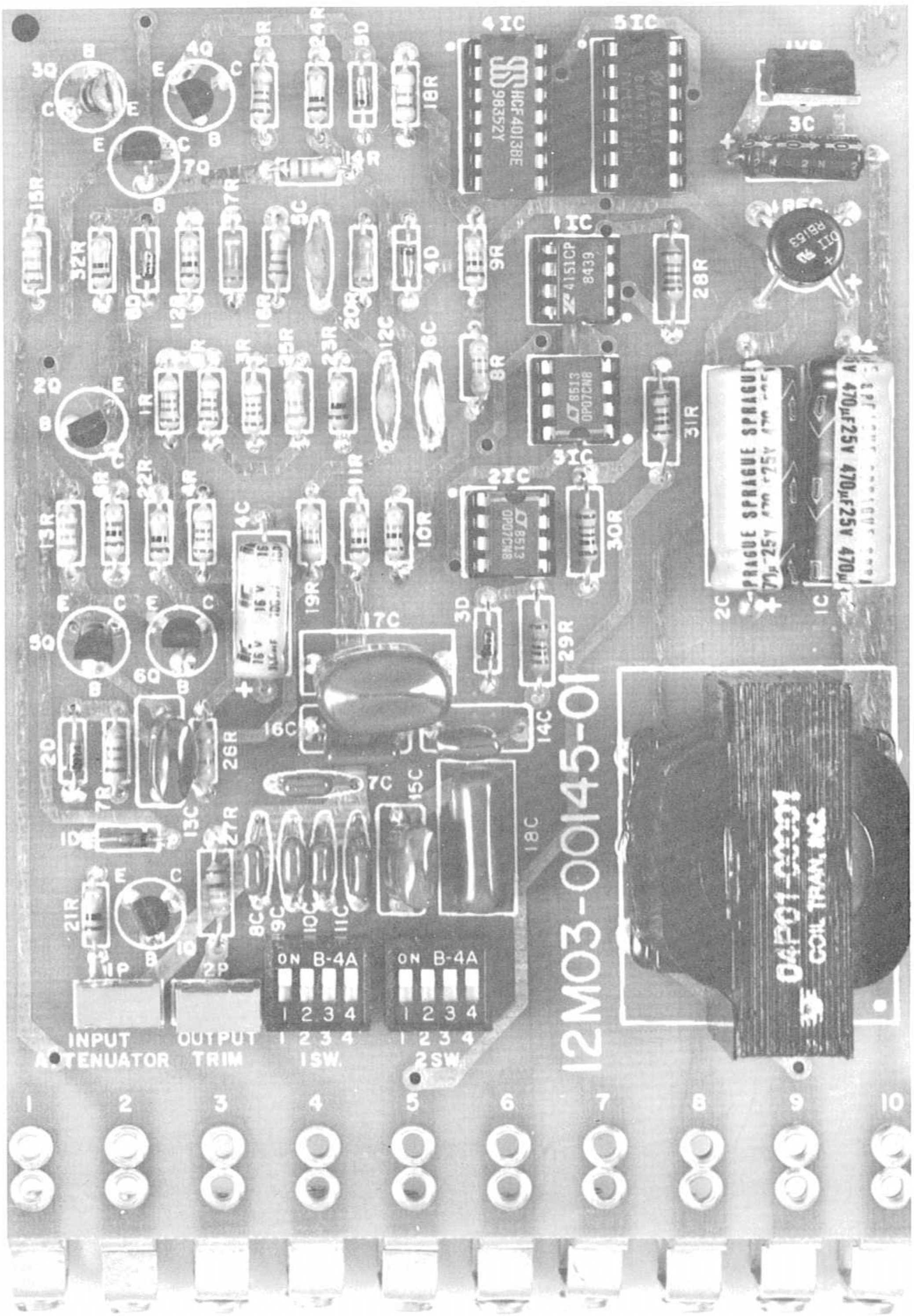
REFLEX®

Trouble-shooting Manual
MODEL 258 FREQUENCY TO VOLTAGE CONVERTER (DIGITAL TACH)

PART NUMBER 12M03-00145-01



REFLEX® MODEL 258 FREQUENCY TO VOLTAGE CONVERTER (DIGITAL TACH)

PART NUMBER 12M03-00145-01
SCHEMATIC DIAGRAM 12M03-00145-01

I. SPECIFICATIONS

SUPPLY:

- 120V AC ±10%
  50/60 Hz, Single Phase

AMBIENT TEMPERATURE:

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

INPUT:

- Sine wave or Pulse of 50mV or greater. At frequencies below 60 Hz, higher input voltages may be required depending on waveform.

  Common Logic Families (TTL, CMOS, etc.) frequency can go to zero.

  Frequency: 0 to 50KHz in five ranges: 2.5K, 5K, 10K, 25K and 50K (intermediate ranges with switch combinations).

  Quadrature input for two-phase pulse generator automatically provides reversal of output polarity for direction of rotation logic.

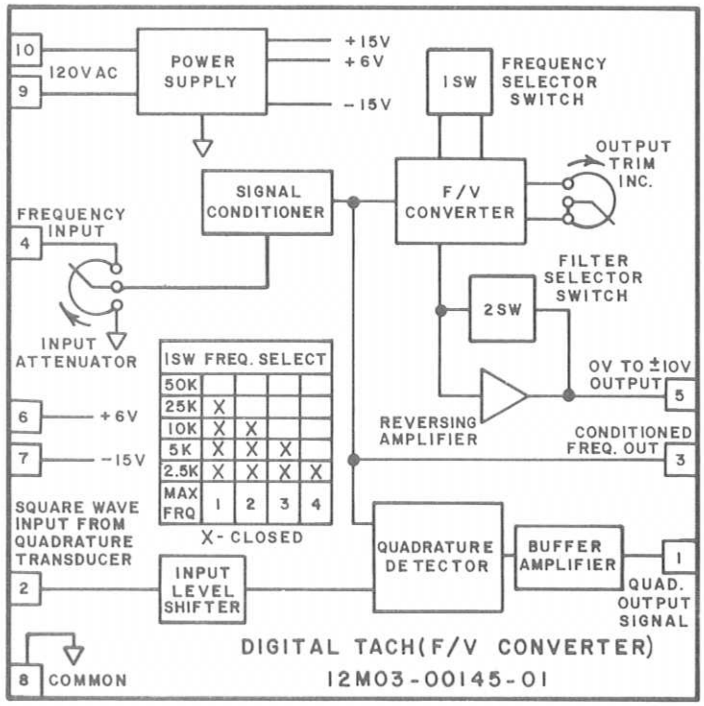


FIGURE 1. SIMPLIFIED SCHEMATIC

OUTPUT:

- 0 to 10V DC @ 5mA positive or negative

  Single pole filter with a time-constant from .009 to .36 seconds selectable by four DIP switches.

  Conditioned Frequency Output: Amplified and squared signal from Main Input.

  Digital Directional Output: 15V DC logic signal (0 or 1) indicating direction of rotation.

LINEARITY: within 0.1% of full scale

DRIFT: 100 ppm per degree C maximum from 0° to 50° C.

MOUNTING: Standard Reflex® 10 terminal chassis (P/N 12M04-00011)

II. THEORY OF OPERATION

The REFLEX® Model 258 Frequency to Voltage Converter is a circuit that converts a train of logic pulses or an AC sinusoidal signal to a DC voltage that is proportional to frequency. In addition, if a rotary pulse generator with a two-phase output is available, the direction of rotation determines the polarity of the analog output voltage.

The circuit consists of the following sections as shown in the Simplified Schematic, Figure 1.

1. Power Supply
2. Signal Conditioner
3. Frequency to Voltage Converter
4. Reversing Amplifier
5. Quadrature Input Level Shifter
6. Quadrature Detector

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 6 volts regulated is obtained from the positive 15 volt supply, using regulator 1VR with a 10 MF filter capacitor.

2. **Signal Conditioner** — This section consists of 1, 2, 5 and 6 Q. It amplifies an adjustable portion of the input signal as selected by "Input Attenuator," 1P. Diodes 1 and 2D are to limit the voltage for very large signals.

   Sine waves are converted into square waves and pulses are passed through with enhanced rise and fall times. The output is fed through two differentiating capacitors 6C and 5C to the Frequency to Voltage Converter and Quadrature Detector respectively.

3. **Frequency to Voltage Converter** — An integrated circuit is used that is specifically designed to convert a series of incoming trigger pulses to a DC output whose magnitude is dependent on the frequency of the incoming pulses, and an R-C time constant determined by 27R, 2P, and capacitors 7 through 11C. The Chart, Figure 2 shows the selection of capacitors for various ranges of input frequencies. "Output Trim" potentiometer 2P is used to adjust for exact calibration.

The output of the Frequency to Voltage Converter, 1IC, is converted to a steady DC by op-amp 2IC in conjunction with its filter capacitors 14 through 18C. The filter capacitors are selected to provide an acceptable amount of ripple consistent with time of response. The peak-to-peak ripple for any combination of capacitors can be calculated by the formula:

1 SW FREQUENCY SELECT				
MAX FREQ HERTZ	1	2	3	4
50K				
25K	X			
10K	X	X		
5K	X	X	X	
2.5K	X	X	X	X
X = SWITCH CLOSED				

FIGURE 2

$$E = \frac{135t}{C}$$

where "C" is the sum of capacitors 14 through 18C in microfarads and "t" is the sum of capacitors 7 through 11C in microfarads times 10^{-2}.

Example: with only 14C and 7C the peak to peak voltage is:

$$E \times \frac{135 \times .0012 \times 10^{-2}}{.047} \times 34\text{mV}$$

4. **Reversing Amplifier** — This section takes the output from 2IC and delivers it to the ouput terminal buffered and inverted or non-inverted depending on the state of analog switch 5IC.

Analog switch, 5IC, is activated by the Quadrature Detector, or in the absence of a quadrature signal, by the logic level at the Quadrature Input, terminal 2.

5. **Quadrature Input Level Shifter** — This section takes a logic input and converts it to a positive or negative 15 volt DC signal at the collector of transistor 7Q. A voltage divider consisting of 16 and 17R shifts the DC level to approximately zero to 15 volts negative for the Quadrature Detector.

6. **Quadrature Detector** — To understand the action of the Quadrature Detector, look at the waveform in Figures 3 and 4.

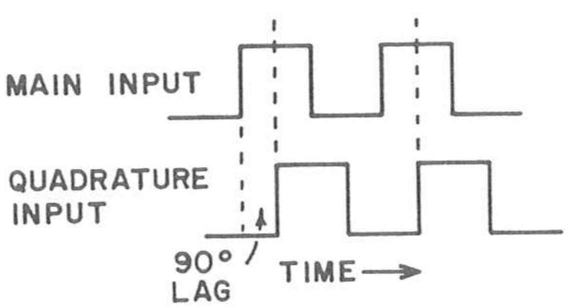


FIGURE 3

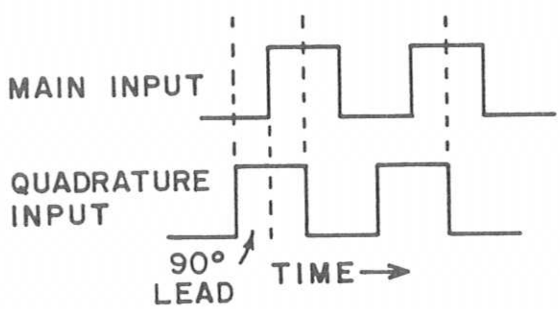


FIGURE 4

In Figure 3 the Quadrature Input is shown lagging the Main Input by 90° and in Figure 4 it is shown leading by 90°. Op-amp 4IC is a "D" type flip-flop in which the logic level at data terminals 5 and 9 is transferred to ouput terminals 12 and 13 at every positive transition of clock inputs 11 and 3.

Observe Figure 3. Every time the Main Input makes a positive transition, the Quadrature Input is at logic level zero. This means that the output of the flip-flop will always remain at logic level zero.

Similarly, in Figure 4, representing the opposite direction of rotation, the Main Input positive transistions occur when the Quadrature Input is at logic level 1. Thus the flip-flop output remains at logic level 1 for this direction of rotation.

Since the relative position of the Main and Quadrature Inputs is unaffected by frequency, the flip-flop will always produce an output which is indicative of the direction of rotation.

The normal inverted outputs of the flip-flop are used to drive the Analog Switch, 5IC, which determines the polarity of output for the Reversing Amplifier.

The logic level indicating direction of rotation is also available at output terminal 1, buffered by transistor 4Q for use where a logical direction signal is required.

VOLTAGE CHECKS

1. Terminal 8 (common) to +(1C), +15V nominal.
2. Terminal 8 to terminal 7, -15V nominal.
3. Terminal 8 to terminal 6, +6V nominal.

COMPONENT LIST — ASSEMBLY #12M03-00145-01

Symbol	Part #	Description (Acceptable Substitute) *
1T	04P01-00001	Transformer - 120V AC PRI, two 10V AC SEC @ 220 mA (Signal - PC 20-220)
1REC	05P01-00003	Rectifier Bridge - 50V, 1A (EDI-PF50)
1-6D	05P02-00001	Diode - Signal, 50mA, 200 PIV (IN4148)
1VR	05P08-00006	+6V Regulator (7806)
1IC	05P10-00003	V/F Converter (4151)
2, 3IC	05P08-00005	Precision Op-Amp (Fairchild 714HC)
4IC	05P09-00007	Dual DQ Flip-Flop (4013)
5IC	05P09-00008	Quad Analog Switch (4016)
1-4Q	05P04-00002	Transistor, NPN Signal (2N3392)
5-7Q	05P04-00001	Transistor, PNP Signal (2N3638A)
1, 2SW	09P01-00004	Switch, 4SPST, DIP (Grayhill 78B04)
1P	02P04-50301-00	Potentiometer - 50K, ¼W (Beckman 72XR50K)
2P	02P04-10301-00	Potentiometer - 10K, ¼W (Beckman 72XR10K)
1, 2C	03P01-47102-01	Capacitor, 470MF, 25V, Elect
3C	03P01-10001-00	Capacitor, 10MF, 16V, Elect
4C	03P01-10101-11	Capacitor, 100MF, 16V, Elect
5C	03P06-10105-00	Capacitor, 100PF, 50V, Ceramic
6C	03P06-22105-00	Capacitor, 220PF, 50V, Ceramic
7, 8C	03P07-12210-00	Capacitor, .0012MF, 50V, Film
9C	03P07-27210-00	Capacitor, .0027MF, 50V, Film
10C	03P07-56210-00	Capacitor, .0056MF, 50V, Film
11C	03P07-15310-00	Capacitor, .015MF, 50V, Film

Symbol	Part #	Description (Acceptable Substitute) *
12C	03P06-10205-00	Capacitor, .001MF, 50V, Ceramic
13, 15C	03P07-10410-00	Capacitor, 0.1MF, 100V, Film
14C	03P07-47310-00	Capacitor, .047MF, 100V, Film
16C	03P07-22410-00	Capacitor, .22MF, 100V, Film
17C	03P07-47410-00	Capacitor, .47MF, 100V, Film
18C	03P07-10510-00	Capacitor, 1.0MF, 100V, Film
1-5R	01P01-22200-02	Resistor, 2.2K, 5%, ¼W
6R	01P01-10200-02	Resistor, 1K, 5%, ¼W
7R	01P01-27200-02	Resistor, 2.7K, 5%, ¼W
8R	01P01-47200-02	Resistor, 4.7K, 5%, ¼W
9-12R	01P01-10300-02	Resistor, 10K, 5%, ¼W
13R	01P01-33300-02	Resistor, 33K, 5%, ¼W
14-16R	01P01-22300-02	Resistor, 22K, 5%, ¼W
17R	01P01-27300-02	Resistor, 27K, 5%, ¼W
18-19R	01P01-47300-02	Resistor, 47K, 5%, ¼W
20R	01P01-68300-02	Resistor, 68K, 5%, ¼W
22-24, 32R	01P01-10400-02	Resistor, 100K, 5%, ¼W
25R	01P01-33400-02	Resistor, 330K, 5%, ¼W
26R	01P01-47400-02	Resistor, 470K, 5%, ¼W
27R	01P02-49911-01	Resistor, 4.99K, 1%, ½W
28R	01P02-15021-01	Resistor, 15.0K, 1%, ½W
29R	01P02-20031-01	Resistor, 200K, 1%, ½W
30, 31R	01P02-10031-01	Resistor, 100K, 1%, ½W

* OR EQUAL

BENCH TEST

TEST MATERIAL REQUIRED:

- 1 – Oscilloscope
- 1 – DVM (Fluke 8020A or Equivalent)
- 1 – Frequency Generator (0-60 KHz Range) (1 to 10 VP-P)
- 1 – Frequency Meter
- 1 – Jumper
- 1 – 120V AC Source

PROCEDURE:

1. Open all switches on 1 and 2 SW; jumper terminals 2 to 8 and turn 1P full CW.
2. Apply 120V AC to terminals 9 and 10.
3. Apply 50.0 KHz to terminals 4 and 8.
4. Connect DVM to terminals 5 and 8 with common on 8 and adjust the output trim potentiometer for –10.0V DC on terminal 5.
5. Compare the following input frequencies to the nominal output values:

Frequency	Output Voltage
50.0 KHz	–10.00V
25.0 KHz	– 5.00V
5.0 KHz	– 1.00V
500 Hz	– 0.10V
1000 Hz	– 0.20V

6. Compare the following switch positions to the nominal output values at 1000 Hz input frequency.

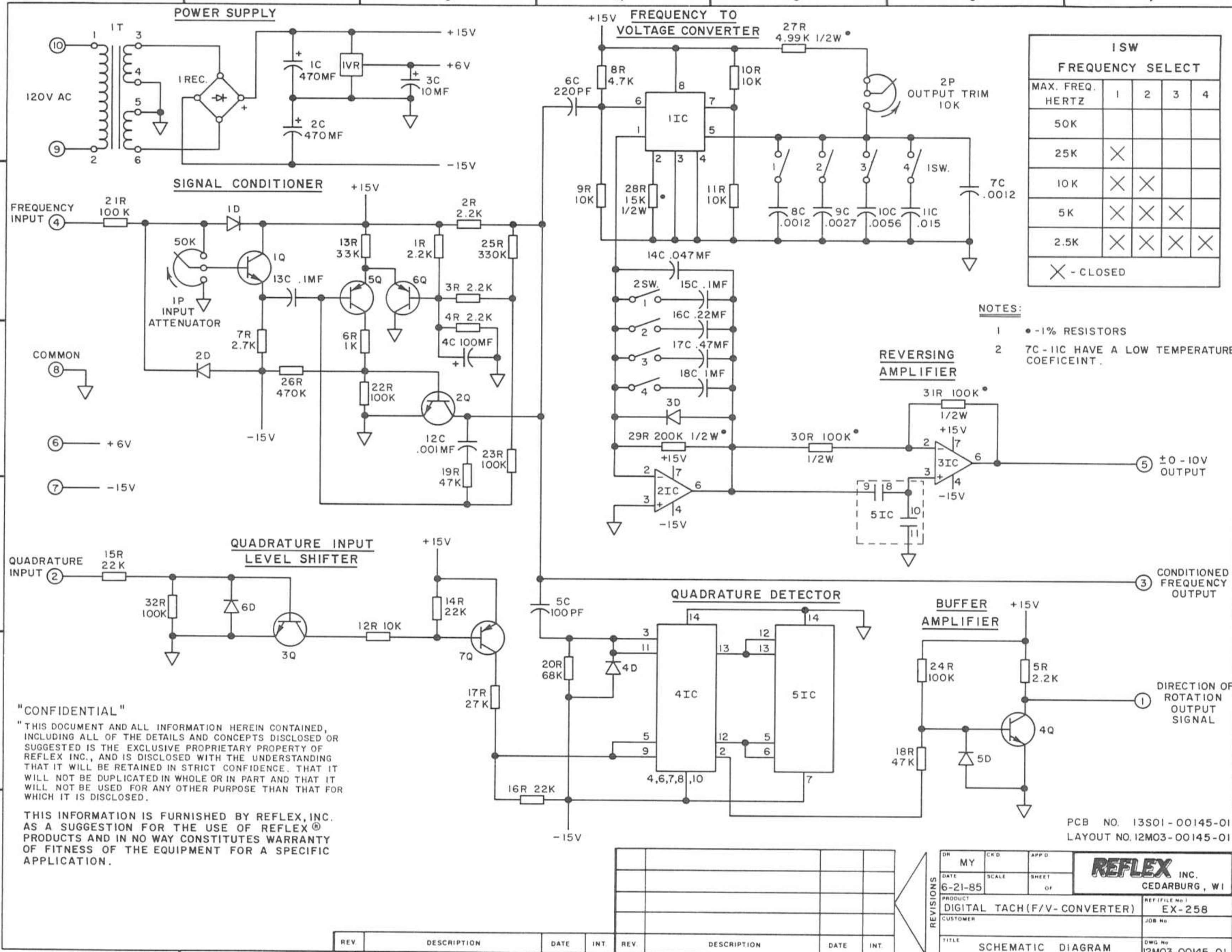
1SW	Output Voltage
All Open	– 0.20V
1 Closed	– 0.39V
1 & 2 Closed	– 0.82V
1, 2 & 3 Closed	– 1.71V
All Closed	– 4.12V

7. Remove jumper between terminals 2 and 8 and connect a jumper between terminals 2 and 6. The negative output should switch to a positive output of the same magnitude. Output on terminal 1 will go from 0V to +15V when jumpers are switched.
8. Put the oscilloscope on terminals 5 and 8 with scope common on terminal 8. Set the scope on AC and adjust attenuation for 8 divisions P-P ripple. Compare the following switch position with those listed below.

2SW	P-P RIPPLE
All Open	8 divisions
1 Closed	4 divisions
1 & 2 Closed	2 divisions
1, 2 & 3 Closed	1 division
All Closed	.5 divisions

9. With oscilloscope common on terminal 8 look at terminal 3. Observe a pulse equal to input frequency but with sharp edges regardless of input waveform.
10. With 1000 Hz on terminal 4, compare the values in the following table with the jumper location. All terminals referenced to common terminal 8.

Jumper Position	Terminal 5	Terminal 1
8 to 2	Negative	+ 15V
6 to 2	Positive	0V



1SW FREQUENCY SELECT				
MAX. FREQ. HERTZ	1	2	3	4
50K				
25K	X			
10K	X	X		
5K	X	X	X	
2.5K	X	X	X	X

X - CLOSED

NOTES:

1. • - 1% RESISTORS
2. 7C - 11C HAVE A LOW TEMPERATURE COEFICEINT.

PCB NO. 13S01-00145-01
LAYOUT NO. 12M03-00145-01

REV	DESCRIPTION	DATE	INT.	REV.	DESCRIPTION	DATE	INT.

REVISIONS

DR: MY | CK'D | APP'D
DATE: 6-21-85 | SCALE | SHEET OF
PRODUCT: DIGITAL TACH (F/V-CONVERTER)
CUSTOMER
TITLE: SCHEMATIC DIAGRAM

REFLEX INC. CEDARBURG, WI
REF FILE No.: EX-258
JOB No
DWG No: 12M03-00145-01