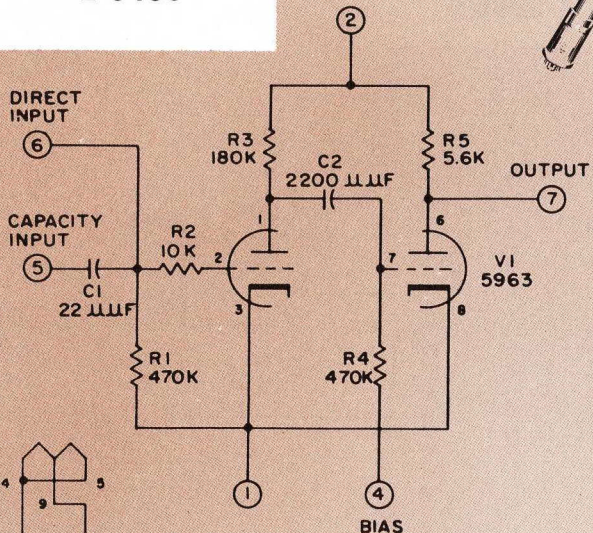
Header: 11-pin.

*Applicable only if unit is operated as a gate. For operation as an amplifier only, pin 6 is not used.

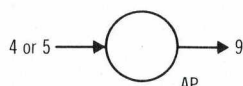


Pulse Amplifier

Z-8489

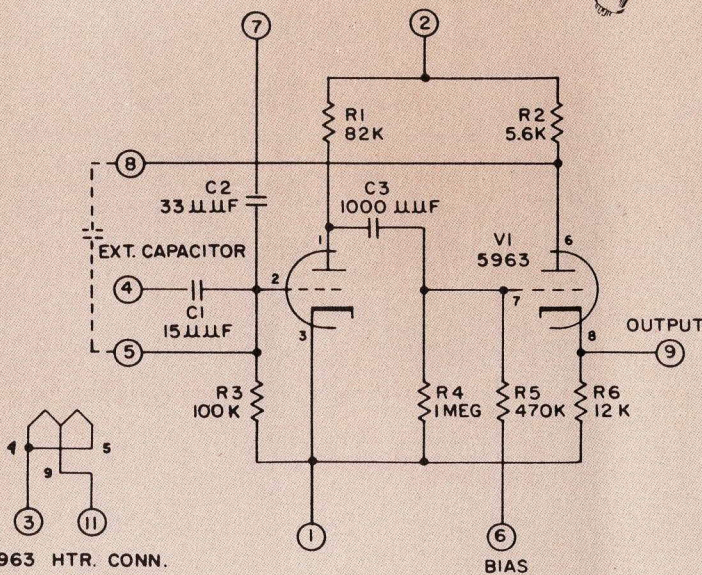


5963 HTR. CONN.



Pulse Amplifier

Z-90030



5963 HTR. CONN.

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.

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.

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.

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 5 to 10 microseconds, omit external capacitor and connect pin 7 to pin 8.

Impedance: Approximately 7,000 ohms.

Input Signal (pin 4):

The minimum input amplitude is dependent upon the input rise time:

Amplitude: 20-volt minimum negative pulse at 3 microseconds or less rise time. 35-volt minimum negative pulse at 40 microseconds rise time.

Duration: 5 microseconds, minimum.

Power Requirements:

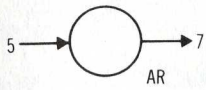
+200 volts dc at 3 ma. Pin 2 to be positive with respect to pin 1.

-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.

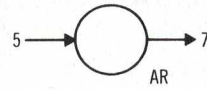
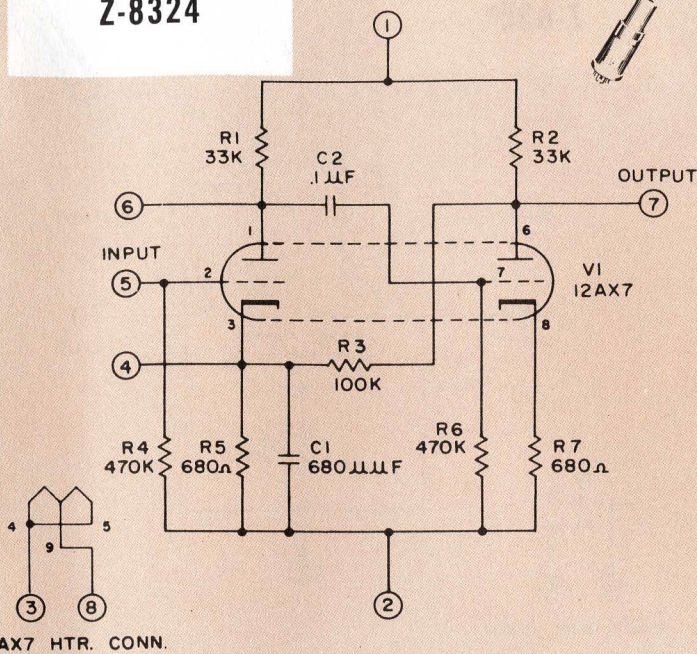
Tube Type: 5963.

Header: 11-pin.



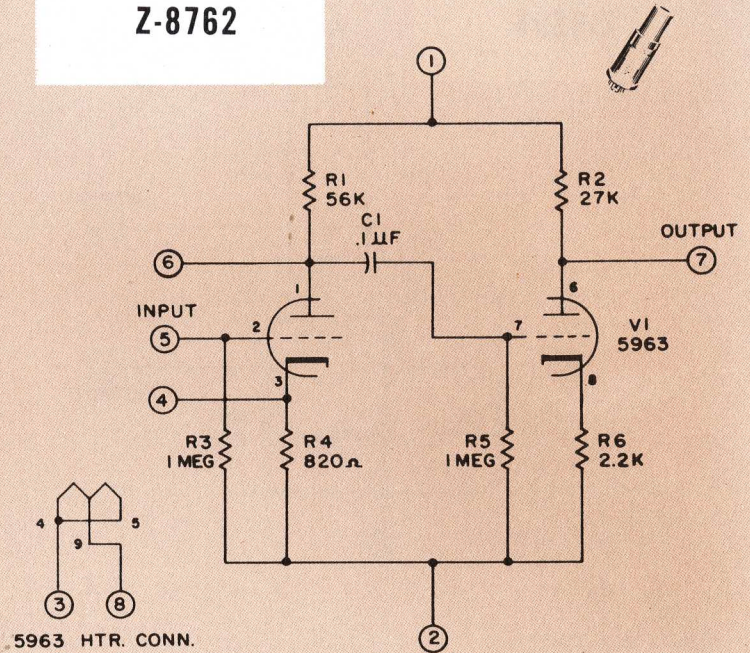
Linear Amplifier

Z-8324



Linear Amplifier

Z-8762



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.

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 feed-back from pin 7 to pin 4 or pin 6.

Input Signal (pin 5):

Amplitude: 1 volt rms, maximum.
Impedance: 500,000 ohms at 50 kc.

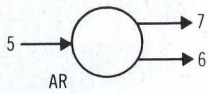
Amplification: 34 db.

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.

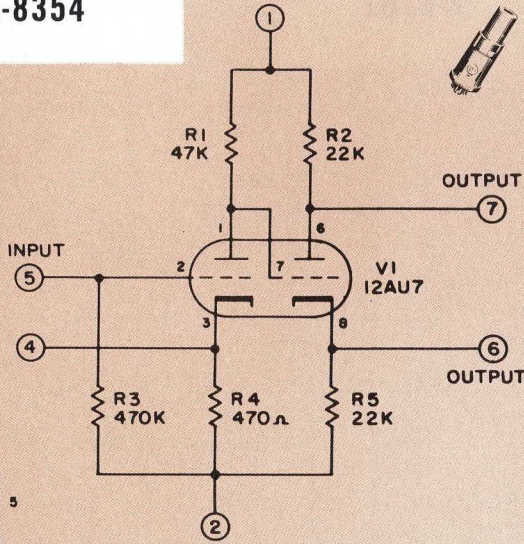
Tube Type: 5963.

Header: 8-pin.

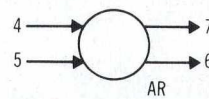


Z-8354

Amplifier Phase Inverter

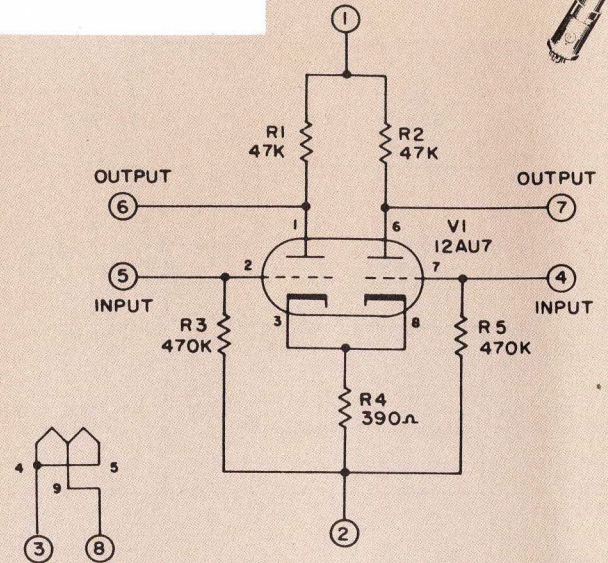


12AU7 HTR. CONN.



Z-8351

Amplifier Push-Pull Voltage



12AU7 HTR. CONN.

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.

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.

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:

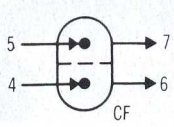
200 volts dc to 400 volts dc (7.5 ma for 300-volt operation).

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.

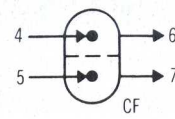
Tube Type: 12AU7.

Header: 8-pin.



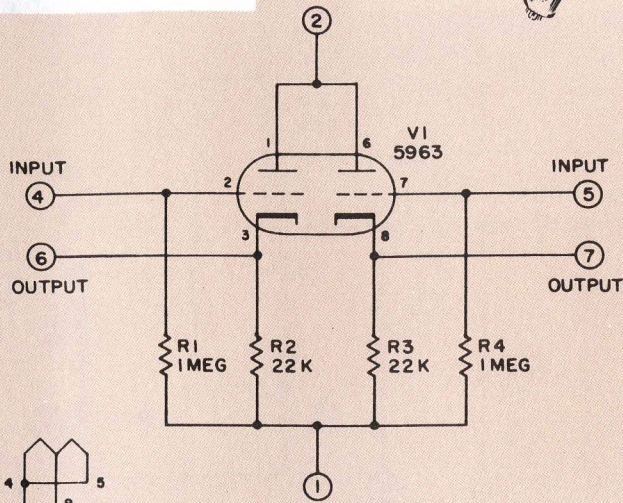
Z-8309

Dual Cathode Follower

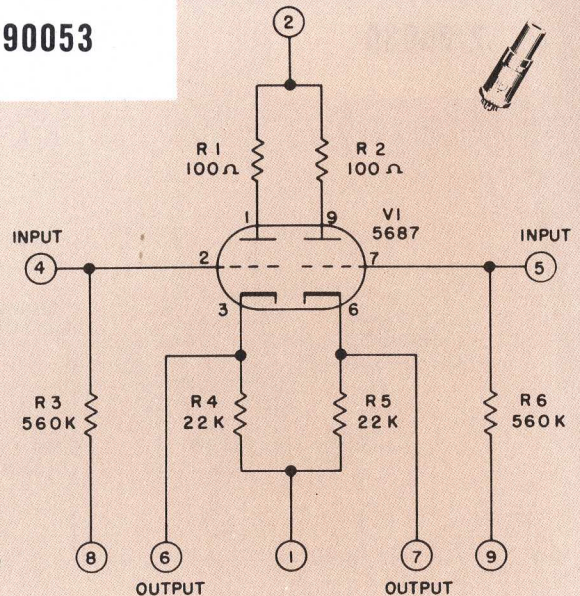


Z-90053

Dual Cathode Follower



5963 HTR. CONN.



5687 HTR. CONN.

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):

Normally driven by a flip-flop.

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.

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).

36 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.

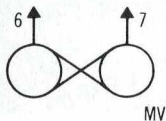
-100 volts dc at 5.5 ma to 10 ma. Pin 1 to be 100 volts negative with respect to ground.

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

Tube Type: 5687.

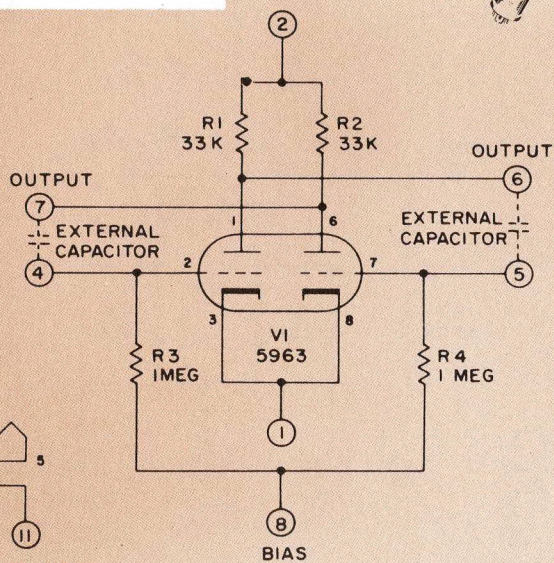
Header: 11-pin.

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



Multivibrator

Z-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: 170-volt peak-to-peak square or rectangular wave.

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:

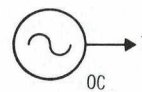
200 volts dc at 2 ma. Pin 2 to be positive with respect to pin 1.

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

Bias: Pin 8 to be positive with respect to pin 1.

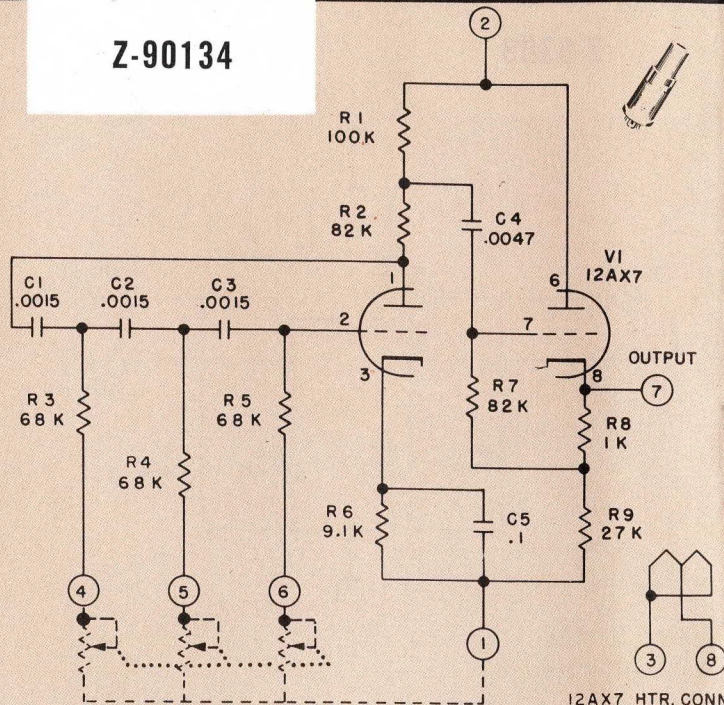
Tube Type: 5963.

Header: 11-pin.



Phase Shift Oscillator

Z-90134



SPECIFICATION

A variable-frequency audio oscillator designed to cover any portion of the audio range when used with proper external resistances. When used with three-section 500 K-ohm ganged potentiometer, frequency range is 175-500 cycles per second. Single- or dual-section potentiometers may be used to cover smaller portions of the band or fixed resistors may be used for fixed-frequency operation. The frequency of operation is given by the following formula, when all three legs of the feedback network are equal:

$$f_{cps} = \frac{1}{2\pi RC\sqrt{6}}$$

where R = Total resistance in one leg, including fixed resistor (R₃, R₄, or R₅) and one section of external potentiometer.

C = C₁, C₂, or C₃.

Output Signal (pin 7):

Amplitude: 13 volts to 23 volts peak-to-peak, depending upon frequency of operation.

Maximum Load: 15,000 ohms.

Frequency: Any portion of audio range. (For example, 175 to 500 cycles per second when used with three-section, 500,000-ohm ganged potentiometer.

Oscillator frequency is independent of external load (pin 7) up to maximum load conditions.

(Total harmonic distortion is less than 8%.) For minimum distortion, narrow-band, or fixed-frequency operation, see note below.

Power Requirements:

200 volts dc at 4 ma. Pin 2 to be positive with respect to pin 1.

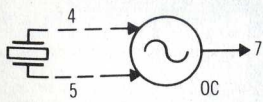
6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and -90 volts of pin 1.

Tube Type: 12AX7.

Header: 8-pin.

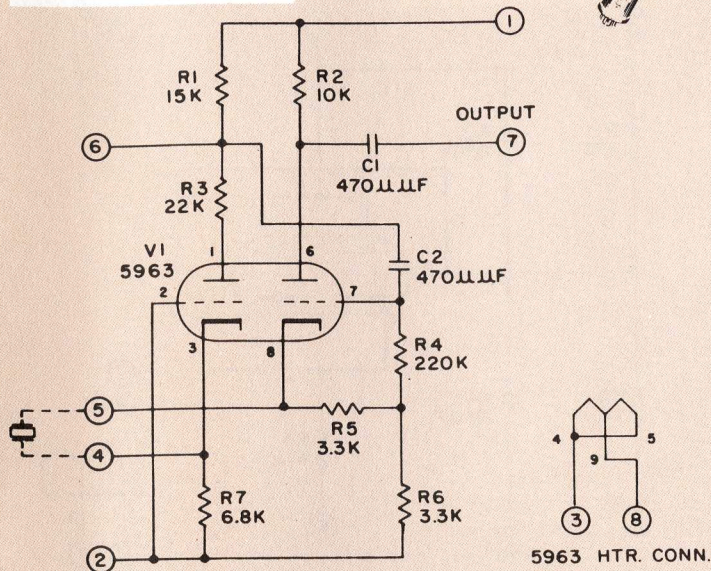
NOTE: Narrow-band-width oscillators (band width approximately 5% of upper frequency) or fixed-frequency oscillators can be supplied with low harmonic content.

Units covering other frequencies in the audio range available on request.



Crystal Oscillator

Z-90009



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.

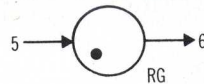
Power Requirements:

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.

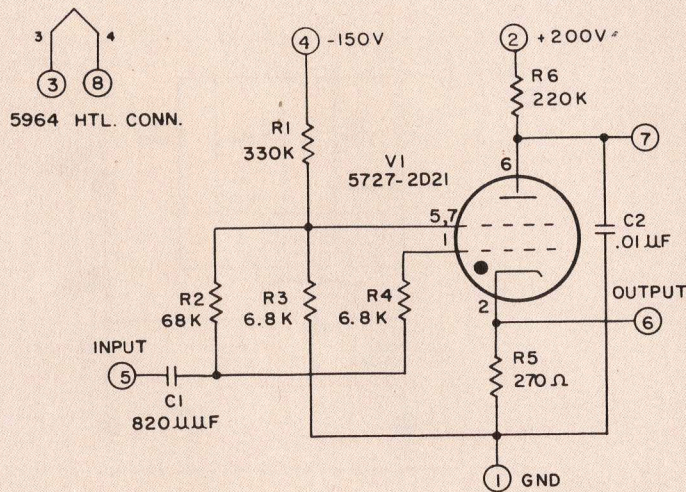
Tube Type: 5963.

Header: 8-pin.



Reset Generator

Z-90020



SPECIFICATION

This circuit is designed to reset simultaneously several decade scalars such as the ZA-10057, and flip-flops such as Z-90048, 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 positive, minimum, with minimum 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.

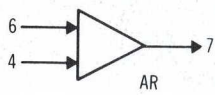
6.3 volts at 600 ma.

Tube Type: 5727 or 2D21.

Header: 8-pin.

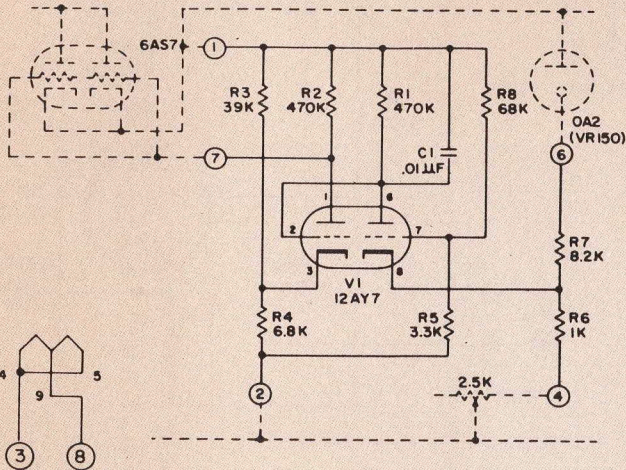
*Output amplitude and rise time are dependent upon input pulse rate. At rates below 100 pps, output is maximum and drops to 90 volts at 500 pps.

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



Power Supply Regulator - Amplifier

Z-90016



12AY7 HTR. CONN.

SPECIFICATION

A dc amplifier unit for use in a 200-volt regulated power supply as a regulator-amplifier. It is designed to be used with a 6AS7 regulator tube and an OA2 (VR-150) reference tube. The output of this unit connects directly to the grid of the regulator tube.

Output Signal (pin 7):

Connect as shown with dotted lines in the schematic diagram.

Input Signal (pin 6):

Connect as shown with dotted lines in the schematic diagram.

Regulation:

The amplifier has a voltage gain of approximately 60.

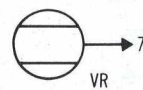
Power Requirements:

200 volts dc at 13 ma. Pin 1 to be positive with respect to pin 2.

6.3 volts ac at 300 ma. DC potential on heaters to be between +90 volts and -60 volts of pin 2.

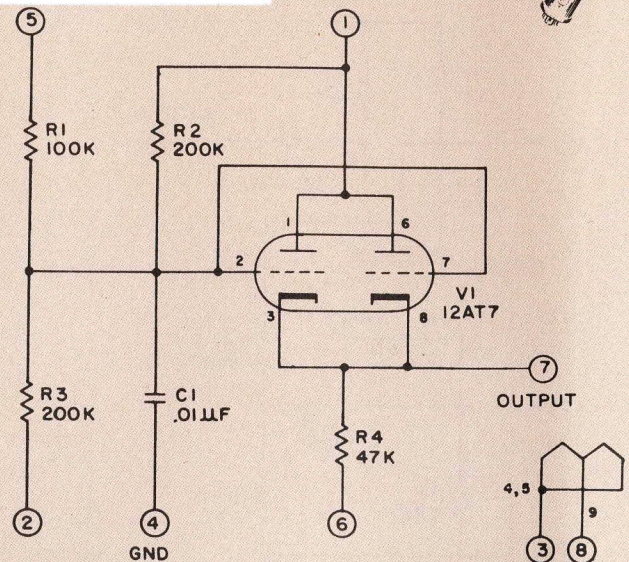
Tube Type: 12AY7.

Header: 8-pin.



Power Supply Regulator

Z-90005



12AT7 HTR. CONN.

SPECIFICATION

A shunt-type regulator using two high- μ triodes in parallel. A precision resistor network controls the grid voltage. By the proper external pin connections, the regulator will provide an output voltage of 50, 100, or 150 volts from a 200-volt regulated supply. The regulation is approximately 1 volt per 8 ma change in load current.

SOCKET CONNECTIONS

OUTPUT VOLTS	Pin 1	Pin 2	Pin 5	Pin 6	Max. Output ma
+ 50	+200	Gnd.	Gnd.	**	20
+100	+200	Gnd.	N.C.	**	15
+150	+200	Gnd.	+200	**	6
- 50	Gnd.	-200	Gnd.	-200	6*
-100	Gnd.	-200	N.C.	-200	15*
-150	Gnd.	-200	-200	-200	20*

*Add external resistor between pin 6 and pin 7, according to the following table.

Output Volts	Load	Resistor
- 50	3 ma to 6 ma	47 K
-100	2 ma to 8 ma	15 K
-100	8 ma to 14 ma	8.2 K
-150	1 ma to 11 ma	5 K
-150	11 ma to 19 ma	2.7 K

**Connect pin 6 through 180,000-ohm, 1/2-watt resistor to ground (pin 2).

Power Requirements:

6.3 volts at 300 ma. DC potential on heaters to be between +90 volts and -90 volts of pin 7.

Tube Type: 12AT7.

Header: 8-pin.

Diode Plug-in Units

Engineered Electronics Company now provides a practical way of packaging a wide variety of diodes in Standard Plug-in Units. These units eliminate the need for the soldering of diodes during breadboarding or standard production wiring. This means no burned-out diodes. The design engineer is thus freed from the long and frustrating testing periods that all-too-frequently accompany the wiring of diode circuits. And he is able to maintain matrix advantages with the ease of shelf wiring.

ENGINEERED ELECTRONICS COMPANY'S diode plug-in units allow all diodes in a circuit to be replaced in groups of 8, 12, and 16 diodes. By making use of spare diode plug-in units, equipment maintenance and downtime are materially reduced. Diode plug-in units, manufactured by Engineered Electronics Company, readily enable all defective diode units to be bench-tested without the need of soldering or unsoldering the diode terminals.

EECO diode plug-in units protect the diodes from physical damage at all times. Each of the diodes is connected across the terminals of an Amphenol, Cannon, or other connector, and the complete unit is cased in a die-cast aluminum container. A standard receptacle is used, which allows each diode plug-in unit to be connected into its related circuit where large numbers of diodes are required. All diodes are tested *after* assembly in the plug-in containers.

EECO diode plug-in units enjoy wide application. They can be used as multiple clippers, limiters, dc restorers, modulators or demodulators, ring circuits, bridge circuits, rectifiers, and diode gates.

Where diodes form part of an equipment system, the use of EECO diode plug-in units can be a tremendous help in both design and production work.

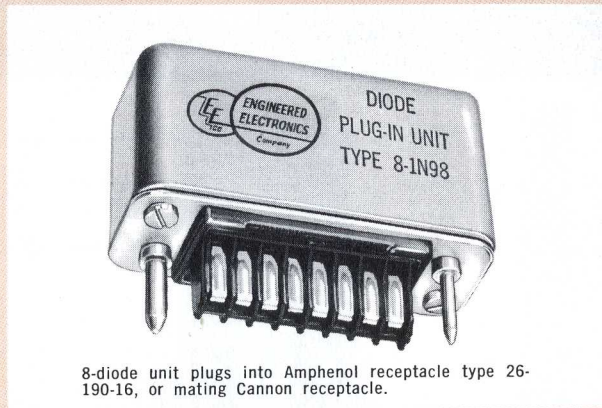
MECHANICAL SPECIFICATIONS

The schematic diagram shows the method of connection within an 8-diode unit. The polarity of each diode is established by the terminal numbers on the connector and receptacle. Construction consists of soldering individual diodes to the correct size of plug-in connector.

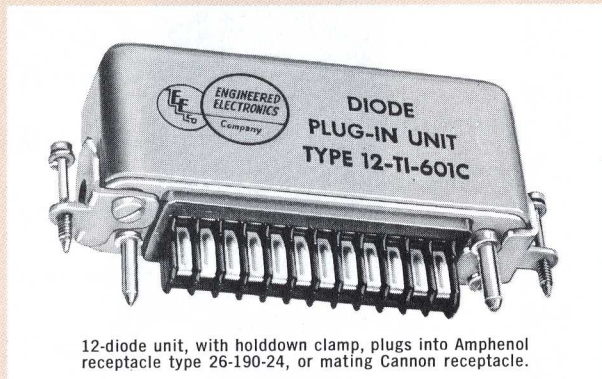


The die-cast aluminum cover, finished in gray enamel, is marked with the schematic as well as with the type and number of diodes, for easy identification.

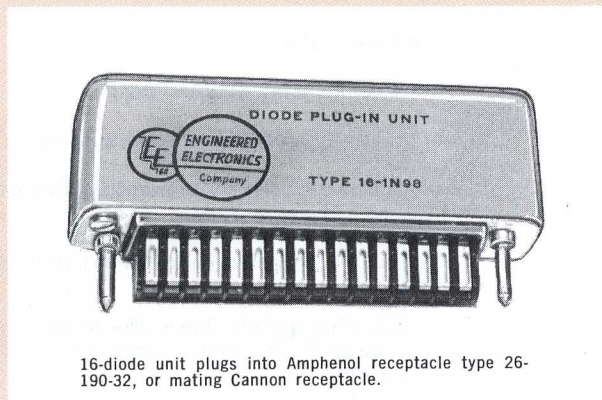
All units are 1 inch wide, with a seated height of 1-5/16 inches.



8-diode unit plugs into Amphenol receptacle type 26-190-16, or mating Cannon receptacle.

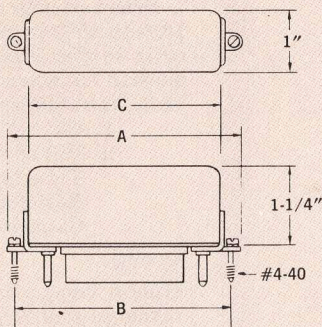


12-diode unit, with holddown clamp, plugs into Amphenol receptacle type 26-190-24, or mating Cannon receptacle.



16-diode unit plugs into Amphenol receptacle type 26-190-32, or mating Cannon receptacle.

OVERALL DIMENSIONS OF STANDARD DIODE PLUG-IN UNITS WITH HOLDDOWN CLAMPS



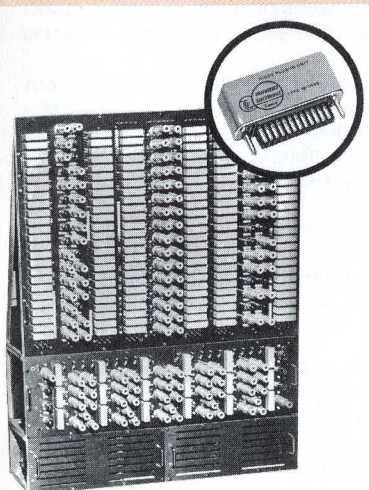
DIM	8-DIODE UNIT	12-DIODE UNIT	16-DIODE UNIT
A	3-1/6"	3-3/4"	4-27/64"
B	2.82"	3.50"	4.18"
C	2-7/16"	3-1/8"	3-51/64"

ELECTRICAL CHARACTERISTICS

The electrical specifications for diodes correspond to those of the manufacturer whose diodes are packaged in the unit. All diode plug-in units are tested to these specifications after assembly.

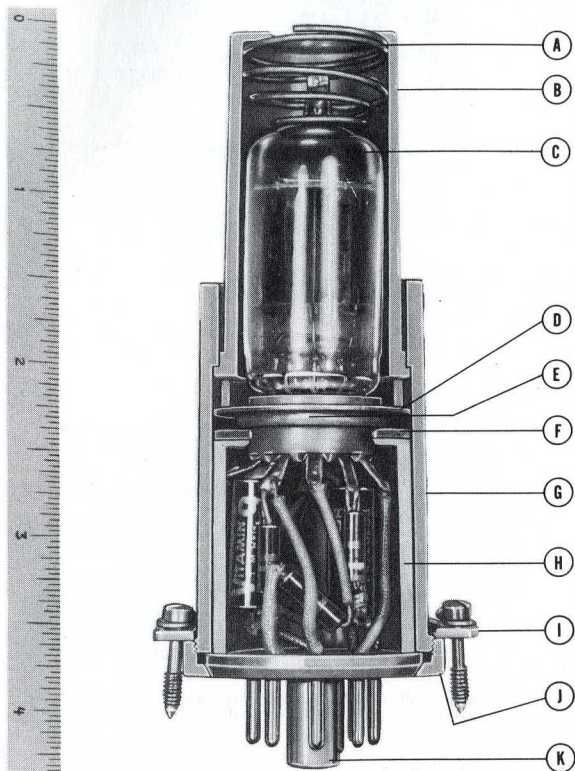
PARTIAL LIST OF DIODES THAT CAN BE PACKAGED IN EECO DIODE PLUG-IN UNITS

1N55B	1N191	1N221	1N438	HD2170
1N67A	1N192	1N222	1N439	HD2171
1N68A	1N198	1N270	1N460	HD2172
1N69A	1N200	1N273		HD2173
1N70A	1N201	1N277	HD2013	HD2174
1N81A	1N202	1N278	HD2014	HD2175
1N89	1N203	1N279	HD2015	HD6001
1N90	1N204	1N283	HD2150	HD6002
1N95	1N205	1N300	HD2151	HD6009
1N96	1N206	1N301	HD2152	
1N97	1N207	1N302	HD2154	T1-G thru T25-G
1N98	1N208	1N303	HD2155	
1N99	1N209	1N306	HD2157	CK851
1N100	1N210	1N307	HD2158	CK852
1N116	1N211	1N350	HD2159	CK856
1N117	1N212	1N351	HD2160	CK860
1N118	1N213	1N352	HD2161	CK861
1N126	1N214	1N353	HD2162	
1N127	1N215	1N354	HD2163	DR301 thru DR307
1N128	1N216	1N432	HD2165	DR310 thru DR312
1N137A	1N217	1N433	HD2166	DR314 thru DR317
1N137B	1N218	1N434	HD2167	DR319
1N138A	1N219	1N436	HD2168	DR321 thru DR325
1N138B	1N220	1N437	HD2169	



Diode Plug-in Units produced by Engineered Electronics Company simplified the construction of this computer.

Mechanical Specifications of Standard-Series Plug-in Units



- A—Spring
- B—Removable die-cast tube shield
- C—Tube
- D—Ring supports components against tension
- E—Tube socket
- F—U-Ring supports components against compression
- G—Die-cast container
- H—Nylon sleeve for insulation and mechanical support
- I—Holddown clamp (when specified)
- J—Screw cap to assemble and disassemble unit
- K—8- or 11-pin base. (4- to 11-pin base can be supplied on special order)

The cross-sectional photograph shows the basic construction of the Engineered Electronics Company Standard-Series packaged plug-in circuit.*

*U.S. Patent applied for.

CONSTRUCTION

The most unique construction feature of EECO Standard-Series plug-in units is the nylon sleeve (H), which is strong enough to support the weight of a man. This sleeve not only serves as an insulator for the packaged circuitry, but, in combination with a U-ring; a washer, and a shoulder inside the container, gives solid, all-around support to the tube socket. This prevents any flexing or straining of components, leads, or soldered joints, thus assuring long life and maintenance-free operation.

The entire unit can be disassembled in a matter of seconds. Removal of the nylon sleeve then gives easy access to the circuitry for testing and possible replacement of any component. The tube shield (B) is separately removable to permit easy replacement of the vacuum tube without removal of the plug-in. The die-cast container (G) is easily removed by means of a screw cap on the bottom of the unit. The entire sub-assembly is protected with a fungus- and moisture-proof coating.

MECHANICAL SPECIFICATIONS

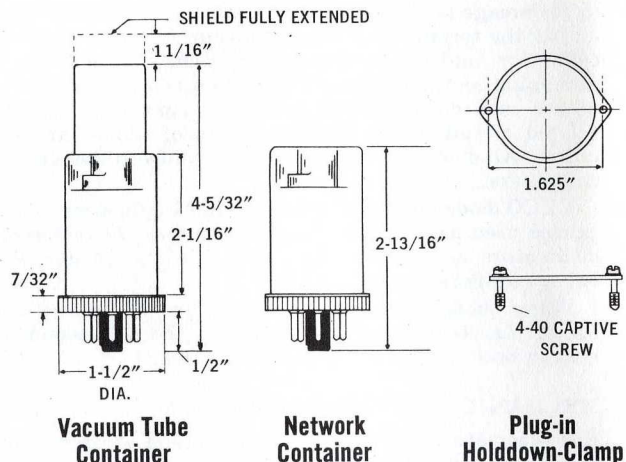
- Over-all Height: 4-5/32"
- Seated Height: 3-5/8"
- Over-all Diameter: 1-1/2"
- Finish: Gray baked enamel**
- Weight: 3.25 oz. (approx.)
- Outline Dwg.: No. A-8817

Unit plugs into a standard octal-type socket.

In addition to the popular 8-pin octal base, any type of base, from 4-pin to 11-pin, can be supplied without altering the dimensions of the unit.

A Standard-Series EECO plug-in holddown clamp with 19/32" or 27/32" captive screws is available for shock and vibration applications. 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.

**Other colors are available at slight additional cost.



Special Circuits in EECO Plug-ins

Although Engineered Electronics Company offers an extremely comprehensive selection of tested and proven circuits in Standard-Series plug-in units, special circuits are frequently required by the systems or equipment designer. In order to ensure complete system or equipment compatibility, EECO will package large or small quantities of any circuit of your design in Standard-Series plug-ins.

Prices on your special circuits may be estimated within 10% to 15% by comparing your circuit with similar circuits in the Standard 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
Tube type;
Resistor values, tolerances, and wattages;
Capacitor values, tolerances, and voltages.

NOTE:

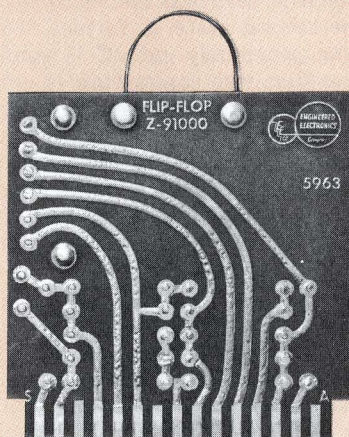
Unless component values are otherwise specified, 5% resistors and 20% capacitors will be quoted.

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

Custom Plug-in Containers

Equipment Design and Fabrication with Plug-in Construction

ETCHED BOARD
PLUG-IN UNIT



Engineered Electronics Company can furnish special plug-in assemblies to meet unique space and component specifications. In addition, EECO engineers, long experienced in electronic packaging, are available to design custom plug-ins to meet any special systems or equipment requirements. Multi-function circuits, with one or more vacuum tubes, transistors, diodes, networks, and special components, can be packaged in custom-designed plug-ins.

One of the special plug-ins is the printed circuit or etched board. EECO facilities are available to assist you with your etched board plug-in requirements and to fabricate special etched board plug-ins of any design.

When requesting quotations on the fabrication of custom etched boards, include the following:

1. Master drawing or photographic negative.
2. Shape, thickness, type, and size of board.
3. Type and thickness of conductor.
4. Special plating or solder-coating requirements, if any.
5. Make, type, size, rating, and tolerance of all parts to be assembled in position.



SPECIAL PLUG-IN CIRCUITS CAN BE
HOUSED IN STANDARD CONTAINERS

The Engineered Electronics Company has production facilities for the production of complete systems, equipment, and equipment sub-assemblies.

When requesting quotations on the fabrication of special or custom equipment, please include:

1. Complete schematics.
2. Complete chassis drawings.
3. Specifications.

NOTE:

In lieu of such drawings and specifications, a finished piece of equipment may be submitted for production quotations.

The engineering and production facilities of Engineered Electronics Company are available to assist you in designing and producing equipment. The Pulse Generator illustrated below is an example of EECO's custom work. This Pulse Generator was designed by EECO engineers with a minimum of engineering time through the use of plug-in symbol design techniques. The plug-in design facilitates rapid standardized production and incorporates all of the advantages of plug-in construction.

When requesting quotations on your *present* equipment repackaged with EECO plug-in construction, please include:

1. Complete circuit schematic.
2. Bill of materials.
3. Performance specifications.
4. Equipment mounting requirements.

When requesting quotations on the design of *new* equipment with EECO plug-ins, please include:

1. Complete specifications.
2. Space requirements.
3. Mounting desired.

TOP VIEW



BOTTOM VIEW



PRESET PULSE GENERATOR PRODUCED BY
ENGINEERED ELECTRONICS COMPANY

Standard-Series Plug-in Applications

APPLICATION

It is the purpose of this section to illustrate some of the more common uses of Engineered Electronics Company's plug-in circuits. The applications included here are but a few of the many possible uses of plug-in circuits in electronic systems. As these "building blocks" can be arranged in limitless combinations, depending upon the desired results, Engineered Electronics Company invites you to allow its engineering staff to assist you with your specific system needs.

I. COUNTING AND FREQUENCY DIVISION

Counting circuits are used in a wide number of applications, such as computers, nuclear-physics experiments, automatic control devices, and radar range and azimuth marker generators. Engineered Electronics Company's plug-in counting circuits are available for digital counting of information at a rate of from 0 to 1 megacycle, and for analog or energy-storage-type counting at rates up to 10 kc.

A. DIGITAL COUNTING

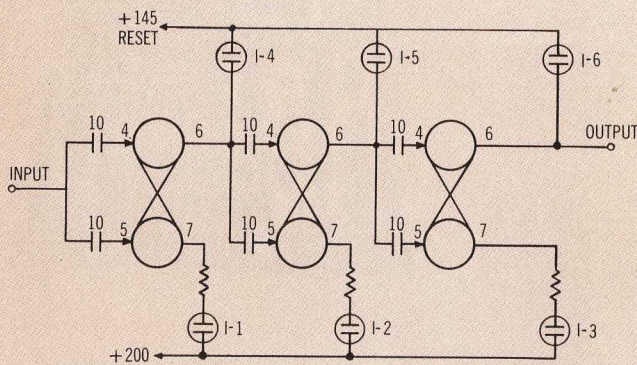
For digital counting, the flip-flop unit is a basic circuit that has two stable states. One state exists

when one triode is at zero bias and the other triode is cut off. The second state is formed when the triode that was previously cut off is conducting and the section that was conducting is cut off.

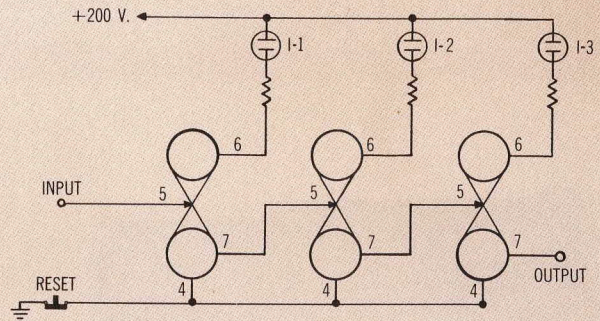
The counting ability is derived from the fact that a negative pulse at the input causes a change from one state to the other. Since it requires two input pulses to cause a change from state 1 to state 2 and back to state 1, each flip-flop unit will divide the input by two. These units can be cascaded in straight binary fashion to obtain counts of 4, 8, 16, etc. By the use of feedback or feed-through networks around the binary stages, other counting rates, such as 3, 5, 7, etc., can be obtained. Flip-flops Z-8336, Z-8339, and Z-8342 are all basically the same circuit with operating ranges of from 0 to 100 kc. Depending upon the specific application, panel wiring can be simplified by use of the Z-8339 or Z-8342 in place of the Z-8336. However, with the use of external capacitors, the Z-8336 can be employed for all applications within the stated frequency range.

Figure 1 shows the external wiring necessary for Z-8336 flip-flops coupled for binary counting. Neon lamps I₁, I₂, and I₃ are intended only as visual indicators. I₄, I₅, and I₆ are used for resetting. The reset bus is set at a bias of +145 volts with respect to pin 2 so that, during the counting period, the resetting neons are not ionized. Resetting is accomplished by dropping the resetting bus to 65 volts positive with respect to pin 2 and then returning it to its initial 145-volt level. The Z-8339 or Z-8342, used in this application, will require

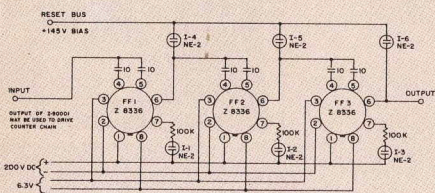
FIGURE 1.—BINARY COUNTER APPLICATION OF FLIP-FLOP Z-8336.



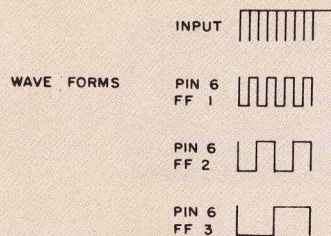
SYMBOLIC DIAGRAM OF SAME BINARY COUNTER.

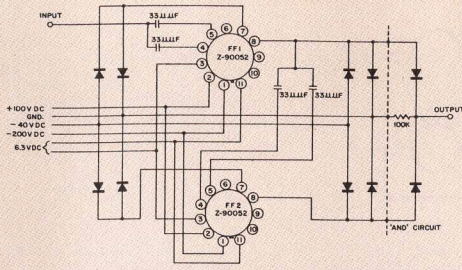


SYMBOLIC DIAGRAM OF EQUIVALENT BINARY COUNTER WHEN Z-90059 FLIP-FLOPS ARE USED. NOTE THAT COUPLING CAPACITORS ARE INTERNALLY CONTAINED.

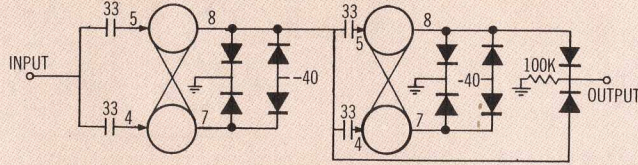


SCHEMATIC





SCHEMATIC



SYMBOLIC DIAGRAM.

WAVE FORMS

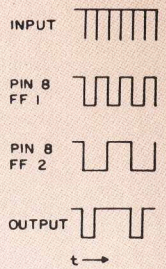
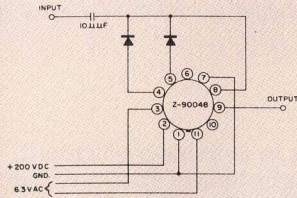
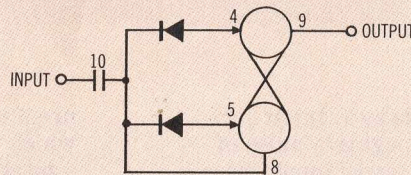


FIGURE 2.—APPLICATION OF FLIP-FLOP Z-90052.



SCHEMATIC



SYMBOLIC DIAGRAM.

WAVE FORMS

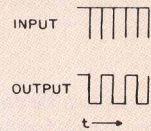
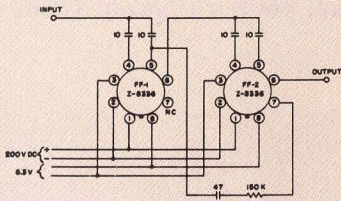
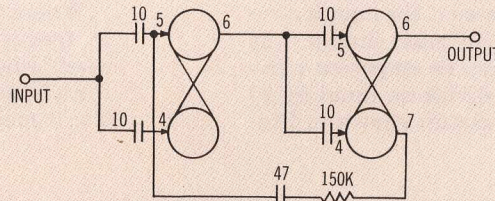


FIGURE 3.—CONNECTIONS TO FLIP-FLOP Z-90048.

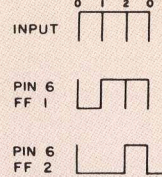


SCHEMATIC



SYMBOLIC DIAGRAM.

WAVE FORMS



SYMBOLIC DIAGRAM (NOTE SIMPLIFICATION IF Z-8339 FLIP-FLOPS ARE USED).

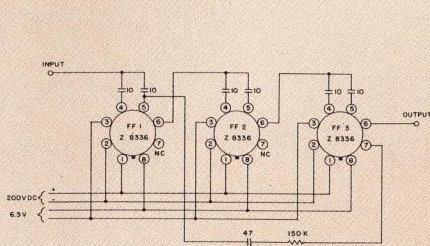
FIGURE 4.—DIVIDE-BY-THREE CIRCUIT.

only a connection between the output of a stage and the input(s) of the following stage, in place of the 10- μ F capacitors.

The flip-flop circuit, Z-90052, is a special unit designed to drive "and" and "or" circuits in the frequency range of 0 to 100 kc. Figure 2 indicates the use of two cascaded Z-90052 flip-flops driving a diode "and" circuit. The maximum number of logical diode circuits that can be connected to one stage is dependent upon the back resistance of the diodes used. A Z-90052 flip-flop will drive three diodes with back resistances as low as 100,000 ohms each.

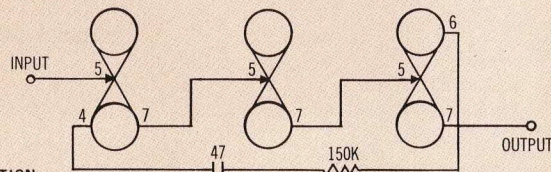
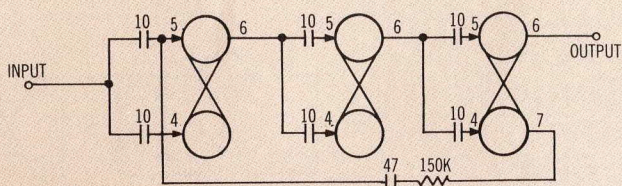
For counting rates up to 1 megacycle, the Z-90048 flip-flop may be employed. In straight binary operation, as shown in Figure 3, point contact crystal diodes are connected between pins 4 and 8, and 5 and 8, with a 10- μ F capacitor from the output of the preceding stage to pin 8. Pin 7 is normally connected to pin 1, but can be used for resetting by momentarily breaking the connection from pin 7 to pin 1 or by applying a positive pulse to pin 7.

Figure 4 shows the network arrangement for dividing by 3, for medium frequency (0 to 40 kc) feedback counting. Figure 5 illustrates how Z-8336



SCHEMATIC

SYMBOLIC DIAGRAM. FURTHER SIMPLIFICATION RESULTS WHEN Z-8339 FLIP-FLOPS ARE USED DUE TO INTERNALLY CONTAINED COUPLING CAPACITORS.



SYMBOLIC DIAGRAM.

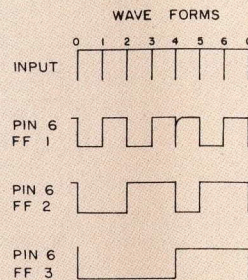


FIGURE 5.—DIVIDE-BY-SEVEN CIRCUIT.

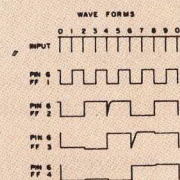
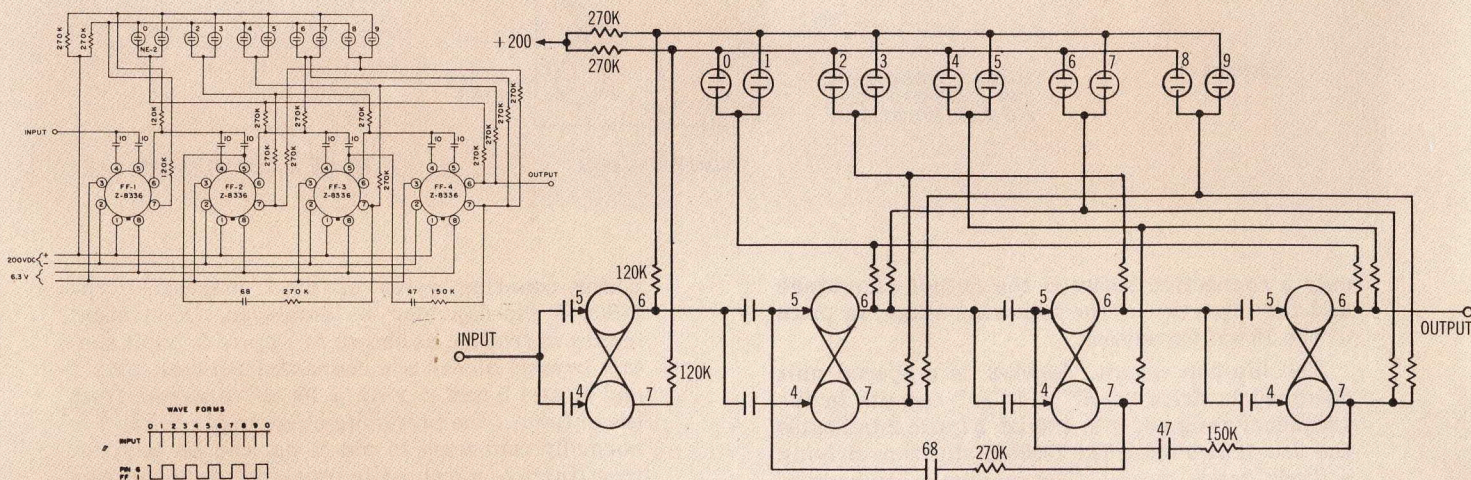
flip-flops can be connected to divide by 7. Input signal required for either unit is a negative pulse of from 60 to 130 volts, depending upon input rate and output load.

In the divide-by-3 circuit, the last stage feeds back a pulse into the first stage at the count of 2, so that, upon the arrival of the third pulse, the circuit resets to 0. Similarly, in the divide-by-7 circuit, the last stage feeds a pulse back to the input at the count of 4 so that, after three more input pulses (or a total of seven), the counter resets to 0. Neon indicators and reset circuits, as indicated in Figure 1, can also be employed here.

It is frequently desired to divide an input by 10 for decade applications. The circuit shown in Fig-

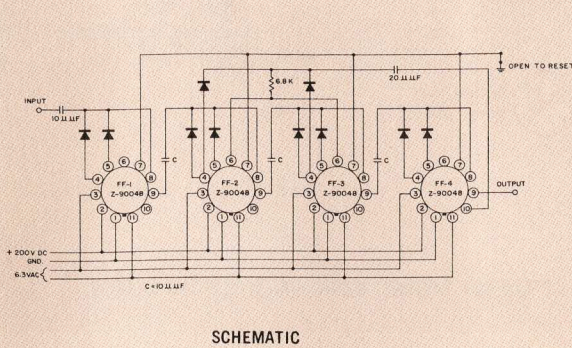
ure 6 utilizes three stages in a divide-by-5 circuit, which is fed from a straight binary stage, giving a total count of 10. The 270,000-ohm resistors and NE-2 neon lamps shown are used solely to obtain a visual, digital indication at low counting rates and may be omitted if desired without hampering the operation of the decade. The counter may be reset in the same manner as the binary counter. The frequency range of this system is from 0 to 40 kc.

Where it is desired to employ feedback counting at frequencies over 100 kc, the Z-90048 can be used. Figure 7 indicates feedback arrangement for a divide-by-10 circuit, which will operate from 0 to 1 megacycle.

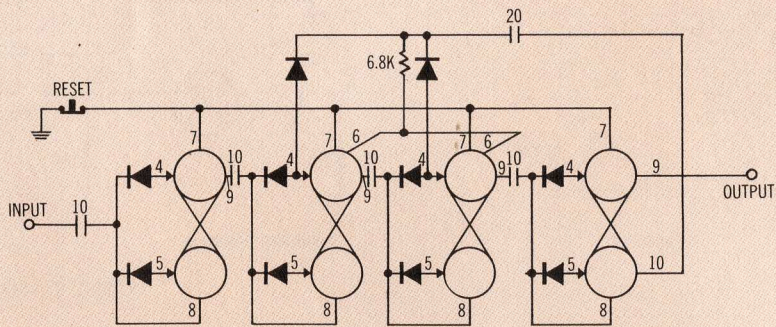


SYMBOLIC DIAGRAM. COUPLING CAPACITORS CAN BE ELIMINATED IF Z-8339 FLIP-FLOPS ARE SUBSTITUTED FOR THE Z-8336'S SHOWN.

FIGURE 6.—DECADE COUNTER, USING FLIP-FLOP Z-8336.



SCHEMATIC



SYMBOLIC DIAGRAM.

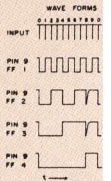


FIGURE 7.—0 TO 1 MEGACYCLE DECADE SCALER.

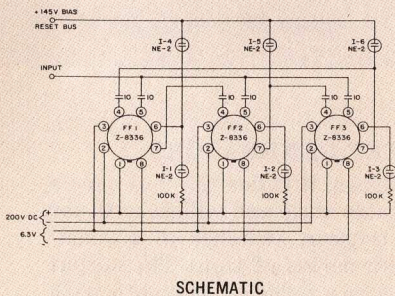
Reasonable care should be taken in wiring when cascading binary stages with a view toward keeping distributed capacitance as small as possible.

Ring- or linear-counting circuits can be called upon for such applications as scanning or sequential switching. Figure 8 indicates the manner in which Z-8336's can be arranged for ring-counting operation at rates up to 100 kc. Pin 6 is in the negative position in only one flip-flop in the chain during the time between any two input pulses, the negative states being transferred to the next stage in the chain with each input trigger. I₁ through I₃ are neon indicators with I₄ through I₆ used for resetting. The reset circuit is similar to that described under binary operation. Any number of

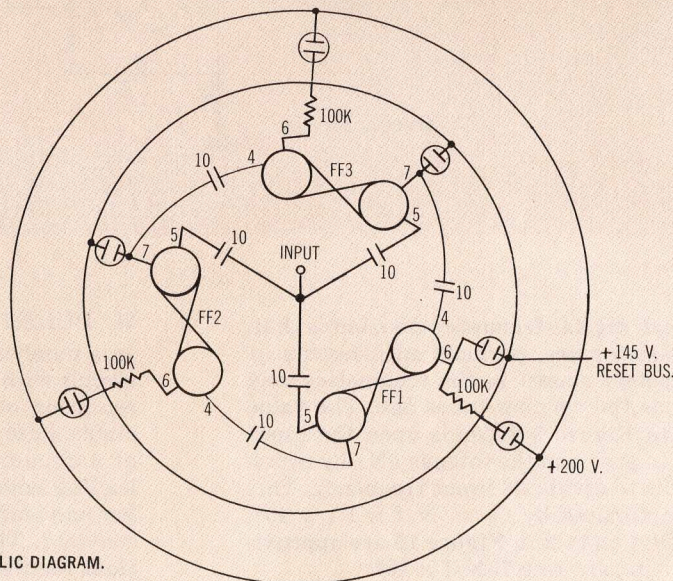
stages can be cascaded in this fashion.

B. ANALOG COUNTING

Analog counting circuits compare the input pulse rate to a voltage function changing in time, in order to divide by a desired number. This system of division requires that the input signal be of one fixed recurrent frequency and is not applicable to counting random input pulses. If space is at a premium, it may be desired to use this technique, where applicable, over that of digital circuits. Either the phantastron plug-in circuit, Z-90018, or the one shot, Z-8889, is useful for this application, as shown in Figures 9 and 10, respectively. The disadvantage of using analog-frequency divi-



SCHEMATIC



SYMBOLIC DIAGRAM.

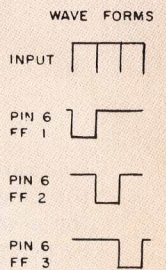


FIGURE 8.—RING COUNTER APPLICATION OF Z-8336 FLIP-FLOP.

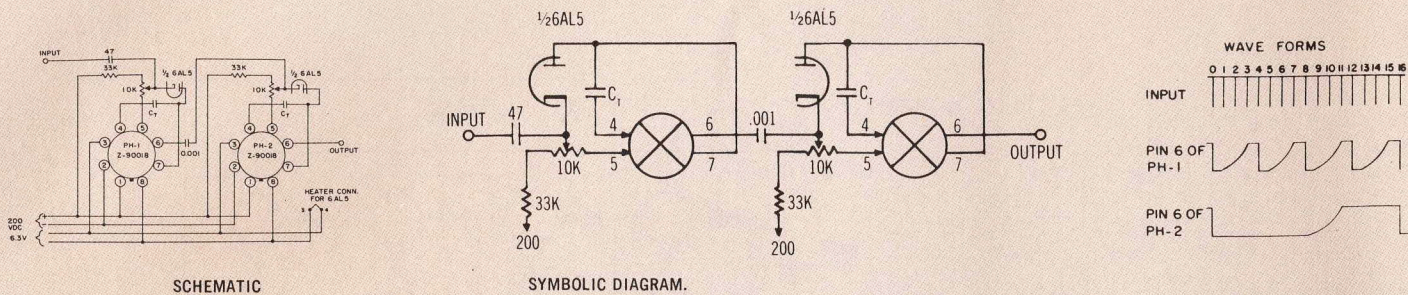


FIGURE 9.—FIXED FREQUENCY DIVIDER, USING PHANTASTRONS Z-90018.

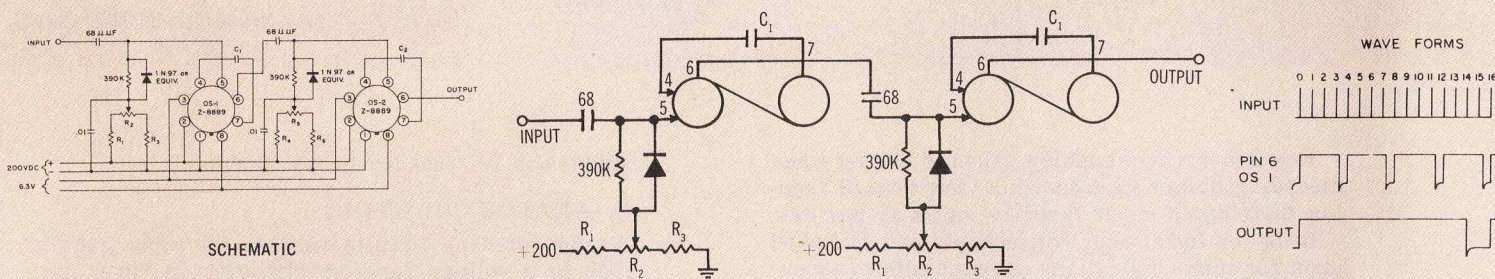


FIGURE 10.—CASCADE FIXED FREQUENCY DIVIDER, USING ONE SHOTS Z-8889.

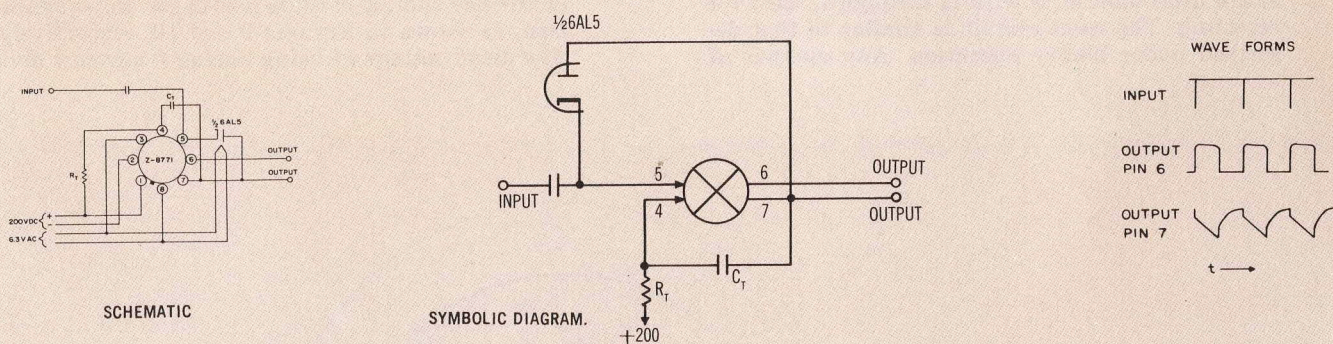


FIGURE 11.—PHANTASTRON Z-8771 APPLICATION.

sion rather than digital-frequency division is that, for large division rates, periodic adjustments of the potentiometers shown in the schematics may be necessary as the vacuum tubes age. The value of C_t in $\mu\mu\text{f}$ in Figure 9 depends upon the input frequency (f in pps) and the integer (N) by which a given stage is to divide its input frequency. This value is approximated by $C_t = N/f \times 1.1 \times 10^6$. The values of C_1 and C_2 in Figure 10 are approximately equal (in $\mu\mu\text{f}$) to $0.75N/f \times 10^6$.

Potentiometers R_2 and R_5 (Figure 10) should have a range of from 15 to 30 volts positive with respect to pin 1 of their associated plug-in unit.

II. PULSE AND SWEEP GENERATORS

In a number of applications, it is desirable to have a circuit with only one stable state and which, with the reception of an input trigger, switches to a quasi-stable state for a certain period of time. The output of a circuit of this type is a pulse or sawtooth with leading edge coincident in time with the input trigger and trailing edge time established by an R-C time constant. The quasi-stable state is useful in applications requiring time selection or gating (see Part III, Time Selection), as well as for time delay, where the trailing edge of the quasi-stable state is used to trigger some other circuit (i.e., delayed sweep, and

delayed time selection). It is also useful for timing momentary closures, and for generating a fixed-duration pulse for data transmission or data recording. Engineered Electronics Company's plug-in one shots, Z-8318 and Z-8889, and phantastrons, Z-8771 and Z-90018, are units designed for this function. The output of a one shot is a positive pulse, while a phantatron has, in addition to a pulse output, a linear negative waveform that may be amplified and applied to C.R.T. deflection elements for obtaining a sweep.

Immediately following the termination of the quasi-stable state, a certain length of time (known as the recovery time) must elapse for the R-C network to discharge completely before generation of another waveform. Z-8889 one shots have been designed for operations requiring fast recovery time and will consequently work up to duty cycles (ratio of pulse duration to period) of 90%. Maximum duty cycle of the Z-8318, Z-8771, and Z-90018 is approximately 60%. By using a cathode-follower stage for coupling the timing capacitor from plate to grid, recovery time of these three circuits may be considerably shortened (Figure 12).

Two methods of applying the phantatron, Z-8771, are indicated in Figures 11 and 12. In both examples, one half of a 6AL5 is used between pins 5 and 7.

A high-peak inverse voltage and high-back-resistance diode may be used in place of the vacuum diode at the cost of sweep linearity and output swing. R_t and C_t are the timing resistor and capacitor. R_t is normally on the order of 1 megohm. The phantatron, Z-90018, can be applied in the same manner. The primary difference is that a negative pulse output is then available rather than a positive one, as from the Z-8771. R_t is internal to the Z-90018.

Figure 13 is a typical gating arrangement of a Z-8889 one shot controlling a Z-90023 gate. Here a negative signal input to the one shot causes the potential at pin 5 of the Z-90023 to change from approximately 60 volts negative with respect to pin 1 of the Z-90023 to the same potential as pin 1. The Z-90023 will act as an amplifier as long as pin 5 and pin 1 are the same potential. At the end of the quasi-stable state of the one shot, pin 5 returns to its negative condition, cutting off the gate.

A one shot, Z-8318, and a pulse amplifier, Z-8489, are shown in Figure 14, connected for use in systems requiring a delayed pulse. The time delay is established by the one shot pulse duration. C_1 and R_1 (see Z-8489 specification), the internal coupling network in the amplifier, act as a differentiating network to impart a positive pulse to the amplifier grid at the leading edge of the one shot pulse and a negative

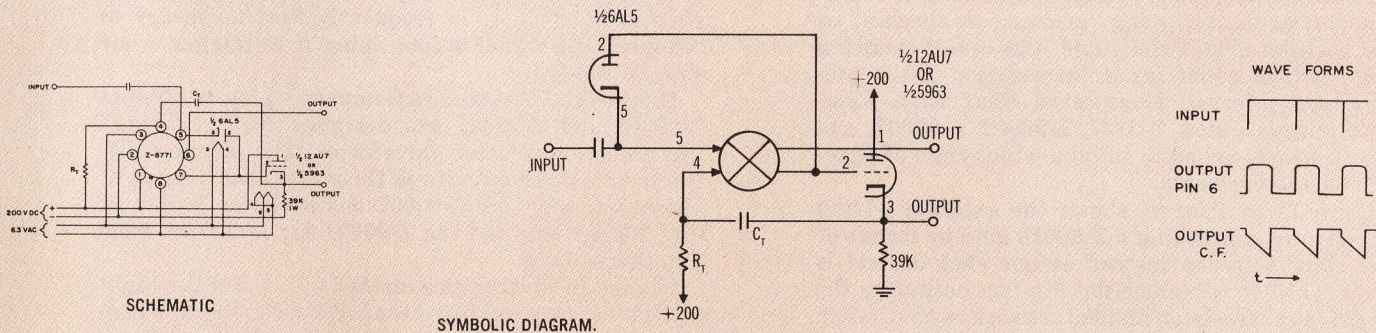


FIGURE 12.—PHANTASTRON Z-8771 CONNECTED FOR SHORT RECOVERY TIME.

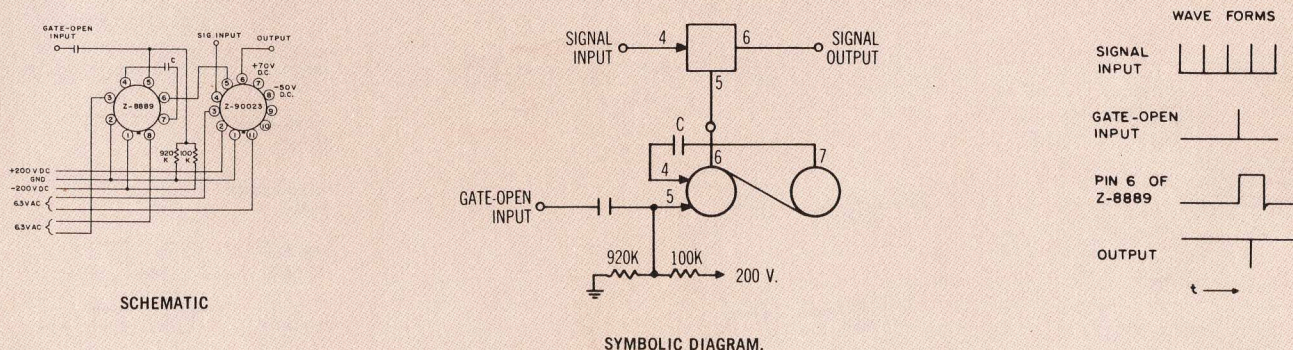


FIGURE 13.—ONE SHOT OPERATED GATE.

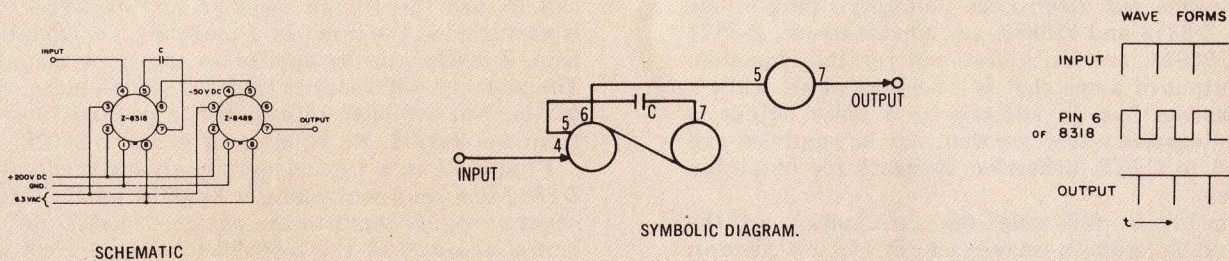


FIGURE 14.—ONE SHOT-PULSE AMPLIFIER COMBINATION FOR PULSE DELAY.

pulse at the end of the one shot pulse. An external differentiating circuit may be used for applications where the internal R1 and C1 are too large. Since the Z-8489 is sensitive only to negative input signals, its output is a negative pulse, delayed by the one shot pulse duration.

III. TIME SELECTION

Time selection requirements come about when it is necessary to sort certain signals with respect to their arrival in time. Examples of the use of time selection are found in applications such as digital scanners, where the stored code is periodically read-out; transmission systems employing "presence or absence" or pulse position modulation; and high-speed counting devices, which count input information for a pre-determined interval. Engineered Electronics Company's plug-in gates, Z-8327, Z-90002, Z-90007, and Z-90023, are designed to fulfill a wide range of time-selection requirements.

Figure 13 in Part II shows the external wiring necessary for controlling a Z-90023 gate by means of a one shot. Flip-flop instead of one shot control is accomplished by coupling the flip-flop output to the gate through a resistor divider network so that, when the flip-flop output is in its positive (10 volts negative with respect to pin 1 of the Z-90023), pin 5 of the gate is at the same potential as pin 1. Figure 15 shows how a gate, Z-90002 or Z-90007, may be controlled by a flip-flop.

In all of these arrangements, a flip-flop or one shot is used for controlling the time during which the gate is open, depending upon whether a pulse is available for the beginning and end of the gate-opened interval or only for the beginning of the gating period, with the time the gate stays open to be set by a one shot circuit.

IV. SQUARING CIRCUITS

The units in Part III require relatively fast rise time input pulses for switching from one state to the other. Since the original information may have poor rise time (i.e., output of some transducers, sinewaves, etc.), it is frequently first necessary to "square" the signal before using it to trigger a one shot or flip-flop.

Engineered Electronics Company's plug-in circuits Z-90001 and Z-90021 are designed for "squaring" input sine or complex waveforms. The primary difference in these circuits is their frequency range of operation, with the Z-90001 designed for inputs of 0 to 100,000 cps and the Z-90021 for inputs of from 0 to 200,000 cps.

Figure 16 illustrates a method of biasing the input section of the squaring circuit Z-90001. Pin 4 is connected to pin 2 and an external resistor (R1) is connected between pin 5 and pin 1. The value of R1 is chosen so that the series arrangement of R1 and the 470,000-ohm resistor (internally connected between pin 4 and pin 5) sets V1 at from 50 to 75 volts

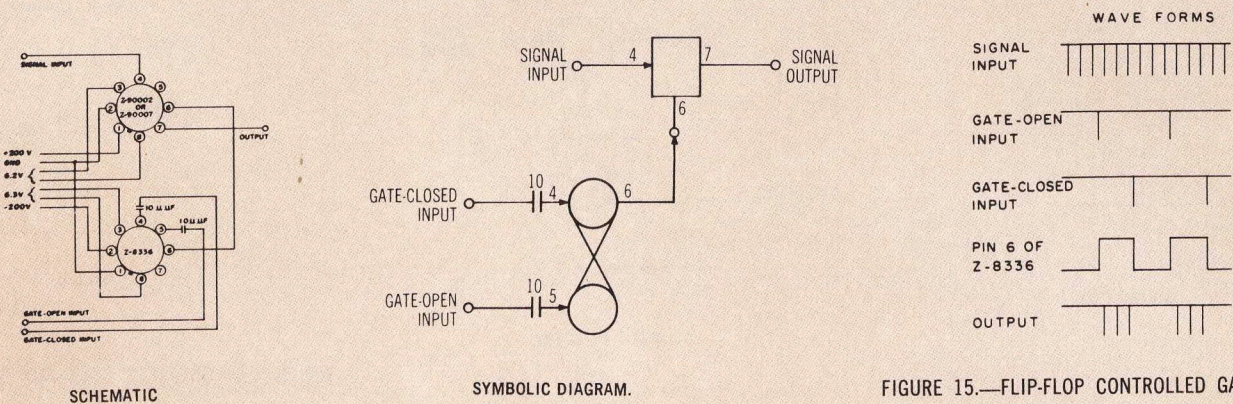


FIGURE 15.—FLIP-FLOP CONTROLLED GATE.

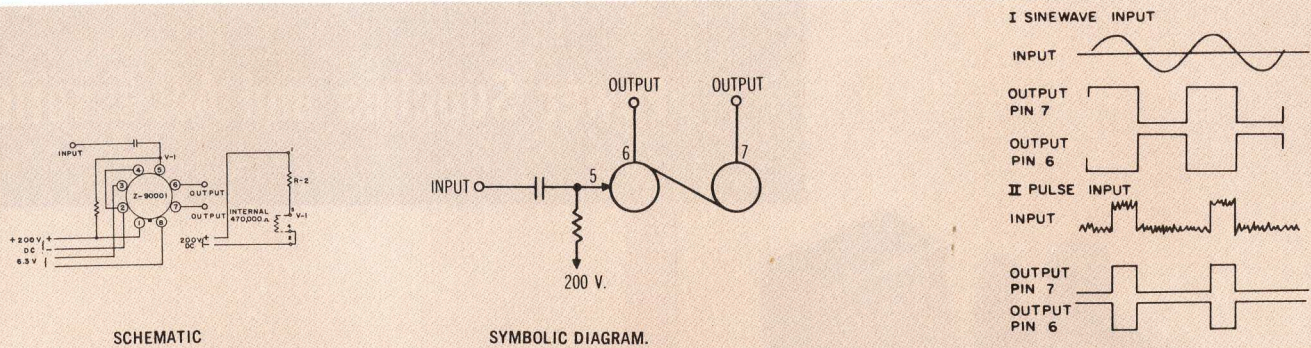


FIGURE 16.—APPLICATION OF SQUARING CIRCUIT Z-90001.

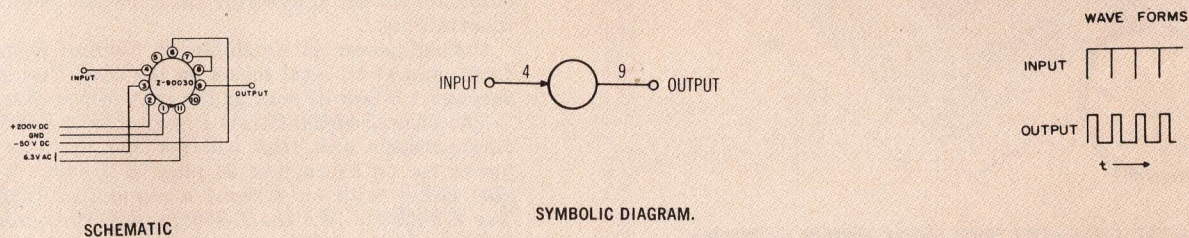


FIGURE 17.—PULSE AMPLIFIER Z-90030.

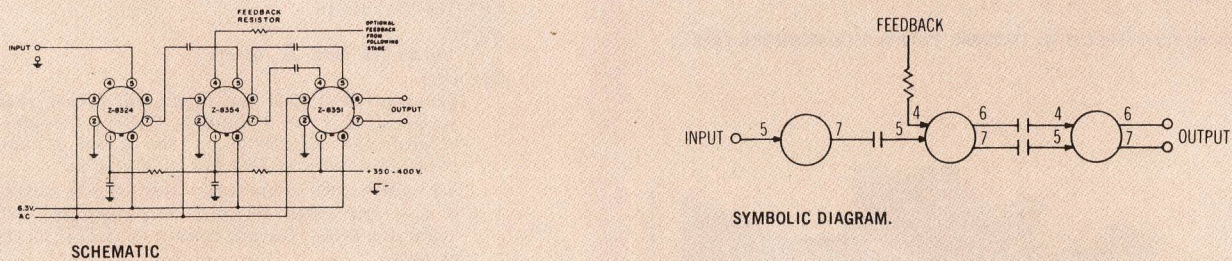


FIGURE 18.—LINEAR AMPLIFIER.

positive with respect to pin 2. The exact voltage to use will depend upon the application. In using the Z-90001 to square positive pulses, the bias should be approximately 50 volts, while with a negative input pulse, a bias on the order of 75 volts is needed.

V. PULSE AMPLIFIERS

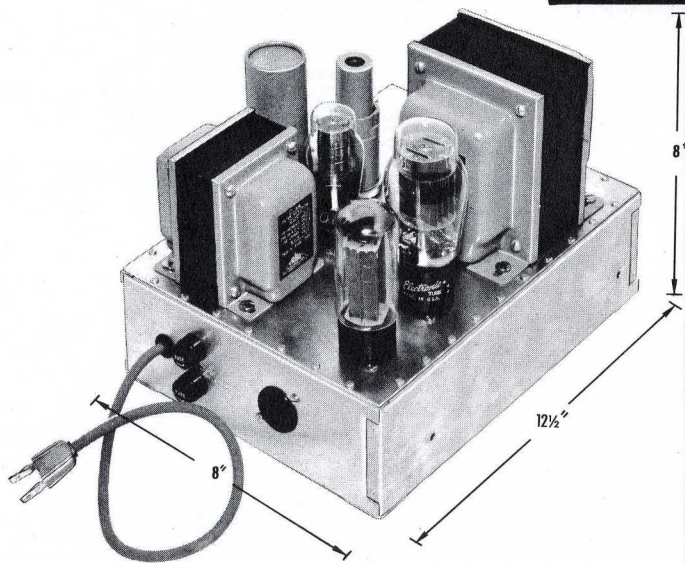
The Z-8489 and Z-90030 pulse amplifiers are used primarily for improving the rise time and increasing the amplitude of pulse waveforms. The Z-8489 (see Figure 14) accepts negative input pulses and produces negative pulses at the output. When a positive input is available, the Z-90030 can be used to generate a standard amplitude and duration negative pulse (Figure 17).

VI. LINEAR AMPLIFIERS

The linear amplifiers, Z-8324, Z-8351, Z-8354, and Z-8762, can be used individually or in combination to fill the needs of amplification with low distortion. Figure 18 shows a possible arrangement of three of these units in a circuit used for amplifying signals from a low-level source to drive a push-pull power output stage. The resultant circuit is similar to the basic Williamson amplifier.

Frequency response compensating networks can be connected to amplifier Z-8324. Feedback from the secondary of an output transformer can be applied to Amplifier-Phase Inverter Z-8354 to obtain improved response and reduced distortion.

Power Supplies and Accessories



SINGLE-UNIT, CHASSIS-TYPE POWER SUPPLY, SHOWING DIMENSIONS.

Power Supplies — Z-95000 Series

The Engineered Electronic Company's Z-95000-Series Power Supplies are specially made for service with EECO STANDARD-Series plug-in circuits.

Their primary application is in Systems Development Rack service, or as companion units for panel-equipped, chassis-mounted, plug-in circuit 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 ac 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 on the opposite page 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.

SPECIFICATIONS

Input:

105 to 125 volts ac, 60 cps.

Outputs:

200 volts dc at 200 ma, regulated. Either plus or minus terminal may be grounded. Output voltage control is screwdriver adjustable, at the front of unit. Control range is approximately 175 to 225 volts.

6.3 volts ac at 8 amperes, center-tapped, unregulated.

0 to -145 volts dc at 5 ma, regulated (OD3/VR150 regulator tube). Output voltage control is located at front of unit.

Regulation:

With output voltage set at 200 volts, regulation is 1% or better versus changes in load (0 to 130% rated load) with 115 volts ac input; 1% or better versus line voltage variation (± 10 volts) at rated load. Bias voltage 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 (in Z-90016). Models with bias supply have an additional OD3/VR150.

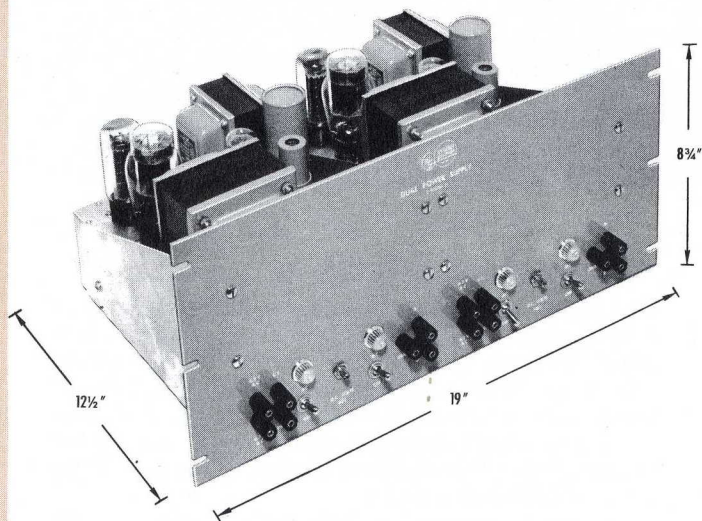
Dimensions:

See illustrations.

Weight:

TYPE	MODEL NO.	WEIGHT (Lbs.)	TYPE	MODEL NO.	WEIGHT (Lbs.)
Chassis	Z-95091	19	Panel	Z-95091-2	41
Chassis	Z-95098	20	Panel	Z-95098-1	24
			Panel	Z-95098-2	42
Panel	Z-95091-1	23	Panel	Z-95098-3	43

DUAL POWER SUPPLY WITH STANDARD 19-INCH RACK MOUNTING PANEL.



Section Two

POWER SUPPLIES

	TYPE	NUMBER
SINGLE UNITS	Chassis	Z-95091
	Chassis with Bias Supply	Z-95098
	Panel	Z-95091-1
	Panel with Bias Supply	Z-95098-1
DUAL UNITS	Panel	Z-95091-2
	Panel with One Bias Supply	Z-95098-3
	Panel with Two Bias Supplies	Z-95098-2

NOTE: Specifications are subject to change without notice.

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 Engineered Electronics Company Standard-Series plug-in units.

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 EECO Standard-Series plug-ins, thus checking out his system design.

EECO Systems Development Racks are available complete (less power supply) in two models—Z-95100 and Z-95101. Individual components are also available for engineers who may desire to start with a single-panel rack and build up gradually. (See specifications for Z-95102 through Z-95105, below.) All components are finished in EECO Standard grey baked enamel with the exception of Rack Z-95105, which has a black wrinkle finish.

SPECIFICATIONS

Z-95100—Systems Development Rack, complete as illustrated at right, but less power supply. (Shipped disassembled.) Consists of one Z-95102 Rack; one Z-95103 Blank Panel; two Z-95104 Panels, each complete with sockets, filament wiring, etc.; power cabling; Jones Terminal Strip; etc. (NOTE: Power can be supplied by one of the Z-95000-Series Panel-Type Power Supplies, any one of which will fit into the bottom of the Rack.)

Z-95101—Systems Development Rack. Same as Z-95100, except that panels are reversed so that sockets face front of rack to provide easy access for soldering signal connections. Power cabling is not included, since operator makes his own patching from front panel of Power Supply to connector on each of the Z-95104 panels. (Shipped disassembled.)

Z-95102—Rack only, grey finish. (Does *not* include panels.)

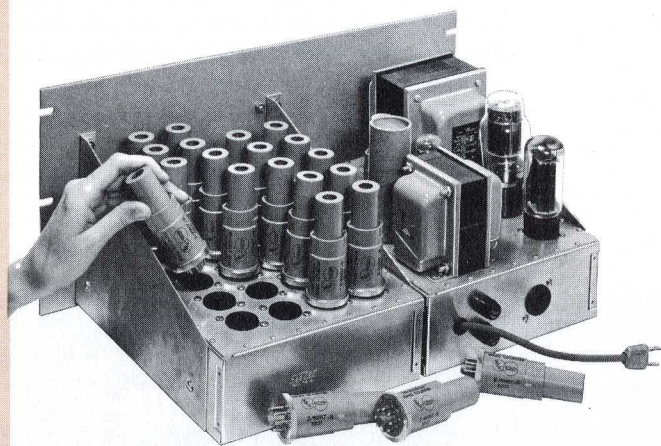
Z-95103—Blank Panel, 13¼" x 19", grey finish.

Z-95104—Panel, 5¼" x 19", complete with 10 octal and two 11-pin sockets* to accommodate 12 EECO Standard-Series plug-in units. Filaments are wired directly; B+, B-, and Ground busses are connected to the individual sockets. Grey finish.

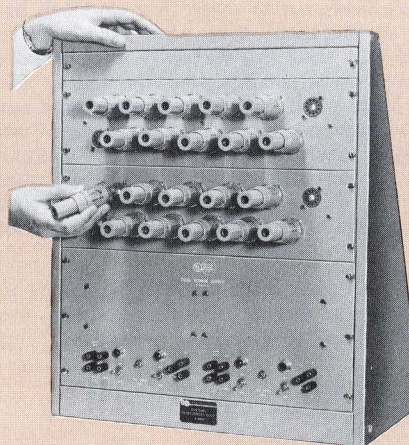
Z-95105—Rack only, black wrinkle finish. (Does *not* include panels.)

Custom and special racks are available upon request.

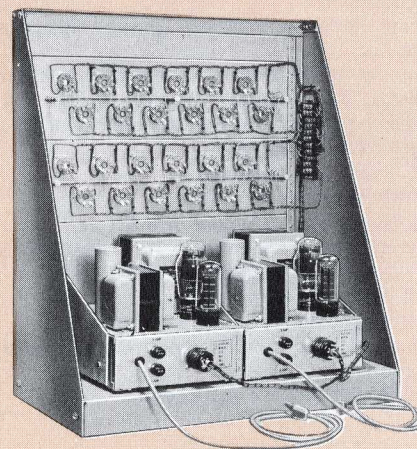
*Panel can be furnished with other combinations of sockets on special order.



SOCKETS HAVE BEEN INSTALLED IN THE BLANK CHASSIS OF THIS SINGLE-UNIT PANEL-MODEL POWER SUPPLY TO PERMIT "BREADBOARDING" WITH PLUG-IN CIRCUITS.



FRONT VIEW OF Z-95100 SYSTEMS DEVELOPMENT RACK. STANDARD SERIES PLUG-IN UNITS APPROPRIATE TO THE SYSTEM BEING "BREADBOARDED" ARE PLUGGED INTO PANEL-MOUNTED SOCKETS.



REAR VIEW OF SYSTEMS DEVELOPMENT RACK, WITH Z-95091-2 POWER SUPPLY IN PLACE. NOTE SIMPLICITY OF SOCKET-TO-SOCKET SIGNAL CONNECTIONS.

A compatible series of digital and logic circuits for

- *Computers*
- *Test Equipment*
- *Data Processing Systems*
- *Control Systems*

Permits engineers to concentrate on design of systems, knowing they have available a full line of reliable, tested, and proven building blocks to use.

Reduce Development Time

Reduce Cost

Improve Delivery Time

Computer-Series Plug-in Units

Section Three

INTRODUCTION

Modern, high-speed electronic systems are becoming more and more complex. At the same time, customer demands for delivery "yesterday" are becoming more and more difficult — if not impossible — to meet.

Engineered Electronics Company's Computer-Series plug-in units are designed to meet this problem, by reducing system development time to a bare minimum. Drafting and layout time are virtually eliminated and, since ultra-conservative ratings are inherent in the individual units, quite often the system prototype can be built directly, without need for the "breadboard" stage. These advantages accrue because EECO Computer-Series plug-ins represent a refinement of the building-block concept to a degree hitherto unknown — making each circuit truly an off-the-shelf packaged function.

Performance

The performance of Computer-Series plug-ins is engineered for application where ultra-conservative design at the component level is essential because of system complexity.

Here's why they work:

Tube dissipation de-rated 75%.

Cathode current de-rated 50%.

1%-components used where 5% required.

5%-components used where 10% required.

Circuits operate reliably with $\pm 20\%$ change in filament voltage, 30% change in tube trans-conductance.

Isolating diodes on multiple inputs eliminates crosstalk.

Low output impedance — in general, cathode follower. For example, flip-flop Y-101 will trigger another Y-101 at the end of a 50-foot length of twisted pair!

Signal levels are clamped.

Computer-type tubes used.

Here's why they save time and effort:

No circuit troubleshooting — it's been done already.

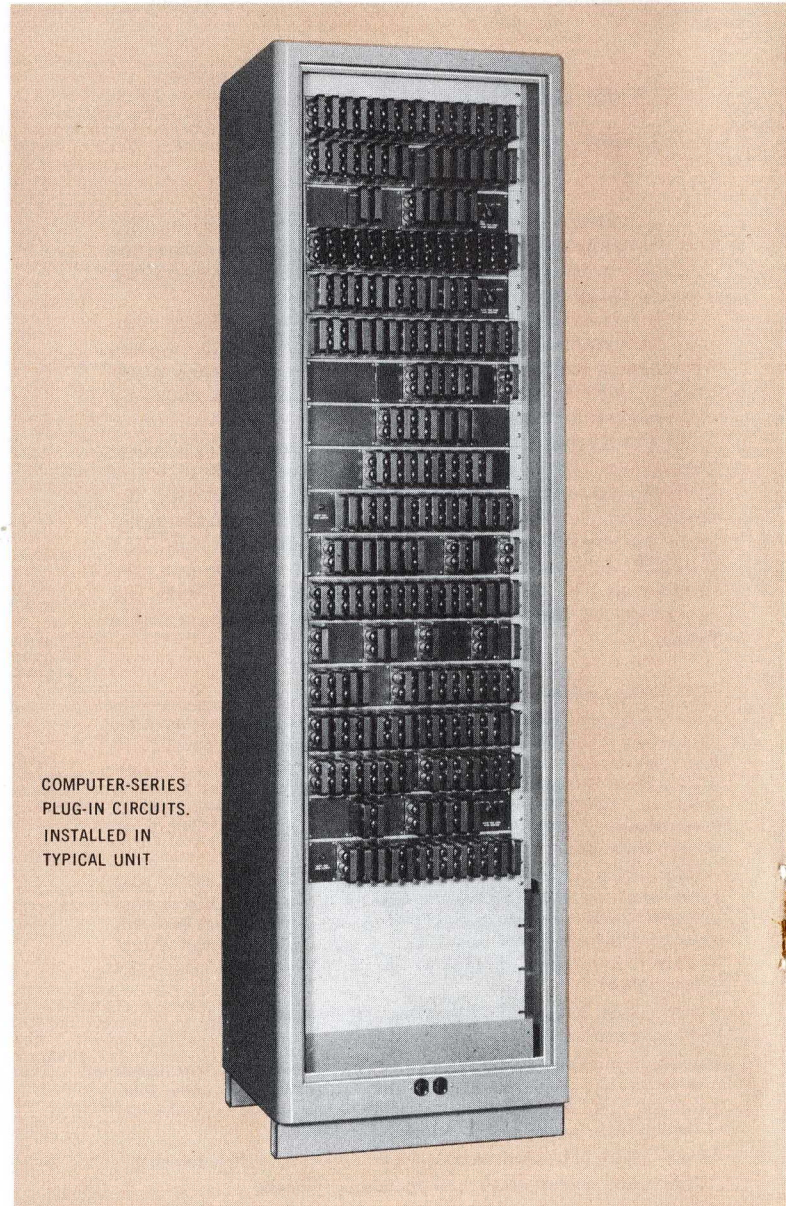
Units have been proven in critical use.

Layout basically completed.

Packaging problems have been solved.

Heat barrier and ventilation problems have been solved.

In-circuit test fixture available.



COMPUTER-SERIES
PLUG-IN CIRCUITS.
INSTALLED IN
TYPICAL UNIT

Circuits

An extremely wide variety of circuits is available in EECO Computer-Series plug-ins, as a look at this list will show:

- Flip-Flop — General (1 MC)
- Flip-Flop — Delay
- Flip-Flop — Ring Counter
- Flip-Flop — Divider
- Flip-Flop — Gate
- Shift Register Element
 - Series in — Series out
 - Parallel in — Series out
 - Gray code to binary converter and series out shift register

DC "Not" Circuit

- Inverting
- Squaring
- Waveform restorations.

Delay Unit — negative-going signal.

Pulse Mixer Amplifier — Trigger Pulse Generator.

Quadruple Cathode Follower, Light Duty.

Quadruple Cathode Follower, Heavy Duty.

One-Digit Adder Matrix.

One Shot — Pulse Forming, Delay, and Storage.

One-Digit Subtractor Matrix.

Neon Driver — Indicator.

All of these, plus 28 Diode Logic Units incorporating "And" Circuits
"Or" Circuits

Isolation Circuits.

In addition, Engineered Electronics Company stands ready to design diode logic circuits and produce plug-in units to yield any equation you may require. That means custom-built logic to order — quickly!

Design Criteria

D.C. Coupled system concept.

20-volt standard signal.

"One" equals a nominal minus 20 volts, tolerance from -14 to -25 volts.

"Zero" equals a nominal zero volts, tolerance from +10 to -5 volts.

Power Supply voltages required:

+200 volts dc (some units).

+100 volts dc.

-100 volts dc.

-25 volts ac.

Typical tolerances: DC voltages, either $\pm 10\%$ or $\pm 5\%$.

AC voltages, $\pm 20\%$.

Supply voltage transients, $\pm 5\%$.

Tube transconductance, 30%.

System is basically low-impedance, using cathode follower buffers liberally.

Mechanical — Structural

Modules for system functions are assembled, using the plug-in circuits and Mounting Frame Assemblies. These assemblies are designed for installation in standard 19-inch racks and accommodate 15 plug-in units each. Each Mounting Frame Assembly is 3½ inches x 19 inches. These modules and special-purpose switch panels, light panels, etc., may be bolted together in almost any conceivable combination to provide maximum flexibility for the system designer. Selected mechanical and electrical characteristics are:

Gold-plated epoxy-glass etched material used for greater strength and thermal stability.

Rugged handle and frame.

Units fit standard 19-inch racks.

Vertically oriented boards for more efficient air

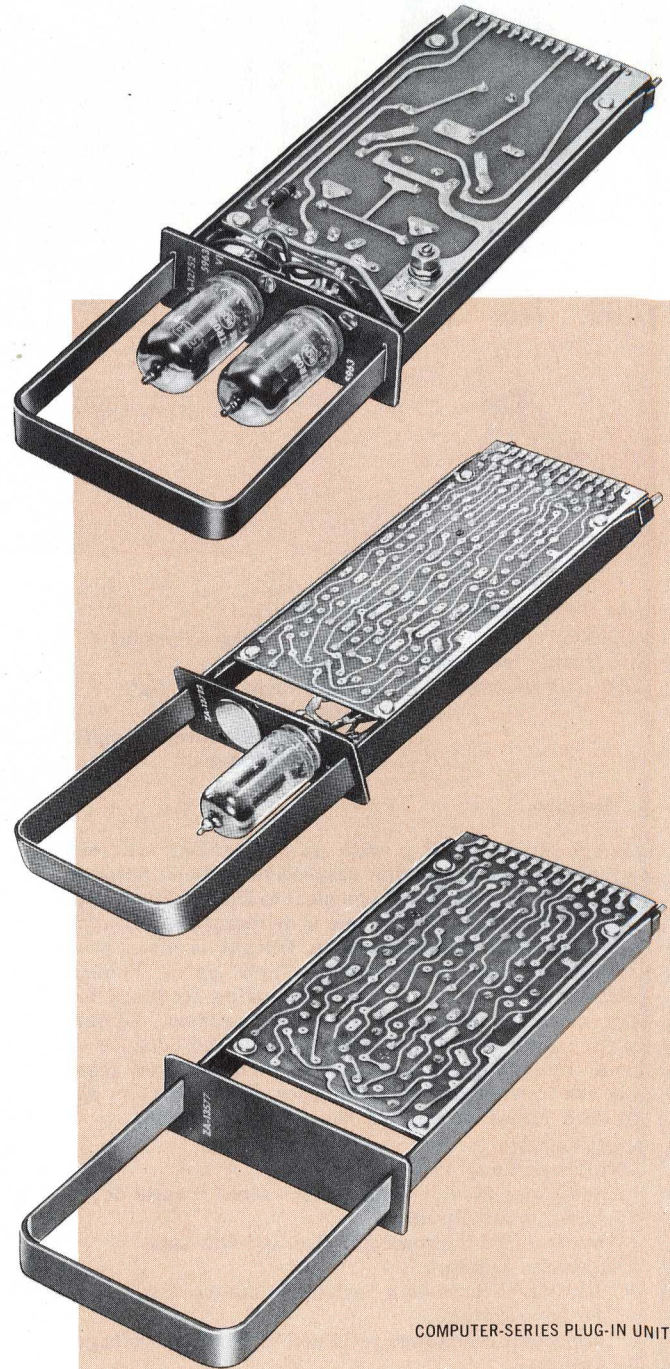
cooling.

Panels provide heat barrier between tubes and other components.

Up to 15 units (30 tubes) fit in 3½-inch panel height x 19-inch panel width.

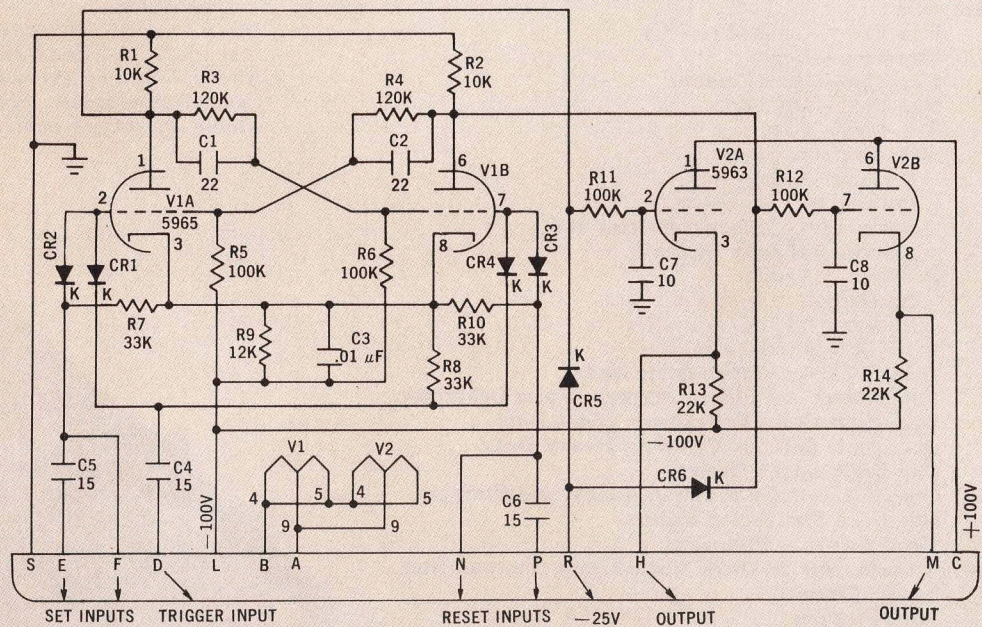
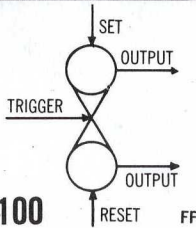
All metal frames grounded.

Construction system permits fast interconnecting wiring and easy troubleshooting.



COMPUTER-SERIES PLUG-IN UNITS

Flip-Flop



Major Components:

- 1 Flip-Flop
- 2 Integrating Networks
- 2 Cathode Followers

Primary Uses:

1. General delayed output applications.
2. Interstage "and" Gate Control.
3. Feedback Counter Circuits.
4. Shift Registers.

N (direct coupled) and pin P (capacity coupled).
 Amplitude: 20 volts nominal, 0 volts to -20 volts.
 Waveform: Fall time to 1.0 microsecond, maximum.
 Frequency: 150,000 cycles per second, maximum.

Power Requirements:

+100 volts dc at 8.2 ma. -25 volts dc at 1.1 ma.
 -100 volts dc at 12.7 ma. 6.3 volts ac at 750 ma
 (0 volts dc).

Specification:

A clamped-plate flip-flop with an integrating network between each plate and the respective cathode follower grid. The flip-flop section is identical to that of Flip-Flop, Y-101. Output rise and fall time is deliberately degraded to approximately 6 microseconds. Output is often used for control of external inter-stage "and" gates. Typical application is in counter circuits requiring feedback for proper counting action, or in shift registers. Upper-frequency limit is 150,000 cycles per second because of internal integrating networks. Set, trigger, and reset inputs are independent of each other. One input can operate with either or both of the others grounded.

Output Signals:

Number: Two: Pin H and pin M.
 Amplitude: 20-volt level shift; "zero" 0 volts dc;
 "one" -20 volts dc.

Waveform: 6-microsecond rise and fall time.

Maximum Loading,

Resistive: 2 ma to a resistance returned to positive voltage.

4 ma to a resistance returned to negative voltage.

Input Signals:

Number: Five: Set, pin E (capacity coupled) and pin F (direct coupled); trigger, pin D; reset, pin

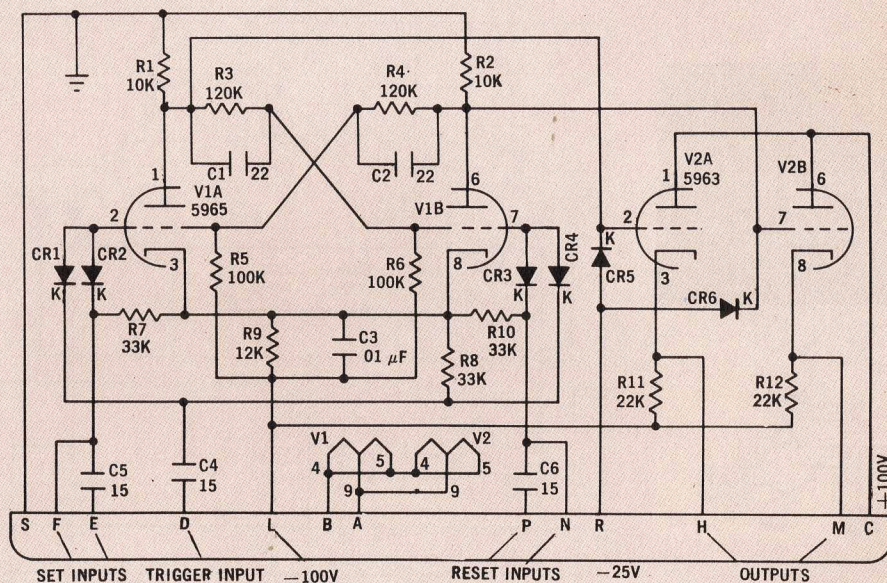
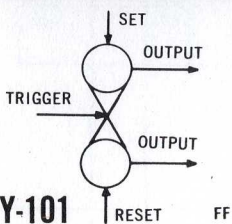
Tubes:

Two: One type 5963 and one type 5965.

Circuit Tolerance:

DC supply, $\pm 10\%$;
 AC supply, $\pm 20\%$;
 Transients, 5%;
 Tube g_m , 30%.

Flip-Flop



Major Components:
 1 Clamped Flip-Flop
 2 Cathode Followers

Primary Use:
 General

Circuit Tolerance:
 ±100-volt dc supply, ±10%;
 -25-volt dc supply, ±5%;
 AC supply, ±20%;
 Transients, 5%;
 Tube g_m , 30%.

Specification:

A high-speed, clamped-plate flip-flop with cathode follower output. Maximum input trigger rate is 1 megacycle. Useful frequency limits depend on specific waveshape requirements of particular application. The three inputs ("set," "reset," and "trigger") are independent of each other. Unit can be operated with any one or two inputs grounded. Can be operated in binary fashion (one unit driving another).

Output Signals:

Number: Two: Pin M and pin H.
 Amplitude: 20-volt level shift; "zero" 0 volts dc; "one" -20 volts dc.
 Maximum Loading,
 Resistive: 2 ma to a resistance returned to positive voltage.
 4 ma to a resistance returned to negative voltage.
 Waveform: Fall Time: 0.4 microsecond (no load).
 Rise Time: Approximately twice fall time.

Capacitive Loading

Effects: See Capacity Loading Curve.

Input Signals:

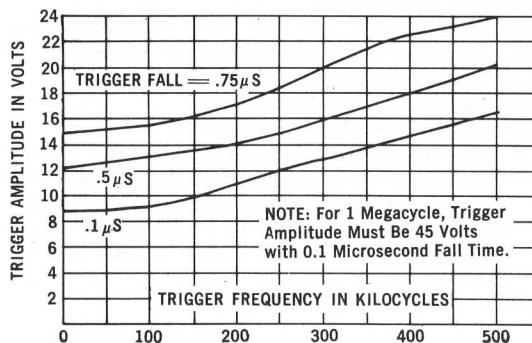
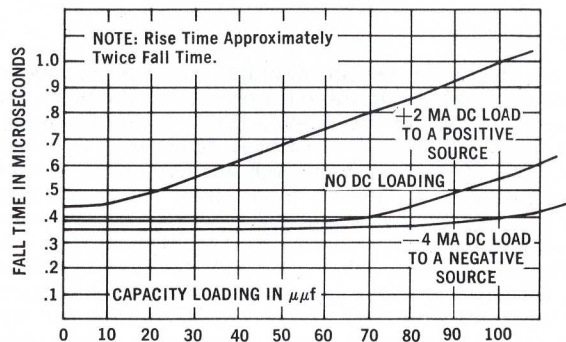
Number: Five: Set, pin E or pin F; trigger, pin D; and reset, pin N or pin P.
 Trigger Amplitude: Negative-going signal, see Trigger Amplitude Curve.

Power Requirements:

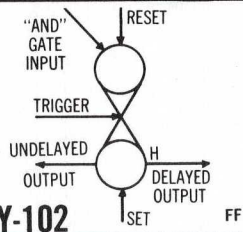
+100 volts dc at 8.2 ma. -25 volts dc at 1.1 ma.
 -100 volts dc at 12.7 ma. 6.3 volts ac at 750 ma
 (0 volts dc).

Tubes:

Two: One type 5965, one type 5963.

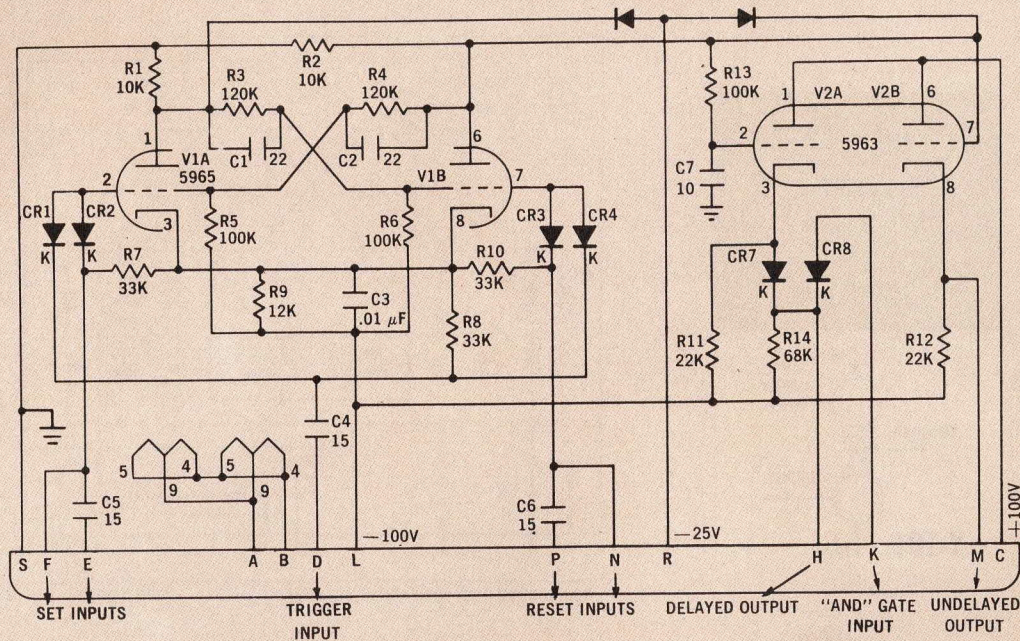


Flip-Flop



Y-102

FF



Major Components:

- 1 Flip-Flop
- 2 Cathode Followers
- 1 Integrating (delay) Network
- 1 "and" Gate

Primary Uses:

- 1. Ring Counter.
- 2. Divider.
- 3. Gate.

Input Signals:

Number: Six: Set, pin E and pin F; flip-flop trigger, pin D; reset, pin N and pin P; "and" circuit drive, pin K.

Amplitude: 20-volt level shift nominal, 0 volts to -20 volts.

Waveform: Fall Time: 1 microsecond, maximum.

Power Requirements:

+100 volts dc at 8.2 ma.

-100 volts dc at 13 ma.

-25 volts dc at 1.1 ma.

6.3 volts ac at 750 ma
(0 volts dc).

Tubes:

Two: One type 5963, one type 5965.

Circuit Tolerance:

DC supply, $\pm 5\%$;

AC supply, $\pm 20\%$;

Transients, 5%;

Tube g_m , 30%.

Specification:

This unit provides two outputs, one delayed, one not delayed. Both are in the same phase, i.e., are taken from the same plate of the flip-flop. The undelayed output is brought out through a cathode follower. The delayed output is brought out through an integrating network, cathode follower, and an "and" gate. The second input to this "and" gate is supplied from an external source. In addition to use as a ring counter element, the Y-102 is also useful as a frequency divider or gate. When used as a frequency divider it has the advantage of delivering on separate outputs both the typical rectangular wave of an $n/2$ flip-flop and every other input pulse without changing its waveshape.

The flip-flop section has the same characteristics as Y-101. Maximum operating frequency is 150,000 cycles per second because of the delayed output.

Output Signals:

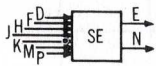
Number: Two: Pin M and pin H.

Amplitude: 20-volt level shift, nominal, 0 volts to -20 volts. Pin H output amplitude is determined by the lesser of the inputs to the "and" gate.

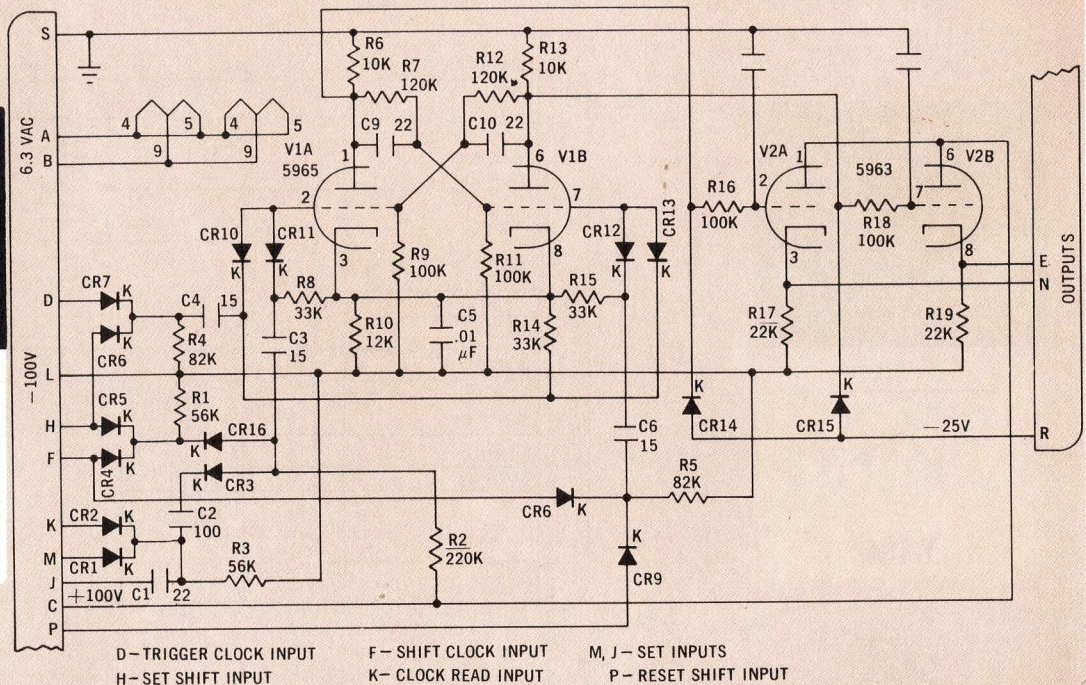
Waveform: Pin M same as Y-101; pin H same as pin K input (only when "and" is open).

Loading Effects: Same as Y-101.

Shift Register Element



Y-103



D - TRIGGER CLOCK INPUT F - SHIFT CLOCK INPUT M, J - SET INPUTS
H - SET SHIFT INPUT K - CLOCK READ INPUT P - RESET SHIFT INPUT

Major Components:

- 1 Flip-Flop
- 2 Cathode Followers
- 2 Integrating Networks
- 4 Two-element "and" Gates
- 1 Two-element "or" Gate

Primary Uses:

- 1. Series in-series out shift register.
- 2. Parallel in-series out shift register.
- 3. Gray code to binary converter and series out shift register.

Power Requirements:

- +100 volts dc at 8.9 ma.
- 100 volts dc at 20 ma.
- 25 volts dc at 1.2 ma.
- 6.3 volts ac at 750 ma (0 volts dc).

Tubes:

Two: One type 5965, one type 5963.

Circuit Tolerance:

- DC supply, $\pm 5\%$;
- AC supply, $\pm 20\%$;
- Transients, 5% ;
- Tube g_m , 30% .

Specification:

This unit is a clamped-plate flip-flop, with delayed outputs. The internal gates make it a self-contained shift register element. Where a group is connected in cascade, the diode "and" gates permit control of the shift register and the actual shift operations are effected by "clock" pulses, fed in parallel to all flip-flops in the register, through these "and" gates. This unit may also be employed for translation of gray code to binary code. See page 56.

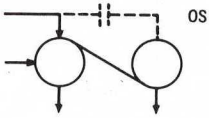
Output Signals:

- Number: Two: Pin E and pin N.
- Amplitude: 20-volt level shift, delayed and complementary, 0 volts or -20 volts.
- Rise and Fall Time Delay: Approximately 6 microseconds.

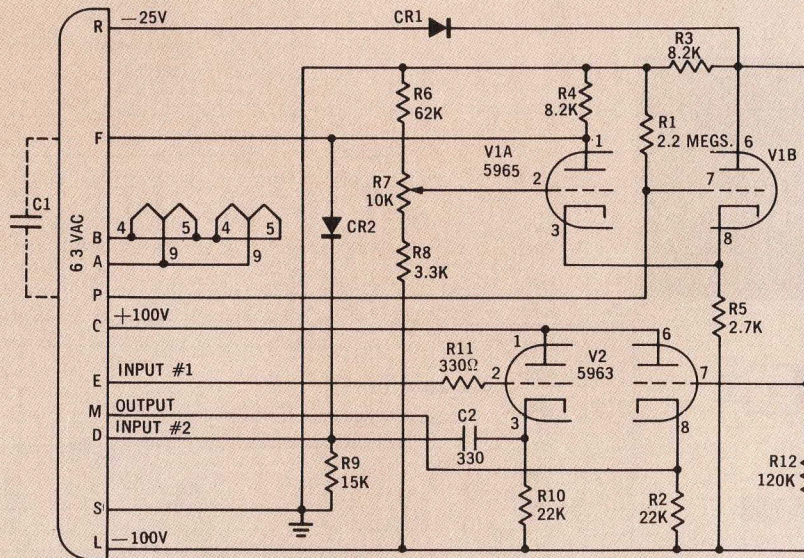
Input Signals:

- Number: Seven: Pins D, F, H, J, K, M, and P.
- Amplitude: All dc level shifts 0 volts or -20 volts, nominal.
- Frequency: 0 to 50,000 cycles per second.
- Square wave degradation on "Clock" inputs: 0.5 microsecond, maximum.

One Shot



Y-104



Major Components:

- 1 Monostable Multivibrator
- 1 Differentiating Network
- 2 Cathode Followers

Primary Uses:

- 1. Delaying Negative Wavefronts.
- 2. Pulse Forming.
- 3. Digit Storage.

Specification:

A one-shot delay multivibrator with cathode-follower input and output. Requires external fixed capacitor to establish control range of internal potentiometer. Delay is screwdriver-adjustable from 30 microseconds to 70 milliseconds, with appropriate capacitors. Unit triggers on negative-going wavefront.

Output Signals:

Number: One: Pin M.

Amplitude: ± 20 -volt level shift, nominal; output rests at -20 volts, nominal.

Maximum Loading,

Resistive: 2 ma to a resistance returned to positive voltage.

4 ma to a resistance returned to negative voltage.

Capacity Loading

Effects: See Capacity Loading Curve.

Stability: $\pm 1\%$ change in delay for $\pm 2\%$ change in dc supply.

Input Signals:

Number: Two: Pin D, direct; pin E, to grid of internal cathode follower (provides constant trigger source impedance).

Amplitude: 20-volt negative trigger, nominal; 16 volts, minimum.

Waveform: Fall time: .5 microsecond, normal; 1.0 microsecond, maximum.

Maximum

Trigger Rate: Determined by delay setting.

External

Capacitor: Connect between pin F and pin P of mating connector.

NOTE: Delay Capacitor Selection Chart furnished with order.

Power Requirements:

± 100 volts dc at 7 ma.

-100 volts dc at 12 ma.

-25 volts dc at 2.7 ma.

6.3 volts ac at 750 ma

(0 volts dc).

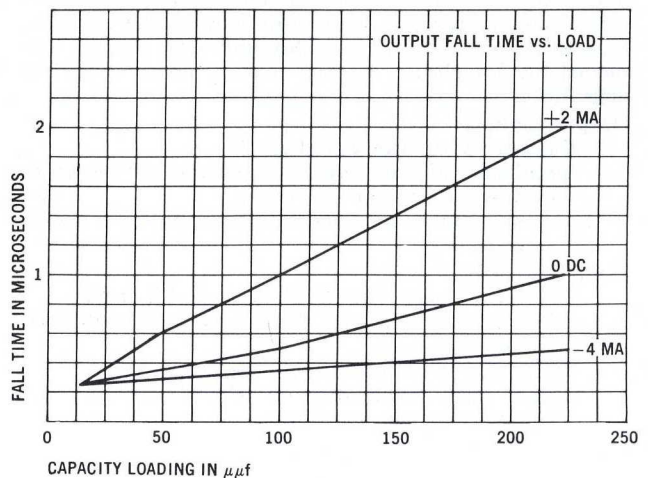
Tubes:

Two: One type 5963, one type 5965.

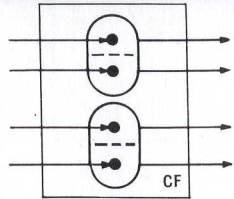
Circuit Tolerance:

DC supply, $\pm 2\%$;

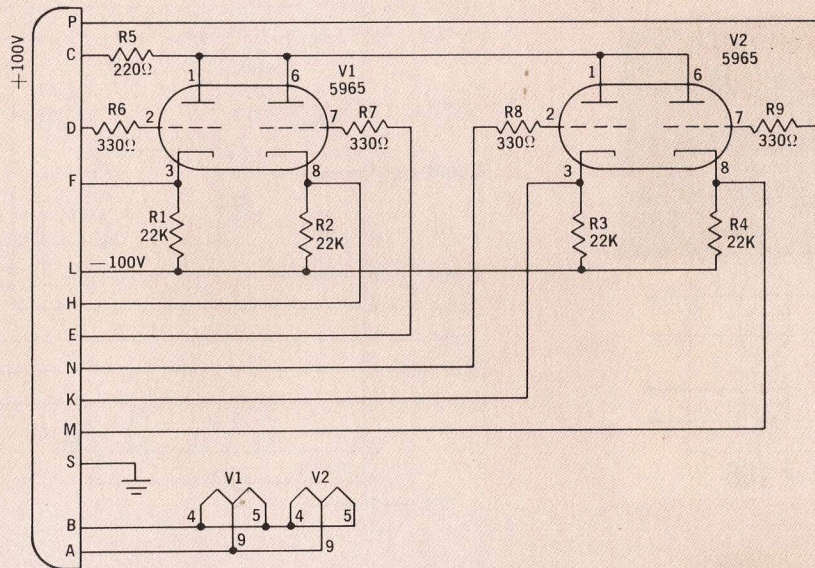
AC supply, $\pm 20\%$.



Multiple Cathode Follower



Y-105



Major Components:
4 Cathode Followers

Primary Uses:
1. Isolation.
2. Impedance Transformation.
3. Driver.

Tubes:
Two: Type 5965.

Circuit Tolerance:
DC supply, $\pm 10\%$;
AC supply, $\pm 20\%$;
Tube g_m , 30%.

Specification:

Four independent cathode followers for dc inputs varying about 0 volts and -20 volts. Similar in operation to Y-106, but designed for light-duty applications. Requires less power to operate, and maintains rise time better under light loads than Y-106.

Output Signals:

Number: Four: Pins F, H, K, and M.
Amplitude: 20-volt level shift, nominal, 0 volts to -20 volts.

Delay Time: 0.55 microsecond.

Maximum Loading,

Resistive: 2 ma to a resistance returned to positive voltage.
4 ma to a resistance returned to negative voltage.

Capacitive

Loading Effects: Fall time of output waveform degrades .4 microsecond with 2 ma dc load above, and negligibly with 4 ma dc load above, as load capacity varies from 0 to 100 μf .

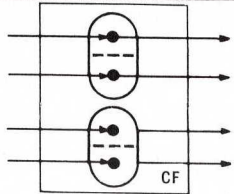
Input Signals:

Number: Four: Pins D, E, N, and P.
Amplitude: 20-volt level shift nominal, varying about 0 volts and -20 volts.

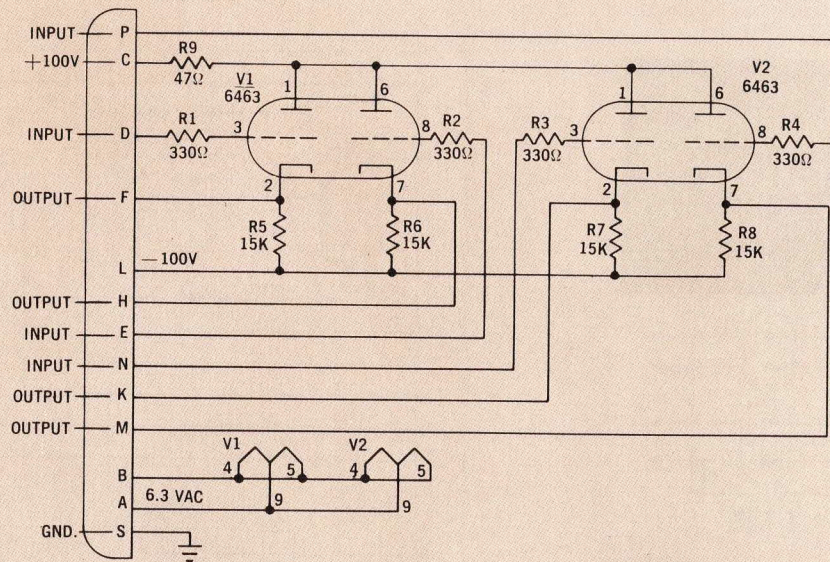
Power Requirements:

+100 volts dc at 20 ma.
-100 volts dc at 20 ma.
6.3 volts ac at 900 ma (0 volts dc).

Multiple Heavy-Duty Cathode Follower



Y-106



Major Components:
4 Cathode Followers

Primary Uses:
1. Isolation.
2. Impedance Transformation.
3. Driver.

Circuit Tolerance:
DC supply, $\pm 10\%$;
AC supply, $\pm 20\%$.

Specification:

This unit has four independent cathode followers designed for driving heavy loads such as "and" gates from inputs of from 0 to -20 volts dc. For light loads, see Y-105.

Output Signals:

Number: Four: Pins F, H, K, and M.

Amplitude: 20-volt level shift, nominal.

Maximum Loading,

Resistive: 3 ma to a resistance returned to positive voltage.

8 ma to a resistance returned to negative voltage.

Capacitive

Loading Effects: At 100 kc, with input rise time of 0.5 microsecond, output degrades by .8 microsecond with 200- μ f load and +3 ma dc load above.

Output degrades .02 microsecond with 200- μ f load and -8 ma dc load above.

Input Signals:

Number: Four: Pins D, E, N, and P.

Amplitude: 20-volt level shift, nominal, 0 volts to -20 volts.

Power Requirements:

+100 volts dc at 27 ma.

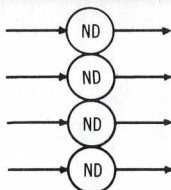
-100 volts dc at 27 ma.

6.3 volts ac at 1,200 ma.

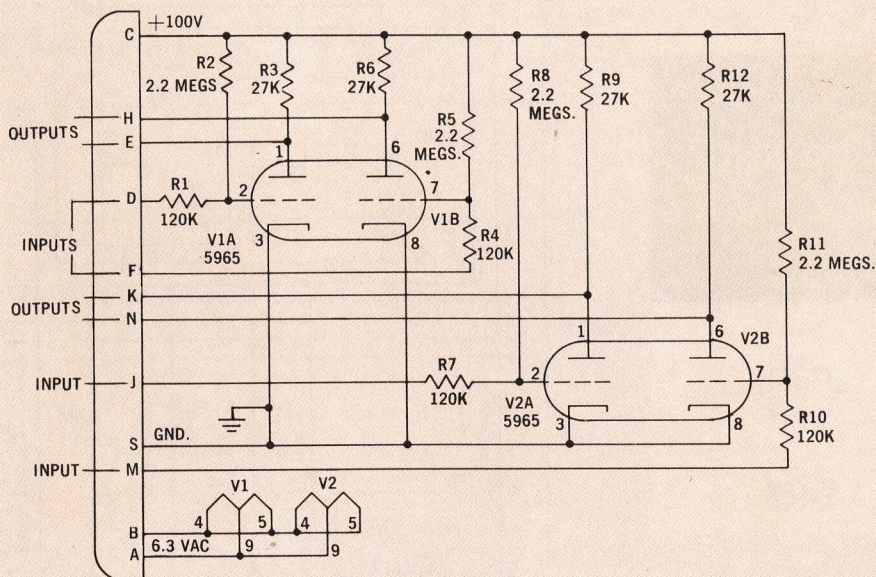
Tubes:

Two: Type 6463.

Neon Driver



Y-107



Major Components:
4 Neon Driving Amplifiers

Primary Uses:
Driving Neon Lamps as
Status Indicators.

Specification:

This unit contains four independent, identical neon driver circuits. Each circuit will drive two external neon lamps, such as the NE-2 or NE-51, for dual indication of the input dc level. An appropriate current-limiting resistor is required for each neon lamp. This unit is typically used for indicating the operating state of units such as Y-100, Y-101, Y-102, and Y-103, whose outputs vary about 0 volts and -20 volts.

Output Signals:

Number: Four: Pins E, H, K, and N.
Maximum Loading: Two NE-51 lamps per output;
100,000-ohm current-limiting resistor with each lamp.

Input Signals:

Number: Four: Pins D, F, J, and M.
Amplitude: "Zero" (lamps extinguish); +4 volts to -6 volts.
"One" (lamps glow); -10 volts to -25 volts.

Power Requirements:

+100 volts dc at 12 ma. (Maximum drain with all lamps extinguished.)
6.3 volts ac at 900 ma.

Tubes:

Two: Type 5965.

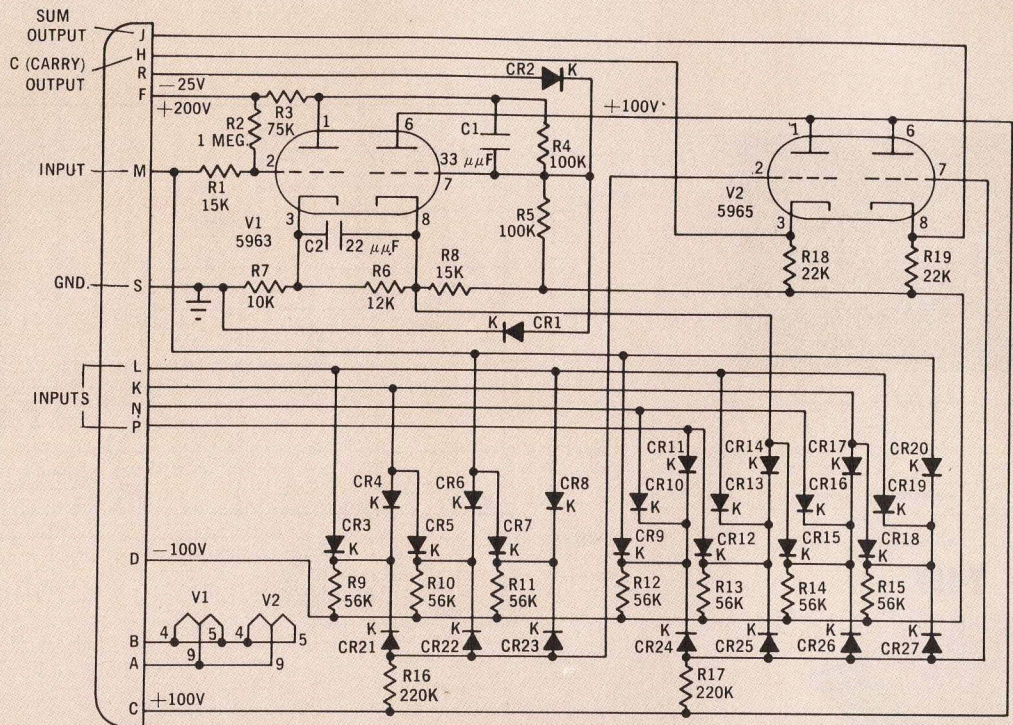
Circuit Tolerance:

DC supply, $\pm 5\%$;
AC supply, $\pm 20\%$;
Tube g_m , 30%.

One-Digit Adder Matrix



Y-108



Major Components:

- 1 Inverter
- 2 Cathode Followers
- 4 Three-element "and" circuits
- 3 Two-element "and" circuits
- 1 Three-element "or" circuit
- 1 Four-element "or" circuit

Specification:

The primary purpose of this unit is to add binary numbers. When properly connected, these units will add either serially or in parallel at high speed. Each unit accepts either a "1" or a "0" as each of the two primary inputs and also either a "1" or a "0" as the carry output of a preceding stage.

Each unit produces a sum and a carry output.

The speed of operation is 0.1 microsecond.

When used in parallel, carry amplitude diminishes as the carry progresses from step to step and amplification is required every five digits. DC "Not" Circuit Y-110 is recommended as a carry amplifier. "Not A" and "Not B" inputs are also required for internal logical functions. "Not C" is generated internally. The logical equations for this unit are:

1. $Sum = A \bar{B} \bar{C} + \bar{A} B \bar{C} + \bar{A} \bar{B} C + A B C$
2. $Carry = A B + B C + A C$

For explanation of logical notation, see page 56.

Output Signals:

- Number: Two: Sum, pin J, and carry, pin H.
- Amplitude: 20-volt level shift, nominal;
- "zero" 0 volts, "one" -20 volts.

Primary Uses:

- Binary addition, either serially or in parallel.

Maximum Loading,

- Resistive: 1 ma to a resistance returned to positive voltage.
- 3 ma to a resistance returned to negative voltage.

Operate Time: .1 microsecond.

Input Signals:

- Number: Five: A, pin K; B, pin L; C, pin M; \bar{A} , pin P; \bar{B} , pin N.
- Amplitude: 20-volt level shift, nominal;
- "zero" 0 volts, "one" -20 volts.

NOTE: "Not C" (\bar{C}) is generated internally.

Power Requirements:

- 25 volts dc at 0.4 ma.
- +200 volts dc at 2.5 ma.
- +100 volts dc at 19 ma.
- 100 volts dc at 28 ma.
- 6.3 volts ac at 750 ma (0 volts dc).

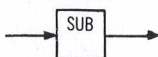
Tubes:

- Two: Type 5963 and type 5965.

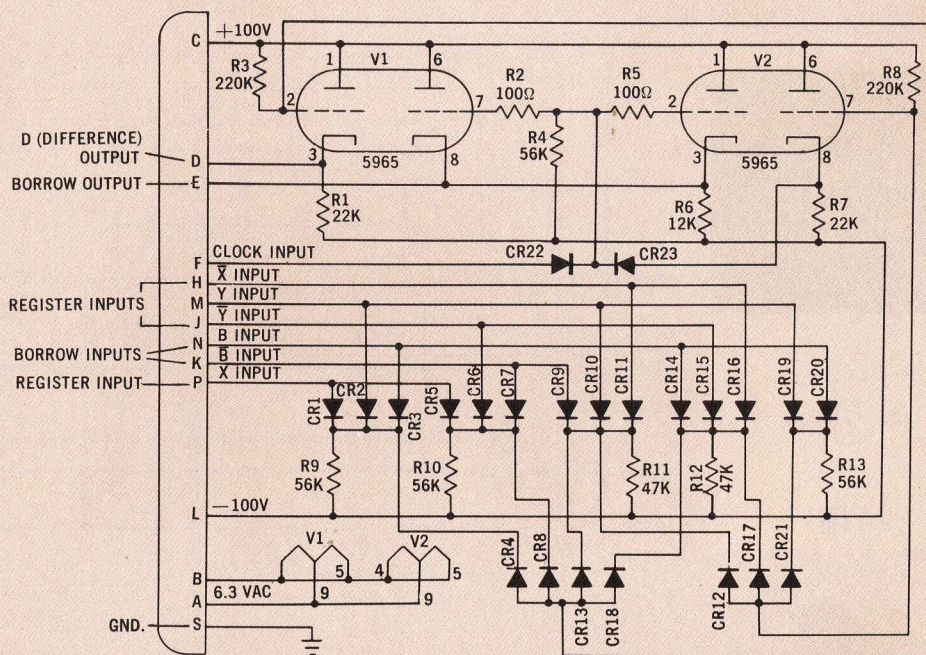
Circuit Tolerance:

- DC supply, $\pm 5\%$;
- AC supply, $\pm 20\%$;
- Transients, 5%;
- Tube g_m , 30%.

One-Digit Subtractor Matrix



Y-109



Major Components:

- 2 Two-element "and" Gates
- 4 Three-element "and" Gates
- 1 Four-element "or" Gate
- 1 Three-element "or" Gate
- 4 Cathode Followers

Primary Uses:

Subtracting binary numbers, either serially or in parallel.

Output Signals:

- Difference: Pin D.
- Borrow: Pin E.

Power Requirements:

- +100 volts dc $\pm 5\%$ at 19 ma.
- 100 volts dc $\pm 5\%$ at 28 ma.
- 6.3 volts ac $\pm 20\%$ at 0.9 ampere at 0 microvolts dc.

Output Voltage Levels:

- "Zero" = 0 volts dc, nominal.
- "One" = -20 volts dc, nominal.

Borrow Output Pulse:

Fall time is that of input clock pulse plus 0.1 microsecond.

Output Loading:

Loading (Both Outputs)	Difference Output Voltage	Borrow Output Voltage
3 ma dc load to a negative source	+0.5 to -18.8	+0.88 to -18.25
No dc load	+1.00 to -18.6	+1.25 to -17.4
1 ma dc load to a positive source	+1.2 to -18.2	+1.4 to -18

NOTE: Table assumes input levels of 0 and -20 volts dc and -20 volts clock pulse.

Tube Variations:

Tolerates 30% g_m change in tubes without change in operation.

Specification:

The primary purpose of this unit is to subtract binary digits. It samples three binary digits and produces a difference number and a borrow number as outputs. The three input numbers are minuend, subtrahend, and the borrow resulting from a previous subtraction on a lower-order digit.

For serial subtraction, the borrow output is a gated pulse used to drive a storage device long enough to perform the subtraction of the next higher-order digit.

Speed of operation is 0.1 microsecond.

The negation ("not") of the three input digits is required for internal logical functions. The logical equations for this unit are:

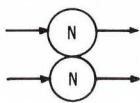
1. Difference = $X\bar{Y}\bar{B} + \bar{X}Y\bar{B} + \bar{X}\bar{Y}B + XYB$
2. Borrow = $\bar{X}Y\bar{B} + \bar{X}\bar{Y}B + \bar{X}YB + XYB$
or Borrow = $\bar{X}Y\bar{B} + \bar{X}\bar{Y}B + YB$. (Equation 2 reduced.)

See page 56 for explanation of logical notation.

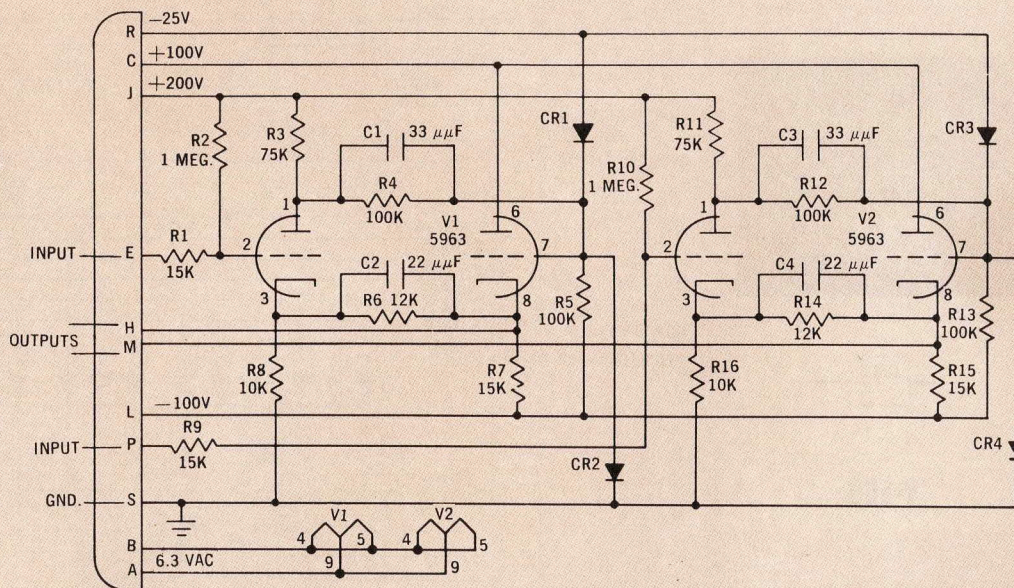
Input Signals:

- Minuend: X, pin P; \bar{X} , pin H.
- Subtrahend: Y, pin M; \bar{Y} , pin J.
- Borrow: B, pin N; \bar{B} , pin K (both delayed).
- Clock: Pin F (to read out "borrow").

DC "Not" Circuit



Y-110



Major Components:

- 2 Regenerative Clamped Squaring Circuits
- 2 Cathode Followers

Primary Uses:

1. "Not" Circuit.
2. DC Level Restorer.
3. Rise-and-Fall Time Restorer.
4. Dual Squaring Circuit.
5. Non-inverting Pulse Amplifier.

Specification:

This unit has two separate regenerative clamped squaring amplifiers with cathode follower outputs. Typical application is to produce a standard square pulse from deteriorated inputs. The outputs have two discrete states, 0 volts and -20 volts. The 0-volt output is produced for inputs between -14 volts and -25 volts and the -20-volt output for inputs between +10 volts and -5 volts, thereby inverting as well as squaring the input, by a regenerative action. The shape of the input pulse is not critical. Where inversion of the signal is not desirable, the two sections of the unit may be connected in cascade to supply a rectangular wave output of the same polarity as the input signal.

Output Signals:

Number: Two: Pin H and pin M.
Amplitude: 20 volts, 0 volts or -20 volts.

Maximum Loading,

Resistive: 1 ma to a resistance returned to positive voltage.

4 ma to a resistance returned to negative voltage.

Capacitive

Loading Effects: Square wave degradation is .4 microsecond to .8 microsecond with 0- or 100- μ F loading, respectively.

Input Signals:

Number: Two: Pin E and pin P.

Amplitude: "Zero" level, -5 volts to +10 volts.

"One" level, -14 volts to -25 volts.

Trigger Level: -8.5 volts \pm 1.5 volt dc level. Excursion to the trigger level will cause regenerative inversion of the input signal. Unit should not be operated on steady-state signals between -5 volts and -14 volts.

Maximum Input

Frequency: 250,000 cycles per second.

Power Requirements:

+200 volts dc at 4 ma.

+100 volts dc at 10 ma.

-100 volts dc at 14 ma.

-25 volts dc at 0.7 ma.

6.3 volts ac at 600 ma

(0 volts dc).

Circuit Tolerance:

DC supply, \pm 5% ;

AC supply, \pm 20% ;

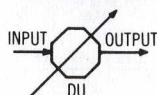
Transients, 5% ;

Tube g_m , 30%.

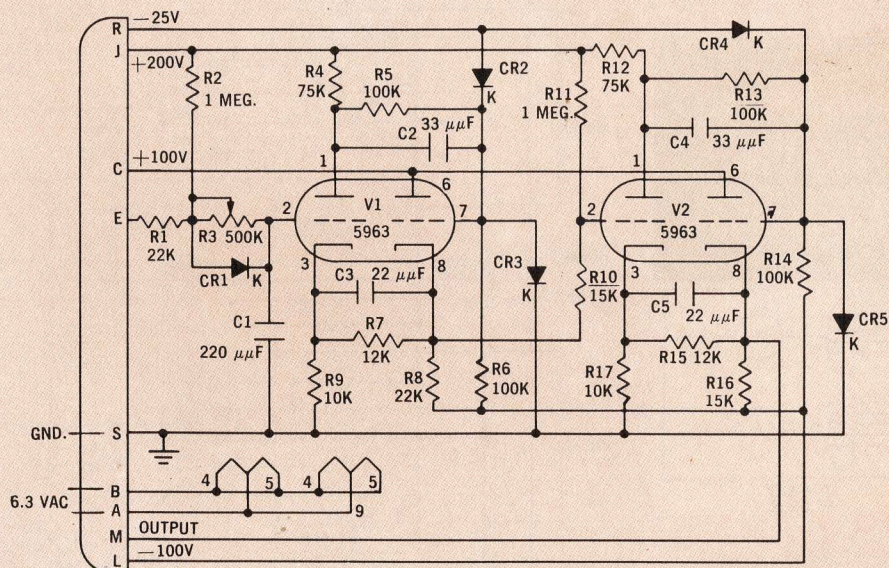
Tubes:

Two: Type 5963.

Delay Unit



Y-111



Major Components:

- 1 Integrating Network
- 2 Regenerative Squaring Amplifiers
- 2 Cathode Followers

Primary Uses:

1. Delay negative-going signals.
2. Pulse stretcher.
3. Pulse shortener.
4. Pulse width detector.
5. Diode Logic Driver.

4 ma to a resistance returned to negative voltage.
 Stability: 20% change in delay for 5% change in -100 volts dc or +100 volts dc.
 10% change in delay for 5% change in +200 volts dc.

Input Signals:

Number: One; Pin E.
 Amplitude: "Zero," +10 volts to -5 volts (gives 0-volt output).
 "One," -14 volts to -25 volts (gives -20-volt output).
 (Values between -5 volts and -14 volts should be avoided.)
 Trigger Level: -8 volts \pm 1 volt.
 Waveform: 1 microsecond maximum rise and fall time.
 Frequency: Maximum input rate is governed by the delay setting.

Power Requirements:

+200 volts dc at 4 ma.	-25 volts dc at 0.3 ma.
+100 volts dc at 8.4 ma.	6.3 volts ac at 600 ma
-100 volts dc at 12 ma.	(0 volts dc).

Tubes:

Two: Type 5963.

Circuit Tolerances:

DC supply, \pm 5%;
 AC supply, \pm 20%;
 Transients, 5%;
 Tube g_m , 30%.

Specification:

A time delay device for providing a short delay of a negative-going dc level shift. This unit generates an output which is delayed by 2.5 microseconds to 45 microseconds from a corresponding input negative-going dc level shift. Delay is screwdriver-adjusted. Input and output change from 0 volts to -20 volts, with no phase reversal. The output waveform of a negative-going pulse is narrower than the input because the positive-going portion of the input waveform is not delayed. Positive-going pulses are lengthened.

Some use of this circuit as a pulse-width detector has been made, since only those pulses that are longer than the established delay will appear in the output.

Output Signals:

Number: One; Pin M.

Amplitude: DC level shift, 0 volts to -20 volts.

Delay: Adjustable from 2.5 microseconds to 45 microseconds.

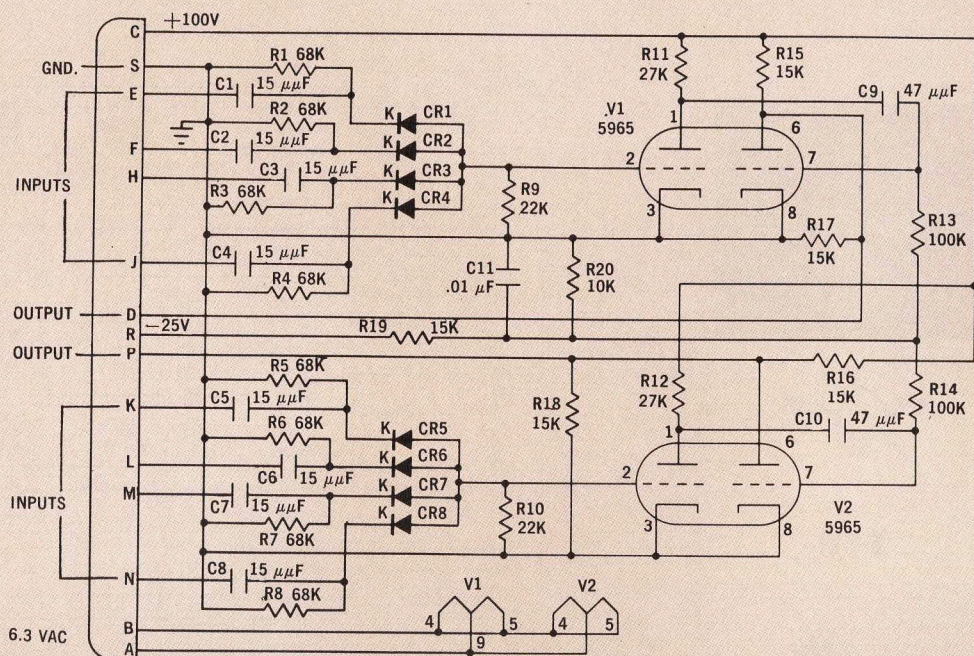
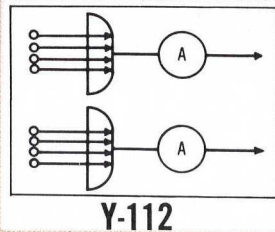
Fall Time: Varies 0.4 microsecond to 0.8 microsecond, maximum, under conditions of maximum dc loading, with 0- to 100- μ f capacitive loading.

Rise Time: Approximately 1 microsecond.

Maximum Loading,

Resistive: 1 ma to a resistance returned to positive voltage.

Pulse Mixer Amplifier (Trigger Pulse Generator)



Major Components:

- 2 Two-stage, Pulse-shaping Amplifiers
- 2 Four-Element "or" Circuits
- 8 Differentiating Networks

Primary Uses:

- 1. General multiple-input trigger source.
- 2. Combining Signals to be applied to a flip-flop.

Tubes:

Two: Type 5965.

Circuit Tolerance:

DC supply, $\pm 5\%$;
AC supply, $\pm 20\%$;
Transients, 5% ;
Tube g_m , 30% .

Specification:

Contains two separate identical units. Each unit accepts up to four input signals from separate sources and provides a one-microsecond negative-going pulse for each negative-going wavefront occurring on any of the four associated inputs. Typical use is to provide input to a flip-flop. Minimum spacing between incoming negative-going signals is 5 microseconds. This unit differs from an "or" gate in that it senses inputs applied after the first one. NOTE: This is an ac device, i.e., output is not suitable for diode gate control.

Output Signals:

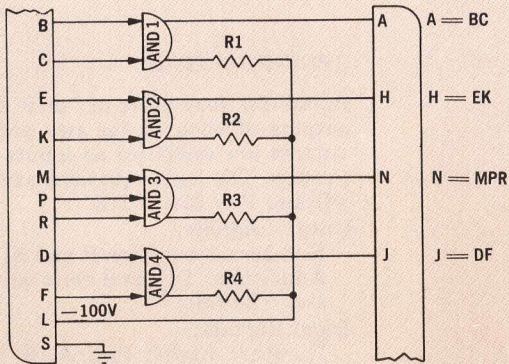
Number: Two: Pins D and P.
Amplitude: 25-volt level shift, +50 volts to +25 volts.
Pulse Width: 1 microsecond, fall time .2 microsecond.
Output Impedance: Approximately 7,000 ohms.

Input Signals:

Number: Eight: Pins E, F, H, and J (for output A); and pins K, L, M, and N (for output B).
Amplitude: 20-volt level shift, nominal, 0 volts to -20 volts; 14-volt minimum signal.
Pulse Characteristics: Minimum spacing 5 microseconds; fall time 1 microsecond or less.

Power Requirements:

+100 volts dc at 12 ma.
-25 volts dc at 1 ma.
6.3 volts ac at 900 ma (0 volts dc).



ALL RESISTORS 82K

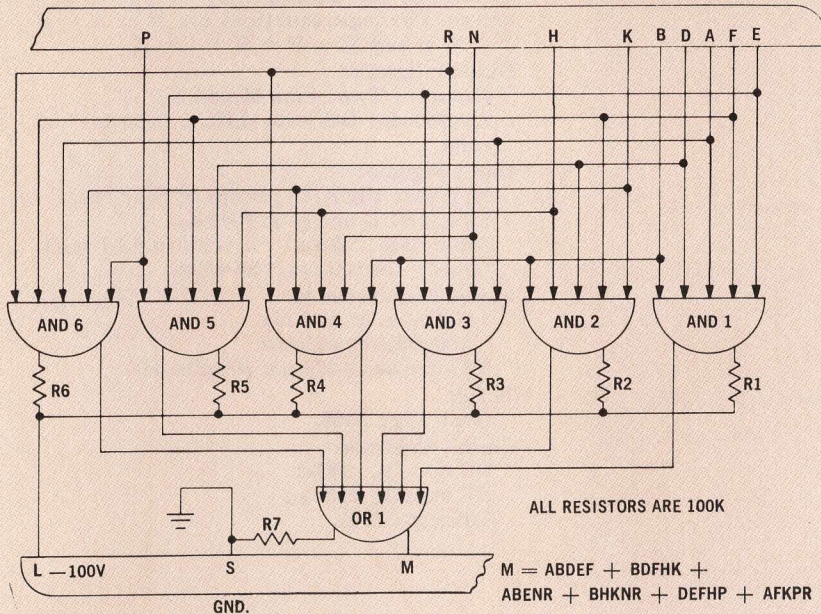
Y-405



Diode Logics



Y-414



ALL RESISTORS ARE 100K

$M = ABDEF + BDFHK + ABENR + BHKNR + DEFHP + AFKPR$

SPECIFICATION

Inputs for four "and" circuits, one of which has three inputs, the others two inputs each. The logic equations are $A = BC$, $H = EK$, $N = MPR$, and $J = DF$.

Output Signals:

Number: Four: Pins A, H, N, and J.

Amplitude: DC level shift between 0 volts and -20 volts.

Input Signals:

Number: Nine: Pins BC, EK, MPR, and DF.

Amplitude: "Zero," -5 volts to +10 volts. "One," -14 volts to -25 volts.

Power Requirements:

-100 volts dc at 9 ma (peak).

Tubes:

None.

Circuit Tolerance:

DC supply, $\pm 5\%$.

SPECIFICATION

Inputs for six "and" circuits, each of which combines five of the ten inputs. Coincident inputs to any one or more of these "and" circuits will give "or" output. The logic equation is $M = ABDEF + BDFHK + ABENR + BHKNR + DEFHP + AFKPR$.

Output Signals:

Number: One: Pin M.

Amplitude: DC level shift between 0 volts and -20 volts.

Input Signals:

Number: Ten: Pins E, F, A, D, B, K, H, N, R, and P.

Amplitude: "Zero," -5 volts to +10 volts. "One," -14 volts to -25 volts.

Power Requirements:

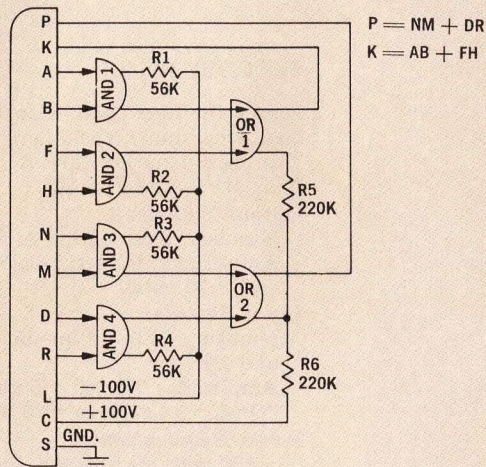
-100 volts dc at 30 ma (peak).

Tubes:

None.

Circuit Tolerance:

DC supply, $\pm 5\%$.



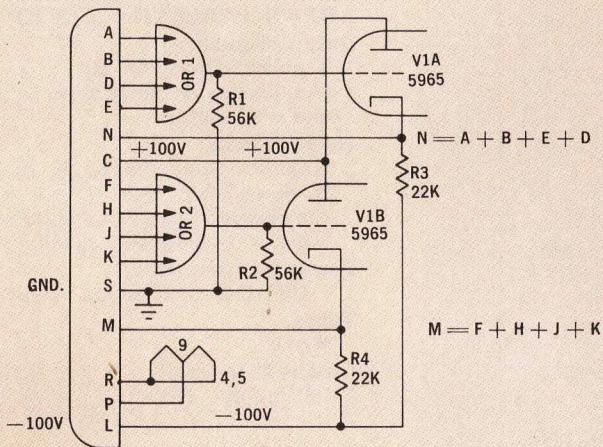
Y-417



Diode Logics



Y-426



SPECIFICATION

Inputs for four pairs of "and" circuits. The outputs of each of the two pairs of "and" circuits are combined as inputs to two "or" circuits. The logic equations are $K = AB + FH$ and $P = MN + DR$.

Output Signals:

Number: Two: Pins P and K.

Amplitude: DC level shift between 0 volts and -20 volts.

Input Signals:

Number: Eight: Pins A, B, F, H, N, M, D, and R.

Amplitude: "Zero," -5 volts to +10 volts.

"One," -14 volts to -25 volts.

Power Requirements:

+100 volts dc at 2 ma.

-100 volts dc at 10 ma.

Tubes:

None.

Circuit Tolerance:

DC supply, $\pm 5\%$.

SPECIFICATION

Two four-input "or" circuits with cathode-follower output, for application where low-impedance or high-current output is required. The logic equations are $N = A + B + D + E$ and $M = F + H + J + K$.

Output Signals:

Number: Two: Pins M and N.

Amplitude: DC level shift, 0 volts to -20 volts.

Input Signals:

Number: Eight, in groups of four each: Pins ABDE and pins FHJK.

Amplitude: "Zero," -5 volts to +10 volts.

"One," -14 volts to -25 volts.

Power Requirements:

+100 volts dc at 4 ma.

-100 volts dc at 4 ma.

6.3 volts ac at 475 ma (0 volts dc).

Tubes:

One: Type 5965.

Circuit Tolerance:

DC supply, $\pm 5\%$;

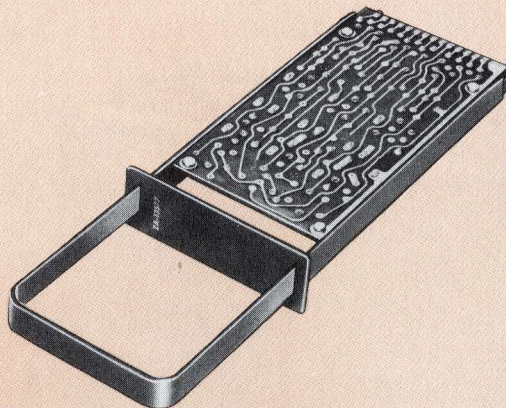
AC supply, $\pm 20\%$;

Tube, g_m , 30%.

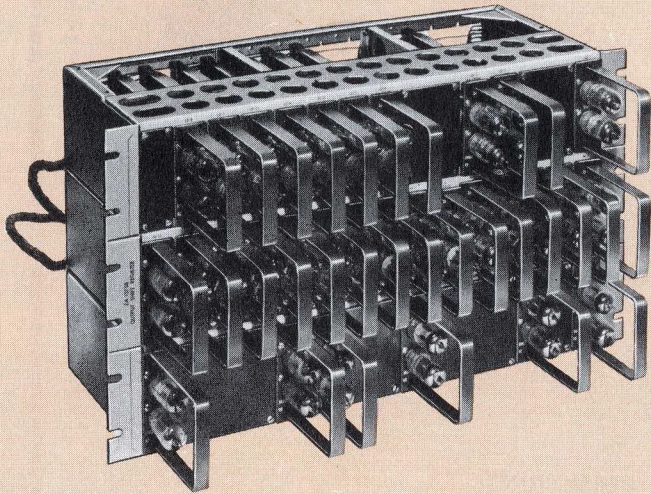
Diode Logics & Equations

The table on this page includes a representative list of logic equations obtainable from EECO diode logic circuits. Although a wide range of equations is covered, it is only natural that individual problems will dictate the need for equations other than those listed.

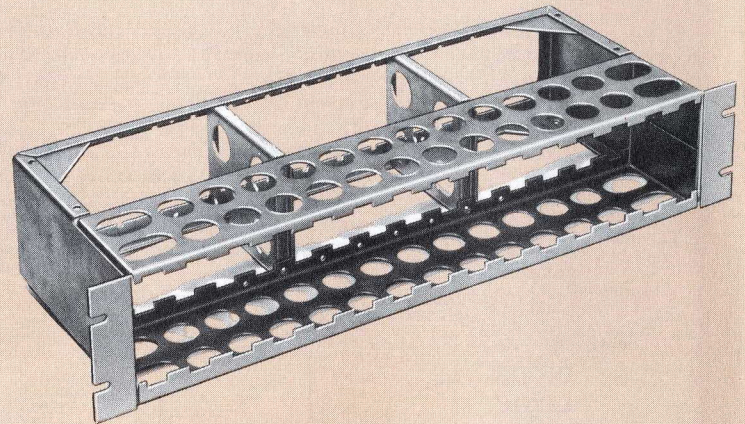
In this connection, Engineered Electronics Company is prepared to produce diode logic plug-in units that will yield other desired logic equations. It is necessary merely to furnish us the equation or equations you require. We will design the circuit and produce the plug-in to meet your individual problem.



DIODE LOGIC CATALOG NO.	"AND" CIRCUITS	"OR" CIRCUITS	LOGIC EQUATIONS
Y-400	3	2	$N = M + K, R = BDFJ + EP, A = BDEF, H = EP$
Y-401	2	2	$H = F + J + N, R = K + P, A = CD, M = BE$
Y-402	6	0	$A = BCDE, F = BCEJ, K = BCDN, M = BCJN, H = CDEP, R = CEJP$
Y-403	3	0	$N = JKMPR, F = BCEH, A = BCDE$
Y-404	4	1	$B = (ACDE) (FHJ), M = KR, N = KP$
Y-405	4	0	$A = BC, H = EK, N = MPR, J = DF$
Y-406	3	4	$P = (A + D) B + (F + J) H + (N + R) M + E + K$
Y-407	1	3	$F = (A + D) E, N = B + J, P = H + K + M + R$
Y-408	3	3	$N = (A + E) B, H = (F + J) D, M = (K + R) P$
Y-409	3	1	$H = (A + F) EJK, P = (A + F) BDJ, N = MR$
Y-410	4	2	$M = H + K, R = J + K, F = BJ, A = BH, D = BEN, P = EN$
Y-411	4	2	$M = B + HJ, K = EJ, A = D + JN, R = JP$
Y-412	6	0	$A = CD, H = CE, N = CM, P = BC, J = CF, R = CK$
Y-413	2	1	$A = BDEF, N = K + P, M = HJ$
Y-414	6	1	$M = ABDEF + BDFHK + ABENR + BHKNR + DEFHP + AFKPR$
Y-415	4	0	$A = BD, F = EJ, H = MN, R = KP$
Y-416	5	1	$P = AB + FJ + NM + HE + DR + K$
Y-417	4	2	$K = AB + FH, P = MN + DR$
Y-418	4	1	$P = ABDE + BDFH + K + R, J = BDFH, N = BM$
Y-419	0	4	$A = B + D + E, J = F + H, M = L + N, R = K + P$
Y-420	4	1	$N = BEM + EFJ + DJM + BDF$
Y-421	1	2	$A = (BDEP) (HJKF), R = F + M, N = K + M$
Y-422	5	0	$A = BD, H = EF, N = JK, M = PR, S = CL$ NOTE: Y-422 requires external load resistors, etc.
Y-423	4	1	$P = AB + FH + NJ + MR$
Y-424	3	1	$P = AB + EF + MN + R$
Y-425	3	1	$N = ABD, E = FHJ + KMR + P$
Y-426	0	2	$N = A + B + D + E, M = F + H + J + K$
Y-427	4	0	$A = BED, J = BDH, N = BEM, R = PFK$



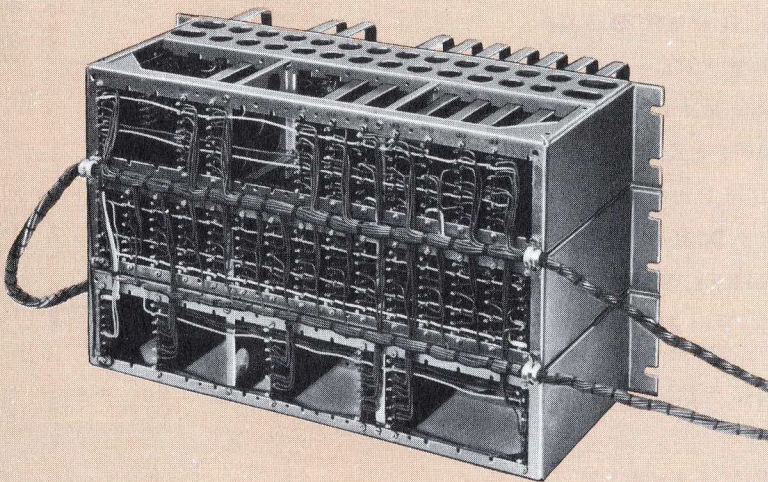
THREE MOUNTING FRAME ASSEMBLIES WERE STACKED TO HOUSE THIS OUTPUT SHIFT REGISTER. NOTE THE USE OF BLANK PANELS OF VARIOUS WIDTHS WHERE COMPUTER-SERIES PLUG-IN UNITS WERE NOT REQUIRED.



MOUNTING FRAME

Computer-Series Accessory Equipment

REAR VIEW OF OUTPUT SHIFT REGISTER SHOWS SIMPLICITY OF POINT-TO-POINT WIRING.



Mounting Frame, Y-900

The Mounting Frame and blank panels illustrated provide for the mounting of up to 15 Computer-Series plug-in units across a standard 19-inch rack. The over-all panel height is 3-1/2 inches. The Mounting Frame is designed to permit effective ventilation.

Frames can be stacked by merely bolting them together with a 1/32" washer used as a spacer. They are furnished with standard notching.

Dimensions: Width 16-7/8 inches.
Height 3-1/2 inches.
Panel mounting drilled on 1-3/4 inch centers.
Depth 6-25/32 inches (exclusive of connectors).

Material: 16-gauge C.R.S. throughout, spot welded.

Finish: Cadmium plated per Fed. Spec. QQ-P-416 Type II, Class B, followed by EECO standard gray enamel.

Plug-in Capacity: 15 units, each approximately 1-3/32 inches wide.

Connectors, Y-906

The mating Connectors for the plug-in units fasten at the rear of the Mounting Frame. One is required for each plug-in unit used. Connectors can be ordered from Engineered Electronics Company by No. Y-906. The names of other qualified suppliers of this item will be furnished upon request.

Blank Panels, Y-901 through Y-905

Blank Panels are available for use where less than 15 plug-in units are to be installed in a Mounting Frame assembly. They can be used as blank fillers or as mounts

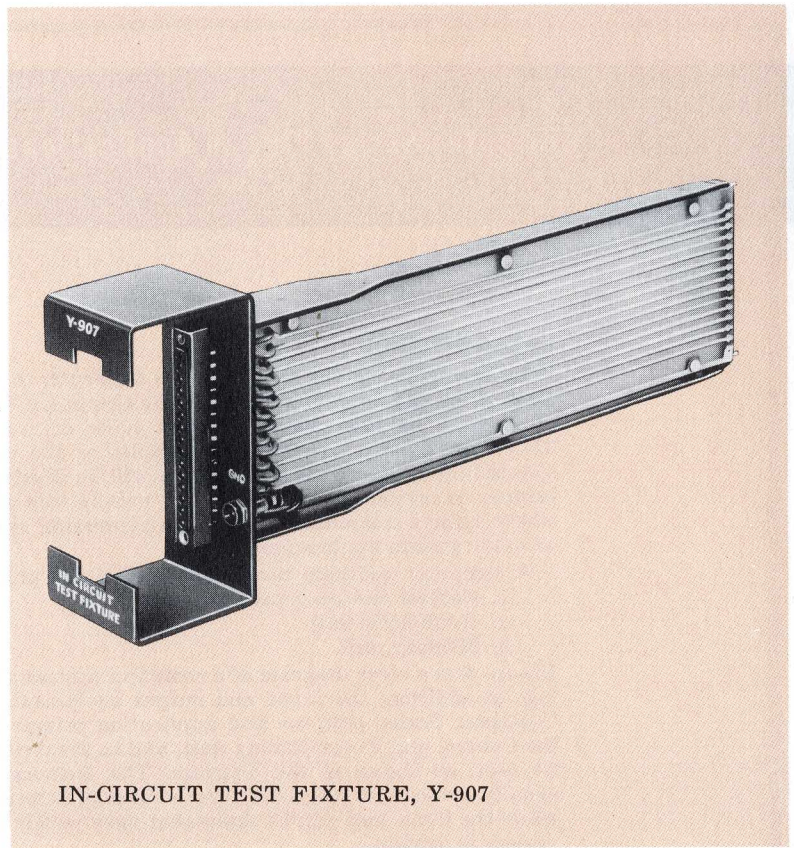
for circuit elements such as potentiometers, auxiliary indicators and controls, switches, etc., if desired. Visible portions of the panels are finished in EECO standard gray enamel, with the balance covered by a protective Iridite coating. The panels are made of 14-gauge 52S-H34 aluminum. They are supplied in five sizes (widths) in multiples of the regular plug-in panel width, as follows:

PANEL NO.	WIDTH
Y-901	1-3/32"
Y-902	2-7/32"
Y-903	3-11/32"
Y-904	4-15/32"
Y-905	5-19/32"

Panels are drilled for installation in the Mounting Frame assembly.

In-Circuit Test Fixture, Y-907

This Test Fixture permits in-circuit troubleshooting, with access to all components on etched board. Holds one plug-in unit. To use, remove suspected plug-in unit and replace with Test Fixture. Then insert suspected plug-in unit in Test Fixture. By providing straight-through signal and power extensions for all plug-in terminals, the Test Fixture acts as an extension to position the Plug-in unit outside and in front of the Mounting Frame, where it is completely accessible for testing while in operation.



IN-CIRCUIT TEST FIXTURE, Y-907

Mechanical Specifications of Computer-Series Plug-in Units

Computer-Series plug-in units are designed to plug into the Y-900 Mounting Frame. In the selection of parts and in the assembly techniques, every effort is made to maintain the highest quality of construction.

MECHANICAL SPECIFICATIONS:

Over-all length: 10 inches.

Over-all height: 3-7/32 inches.

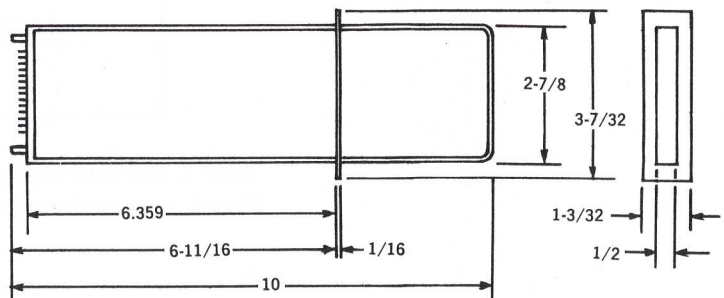
Over-all width: 1-3/32 inches. (Connector only, 1/2 inch.)

Finish: Gray baked enamel. (Other colors are available upon special request.)

Etched Board Material: Epoxyglass, 1/16" thick.

Plug-in Frame and Handle Material: Aluminum.

Connector: 15-pin.



Computer-Series Plug-in Applications

INTRODUCTION

It is impossible, in the limited space available, to show application examples of all units in the Computer Series, or to show applications in different types of systems. Therefore, only representative examples of the use of selected units, in a computer system, will be illustrated. Inquiry is invited on the use of any unit in this series, whether for a computer system, data processing system, or other system application.

- A computer contains three basic functional units:
1. Control and programming unit.
 2. Arithmetic unit.
 3. Memory unit.

Figure A is a block diagram of a computer system, showing, in addition, the input and output equipment. The Computer Series plug-ins find application primarily in the Control and Programming unit, and in the Arithmetic unit, as shown in the diagram. The Memory unit usually consists of magnetic cores or a magnetic drum, while the input and output equipment vary widely from system to system.

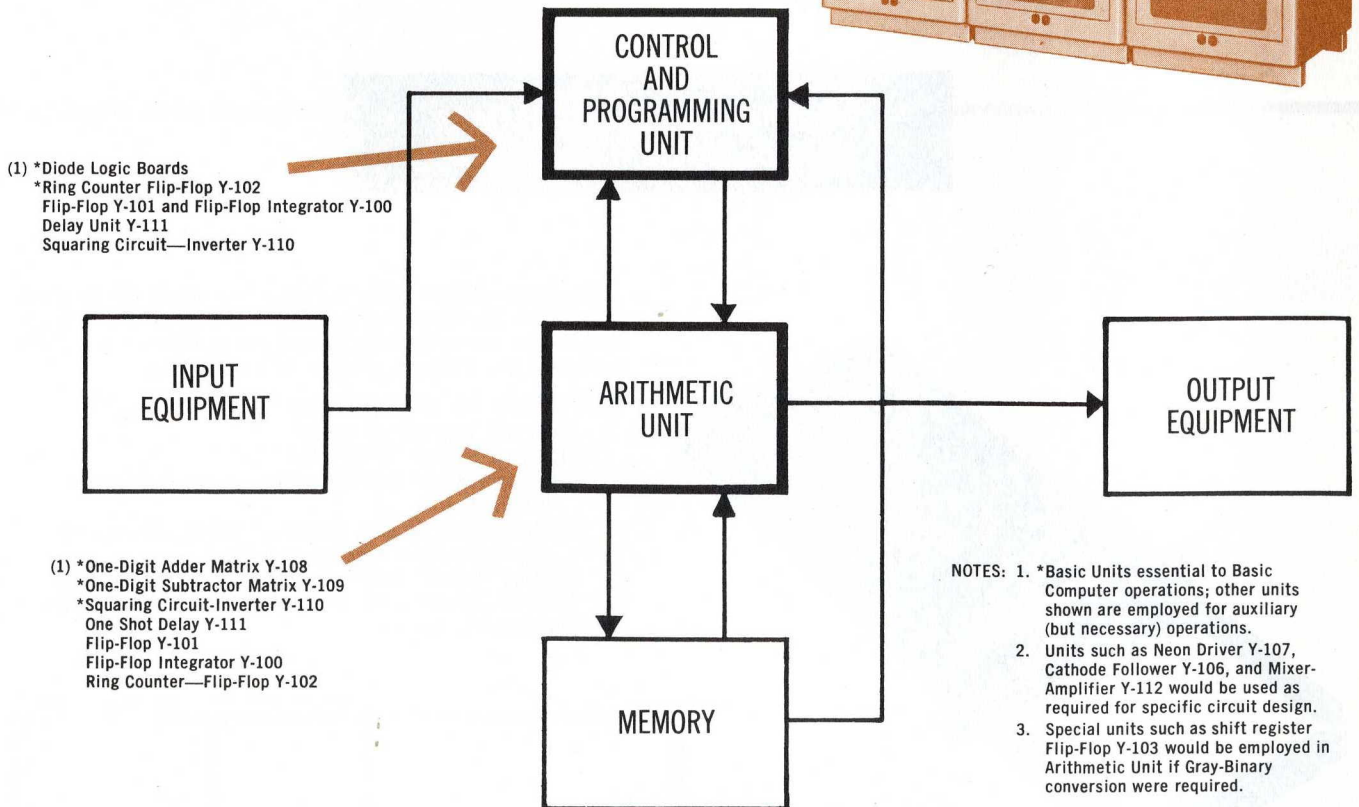
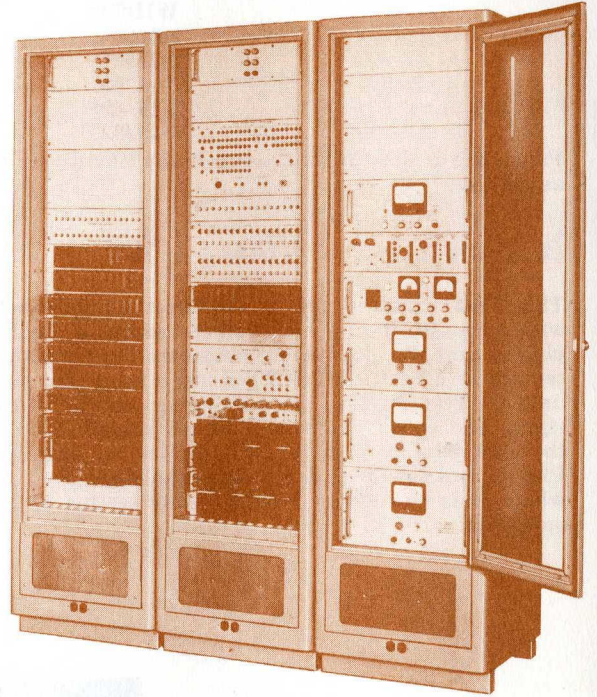


FIGURE A—COMPUTER SYSTEM BLOCK DIAGRAM, SHOWING APPLICATION OF COMPUTER-SERIES PLUG-INS.

Diode Logic

Diode logic units are employed wherever Boolean Algebra is to be used. (Many of the plug-ins contain diode logic elements as well as the active circuits.) A "one" indicates the presence of a quantity; a "zero" indicates the absence of a quantity. A third concept (the "not" function) is used to negate or show the opposite of a quantity. A horizontal bar is placed above the number involved to indicate the "not" function in writing, thus: $\bar{1}$ or $\bar{0}$.

Logic equations for Boolean addition and multiplication, which show "and" and "or" logic, respectively, are given at the top of the next column. "And" logic is analogous to series-connected switches controlling a light bulb; "or" logic to parallel-connected switches.

ADDITION (Or)

$$\begin{aligned} 0 + 0 &= 0 \\ 0 + 1 &= 1 \\ 1 + 1 &= 1 \\ 1 + \bar{1} &= 1 \\ \bar{0} + 1 &= 1 \end{aligned}$$

MULTIPLICATION (And)

$$\begin{aligned} 0 \times 0 &= 0 \\ 0 \times 1 &= 0 \\ 1 \times 1 &= 1 \\ 1 \times \bar{1} &= 0 \\ \bar{0} \times \bar{0} &= 1 \end{aligned}$$

Typical circuits, symbols, and waveforms encountered in the application of diode logic are shown below. The particular logic operations covered in the example pertain to Diode Logic unit Y-413 (Figure B), the logic equations of which are:

$$A = BDEF$$

$$A = K$$

$$N = K + P$$

$$P = M$$

$$M = HJ$$

$$\text{then } N = BDEF + HJ$$

(The letter designations apply to pin marking on the 15-pin connector.)

"and"

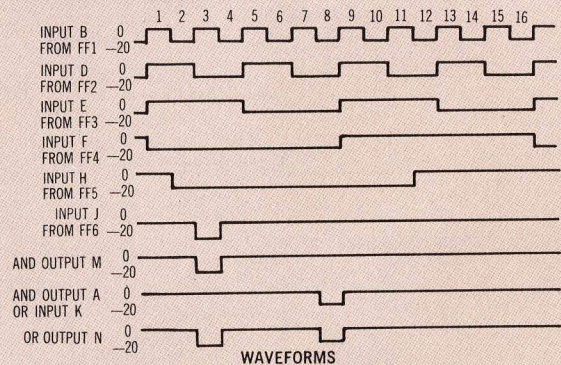
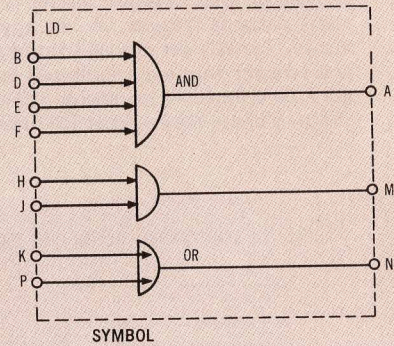
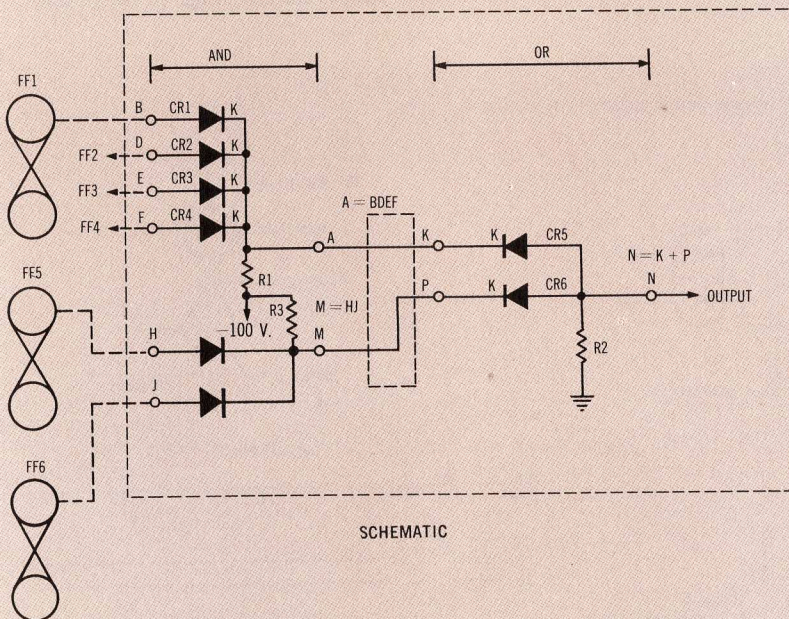
jumper connection

"or"

jumper connection

"and"

FIGURE B—SCHEMATIC, SYMBOL, AND WAVEFORMS OF DIODE LOGIC Y-413.



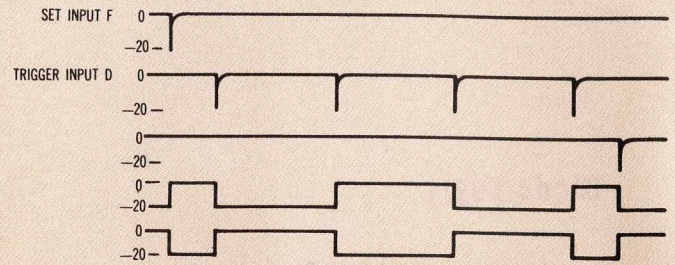
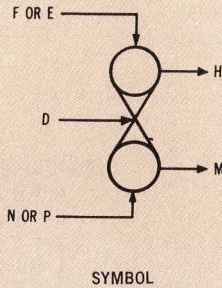
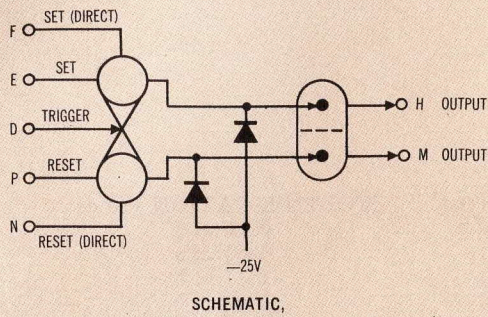


FIGURE C—SCHEMATIC, SYMBOL, AND WAVEFORMS OF FLIP-FLOP Y-101.

Flip-Flop Circuits

FLIP-FLOP Y-101

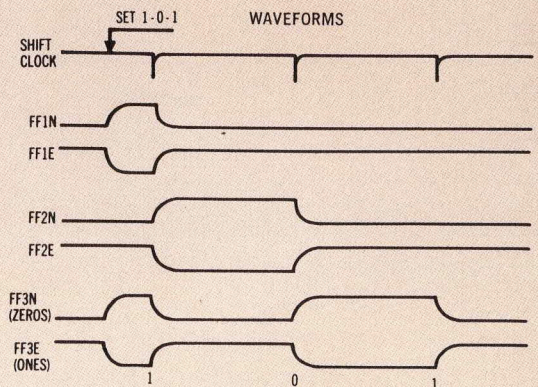
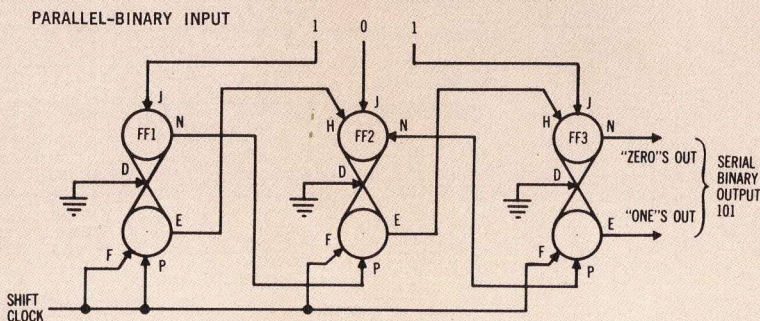
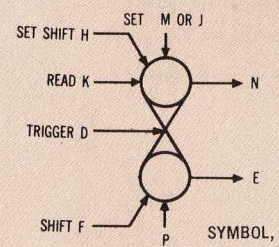
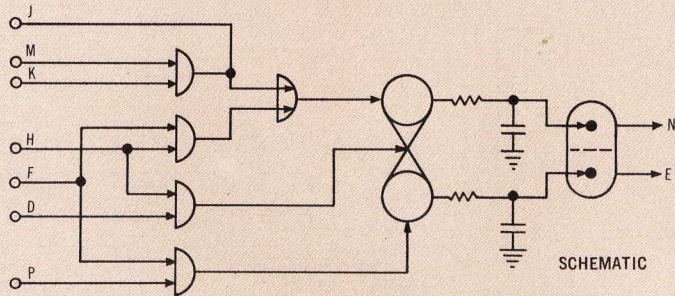
This unit is used as a general-purpose, high-speed flip-flop. It is usable in binary-counter circuits with an input signal rate as high as 1 MC. Negative input pulses are required for operation. Output is direct-coupled from each plate via cathode follower, with diode clamping to maintain the standard 20-volt signal level. Inputs are available for set, trigger, and reset. Figure C shows an output when all three inputs are used, although specific circuit applications may require inputs in various combinations, e.g., trigger alone, trigger with set, set and reset without trigger, etc. In applications where it is desirable for the set or reset input to overrule a simultaneous trigger input, an external capacitor of about 47 $\mu\mu\text{f}$ may be connected in series with the direct set or reset input. This gives a longer RC time constant for this input

and thereby forces set or reset. Ordinarily the capacitive input will be used for either set or reset, to take advantage of the internal coupling capacitors.

FLIP-FLOP Y-100

The flip-flop section of this unit is identical to that of Y-101. However, an integrating network is interposed between each flip-flop plate and its respective cathode follower to deteriorate the rise-and-fall times of the output signals. The integration time is of the order of 6 microseconds and therefore makes the output unsuitable for direct triggering of a succeeding pulse circuit. This apparent "delay" in the operation of the unit makes it eminently suitable for control of an "and" gate, which is "center pulsed" to trigger a succeeding circuit after transient conditions have stabilized. Typical application is in shift registers or in other circuits where sampling of information stored in the flip-flop is desired at the same time it is transferring from one stage to the other.

FIGURE D—SCHEMATICS, SYMBOL, AND WAVEFORMS OF THREE-DIGIT PARALLEL-INPUT, SERIES-OUTPUT SHIFT REGISTER.



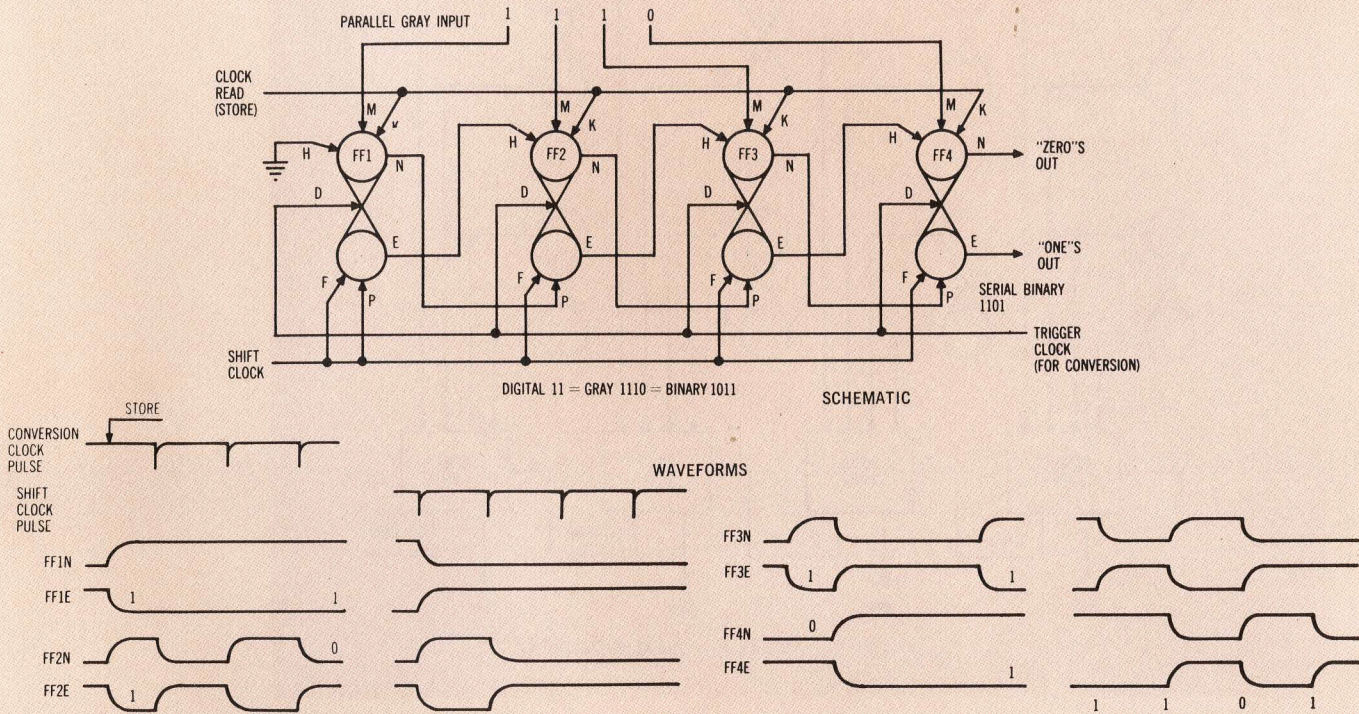


FIGURE E—SCHEMATIC, SYMBOL, AND WAVEFORMS OF FOUR-DIGIT GRAY-TO-BINARY CONVERTER AND SHIFT REGISTER.

FLIP-FLOP — SHIFT REGISTER ELEMENT Y-103

This unit is specifically designed for application in shift registers. The flip-flop and cathode follower sections are identical to those of Y-101 and Y-100. This unit, like Y-100, has integrating networks interposed between the flip-flop plates and cathode followers, but, in addition, has internal diode logic circuits on all inputs to make it a self-contained shift register element. Shift operations are caused by pulses fed through the input diode logic. A simplified schematic, as well as waveforms for this application are shown in Figure D.

A special feature of this unit is its adaptability for use as a composite Gray-to-binary code converter and shift register. A schematic and waveforms for this application are also shown in Figure E. For this use, the Gray num-

ber is read into the shift register in parallel form (say from a code wheel or flip-flop register), converted internally to a binary number, and then shifted out in serial form. In the example shown in Figure E, the input Gray number is 1110, corresponding to decimal 11 and binary 1011. The Gray-to-binary conversion is based on the rules that:

1. The most significant digit is identical in each code system.
2. Each succeeding Gray digit is complemented if the preceding *binary* digit is a 1, or repeated if the *binary* digit is a 0.

Trigger clock (conversion) pulses cause the Gray-to-binary conversion and must be one less in number than the number of digits in the Gray code. After conversion, the binary number is shifted out serially by shift clock pulses.

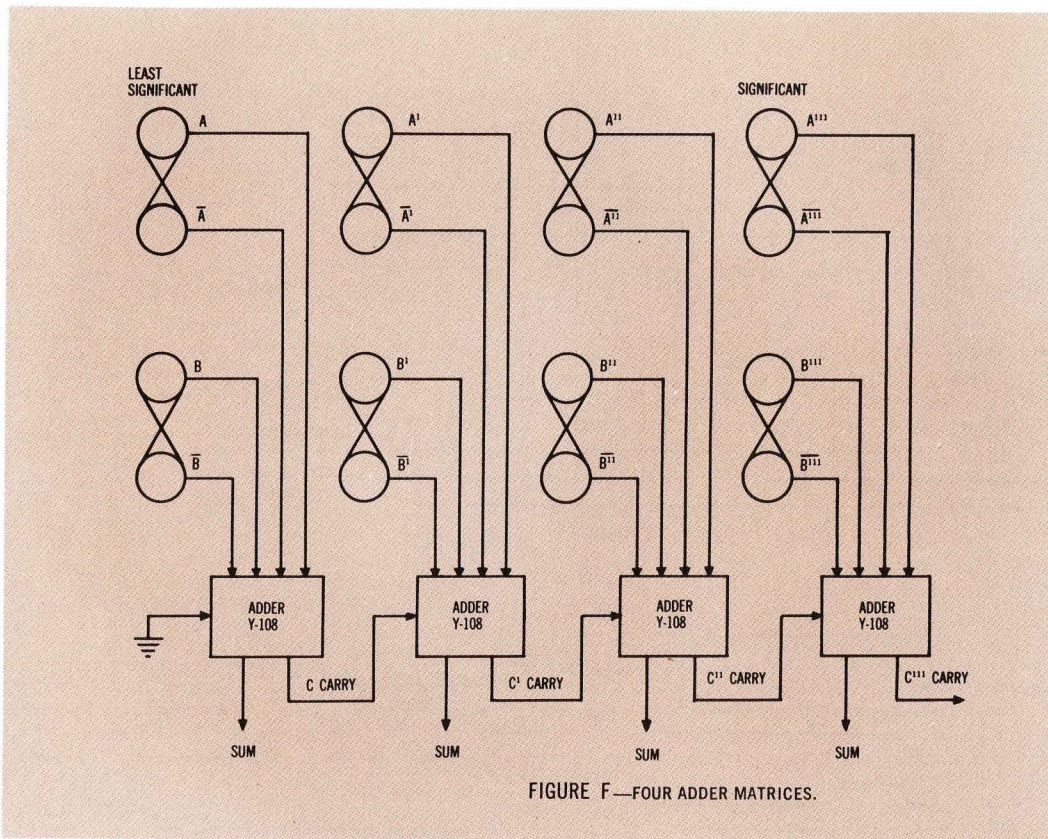


FIGURE F—FOUR ADDER MATRICES.

Adder and Subtractor Circuits

ONE-DIGIT ADDER MATRIX Y-108

This unit adds three binary numbers and produces a sum and carry output. A series of Y-108 units connected together with inputs from flip-flop storage registers, as shown in Figure F, will add two four-digit binary numbers.

The rules governing binary addition are tabulated below and are briefly explained for users who are unfamiliar with the concepts involved. The binary number addition is carried out by the same method, column by column, as decimal numbers, i.e., least-order digit first. The "carry" concept is employed in a similar fashion. For example, when decimal 17 and 15 are added, the sum is 32, with a carry resulting from addition of the "units" column. When binary numbers are added, a carry results when two digits added together each have a value 1. For example, add two binary digits A and B and observe the results in Table I. When successive additions are made, column-by-column, the carry value from each previous addition must also be added, as shown in Table II.

TABLE I				TABLE II				
A	B	SUM	CARRY	A	B	PREVIOUS CARRY	SUM	NEW CARRY
0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	1	1	0
1	0	1	0	0	1	0	1	0
1	1	0	1	0	1	1	0	1
				1	0	0	1	0
				1	0	1	0	1
				1	1	0	0	1
				1	1	1	1	1

In order to perform binary addition with electrical circuits, it is necessary to utilize the "not" concept of Boolean Algebra. As a very simple example, consider the diode logic required to obtain the sum of two one-digit numbers, neglecting carry. A combination of "and" and "or" logic is required, with the Boolean equations Sum =

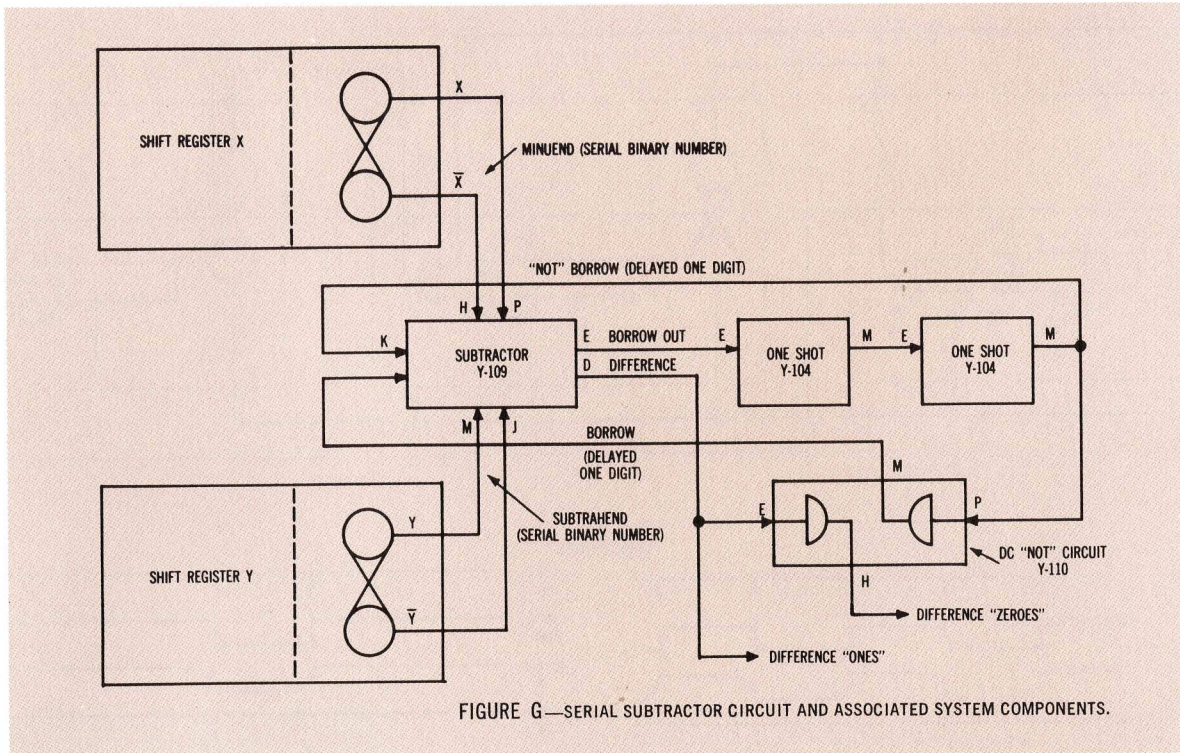


FIGURE G—SERIAL SUBTRACTOR CIRCUIT AND ASSOCIATED SYSTEM COMPONENTS.

$A\bar{B} + \bar{A}B$. The "not" functions for A and B are provided from the "not" or "false" plate of the respective storage flip-flop.

The sum of A and B is 1 whenever *either* A or B is 1, but not both; and is 0 whenever *both* A and B are either 1 or 0. By similar logic, equations are developed for the sum of A, B, and C, where C represents carry; and for the carry output. These equations are:

$$\text{Sum} = A\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}\bar{B}C + ABC$$

$$\text{Carry} = AB + BC + AC$$

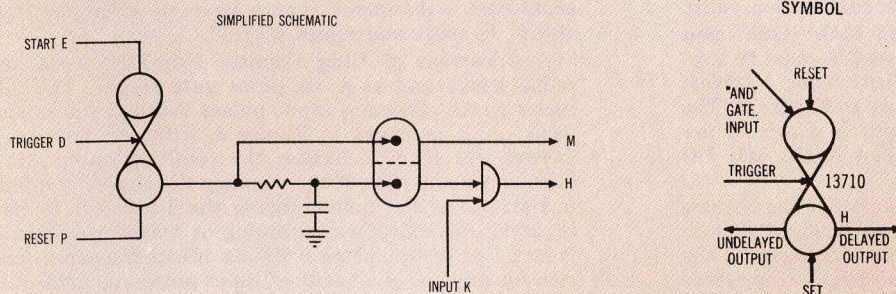
Note that the sum equation includes \bar{C} , in addition to C. The \bar{C} quantity is generated internally by an inverter or "not" circuit, which inverts the carry value input. The carry progresses from stage to stage, decreasing in amplitude each time because of cathode follower losses, and requires amplification after five digits to restore the proper 20-volt signal level. DC "not" circuit Y-110 is recommended as a carry amplifier, with its two sections connected in cascade for proper phasing. The over-all

speed of operation for an adder assembled from Y-108 units is determined by the number of stages used. Each one-digit adder matrix operates in 0.1 microsecond. Therefore, the numbers in two flip-flop registers can be added in parallel at very high speed, giving almost instantaneous answers in parallel form. These answers are then immediately available for further arithmetic operations.

Type Y-108 units arranged in parallel adder circuit can also be made to subtract, by appropriate control of one of the two flip-flop registers supplying inputs to the adder.

The remaining arithmetic operations of concern are multiplication and division. In general, modern-day computers employ adder circuits — with proper control and programming — to perform all arithmetic operations. Even though the subject cannot be covered here, inquiry is invited for help on the circuit configurations possible using type Y-108 units.

FIGURE H—SIMPLIFIED SCHEMATIC AND SYMBOL OF FLIP-FLOP Y-102.



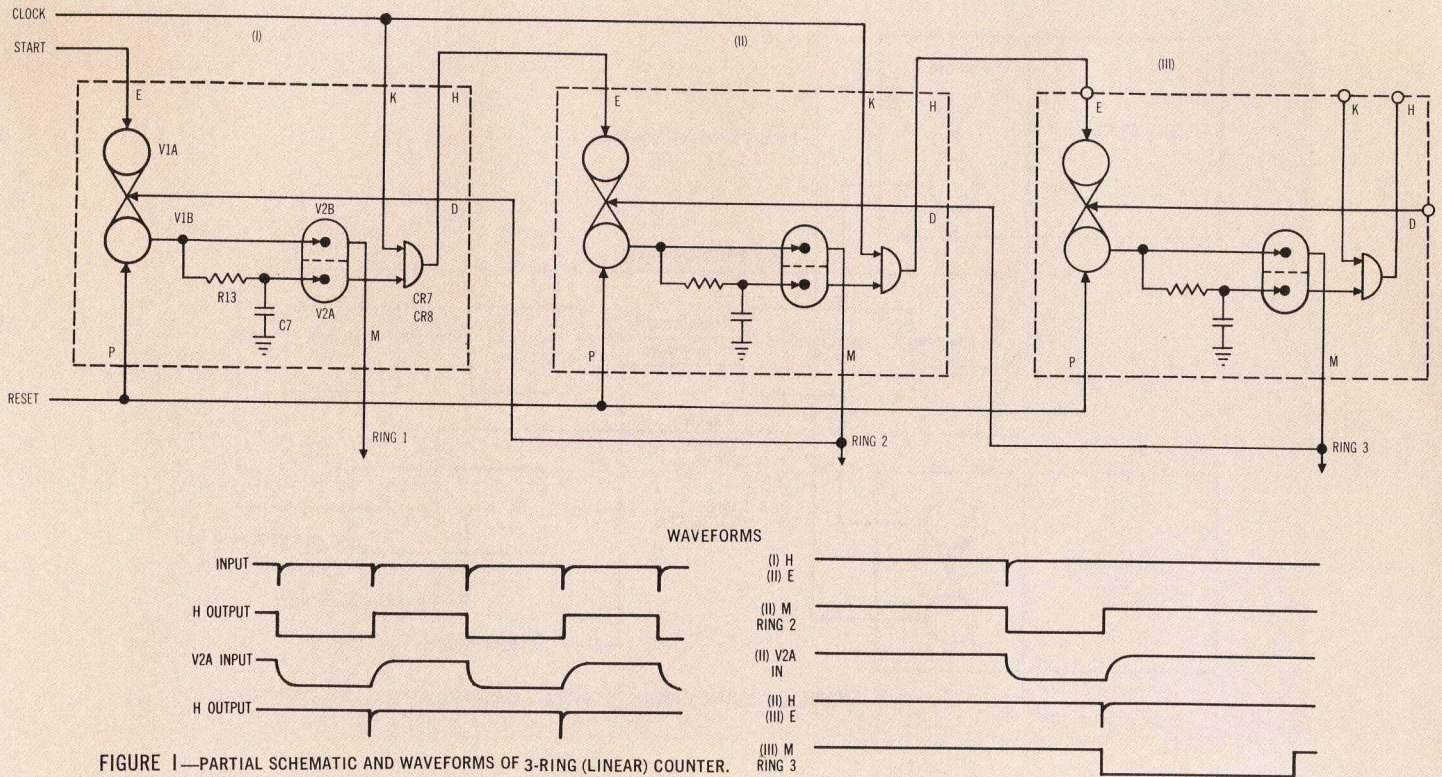


FIGURE I—PARTIAL SCHEMATIC AND WAVEFORMS OF 3-RING (LINEAR) COUNTER.

Parallel arithmetic operations are often used in computers to obtain greater speed, but in various computer-type systems (data processing systems, for example) there are requirements for arithmetic operations in serial form. Take, for example, the case where coded numbers are to be recorded on magnetic tape. During either recording or playback, it is perhaps necessary to correct for scale factor. In such applications, it is necessary to compare two numbers (data, and a reference or control number) digit-by-digit, since the number (data) is generally recorded serially. One-Digit Subtractor Matrix Y-109 is designed for such applications. This unit accepts two coded number inputs serially, subtracts one from the other, and gives a "difference" and "borrow" output. The logic equations for these outputs are:

$$\begin{aligned} \text{Difference} &= BXY + \bar{B}\bar{X}\bar{Y} + \bar{B}\bar{X}Y + B\bar{X}\bar{Y} \\ \text{Borrow} &= \bar{B}\bar{X}Y + B\bar{X}\bar{Y} + BY \end{aligned}$$

where X is the minuend, Y is the subtrahend, and B is the borrow resulting from subtraction of a preceding digit.

The borrow quantity must be delayed (stored) after each subtraction, and fed back into the Y-109 as input. The storage function is necessary so that the borrow value from a preceding subtraction can be subtracted from the minuend in accordance with subtraction rules.

As in the case of binary addition, both "true" and "not" values for each quantity, X, Y, and B, must be supplied to enable subtraction using Boolean logic. A circuit arranged for serial subtraction is shown in Figure G. The storage function for the borrow output is generally accomplished by application of One Shot Y-104 and DC "not" circuit Y-110, as shown.

The one-digit delay (storage interval) for the borrow is broken up into two equal periods, each slightly more than half of the interval between successive digits of the incoming serial numbers. The first One Shot Delay essentially samples the borrow output from a subtraction in

process; while the second One Shot Delay stores the borrow output from a previous subtraction. A serial subtractor is necessarily a closed-loop system for proper operation, as evident in Table III.

FLIP-FLOP Y-102

This unit is basically designed for ring counter use, but is very useful in a variety of applications, including use as a pulse sorter and as a pulse gate. Maximum operating frequency is 150 KC. Y-102 includes a flip-flop section identical to that of Y-101. Only one plate output is available, and is brought out two ways:

1. Direct via cathode follower, and
2. Integrated, then supplied as an output via cathode follower and an internal "and" gate.

A simplified schematic is shown in Figure H.

The use of Y-102 as a ring counter is typified by the schematic and waveforms shown in Figure I. Although only three stages are shown, the linear counting action can be extended to any number desired by connecting additional units. This circuit is arranged to give a linear count of three pulses between "start" (set) and reset inputs. As shown in Figure I, after the linear count is completed, subsequent inputs have no effect until the circuit is reset and again started.

Applications of Ring Counter Flip-Flop Y-102 as a pulse sorter and as a one-pulse gate follow. The pulse sorter gates alternate input pulses through the internal "and" gate as shown in Figure J. Although this circuit is basically an N/2 divider, the resulting action differs markedly from that of the common flip-flop N/2 divider, in that the actual pulse causing the flip-flop to transfer is gated and therefore no timing or waveform accuracy is lost. The one-pulse gate circuit effects the same operation for any one of a series of input pulses, as determined by a set input. See Figure K.

Special-Purpose Circuits

DELAY UNIT Y-111

This unit provides ultra-short time delays, with a standard range of 2.5 microseconds to 45 microseconds. It is a DC device, that is, direct coupled throughout, and is used to delay the negative-going wavefront of an input voltage level change. The positive-going input is not delayed. Internal circuit operation is shown in Figure L. The delay property stems from integration of the change in input DC level. Output waveform has rise and fall time of approximately 0.1 microsecond.

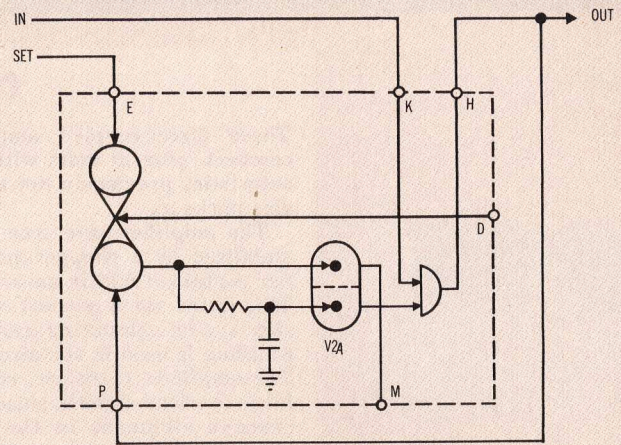
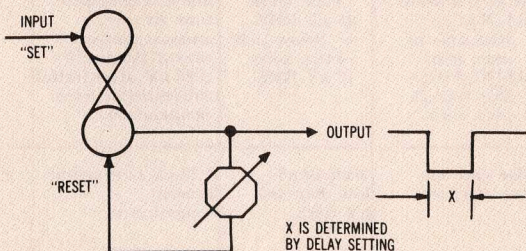
As an application example, Delay Unit Y-111 may be used for pulse shaping when used in conjunction with a flip-flop, as shown in Figure L.

The Delay Unit is also useful in eliminating false information that can exist instantaneously during set and reset operations in high-speed circuits employing diode logic. For example, when a flip-flop counter has its several plate signals fed to "and" diode logic, false output may occur owing to small delays in the operation of the flip-flops. These outputs will be extremely narrow in width (in the order of less than 0.5 microsecond), but will trigger succeeding pulse circuits erroneously. These spurious pulses or "slivers" can be eliminated by feeding the "and" logic output through a Delay Unit. The Delay Unit will operate only when the input DC level falls below -14 volts and remains at this value for longer than the delay adjustment.

TABLE III

X	Y	BORROW FROM PREVIOUS COLUMN	"D" DIFFERENCE IN PRESENT COLUMN	BORROW FROM PRESENT COLUMN
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

FIGURE L—SIMPLIFIED SCHEMATIC OF PULSE SHAPER CIRCUIT.



SCHEMATIC

WAVEFORMS

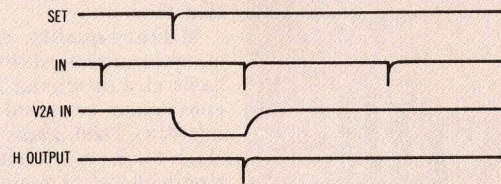
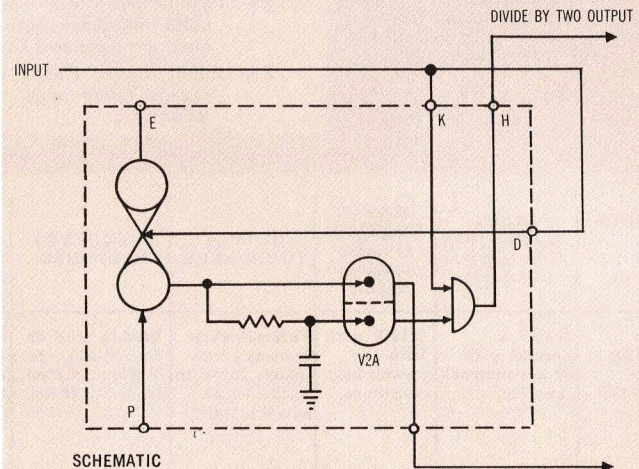


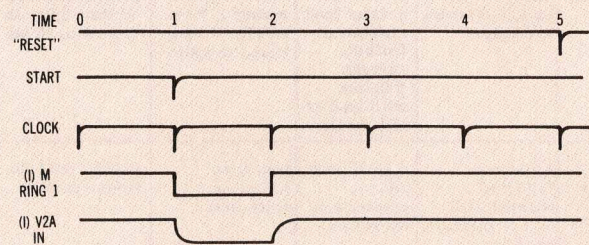
FIGURE J—PARTIAL SCHEMATIC AND WAVEFORMS OF PULSE SORTER.

FIGURE K—PARTIAL SCHEMATIC AND WAVEFORMS OF ONE-PULSE GATE.



SCHEMATIC

WAVEFORMS



Chopper Stabilized D-C Amplifiers

These direct-coupled amplifiers are rugged, compact, plug-in units with performance characteristics previously not available in a small-size package.

The amplifiers are true direct-coupled units stabilized by a chopper-modulated A-C amplifier contained within an over-all feedback loop. This is the same general circuit used in precision analog computing amplifiers. No capacity coupling is used in the direct-coupled amplifier. The amplifier, therefore, recovers rapidly from large overload signals, since there are no energy storage elements in the circuit to become charged during the overload period.

High over-all open-loop gain is used to keep the amplifier output extremely linear and distortion-free.

Military-quality component parts and construction are used throughout the amplifier. The basic circuit wiring is in the form of an etched epoxyglass terminal board. High-temperature, metallic-cased, glass-sealed capacitors are used. High-temperature electrolytic capacitors, operating well below rating, are used for filtering in the plate power supply.

ZA-17019 (Standard)—Variable gain from 1 to 1000 with an output of 30 volts into 100,000-ohm load. Frequency response 0 to 10 kc.

ZA-17020 (25 ma)—Variable gain from 1 to 1000 with an output of 25 volts at 25 ma into 1000-ohm load. Frequency response 0 to 10 kc.

ZA-17093 (Fixed Gain)—Unity gain. Output 15 volts, maximum, into 5,000-ohm load. Frequency response 0 to 2 kc.

ZA-12606 (Fixed Gain)—Same as ZA-17093 except front panel designed for chassis mounting.

COMPACT 7-AMPLIFIER ASSEMBLIES

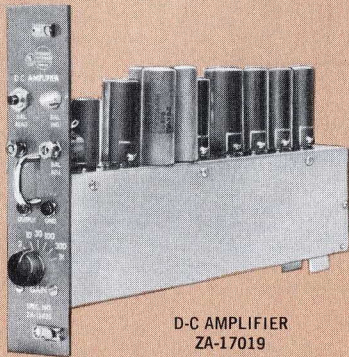
The small size of the amplifier package makes it possible to mount seven amplifiers, together with plate and filament power supplies, in a rack 19" wide, 7" high, and 16" deep. (The mounting rack is intended for a standard 19" cabinet.) Since each seven-amplifier assembly provides seven channels in a system, it takes only two such assemblies to provide the full 14 channels commonly required for magnetic tape units.

Two different plate power supply models are available to handle the range of power requirements among the various models of amplifiers. Two different models of the mounting rack are also available. These are identical in all respects except that their connectors are wired differently. Selection of compatible components for seven-amplifier assemblies can be made from the following chart:

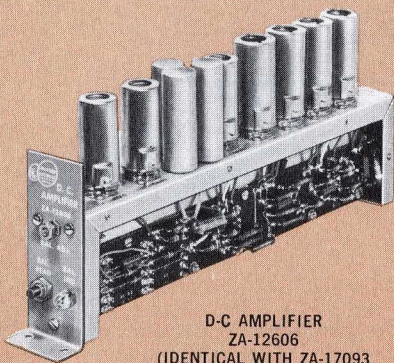
COMPATABILITY CHART FOR MOUNTING 7-AMPLIFIER ASSEMBLY

AMPLIFIER (1 to 7 each)	PLATE POWER SUPPLY (1 only)	MAGNETICALLY REGULATED FILAMENT POWER SUPPLY (1 only)	MOUNTING RACK (1 only)
ZA-17019	ZA-12491 or ZA-17091	ZA-12777	ZA-12512 or ZA-17094
ZA-17020	ZA-17091	ZA-12777	ZA-17094
ZA-17093	ZA-17091	ZA-12777	ZA-17094 or ZA-12512*

*If Mounting Rack ZA-12512 is used for mounting 7-Amplifier Assembly of ZA-17093 (Fixed Gain) Amplifiers, switch in back of Plate Power Supply ZA-17091 must be properly positioned.



D-C AMPLIFIER
ZA-17019

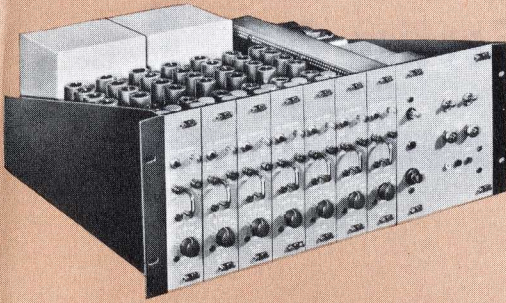


D-C AMPLIFIER
ZA-12606
(IDENTICAL WITH ZA-17093
EXCEPT FRONT PANEL DESIGNED
FOR CHASSIS MOUNTING)

ELECTRICAL & PHYSICAL SPECIFICATIONS	INPUT IMPEDANCE (One terminal grounded)	OUTPUT VOLTAGE (Polarity opposite to input)	OUTPUT IMPEDANCE	FREQUENCY RESPONSE	PHASE SHIFT	TRANSIENT RESPONSE (Measured from 10% to 90% Full Amplitude)	COMPOSITE NOISE AND HUM (Referred to the input)	OUTPUT DRIFT AND OFFSET (Referred to the input, with 1% constant supply voltage)	CHOPPER INTER-MODULATION
D-C AMPLIFIER ZA-17019 (Standard)	100KΩ in parallel with 60 μμf internal capacity.	±30 V with 100KΩ or greater load resistance.	Varies linearly from approximately 200*Ω to 0.027Ω. Proportional to gain.	Within ±0.1 db from 0-1000 cps. Within ±0.5 db from 0 to 10 kc.	Approx. 1.5 deg. per 1000 cps from 0 to 10 kc.	Varies, depending on gain setting. GAIN of 1— Rise time 15 μsec. max. GAIN of 1000— Rise time 25 μsec. max.	†a) Wide Band —max. noise 25 μV RMS. b) Below 10 kc —max. noise 12 μV RMS.	±10 μV at constant ambient temperature. At max. ambient temperature of 150 deg. F, ±20 μV, after initial calibration at room temperature.	±0.1% or less.
D-C AMPLIFIER ZA-17020 (25 ma)	100KΩ in parallel with 60 μμf internal capacity.	±25 V with 100KΩ or greater load resistance. Output current ±25 ma with load of 1KΩ or less.	Varies linearly from approximately 27*Ω to 0.027Ω. Proportional to gain.	Within ±0.1 db from 0-1000 cps. Within ±0.5 db from 0 to 10 kc.	Approx. 1.5 deg. per 1000 cps from 0 to 10 kc.	Varies, depending on gain setting. GAIN of 1— Rise time 15 μsec. max. GAIN of 1000— Rise time 25 μsec. max.	†a) Wide Band —max. noise 25 μV RMS. b) Below 10 kc —max. noise 12 μV RMS.	±10 μV at constant ambient temperature. At max. ambient temperature of 150 deg. F, ±20 μV, after initial calibration at room temperature.	±0.1% or less.
D-C AMPLIFIER ZA-17093 or ZA-12606** (Fixed Gain)	External—750KΩ in parallel with 60 μμf internal capacity.	±15 V with 5KΩ or greater load resistance.	Less than 0.170Ω at unity gain.	Within ±0.5 db from 0 to 2 kc.	Approx. 1.5 deg. per 1000 cps from 0 to 10 kc.	Rise time less than 100 μsec.	Wide Band—less than 150 μV RMS.	±20 μV at constant ambient temperature.	±0.5% or less.

*Output impedance at a gain of 1000. Impedance decreases proportionally with decreasing gain.

**D-C Amplifiers ZA-12606 and ZA-17093 are identical in all respects except that ZA-12606 is equipped with L-shaped front panel 1½" high by 3¾" high for chassis mounting. (See DIMENSIONS column for differences in over-all dimensions.)



COMPLETE ASSEMBLY ZA-17152
CONSISTS OF 7 D-C AMPLIFIERS (ZA-17019),
1 PLATE POWER SUPPLY (ZA-12491),
AND 1 MAGNETICALLY REGULATED
FILAMENT POWER SUPPLY (ZA-12777),
ALL MOUNTED IN ZA-12512 MOUNTING RACK.

MOUNTING RACK ZA-12512 & ZA-17094

These compact, sturdy mounting racks are for cabinet mounting. Each rack houses one Plate Supply, ZA-12491 or ZA-17091, one Filament Supply, ZA-12777, and from one to seven D-C Amplifiers. Mounting Racks ZA-12512 and ZA-17094 are identical in all respects except that their connectors are wired differently. (See Compatibility Chart, page 64, for basis of model selection.)

DIMENSIONS (over-all)	Length—16" Width—19" Height—7"
CONNECTORS	Amphenol—9 ea. 26-4200-16S to mate with one Plate Supply, one Filament Supply, and seven D-C Amplifiers. Amphenol—14 ea. UG 2904 co-ax receptacles for use with input and output signals
WEIGHT	5 pounds, 4 ounces

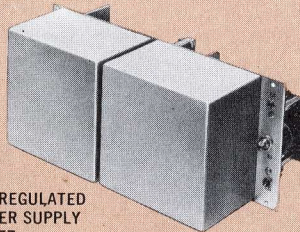
PLATE POWER SUPPLY ZA-12491 & ZA-17091

Two different models are available. Each is a compact, regulated, plate power supply, providing positive and negative voltages and filament voltage for operation of from one to seven D-C Amplifiers. Both models have the same over-all dimensions. Selection of model depends upon power requirements of D-C Amplifiers used. (See Compatibility Chart, page 64.)

Specifications for Plate Power Supply ZA-12491 are shown below. Data on Plate Power Supply ZA-17091 will be furnished upon request.

Electrical Characteristics	
INPUT VOLTAGE	105 to 130 V. AC 60 Cycle
INPUT CURRENT	1.85 to 2.2 amps.
POWER FACTOR	95%
RATED FULL LOAD	+200 V. at 50 ma (75 ma. max.) -200 V. at 50 ma (75 ma. max.)
AC OUTPUT	6.3 V. AC at 14 amps. max.
OUTPUT IMPEDANCE	a) +200 V. DC—less than 0.5 ohm average for load frequencies from 0 to 300 kc. b) -200 V. DC—less than 2.0 ohms average for load frequencies from 0 to 300 kc.
RIPPLE & NOISE	5 mv RMS at 117 V. AC with rated load
RECOVERY TIME (Zero load to full load, switched)	a) +200 V. DC—1 millisecond b) -200 V. DC—2.5 milliseconds
WARM-UP TIME	1 minute
REGULATION	1% from 1/10 to rated full load

Physical Characteristics	
DIMENSIONS (over-all)	Length—15-1/2" Width—5" Height—7"
WEIGHT	23 pounds, 7 ounces
CONNECTOR	Amphenol 26-4100-16P on supply, mates with Amphenol 26-4200-16S
TUBE COMPLEMENT	a) Two 6X4 d) Two 5751 b) Two 6BX7 e) Two 12AY7 c) Two 5651



MAGNETICALLY REGULATED
FILAMENT POWER SUPPLY
ZA-12777

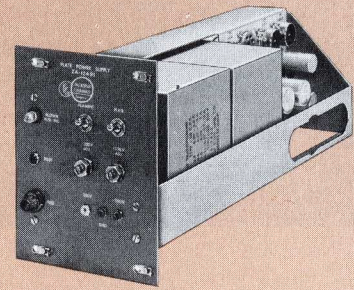


PLATE POWER SUPPLY
ZA-12491

MAGNETICALLY REGULATED FILAMENT POWER SUPPLY ZA-12777

A compact, magnetically regulated filament supply, providing 12.6 volts dc for operation of from one to seven D-C Amplifiers.

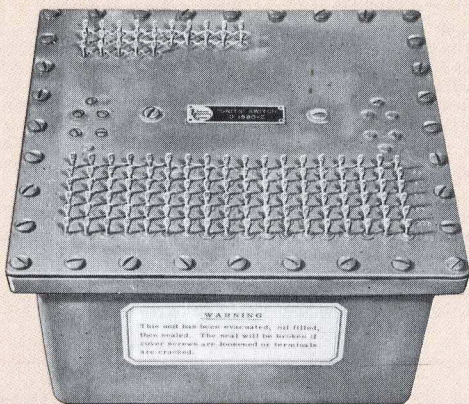
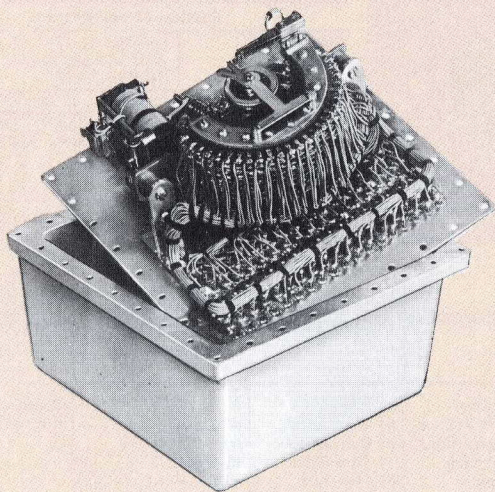
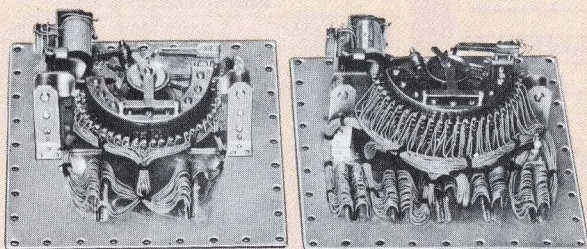
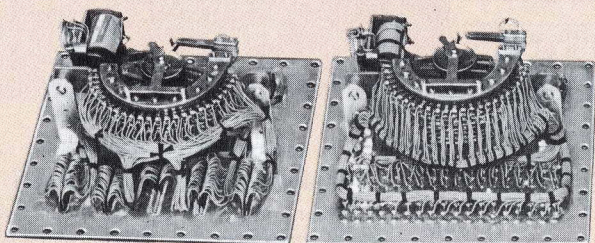
Electrical Characteristics	
INPUT VOLTAGE	105 to 130 V. AC, 60 cycle
INPUT CURRENT	0.25 Amp
BIAS VOLTAGE	+200 V. DC
BIAS CURRENT	10 ma
OUTPUT VOLTAGE & CURRENT	12.6 V. DC at 2.1 amp. max.
RIPPLE (at full load)	2.5 V.P.P.
RESPONSE TIME	Full load to no load 0.4 sec. No load to full load .04 sec. Line, 117 to 105 0.1 sec. Line, 117 to 130 0.3 sec.
REGULATION (105 to 130 V. AC Line)	1%

Physical Characteristics	
DIMENSIONS (over-all)	Length—11-1/8" Width—4-15/16" Height—3-1/2"
WEIGHT	15 pounds, 12 ounces
CONNECTOR	Amphenol 26-4100-16P on unit to mate with Amphenol 26-4200-16S

GAIN (open loop)	GAIN (operating)	GAIN (stability)	GAIN (accuracy)	DIMENSIONS (over-all)	WEIGHT	CONNECTOR	TUBE COMPLEMENT	†POWER REQUIREMENTS (at zero output)	POWER REQUIREMENTS (at full output)
a) Over-all gain at DC greater than 500,000,000. b) DC section only, greater than 50,000. c) AC section only, greater than 10,000.	Selectable by panel switch. 1, 3, 10, 30, 100, 300, and 1,000.	Better than ±1% over temperature range of 70 to 150 deg. F.	1, 3, 10 within ±2%; 30, 100, 300, 1,000 within ±4%.	Length: 12-1/4" Width: 1-19/32" Height: 7"	3 pounds, 2 ounces.	Amphenol 26-4100-16P on DC Amplifier, mates with Amphenol 26-4200-16S.	a) Two 5751 b) Two EF86 c) One 12AY7 d) One 5965 e) One 0B2 f) One chopper, Airpax A-175.	a) +200 V DC at 7 ma. b) -200 V DC at 6 ma. c) 6.3 V AC at 1.35 amps, and 12.6 V DC at 300 ma.	Same as at zero output.
a) Over-all gain at DC greater than 500,000,000. b) DC section only, greater than 50,000. c) AC section only, greater than 10,000.	Selectable by panel switch. 1, 3, 10, 30, 100, 300, and 1,000.	Better than ±1% over temperature range of 70 to 150 deg. F.	1, 3, 10 within ±2%; 30, 100, 300, 1,000 within ±4%.	Length: 12-1/4" Width: 1-19/32" Height: 7"	3 pounds, 2 ounces.	Amphenol 26-4100-16P on DC Amplifier, mates with Amphenol 26-4200-16S.	a) Two 5751 b) Two EF86 c) One 12AY7 d) One 6463 e) One chopper, Airpax A-175.	a) +200 V DC at 19 ma. b) -200 V DC at 18 ma. c) -500 V DC at 0.3 ma. d) 6.3 V AC at 1.5 amps, and 12.6 V DC at 300 ma.	a) +200 V DC at 31 ma. b) -200 V DC at 30 ma. c) Same as at zero output. d) Same as at zero output.
a) Over-all gain at DC greater than 100,000,000. b) DC section only, greater than 50,000. c) AC section only, greater than 2,000.	Fixed at Unity.	Better than ±1% over temperature range of 70 to 150 deg. F.	Unity within ±0.2%.	ZA-17093: Length: 12-1/4" Width: 1-19/32" Height: 7". ZA-12606: Length: 12-1/4" Width: 1-1/2" Height: 5".	3 pounds, 2 ounces.	Amphenol 26-4100-16P on DC Amplifier, mates with Amphenol 26-4200-16S.	a) One 12AY7 b) Two 5751 c) One 5814 d) Two 6AU6 e) One chopper, Airpax A-175.	a) +200 V DC at 11 ma. b) -200 V DC at 13.4 ma. c) 6.3 V AC at 2 amps, 60 cycles.	Same as at zero output.

†Full band-width noise is in terms of noise output at 1000 gain, and does not decrease proportionally to gain because of phase shift at higher frequencies. Noise is proportional to gain from 0 to 10 kc.

‡All filaments can be operated on 6.3 V AC with a noise increase of approx. 3 to 6 db. It is recommended that the amplifiers be mounted in a ventilated cabinet.



Hermetically Sealed Stepping Switches

Engineered Electronics Company packaged Stepping Switches are the "heart" of many data-handling and automatic-control systems as well as of sequencing equipment.

Stepping switches packaged in EECO oil-filled, hermetically sealed containers have been in use in systems and equipment for years without replacement or maintenance. EECO packaged stepping switches have long life and offer maintenance-free operation because they are

- Dust free,
- Self-lubricating,
- Protected from salt spray and sand,
- Protected from fungus,
- Not affected by humidity or varying air pressure.

Special packaging is recommended for *low-level switching*. In order to minimize contact resistances, potentials, and thermocouple effects in low-level applications, noble metal contacts are recommended and special terminal mounting is used.

EECO packaged stepping switches offer these features:

- Minimum dissimilar metal connections.
- Special low-level soldering techniques.
- Temperature equilibrium maintained by surrounding oil bath.

Engineered Electronics Company stepping switch containers are available with solder terminals or plug-in connectors (Cannon DCH-37P-002 or DAH-15P-002). For low-level applications (switching low-level inputs), special terminal mounting is available.

Prices vary with type of switch required. A sample specification is as follows:

EECO Part No. D-1880-2 Price \$265.00 each*
Automatic Electric type 45 Stepping Switch, 50-point, 4-level, 24-volt coil, 1 form C interrupter spring, 1 form C off-normal spring; encased in cast-aluminum container; fused, tin-plated brass or steel cover. Over-all dimensions: 8-11/16" long, 8-1/2" wide, 4-1/2" high. Oil-filled, hermetically sealed under vacuum. Finished in gray baked enamel.

*NOTE: Price subject to change without notice.

EECO containers are die-cast aluminum with baked gray enamel finish. Weight is approximately 6 pounds without oil or switch.

When requesting quotations, please include:

1. Make of switch desired (such as Automatic Electric, C. P. Clare, etc.).
2. Type number of switch.
3. Number of individual terminals or connectors desired on cover.
4. Precious metal plating, if any.
5. Wiring diagram, showing position of all connections.

*Reliable Switching for Automatic Systems
with
Packaged Stepping Switches Hermetically Sealed*

Decimal Counter

SPECIFICATIONS

The ZA-10057 is a high-quality plug-in decimal counter designed to operate reliably under conditions of vibration and extreme temperatures. This counter will operate in the temperature range from -20°F to $+150^{\circ}\text{F}$.

It is used for pulse counting and frequency division applications, and is designed to operate from 0 to 100,000 pulses per second.

Output Signal (pin 3):

Each ZA-10057 will drive a succeeding decimal counter without an intermediate stage. Maximum load occurs with 150,000 ohms in parallel with $50\ \mu\mu\text{f}$ capacitance.

Counter Indicator:

The ZA-10057 comes with a direct-reading scale, where neon lamps illuminate a number scale (0-9) to show the number of input pulses in decimal form.

Input Signal (pin 5):

Amplitude: 32 volts, minimum, to 50 volts, maximum. These values are for the fastest rise time shown. With a slower rise time, somewhat greater amplitude will be required.

Rise Time: 0.05 microsecond, minimum; 2.0 microseconds, maximum.

Pulse Duration: 1.0 microsecond, minimum; 10 microseconds, maximum.

Reset Pulse (pin 2):

25 volts positive. May be reset either by a positive pulse fed into the reset buss across a low resistance or by momentarily opening the reset buss circuit from ground.

Power Requirements:

Supply voltages: 200 volts $\pm 10\%$ dc at 15 milliamperes. Pin 4 positive with respect to pin 6.

6.3 volts $\pm 10\%$ ac at 1.2 amperes (pins 1 and 7).

Tubes: Four type 5963.

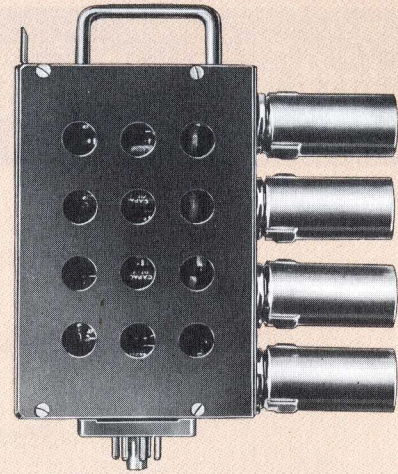
Header: Plugs into octal socket.

Jack Panel Assembly—ZA-11168

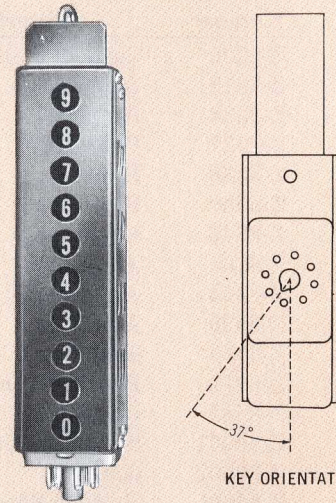
The ZA-11168 Jack Panel Assembly is used in complex systems where many signals must be distributed to different points, such as in data handling, computing, timing, and telemetering receiving systems. The ZA-11168 Jack Panel Assembly provides convenient, high-quality, reliably shielded patching.

SPECIFICATION

Two 48-jack strips, each jack cabled individually to Jones terminal board. Shielded cable used throughout with shield carried as third conductor. For standard racks; panel size $5\text{-}1/4" \times 19"$. Supplied less patch cords. Jones terminals are mounted on two $5" \times 12\text{-}3/4"$ aluminum panels.

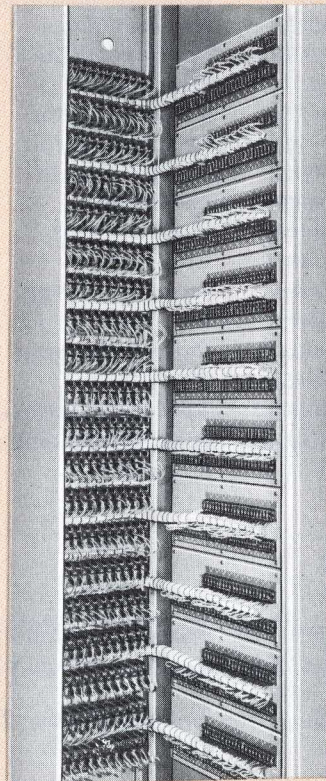


DECIMAL COUNTER, SIDE VIEW

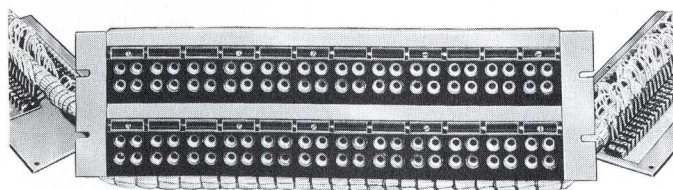


DECIMAL COUNTER, FRONT VIEW

KEY ORIENTATION



REAR VIEW OF JACK PANEL ASSEMBLIES AND JONES TERMINAL BOARDS IN TYPICAL MOUNTING



FRONT VIEW OF JACK PANEL ASSEMBLY, SHOWING SLOTS FOR PANEL MOUNTING

Price List and Ordering Instructions

Section Six

Engineered Electronics Company Price List

Effective September 30, 1956, and subject to change without notice.

Standard-Series Plug-in Units

Catalog Number	Description	Quantity and Price					
		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	Amplifier	10.10*	9.60*	9.25*	8.90*	8.50*	8.15*
Z-8327	Pulse Gate	7.65	7.25	7.00	6.75	6.45	6.15
Z-8336	Flip-Flop	11.30	10.90	10.10	9.30	8.05	7.90
Z-8339	Flip-Flop	11.50	11.10	10.25	9.45	8.20	8.00
Z-8342	Flip-Flop	11.55	11.15	10.30	9.50	8.25	8.05
Z-8351	Amplifier	7.90	7.45	7.20	6.95	6.60	6.35
Z-8354	Amplifier	7.90	7.50	7.20	7.00	6.65	6.35
Z-8489	Amplifier	9.85	9.40	9.10	8.75	8.35	8.00
Z-8762	Amplifier	9.20	8.80	8.50	8.15	7.80	7.45
Z-8771	Phantastron	10.45	10.00	9.65	9.30	8.90	8.50
Z-8889	One Shot	7.65	7.40	6.85	6.30	5.45	5.35
Z-90001	Squaring Circuit	9.90	9.55	8.85	8.15	7.05	6.90
Z-90002	Gate	10.35	10.00	9.25	8.50	7.40	7.25
Z-90005	Voltage Regulator	10.50	10.10	9.35	8.60	7.50	7.30
Z-90007	Gate Amplifier	10.40	10.05	9.30	8.55	7.45	7.25
Z-90009	Crystal Oscillator	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-90016	D-C Amplifier	15.10	14.60	13.50	12.40	10.80	10.55
Z-90017-B	Thyratron Ring Counter	9.60	9.15	8.80	8.50	8.15	7.80
Z-90018	Phantastron	10.35	9.90	9.60	9.25	8.85	8.45
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	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-90048	Flip-Flop	13.30	12.60	12.20	11.70	11.20	10.70
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	Flip-Flop	11.50	11.10	10.25	9.45	8.20	8.00
Z-90063	Thyratron Pulse Generator	11.50	10.85	10.50	9.95	9.55	9.15
Z-90134	Phase Shift Oscillator	18.40	17.60	17.05	16.40	15.80	15.10
Z-90166	Flip-Flop	11.70	11.25	10.50	9.60	8.30	8.10

		1-99	100 and up
95018-19	Holddown clamp with 19/32" captive screw length	.50	.45
95018-27	Holddown clamp with 27/32" captive screw length	.50	.45

*Plus 10% Federal Excise Tax.

All prices include Tube and Tube Shield.

Diode Number	Quantity and Price					
	1-12	13-49	50-99	100-249	250-999	1000 Up
8-1N55B	63.30	49.15	48.45	46.50	41.90	40.70
12-1N55B	91.95	71.10	70.35	61.80	61.20	---
16-1N55B	121.55	94.00	93.10	81.75	81.05	---
8-1N67A	25.65	20.15	19.50	18.20	16.45	15.80
12-1N67A	35.45	27.60	26.90	23.60	23.00	---
16-1N67A	46.25	36.00	35.15	30.75	30.10	---
8-1N89	18.30	14.50	13.85	12.70	11.45	10.90
12-1N89	24.45	19.20	18.45	16.15	15.60	---
16-1N89	31.55	24.75	23.85	20.85	20.15	---
8-1N100	35.50	27.70	27.00	25.60	23.10	22.30
12-1N100	50.25	39.00	38.25	33.60	33.00	---
16-1N100	69.50	51.15	50.25	44.10	43.40	---
				1-99	100 and Up	
95063-19	Holddown clamp with #4-40 captive screws 19/32" long.			.80	.70	
95063-27	Holddown clamp with #4-40 captive screws 27/32" long.			.80	.70	

Standard-Series Diode Plug-in Units

Prices listed at left cover complete multi-diode plug-in unit, which includes:

1. Die-cast aluminum cover in a baked gray enamel finish, marked with description, type number, and diode orientation.
2. Amphenol Blue-Ribbon connector. Prices for other type connectors on request.
3. Diodes, in proper quantity for the respective plug-in units specified. Prices quoted are for Engineered Electronics Company plug-ins, using germanium diodes. Prices for other type diodes, odd quantities, and/or special configurations furnished on request.

NOTE: The electrical specifications for Engineered Electronics Company multi-diode units correspond to those of the manufacturer whose diodes are packaged in the EECO units. All EECO multi-diode units are electrically and mechanically tested after assembly.

Catalog Number	Description	Type	Price
Z-95091	Power Supply, Single Unit	Chassis	128.00
Z-95098	Power Supply, Single Unit	Chassis with Bias Supply	153.00
Z-95091-1	Power Supply, Single Unit	Panel	145.00
Z-95098-1	Power Supply, Single Unit	Panel with Bias Supply	170.00
Z-95091-2	Power Supply, Dual Unit	Panel	260.00
Z-95098-3	Power Supply, Dual Unit	Panel with One Bias Supply	285.00
Z-95098-2	Power Supply, Dual Unit	Panel with Two Bias Supplies	310.00
Z-95100	Systems Development Rack		150.00
Z-95101	Systems Development Rack, less power cabling		121.60
Z-95102	Rack only, without Panels, Grey enamel		21.00
Z-95103	Blank Panel, 1 3/4", Grey enamel		5.00
Z-95104	Panel, 5 1/4", Grey enamel, complete with sockets, filament wiring, etc.		47.80
Z-95105	Rack only, without Panels, Black wrinkle		9.75

Power Supplies and Accessory Equipment

Catalog Number	Description	Price*
ZA-12491	Plate Power Supply	**
ZA-12512	Mounting Rack	235.00
ZA-12606	Chopper Stabilized D-C Amplifier	375.00
ZA-12777	Magnetically Regulated Filament Power Supply	**
ZA-17019	Chopper Stabilized D-C Amplifier	375.00
ZA-17020	Chopper Stabilized D-C Amplifier	†
ZA-17091	Plate Power Supply	†
ZA-17093	Chopper Stabilized D-C Amplifier	375.00
ZA-17094	Mounting Rack	235.00
ZA-17152	Complete Assembly, including 7 D-C Amplifiers (ZA-17019); 1 Plate Supply (ZA-12491); 1 Filament Supply (ZA-12777); 1 Mounting Rack (ZA-12512)	3,475.00

Chopper Stabilized D-C Amplifiers

For Further Information, Call or Write

ENGINEERED ELECTRONICS COMPANY
506 East First Street • Santa Ana, California

*Quantity prices furnished on request.

**ZA-12491 Plate Power Supply and ZA-12777 Magnetically Regulated Filament Power Supply are normally sold as a set at a total combined price of \$615.00. Separate prices will be furnished on request.

†Price furnished on request.

*Computer-Series
Plug-in Units*

Catalog Number	Description	Quantity and Price					
		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	73.85	71.25	66.70	63.70	62.40	59.65
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	Multiple Cathode Follower	33.90	32.50	28.95	27.25	24.75	23.65
Y-106	Multiple Heavy Duty Cathode Follower	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	D.C. "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	87.65	84.60	79.65	76.25	71.70	68.60

*Computer-Series
Diode Logics*

Catalog Number	Description	Quantity and Price					
		1-9	10-24	25-49	50-99	100-199	200-499
Y-400	Diode Logic	85.65	83.10	78.40	75.10	70.65	67.60
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	80.95	78.55	74.00	70.80	66.55	63.70
Y-404	Diode Logic	85.95	83.40	78.70	75.40	70.90	67.85
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	72.65	70.45	66.05	63.15	59.20	56.65
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
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	153.80	149.50	144.15	138.90	132.00	126.50
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	79.45	77.05	72.50	69.40	65.15	62.35
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	57.10	55.50	51.60	49.20	45.85	43.90
Y-423	Diode Logic	57.50	55.55	51.45	49.00	45.65	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	78.50	76.15	71.60	68.55	64.30	61.55

*Computer-Series
Accessory Equipment*

Catalog Number	Description	Quantity and Price					
		1-9	10-24	25-49	50-99	100-199	200-499
Y-900	Mounting Frame	70.15	66.80	59.20	38.50	38.50	38.50
Y-901	Blank Panel	.65	.65	.65	.60	.30	.20
Y-902	Blank Panel	.85	.85	.85	.80	.40	.30
Y-903	Blank Panel	1.05	1.03	1.00	1.00	.50	.40
Y-904	Blank Panel	1.40	1.35	1.35	1.30	.65	.50
Y-905	Blank Panel	1.70	1.70	1.65	1.60	.80	.70
Y-906	Connector	1.10	1.10	1.10	1.10	1.10	1.10
Y-907	In-Circuit Test Fixture	26.45	26.20	24.50	23.85	18.50	18.50

Catalog Number	Description	Quantity and Price			
		1-9	10-24	25-49	50-99
ZA-10057	Decimal Counter	66.00	62.20	50.35	50.35
ZA-11168	Jack Panel Assembly	Unit price \$350.00*			

General: Systems Components

*Quantity prices furnished on request.

General Ordering Information for all EECO Products

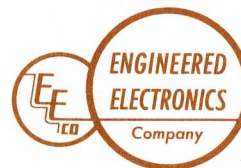
Orders for all shipments should be written *directly* on Engineered Electronics Company, 506 East First Street, Santa Ana, California, and may be transmitted through any of EECO's authorized representatives in the United States and Canada.

Prices and Terms

We are glad to ship on open accounts for companies with approved credit. Such accounts are regularly due and payable *1% within 10 days of date of invoice or net 30 days, except where quotations indicate otherwise.*

Shipment

Shipment is made in accordance with instructions received with your order. In the absence of instructions, we will use our own judgment in routing shipments to give you the very best service. All shipments are made f.o.b. our plant.



ENGINEERED ELECTRONICS COMPANY
506 East First Street • Santa Ana, California

WE WARRANT ALL PRODUCTS manufactured or sold by us to be free from defects in materials and workmanship, excluding vacuum tubes; 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.

Index

Alphabetical Index

Subject and Catalog Number	Series	Page	Subject and Catalog Number	Series	Page
Adder Matrix, One-Digit, Y-108	Computer	46	"Loaner Policy," Standard-Series Plug-ins	Standard	3
Amplifier, Phase Inverter, Z-8354	Standard	18	Mechanical Specifications	Computer	55
Amplifier, Pulse Mixer, Y-112	Computer	50	Mechanical Specifications	Standard	24
Amplifier, Push-Pull Voltage, Z-8351	Standard	18	Mounting Frame Assembly, Y-900	Computer	54
Amplifiers, D-C, Chopper Stabilized, ZA-12606, ZA-17019, ZA-17020, and ZA-17093	Amplifier	64-65	Mounting Racks, ZA-12512 and ZA-17094	Amplifier	64-65
Amplifiers, Linear, Z-8324 and Z-8762	Standard	17	Multivibrator, Z-90036	Standard	20
Amplifiers, Pulse, Z-8489 and Z-90030	Standard	16	Neon Driver, Y-107	Computer	45
Applications, Computer-Series Plug-ins	Computer	56-63	"Not" Circuit, DC, Y-110	Computer	48
Applications, Standard-Series Plug-ins	Standard	26-33	One Shot, Y-104	Computer	42
Cathode Follower, Multiple, Y-105	Computer	43	One Shots, Z-8318 and Z-8889	Standard	10
Cathode Follower, Multiple, Heavy-Duty, Y-106	Computer	44	Ordering Instructions		70
Cathode Followers, Dual, Z-8309 and Z-90053	Standard	19	Oscillator, Blocking, Z-90015	Standard	9
Circuits, Special, in Standard Plug-in Containers	Standard	24	Oscillator, Crystal, Z-90009	Standard	21
Clamps, Holddown, 95018-19 and 95018-27 (for Standard Plug-ins)	Standard	24	Oscillator, Phase Shift, Z-90134	Standard	20
Clamps, Holddown, 95063-19 and 95063-27 (for Diode Plug-ins)	Standard	23	Panel, Blank, Z-95103	Standard	35
Connectors, Y-906	Computer	54	Panel, Complete, Z-95104	Standard	35
Containers, Custom	Standard	25	Panels, Blank, Y-901 through Y-905	Computer	54
D-C Amplifier-Power Supply Assembly, ZA-17152	Amplifier	65	Phantastrons, Z-8771 and Z-90018	Standard	11
D-C Amplifiers, Chopper Stabilized, ZA-12606, ZA-17019, ZA-17020, and ZA-17093	Amplifier	64-65	Power Supplies, Z-95091, Z-95091-1, Z-95091-2, Z-95098, Z-95098-1, Z-95098-2, and Z-95098-3	Standard	34
Decimal Counter, ZA-10057		67	Power Supplies, Plate, ZA-12491 and ZA-17091	Amplifier	64-65
Delay Unit, Y-111	Computer	49	Power Supply, Filament, Magnetically Regulated, ZA-12777	Amplifier	64-65
Diode Logics, Y-405 and Y-414	Computer	51, 53	Price List		68-71
Diode Logics, Y-417 and Y-426	Computer	52-53	Racks, Mounting, ZA-12512 and ZA-17094	Amplifier	64-65
Diode Logics, and Equations, Representative List of	Computer	53	Racks only, Z-95102 and Z-95105	Standard	35
Diode Plug-in Units	Standard	23	Racks, Systems Development, Z-95100 and Z-95101	Standard	35
Driver, Neon, Y-107	Computer	45	Regulator-Amplifier, Power Supply, Z-90016	Standard	22
Equations, Logical, Representative List of	Computer	53	Regulator, Power Supply, Z-90005	Standard	22
Fabrication, Custom		25	Reset Generator, Z-90020	Standard	21
Flip-Flop, Y-100	Computer	38	Shift Register Element, Y-103	Computer	41
Flip-Flop, Y-101	Computer	39	Special Circuit in Standard Plug-in Containers	Standard	24
Flip-Flop, Y-102	Computer	40	Squaring Circuits, Z-90001 and Z-90021	Standard	14
Flip-Flop, Z-90166	Standard	9	Stepping Switches, Hermetically Sealed		66
Flip-Flops, Z-8336 and Z-8339	Standard	6	Subtractor Matrix, One-Digit, Y-109	Computer	47
Flip-Flops, Z-8342 and Z-90048	Standard	7	Switches, Stepping, Hermetically Sealed		66
Flip-Flops, Z-90052 and Z-90059	Standard	8	Systems Development Racks, Z-95100 and Z-95101	Standard	35
Gate Amplifier, Z-90007	Standard	12	Test Fixture, In-Circuit, Y-907	Computer	55
Gate Circuit, Z-90002	Standard	12	Usage Chart	Standard	4-5
Gates, Z-8327 and Z-90023	Standard	13	Warranty		71
Generator, Pulse, Thyatron, Z-90063	Standard	15			
Jack Panel Assembly, ZA-11168		67			

Numerical Index

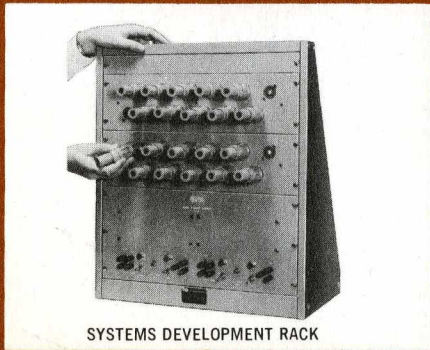
(by Catalog Number)

Catalog Number	Item	Page	Catalog Number	Item	Page
8-1N55B	8-Diode Plug-in Unit.....	23	Z-8342	Flip-Flop	7
8-1N67A	8-Diode Plug-in Unit.....	23	Z-8351	Amplifier, Push-Pull Voltage.....	18
8-1N89	8-Diode Plug-in Unit.....	23	Z-8354	Amplifier, Phase Inverter.....	18
8-1N100	8-Diode Plug-in Unit.....	23	Z-8489	Pulse Amplifier	16
12-1N55B	12-Diode Plug-in Unit.....	23	Z-8762	Linear Amplifier	17
12-1N67A	12-Diode Plug-in Unit.....	23	Z-8771	Phantastron	11
12-1N89	12-Diode Plug-in Unit.....	23	Z-8889	One Shot.....	10
12-1N100	12-Diode Plug-in Unit.....	23	Z-90001	Squaring Circuit (0 to 100 KC).....	14
16-1N55B	16-Diode Plug-in Unit.....	23	Z-90002	Gate Circuit	12
16-1N67A	16-Diode Plug-in Unit.....	23	Z-90005	Power Supply Regulator	22
16-1N89	16-Diode Plug-in Unit.....	23	Z-90007	Gate Amplifier	12
16-1N100	16-Diode Plug-in Unit.....	23	Z-90009	Crystal Oscillator	21
95018-19	Holddown clamp with 19/32" captive screws (for Std. Plug-ins).....	24	Z-90015	Blocking Oscillator	9
95018-27	Holddown clamp with 27/32" captive screws (for Std. Plug-ins).....	24	Z-90016	Power Supply Regulator-Amplifier	22
95063-19	Holddown clamp with 19/32" captive screws (for Diodes).....	23	Z-90018	Phantastron	11
95063-27	Holddown clamp with 27/32" captive screws (for Diodes).....	23	Z-90020	Reset Generator	21
Y-100	Flip-Flop	38	Z-90021	Squaring Circuit (0 to 200 KC).....	14
Y-101	Flip-Flop	39	Z-90023	Pentagrid Gate	13
Y-102	Flip-Flop	40	Z-90030	Pulse Amplifier	16
Y-103	Shift Register Element	41	Z-90036	Multivibrator	20
Y-104	One Shot	42	Z-90048	Flip-Flop (0 to 1 MC).....	7
Y-105	Multiple Cathode Follower	43	Z-90049	Squaring Circuit (0 to 1 MC).....	15
Y-106	Multiple Heavy-Duty Cathode Follower	44	Z-90052	Flip-Flop	8
Y-107	Neon Driver.....	45	Z-90053	Cathode Follower	19
Y-108	One-Digit Adder Matrix	46	Z-90059	Flip-Flop	8
Y-109	One-Digit Subtractor Matrix.....	47	Z-90063	Thyratron Pulse Generator	15
Y-110	DC "Not" Circuit	48	Z-90134	Phase Shift Oscillator	20
Y-111	Delay Unit	49	Z-90166	Flip-Flop	9
Y-112	Pulse Mixer Amplifier	50	Z-95091	Power Supply, Single, Chassis-Type	34
Y-400 thru Y-404	Diode Logic	53	Z-95091-1	Power Supply, Single, Panel-Type	34
Y-405	Diode Logic	51, 53	Z-95091-2	Power Supply, Dual, Panel-Type	34
Y-406 thru Y-413	Diode Logic	53	Z-95098	Power Supply, Single, Chassis-Type, with Bias Supply	34
Y-415 and Y-416	Diode Logic	53	Z-95098-1	Power Supply, Single, Panel-Type, with Bias Supply	34
Y-417	Diode Logic	52-53	Z-95098-2	Power Supply, Dual, Panel-Type, with Two Bias Supplies	34
Y-418 thru Y-425	Diode Logic	53	Z-95098-3	Power Supply, Dual, Panel-Type, with One Bias Supply	34
Y-426	Diode Logic (one-tube)	52-53	Z-95100	Systems Development Rack	35
Y-427	Diode Logic	53	Z-95101	Systems Development Rack, less power cabling	35
Y-900	Mounting Frame Assembly	54	Z-95102	Rack only, without Panels, Grey enamel	35
Y-901	Blank Panel, 1-3/32" Wide	54	Z-95103	Blank Panel, 1 1/4", Grey enamel	35
Y-902	Blank Panel, 2-7/32" Wide	54	Z-95104	Panel, 5 1/4", Grey enamel, complete with sockets, filament wiring, etc.	35
Y-903	Blank Panel, 3-11/32" Wide	54	Z-95105	Rack only, without Panels, Black wrinkle	35
Y-904	Blank Panel, 4-15/32" Wide	54	ZA-10057	Decimal Counter	67
Y-905	Blank Panel, 5-19/32" Wide	54	ZA-11168	Jack Panel Assembly	67
Y-906	Connector	54	ZA-12491	Plate Power Supply	64-65
Y-907	In-Circuit Test Fixture.....	55	ZA-12512	Mounting Rack	64-65
Z-8309	Dual Cathode Follower	19	ZA-12606	Chopper Stabilized D-C Amplifier	64-65
Z-8318	One Shot.....	10	ZA-12777	Magnetically Regulated Filament Power Supply	64-65
Z-8324	Linear Amplifier	17	ZA-17019	Chopper Stabilized D-C Amplifier	64-65
Z-8327	Pulse Gate	13	ZA-17020	Chopper Stabilized D-C Amplifier	64-65
Z-8336	Flip-Flop	6	ZA-17091	Plate Power Supply	64-65
Z-8339	Flip-Flop	6	ZA-17093	Chopper Stabilized D-C Amplifier	64-65
			ZA-17094	Mounting Rack	64-65
			ZA-17152	Complete Assembly, including 7 D-C Amplifiers (ZA-17019); 1 Plate Supply (ZA-12491); 1 Filament Supply (ZA-12777); 1 Mounting Rack (ZA-12512)	65

INDEX

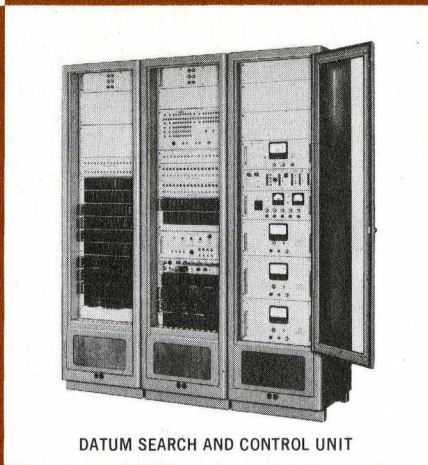
ENGINEERED ELECTRONICS BUILDING BLOCKS FOR SYSTEMS ENGINEERING

AUTOMATION



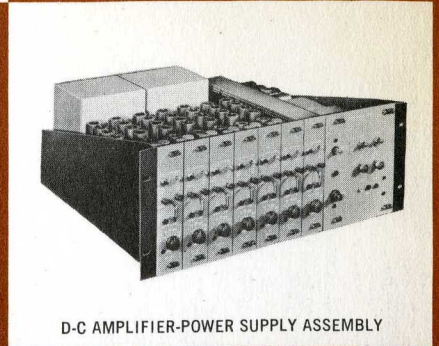
SYSTEMS DEVELOPMENT RACK

INSTRUMENTATION • DATA HANDLING

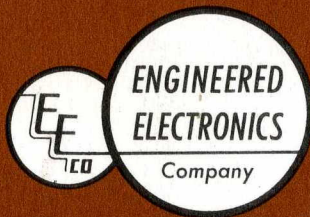


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