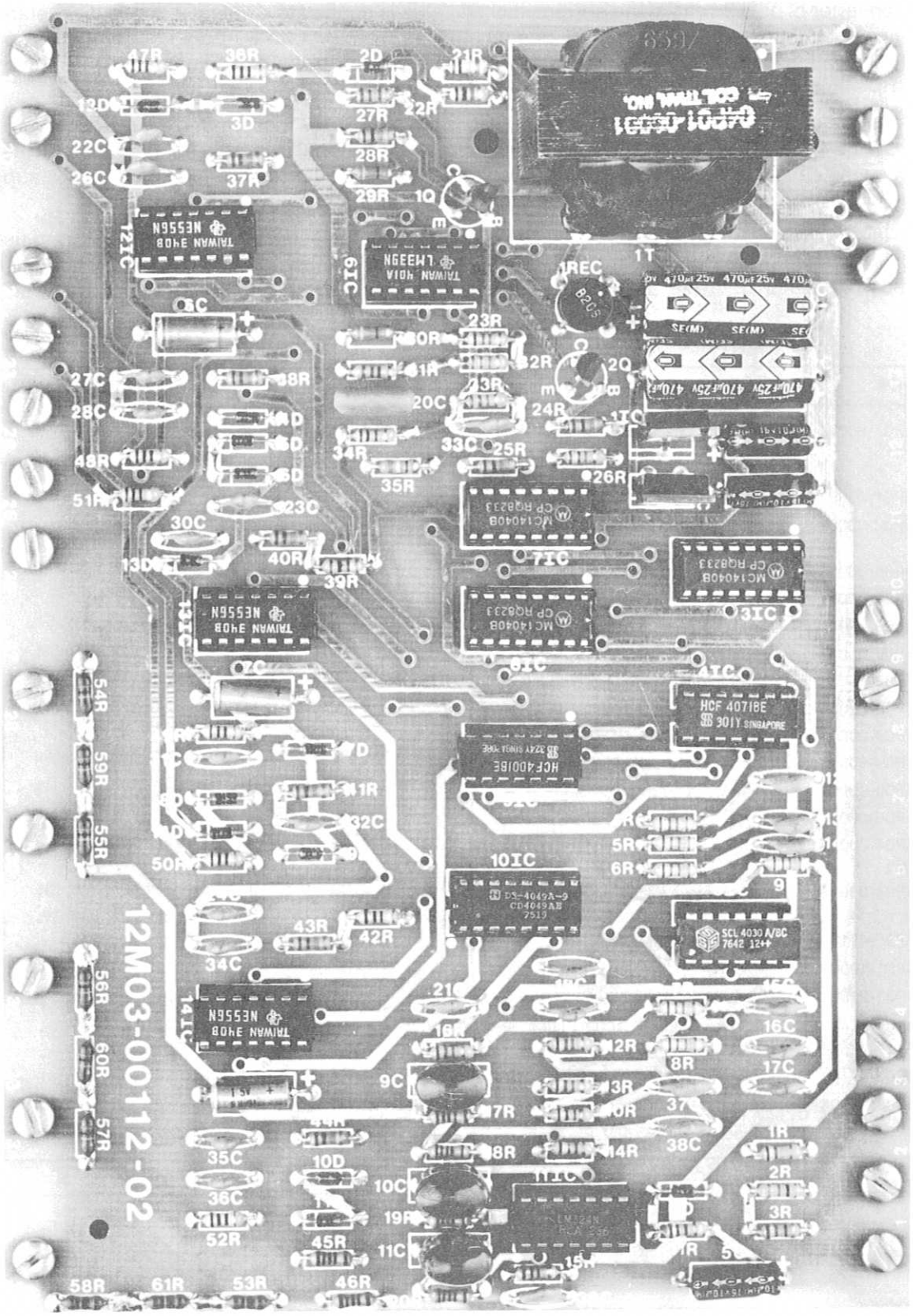
REFLEX®

Trouble-shooting Manual
MODEL 218 THREE-PHASE PULSE GENERATOR
PART NUMBER 12M03-00112-02



REFLEX® MODEL 218 THREE-PHASE GENERATOR

PART NUMBER 12M03-00112-02
SCHEMATIC DIAGRAM 12M03-00112-02

I. SPECIFICATIONS

SUPPLY
- 120 Volts AC ± 10%
- 50/60 Hz, single phase

AMBIENT TEMPERATURE
- 0° to 40°C (32° to 104°F)
- 50°C in cabinet

SYNCHRONIZING INPUT
- 120 to 600 volts AC
- 50/60 Hz, three phase

OUTPUT
- 12V nominal with 200 ohm output resistance

INPUT
- Direct to Oscillator, 0 to positive 6 volts nominal. To Current Regulator, 0 to negative 6 volts on Reference Input terminal and 0 to positive 2 volts on Current Feedback terminal both at zero to 1mA nominal.

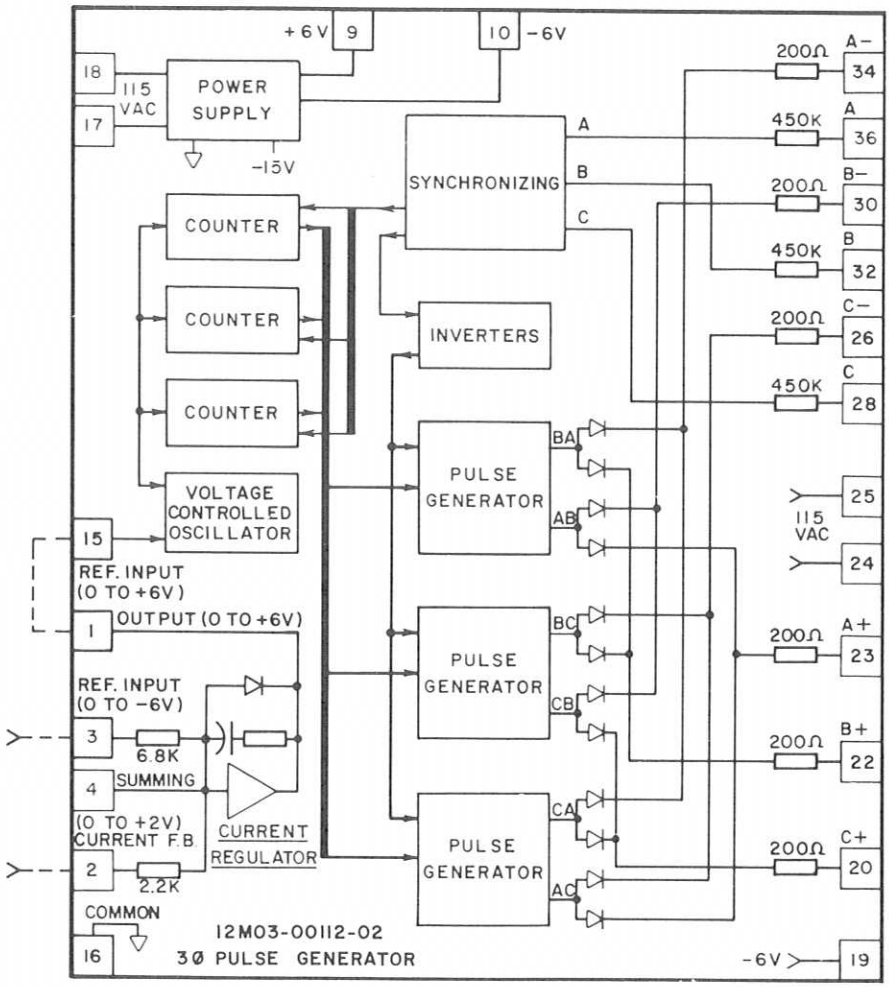


FIGURE 1. SIMPLIFIED SCHEMATIC DIAGRAM

II. THEORY OF OPERATION

The REFLEX® Model 218 Three-Phase Pulse Generator produces six output pulses, each displaced 60 electrical degrees to provide gate firing signals to a pulse amplifier such as the REFLEX® Model 219.

Digital techniques provide balanced firing signals independent of phase rotation. Output is nearly linear with respect to Input, which allows the use of linear analysis to optimize performance. It is designed to handle current flow in the positive and negative halves of the AC supply for "two quadrant" operation. Refer to the "Theory of Operation of a Three-Phase Full Wave Thyristor Power Converter" (DS6200-00107) for a complete understanding of this assembly.

The circuit consists of the following elements shown in the Simplified Schematic Diagram (Figure 1):

1. Power Supply
2. Synchronizing Circuit
3. Oscillator
4. Counter
5. Pulse Generator
6. Current Regulator

1. **Power Supply** — The power supply uses a center-tapped transformer with 10 volts on each side of center together with a bridge rectifier and two 470 MF filter capacitors to provide a nominal positive and negative unregulated 15 volts DC with respect to the transformer center-tap, which is connected to circuit common.

   Additionally, a positive and negative 6 volt regulated voltage is obtained from the positive and negative 15 volt supplies, using regulators 1IC and 2IC each with a 10 MF filter capacitor.

2. **Synchronizing Circuit** — The Synchronizing Circuit provides synchronization with the AC Supply for the Counters and Pulse Generators.

   The three phase AC Supply is connected to terminals 28, 32, and 36. Three 150K, 1% resistors in series from each terminal provide impedance isolation from the power circuit. Capacitors 9C, 10C and 11C are connected to circuit common from each group of these resistors to provide a three phase signal, balanced with respect to circuit common, and shifted a nominal 45 electrical degrees with respect to line-to-neutral of the AC Supply to provide synchronizing signals that are insensitive to phase rotation. The three capacitors are matched in value to within 1% to insure that the 45° phase shift is identical for all three phases.

   The three Synchronizing and Pulse Generating circuits are identical so for purposes of simplicity, the remainder of this discussion will be limited to one of the three.

   The output of one phase of the 45° phase shifting network is applied to a voltage divider consisting of 46R and 20R on one leg and 45R and 19R on another leg of the three phase input. A small voltage from each of these dividers is applied to the two input terminals of the Differential Comparator 11IC (C) which produces a square wave at the zero crossing of the phase-shifted three-phase AC voltage. A 1 megohm feedback resistor (10R) provides hysteresis through positive feedback lock-in for better rise time on the square wave and improved noise immunity.

   The square wave output of the comparator is applied directly to one input and through an R-C time delay to the other input of "exclusive OR" gate 51C (C). This gate acts as a Non-coincidence Detector, producing an output when input pin 9 is high and input pin 8 is low or when pin 9 is low and pin 8 high. When both inputs are low or high there is no output. Because of the time delay at one input, there is a momentary lack of coincidence whenever the square wave from the Comparator goes from low to high or high to low at the beginning and end of the synchronizing interval, and an output pulse is produced for each change.

3. **Oscillator** — A voltage controlled oscillator with an output frequency proportional to the magnitude of its input voltage produces a nominal 35K to a 200K Hz train of pulses to furnish the clock signal to the counter. It provides a nearly linear relationship between input and output which allows use of linear analysis to optimize performance.

   As the positive input reference voltage on terminal 15 increases from zero, the frequency of the Oscillator increases. Pulses from the Oscillator are accumulated in the Counter until a total of 256 pulses are accumulated. The Counter then puts out a signal to the Pulse Generator to fire a pair of thyristors.

   The higher frequency of the Oscillator, the more rapidly the 256 counts are accumulated in the Counter and the earlier in the half cycle the thyristors fire, consequently the higher the output voltage from the thyristor bridge.

   The input to the Oscillator may be a 0 to plus 6 volt reference from the regulated power supply, terminal 9. However, its reference is normally obtained from the output of the Current Regulator as described below (paragraph 6).

4. **Counter** — The Counter, 3IC, determines when in the half cycle a firing pulse occurs. The 8th bit of a 12 bit counter is set to generate an output signal whenever a count of 256 pulses is received on its "clock," pin 10. The Counter advances with each pulse from the Oscillator. The use of 256 as the number of Oscillator pulses to provide a firing pulse, provides resolution of the thyristor output of less than one electrical degree.

   The output of the Counter is fed back through an R-C time delay and an "OR" gate, 41C (B) to the reset Pin 11 so the Counter is reset at the end of 256 counts. The Counter also sends a pulse to the Pulse Generator through a "NOR" circuit, 9IC (C), that inverts the pulse (negative output when either input is positive.)

   The output of the "NOR" circuit provides a trigger signal to both halves of the Pulse Generator, but actually triggers only one half depending on the state of the Comparator in the Synchronizing Circuit. The other input to the "NOR" circuit receives a pulse from the exclusive "OR" circuit whenever the Comparator in the Synchronizing Circuit changes state. The pulse that appears at the beginning of each synchronizing cycle is not capable of firing the thyristor because of various time delays in the circuit. However, the pulse occuring at the end of the synchronizing interval acts through the "NOR" gate to provide a minimum firing angle, commonly called an "End Stop" which prevents commutation failures through regeneration.

   As a point of information, after the Counter is reset, it continues to count and produces another pulse for each 256 clock pulses. The additional pulses in a given half-cycle have no significance, since the thyristor should have been fired by the first pulse.

5. **Pulse Generator** — The Pulse Generator 14IC is a dual-timer integrated circuit connected as a one-shot multivibrator. One half, pin 9, delivers an output pulse to fire two thyristors (B+ and A–) and the other half, pin 5, delivers an output pulse to fire two other thyristors (B– and A+).

   The length of the pulse is determined by the time constant of the R-C network on the inputs, pins 1 and 2 and pins 12 and 13; nominally 100 to 150 microseconds.

   The output pulses provide the input signal to a Pulse Distribution Circuit such as the REFLEX® Model 219 connected to the gates of a three phase thyristor bridge. A diode matrix on the output of the Pulse Generator establishes which output terminals receive a particular pulse.

6. **Current Regulator** — The Current Regulator allows operation with an inner current loop and consists of op-amp 11IC (B), and associated components. A feedback proportional to the output current of the thyristor Power Converter of plus 2 volts at the current-limited value is applied to terminal 2. A negative reference of 6 volts from a potentiometer or other control module such as the REFLEX® Model 217 Universal Closed-Loop Controller is applied to terminal 3. The feedback and reference currents are summed at the junction of pin 6 of 11IC (B).

   A small positive current from the plus 6 volt supply through 1R insures that the Current Regulator is turned off in the absence of a reference signal. As the negative reference signal is increased, the output of the Current Amplifier swings positive. A net positive output on the output of the Current Regulator terminal 1 supplies the input signal for the Oscillator at terminal 15.

   The stability network 11R and 5C around the Current Regulator is optimized for an output current rise time of 10 to 12 milliseconds with 2 volts feedback. This allows the Power Converter to go from no-load to full-load in less than one electrical cycle.

COMPONENT LIST — ASSEMBLY #12M03-00112-02

Symbol	Part #	Description (Acceptable Substitute) *
1T	04P01-00001	Transformer - 120V AC PRI, two 10V SEC @ 220mA (Signal-PC20-220)
1REC	05P01-00003	Rectifier Bridge - 50V, 1A (EDI-PF50)
1-14D	05P02-00001	Diode - Signal, 50mA, 200 PIV (1N4148)
1IC	05P08-00006	+6V Regulator (7806)
2IC	05P08-00007	-6V Regulator (7906)
3,7,8IC	05P09-00004	Binary Counter, 12 Stage (4040)
4IC	05P09-00002	Quad or Gate (4071)
5IC	05P09-00003	Quad Excl. or Gate (4030)
6IC	05P08-00004	Quad Comparator (Nat'l LM339)
9IC	05P09-00001	Quad nor Gate (4001)
10IC	05P09-00005	Hex Inverter (4049)
11IC	05P08-00001	Quad Op-amp (Nat'l LM324)
12-14IC	05P08-00008	Dual timer (Nat'l LM556)
1Q	05P04-00001	Transistor - PNP Small Signal (2N3638A)
2Q	05P04-00002	Transistor - NPN Small Signal (2N3392)
1, 2C	03P01-47102-01	Capacitor - 470MF, 25V, Electrolytic
3-5C	03P01-10001-00	Capacitor - 10MF, 16V, Electrolytic
6-8C	03P03-22601-00	Capacitor - 22MF, 16V, Tantalum
9-11C	03P07-22410-00	Capacitor - .22MF, 100V, Film (Matched to 1%)
12-14C 37-39C	03P06-47105-00	Capacitor - 470PF, 50V, Ceramic
15-17C	03P06-22105-00	Capacitor - 220PF, 50V, Ceramic
33C	03P06-50005-00	Capacitor - 50PF, 50V, Ceramic
18, 19,21C	03P06-10205-00	Capacitor - .001MF, 50V, Ceramic
20C	03P07-10210-00	Capacitor - .001MF, 100V, Film
22-24,26-28, 30-32, 34-36C	03P06-10305-00	Capacitor - .01MF, 50V, Ceramic
1R	01P01-22400-02	Resistor - 220K, ¼W, 5%
2R	01P01-68200-02	Resistor - 6.8K, ¼W, 5%
3,27R	01P01-22200-02	Resistor - 2.2K, ¼W, 5%
4-9R	01P01-27300-02	Resistor - 27K, ¼W, 5%
10,14,15R	01P01-10500-02	Resistor - 1M, ¼W, 5%
11,34R	01P01-10200-02	Resistor - 1K, ¼W, 5%
12, 13, 16, 23R	01P01-56300-02	Resistor - 56K, ¼W, 5%
17,45,46R	01P02-10021-01	Resistor - 10K, ½W, 1%
18,19,20R	01P02-20011-01	Resistor - 2K, ½W, 1%
21R	01P01-10400-02	Resistor - 100K, ¼W, 5%
22, 24, 25, 28R	01P01-10300-02	Resistor - 10K, ¼W, 5%
26,32,33R	01P01-22300-02	Resistor - 22K, ¼W, 5%
29, 30R	01P01-47200-02	Resistor - 4.7K, ¼W, 5%
31R	01P01-33200-02	Resistor - 3.3K, ¼W, 5%
35R	01P01-39100-02	Resistor - 390, ¼W, 5%
36,39,42R	01P01-10100-02	Resistor - 100, ¼W, 5%
37,38,40, 41,43,44R	01P01-12300-02	Resistor - 12K, ¼W, 5%
47-52R	01P01-20100-02	Resistor - 200, ¼W, 5%
53-61R	01P02-15031-01	Resistor - 150K, ½W, 1%

Note: No 25C, 29C

* OR EQUAL

III. BENCH TEST

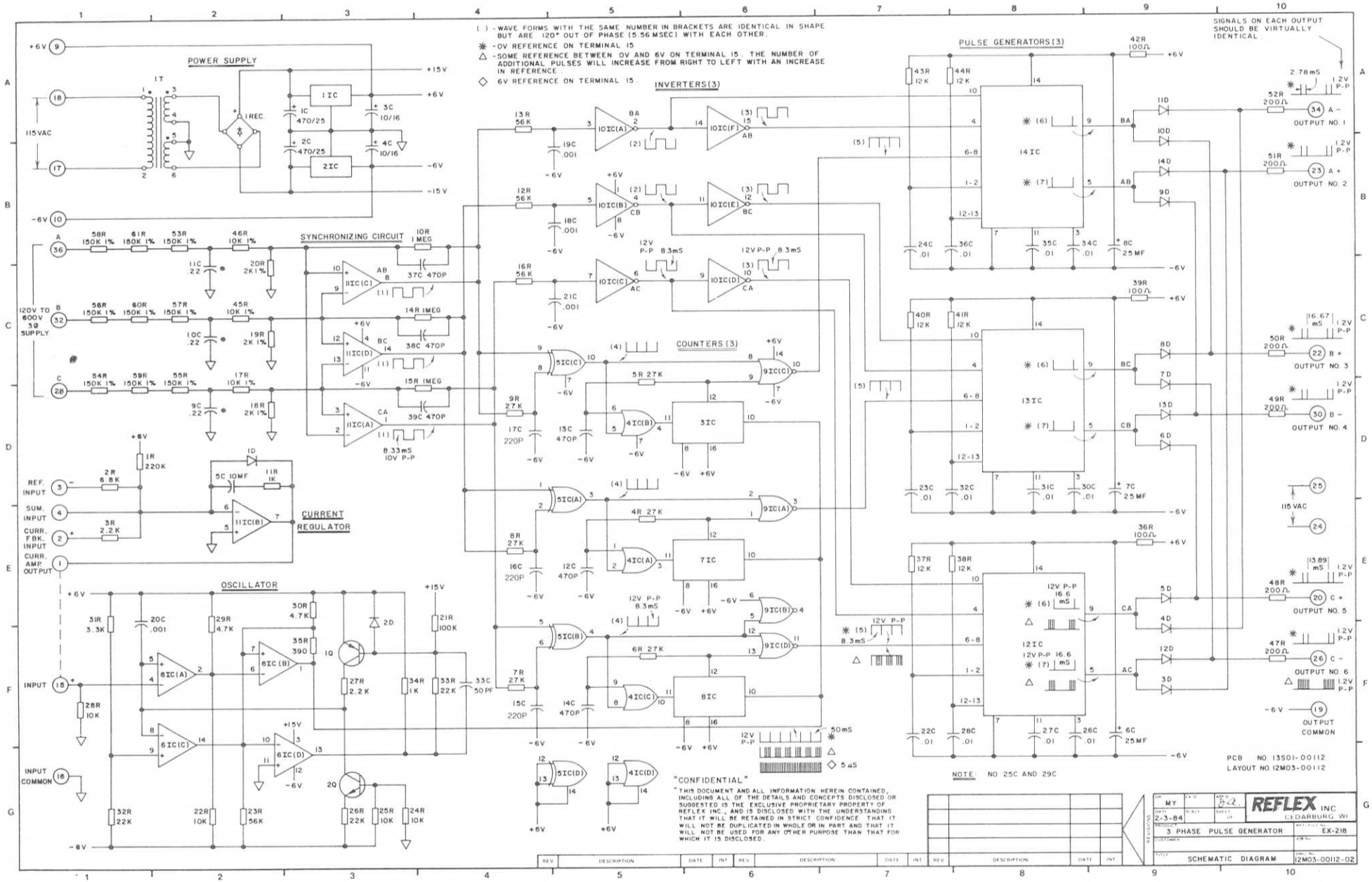
TEST MATERIAL REQUIRED

1 - 120V AC Line Cord
1 - 6.8K, ¼ Watt Resistor
6 - 1K, ¼ Watt Resistors
1 - 5K Potentiometer
14 - Clip leads
1 - Oscilloscope (Tektronix 2213 or equal)

1. Connect a 6.8K resistor from terminals 1 to 4, a jumper from terminals 1 to 15, and a 5K potentiometer to terminal 10 (CW), terminal 16 (CCW) and terminal 3 (wiper).
2. Connect 1K resistors from terminal 19, (common) to each of the following terminals: 20, 22, 23, 26, 30 and 34.
3. Apply 115V AC to terminals 17 and 18. Measure 115V AC at terminals 24 and 25.
4. With DIP test connector, use oscilloscope or frequency counter on pin 1 of 6IC, and with 5K potentiometer CCW read 15 to 26K HZ. Turn potentiometer full CW and read 145 to 190K HZ. Return potentiometer to CCW position.
5. Apply any 3 phase AC power to terminals 28, 32, and 36 — 100 to 600 volts.
6. Using a dual trace oscilloscope across any of the 1K resistors adjust channel "A" vertical and horizontal to read 2 groups of two pulses each, with horizontal spacing adjustment so that the 2nd group is displaced exactly 6 divisions from the first group.
7. Turn the 5K potentiometer CW until additional pulses just barely appear at each group.
8. Use channel "B" to observe the pulses on each of the remaining 1K resistors with the sync. set to channel "A." During this portion of testing, the leading edge of each group of pulses must fall directly on one of the separate vertical division lines between 1 and 6, and be the same magnitude and width.

IV. VOLTAGE CHECKS

1. The primary voltage of 1T, leads 1 and 2 (terminals 18 and 17), should be 120V AC.
2. The secondary voltage of 1T, leads 3 to 4 and leads 5 to 6, should be 10V AC. These can be measured between circuit common, terminal 16 (leads 4 and 5), and each AC input to the bridge rectifier 1REC (leads 3 and 6). Voltage at the AC input to the bridge rectifier 1REC (leads 3 to 6) should be 20V AC.
3. +15V DC nominal between the positive end of capacitor 1C and terminal 16.
4. -15V DC nominal between the negative end of capacitor 2C and terminal 16.
5. +6V DC nominal (5.5 to 6.5 volts) between terminals 9 and 16.
6. -6V DC nominal (5.5 to 6.5 volts) between terminals 10 and 16.
7. Measure 3 phase AC line voltage between terminals 28, 32 and 36.
8. Use an oscilloscope to verify that the waveforms are as shown on the schematic diagram.


( ) - WAVE FORMS WITH THE SAME NUMBER IN BRACKETS ARE IDENTICAL IN SHAPE BUT ARE 120° OUT OF PHASE (5.56 MSEC) WITH EACH OTHER.
✳ -0V REFERENCE ON TERMINAL 15
△ -SOME REFERENCE BETWEEN 0V AND 6V ON TERMINAL 15. THE NUMBER OF ADDITIONAL PULSES WILL INCREASE FROM RIGHT TO LEFT WITH AN INCREASE IN REFERENCE.
◇ 6V REFERENCE ON TERMINAL 15.
SIGNALS ON EACH OUTPUT SHOULD BE VIRTUALLY IDENTICAL
POWER SUPPLY
115VAC
1T
1REC.
1IC
2IC
+15V
+6V
-6V
-15V
SYNCHRONIZING CIRCUIT
120V TO 600V 3Ø SUPPLY
INVERTERS(3)
COUNTERS(3)
PULSE GENERATORS(3)
OUTPUT NO. 1
OUTPUT NO. 2
OUTPUT NO. 3
OUTPUT NO. 4
OUTPUT NO. 5
OUTPUT NO. 6
OUTPUT COMMON
CURRENT REGULATOR
REF. INPUT
SUM. INPUT
CURR. FBK. INPUT
CURR. AMP. OUTPUT
OSCILLATOR
INPUT
INPUT COMMON
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NOTE: NO. 25C AND 29C
PCB NO. 13501-00112
LAYOUT NO. 12M03-00112
REFLEX INC
CEDARBURG, WI
3 PHASE PULSE GENERATOR
EX-218
SCHEMATIC DIAGRAM
12M03-00112-02
2-3-84
MY