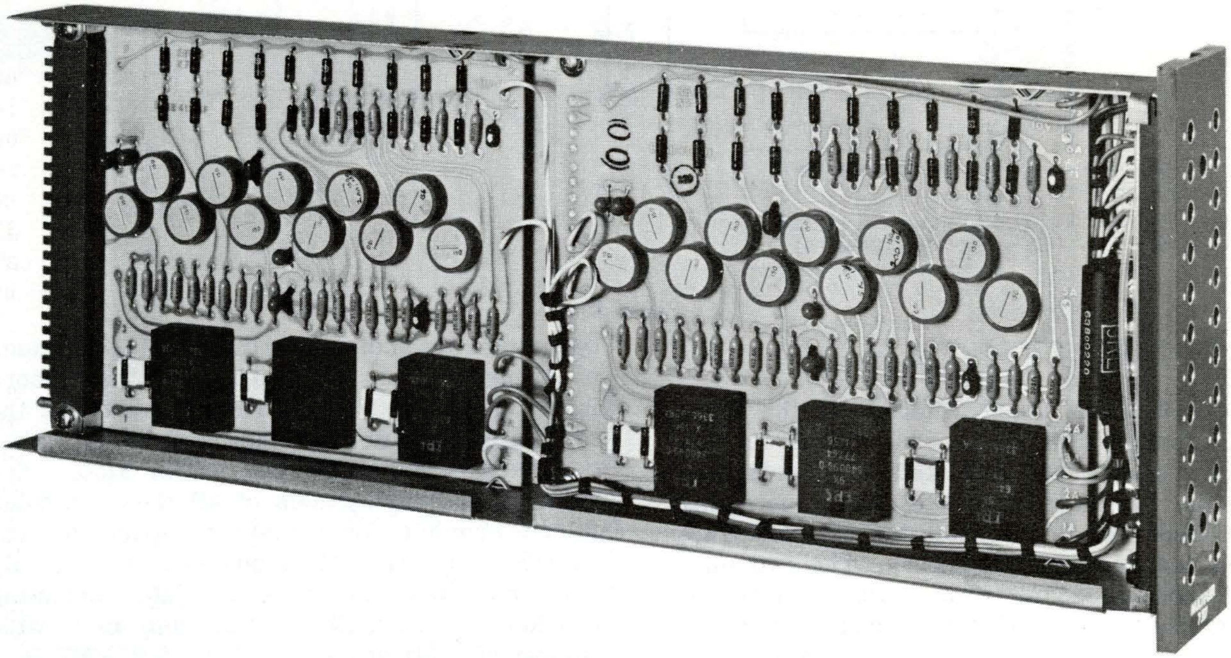
PIR PRODUCT INFORMATION RELEASE

PACE® SOLID STATE Analog Computing Components



ELECTRONIC BI-POLAR QUARTER-SQUARE MULTIPLIER - Type 7.117

. . . . .combining high speed operation, computation precision, and efficient reliable performance in a versatile, easy-to-use computing component. . . . .

Type 7.117 brings to the general purpose analog computer a computational capability for rapid, precise multiplication, division, squaring and square root extraction of problem variables. Designed for use with the EAI TR-48 Analog Computer, it is provided with a compatible front patch-panel strip -- color-coded to facilitate patch-cord connection with other components.

The Type 7.117 chassis contains two fixed diode function generator squaring units. These units are used together with separate uncommitted amplifier components of the computer -- providing added flexibility in interconnection and operation. Each card can be recalibrated periodically or as required, assuring continual computation precision.

Technique

The quarter-square multiplier has obtained its name from the mathematical equation that describes the multiplication technique used. This equation that is mechanized by the multiplier is the non-linear identity

$$xy \equiv 1/4 \left[(x + y)^2 - (x - y)^2\right]$$

in which x and y are the variables to be multiplied.

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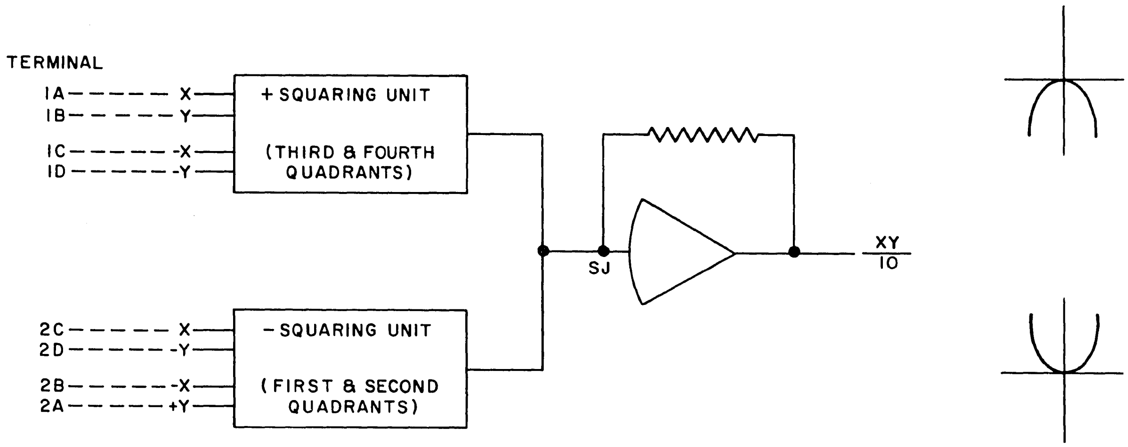

Figure 1

DESCRIPTION

A block-diagram representation of the Type 7.117 Multiplier is shown in Figure 1. The squaring operations indicated are performed using the two squaring units, each containing gated diode networks consisting of solid-state diodes and precision resistors. The two units are interconnected for four quadrant multiplication -- so that the input variables x and y may be of the same or opposite polarity. Each squaring unit is used as a fixed diode function generator with 13 segments, thus making it possible to set up the square-law characteristic with excellent accuracy. Also, each unit is contained on a printed-circuit card. The amplifiers shown are not included in the multiplier assembly; they are connected to it by patch-cords.

Squaring is accomplished by gating the diodes in the squaring units -- so that each diode starts conducting at a preset voltage. As the input voltages increase, each diode conducts in turn. Input resistance is added in parallel, and the gain of the output amplifier increases -- in small increments. The non-linear function representing the product of the two multiplier variables is produced at the amplifier's output.

CONNECTION

Input variables can be multiplied or squared by using the Type 7.117 Multiplier as a variable input resistance to an external, high gain d-c amplifier. Square root extraction or division of the variables can be accomplished by using it as a variable feedback resistance for the amplifier. The multiplier front-panel terminal connections that must be made to perform these operations are indicated in the patching diagrams of Figures 2, 3, 4, 5 and 6. The patch-cord interconnections that are required between the multiplier module and the modules of other computer components are shown also. The color-coded patch panels of all these modules joined together form the patch-panel for the TR-48 Computer. All modules can be easily removed and re-inserted into mounting brackets -- facilitating their use in a wide variety of applications.

SPECIAL OPERATING FEATURES

The voltage at the output of the external output amplifier that is used with Type 7.117 Multiplier may be of either polarity. If normal input connections are made, this output voltage is negative. If one pair of input terminals +x, -x or +y, -y is interchanged, the output voltage will be positive. With this feature, an additional inverting amplifier is not required to change the polarity of the output voltage.

Another important operating feature is provided with the multiplier's ability to perform two squaring operations or two square root extractions -- simultaneously and independently. Separate operation of the squaring units for either polarity of the input voltage can be arranged by making the proper terminal connection. With this feature, a square root extraction and a squaring operation can be performed together -- using only one Type 7.117 Multiplier. In addition, the squaring function is continuous through zero. This assures no abrupt change in feedback impedance at low inputs when in the square root mode.

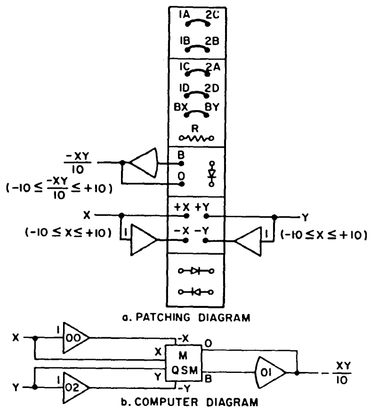

Figure 2. Multiplication-Patching and Computer Diagrams

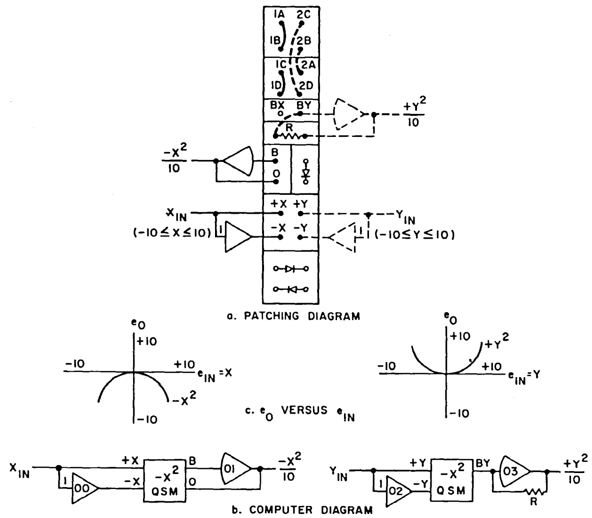

Figure 3. X^2 Squaring-Patching and Computer Diagrams

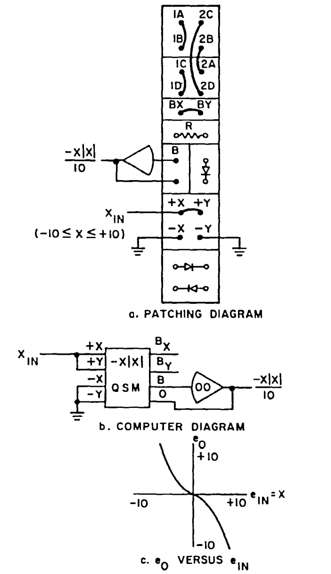

Figure 4. X|X| Squaring-Patching and Computer Diagrams

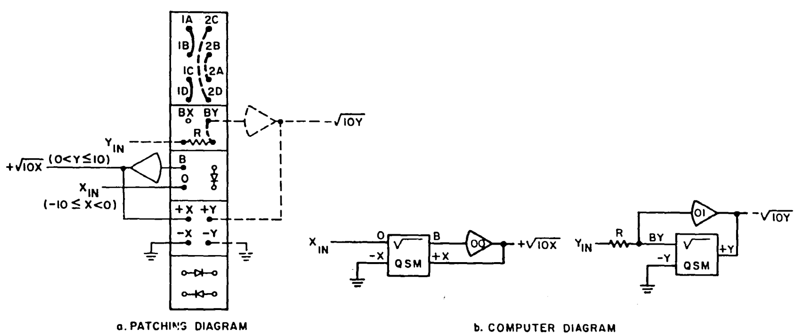

Figure 5. Square Root Extraction-Patching and Computer Diagrams

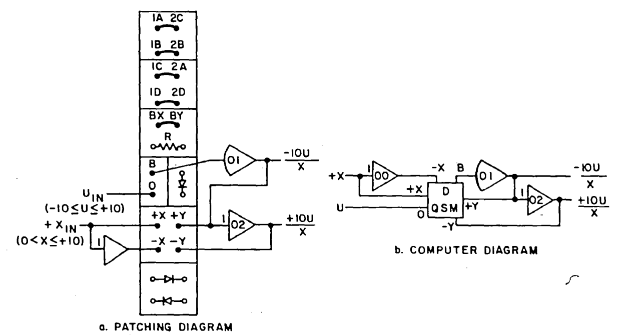

Figure 6. Division-Patching and Computer Diagrams

PERFORMANCE RELIABILITY

The Type 7.117 Multiplier has been designed for long-term, efficient, reliable performance. Its proven circuitry uses long-life silicon semi-conductors and other quality components. Its rugged compact mechanical design is precise in every detail. Its superior operating characteristics are thoroughly tested and assured by stringent quality control. In short -- the unit has been carefully designed, it is carefully assembled, and it is carefully tested -- to assure reliable performance.

SPECIFICATIONS

Static Accuracy*

Error - for both inputs

$\leq$10 volts and $\geq$-10 volts. . ±0.07% of F.S., ABS-MAX
±0.05% of F.S. TYP

Temperature Coefficient

At set-up temperature
±10°F . . . . 1 mV/°F, TYP

Zero Accuracy*

Error - either input zero . . . . ±0.05% of F.S., MAX
±0.025% of F.S., TYP

Error - both inputs zero . . . . ±0.005% of F.S., MAX

Static Accuracy - Independent Operation

Input $\leq$10 volts and $\geq$-10 volts

Squaring Operation. . . . . ±.025% of F.S., TYP
±.05% of F.S., MAX

Square Root Operation . . . $25 \times 10^{-3}/\sqrt{e_{in}}$ V, MAX
$12 \times 10^{-3}/\sqrt{e_{in}}$ V, TYP

Dynamic Accuracy (when used with 6.614 or 6.514 amplifiers)

Error - 1000 cps . . . 0.2% of Output, MAX

Bandwidth

With 6.614 amplifier . . . . . . 250 kc, MIN
With 6.514 amplifier . . . . . . 190 kc, MIN

Phase Shift

At 1 kc . . . . 0.09° MAX (6.614 amplifier)
0.15° MAX (6.514 amplifier)

Input Signal

Range . . . . -10 to +10 volts

Output Signal

Range . . . . -10 to +10 volts

In terms of input signals x and y. . . ±xy/10

Current Range . . . . +2.0 to -2.0mA.

*Accuracy stated is for the standard multiplier connection. Errors associated with the inverting amplifiers and output amplifier are included.

EAI reserves the right to revise its product specifications in accordance with its continuing program of product development.