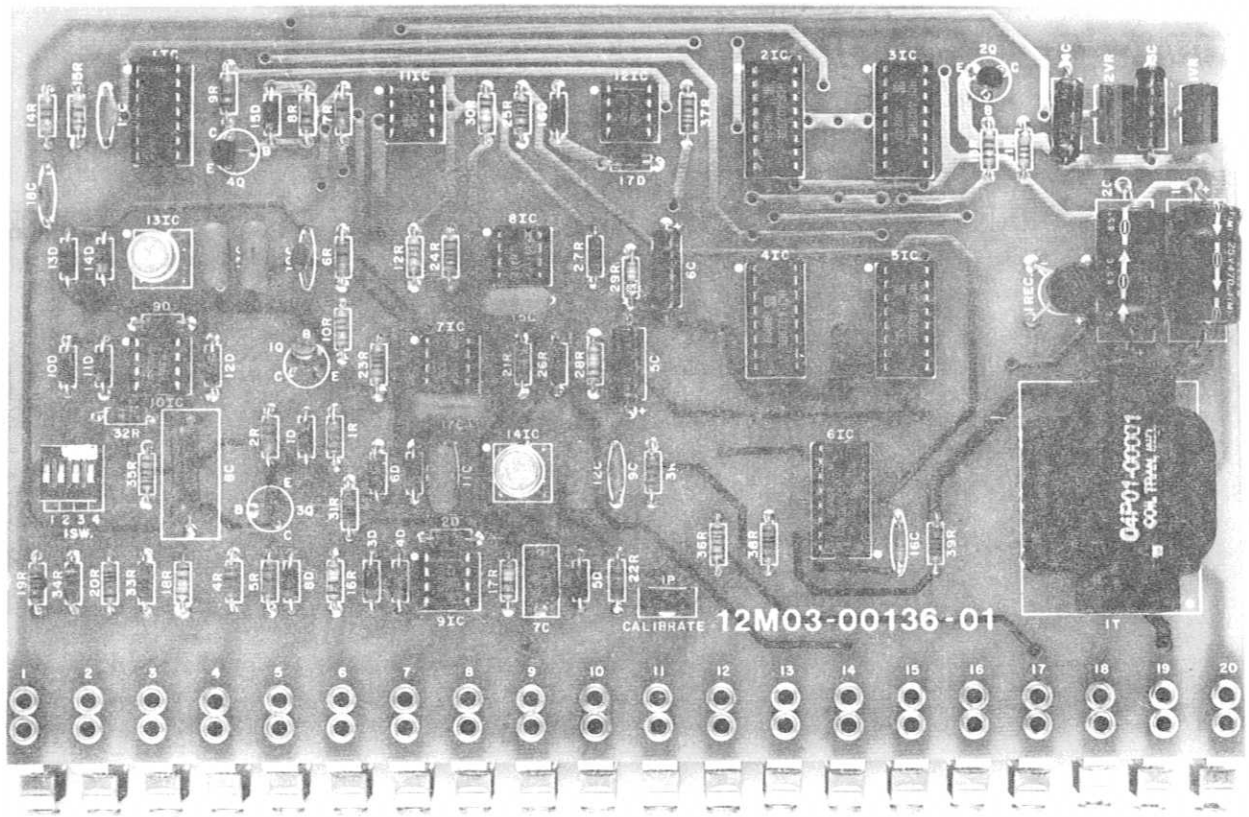
REFLEX®

Trouble-shooting Manual
MODEL 246
RATIO CALCULATOR
PART NUMBER 12M03-00136-01



BENCH TEST

TEST MATERIAL REQUIRED:

- 1 - 115V AC line cord with spade lugs load end.
- 2 - Digital Voltmeters (DVM) (Beckman HD-110 or equal)
- 1 - 5K Potentiometer
- 5 - Clip leads

1. Connect wiper of the 5K potentiometer to terminals 2 and 6, the CW lead to +15V DC terminal 15 and the CCW lead to common, terminal 18.
2. Jumper terminal 9 to terminal 11.
3. Connect 1 DVM to terminal 10 (positive lead) and terminal 18 (negative lead). Connect 2 DVM to terminal 2 (positive lead) and terminal 18 (negative lead).
4. Open 1SW, 2SW, 3SW, and 4SW.
5. Connect 115V AC to terminals 19 and 20.
6. Adjust the 5K potentiometer for +10.0V DC on terminal 2.
7. Adjust the "Calibration" potentiometer for -5.00V DC on terminal 10.
8. Vary the voltage on terminal 2 with the 5K potentiometer from +10.00 down to +0.20V DC and back to +10.00. The output on terminal 10 should not vary more than ±0.1V DC.
9. Close 1SW. The output on terminal 10 should drop to -3.33V ±0.1.
10. Repeat step 8.
11. Close 1SW and 2SW. The output on terminal 10 should drop to -2.00V ±0.1V DC.
12. Repeat step 8.
13. Close 1SW, 2SW and 3SW. The output on terminal 10 should drop to -1.11V ±0.1V DC.
14. Repeat step 8.
15. Close all switches (1, 2, 3 & 4). The output on terminal 10 should drop to 0.59V ±0.1V.
16. Repeat step 8.
17. Jumper terminal 12 to terminal 13. The output should not change.
18. Open 1SW, 2SW, 3SW, and 4SW. The output should not change.
19. Remove the jumper and output should return to -5.00V DC.

REFLEX® MODEL 246 RATIO CALCULATOR

PART NUMBER 12M03-00136-01
SCHEMATIC DIAGRAM 12M03-00136-01

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

INPUTS — ANALOG:
- Numerator (X): 0 to 10 volts positive
- Denominator (Y):
  Maximum 10 volts positive with 2% maximum ripple.
  Minimum - depends on scaling switch settings:
  A. For 1% of full scale accuracy

$$V_{min} = \frac{0.12}{(\text{Switch Setting} + 2)}$$

  B. For 5% of full-scale accuracy

$$V_{min} = \frac{0.08}{(\text{Switch Setting} + 2)}$$

INPUTS — DIGITAL:
- Refer to factory.

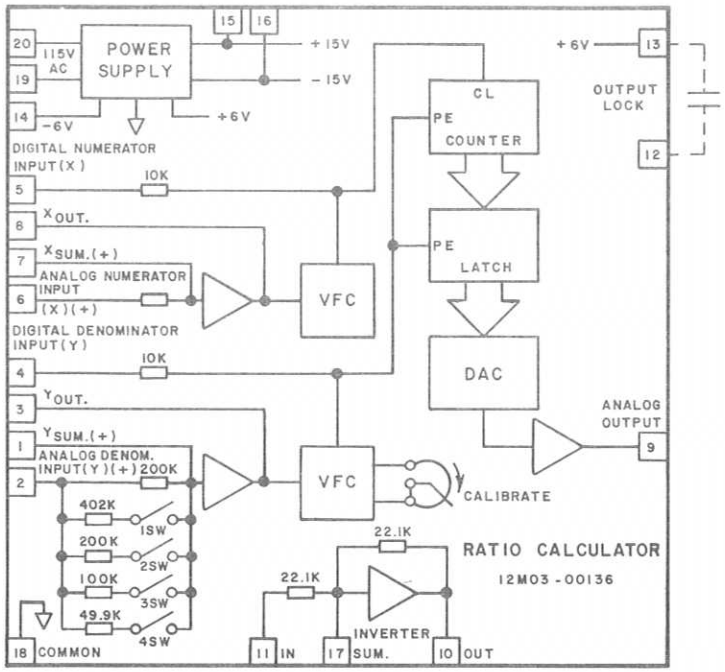


FIGURE 1. SIMPLIFIED SCHEMATIC

OUTPUTS:
- 0 to 10 volts positive maximum or 0 to 10 volts negative with on-board inverter.

$$\text{Output (Z)} = \frac{10X}{(\text{Switch Setting} + 2)Y}$$

LOCK:
- Applying 6 volts positive to terminal 12 or connecting terminal 12 to terminal 13 will hold output to the level attained at the time the "LOCK" is applied. May be used for "Memory" or "Preset."

II. THEORY OF OPERATION

The REFLEX® Model 246 Ratio Calculator provides an analog output voltage proportional to the ratio of two input signals. It consists of the following elements as shown on the Schematic Diagram and in Figure 1.

1. Power Supply
2. Numerator — Voltage to Frequency Converter (NVFC)
3. Denominator — Voltage to Frequency Converter (DVFC)
4. Counter
5. Latch
6. Digital to Analog Converter
7. Output Amplifier
8. Signal Inverter

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

2. **Numerator Voltage to Frequency Converter (NVFC)** — A positive analog signal is conditioned by 9IC. The output of 9IC goes to the NVFC which consists of Op-Amp 14IC and VFC 7IC. The output frequency of this circuit is always greater than the denominator frequency, usually by many times.

3. **Denominator Voltage to Frequency Converter (DVFC)** — A positive analog signal is conditioned by a four position dip switch and Op-Amp 10IC. The dip switch selects the output range of 10IC, which in

turn selects the frequency range of the DVFC to provide different scale factors for ratio calculation. The output of 10IC goes to the DVFC, which consists of Op-Amp 13IC and VFC 8IC. In addition, this VFC has a "CALIBRATE" adjustment which varies the frequency to voltage ratio to calibrate the analog output.

4. **Counter** — An 8-bit counter consists of 2IC and 3IC, each providing four of the eight bits. The output pulses of the numerator VFC are the input to the counter (pin 15 of 2IC). The counter accumulates counts until a pulse from the denominator occurs. At this time the total number of pulses accumulated by the counter is latched to the input of the digital to analog converter where it is held until the next denominator pulse occurs. The counter is reset to a zero count simultaneously. Since the counter is an 8-bit counter, its maximum count is 256, and overflow, which would cause its count to return to zero and start over again, is prevented by a logic signal to the carry-in terminal, pin 5.

   To provide a slight overrange capability, the counter is scaled to provide full output at a nominal 225 counts. This means that an over-range of about 13% is possible without losing accuracy.

5. **Latch** — The 8-bit latch consists of 4IC and 5IC, each providing four bits. Its function is to update and hold the counter output for the Digital to Analog Converter, at the time a denominator pulse occurs, so that it reads a fixed binary number that represents the ratio between the numerator and denominator frequencies. It also serves as an output "hold" should it be desirable to maintain the analog output without up-dating. The binary number is transferred from the counter to the output of the latch by a pulse from the denominator VFC on the P.E. terminal.

6. **Digital to Analog Converter (DAC)** — The DAC, 6IC, converts an 8-bit binary number from the latch output, into an analog signal for the output amplifier.

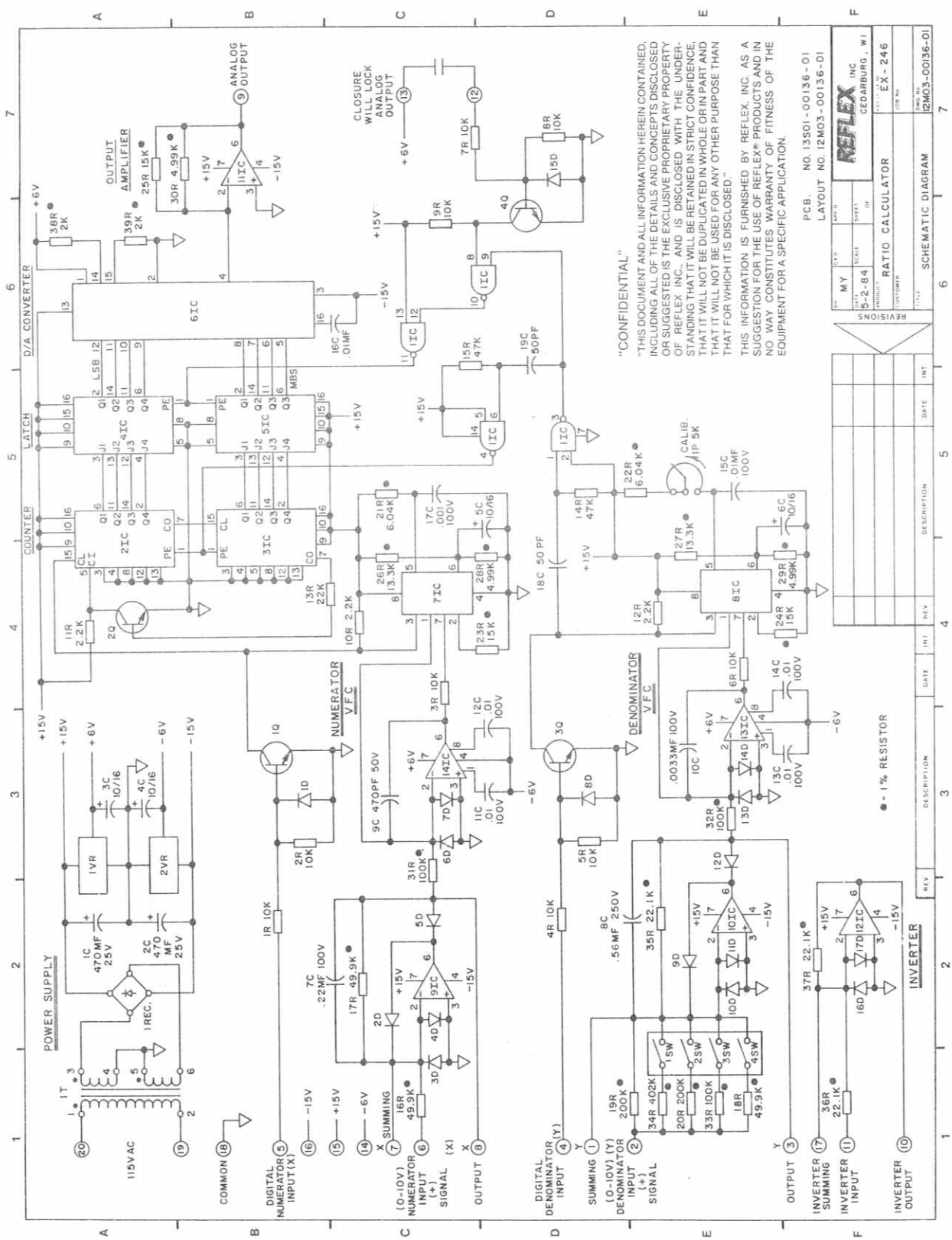
7. **Output Amplifier** — The output amplifier, 11IC, produces a positive 10 volts output with an input to the DAC that represents 225 counts.

8. **Signal Inverter** — The signal inverter 12IC is provided to accommodate an input which may be negative, or to provide a negative output, if required.

COMPONENT LIST — ASSEMBLY #12M03-00136-01

Symbol	Part #	Description (Acceptable Substitute) *
1T	04P01-00001	Transformer-120V AC PRI, two 10V AC SEC @ 220 mA (Signal - PC20-220)
1REC	05P01-00003	Rectifier Bridge - 50V, 1A (EDI-PF50)
1-17D	05P02-00001	Diode - Signal, 50mA, 200 PIV (1N4148)
1VR	05P08-00006	+6 Volt Regulator (7806)
2VR	05P08-00007	-6 Volt Regulator (7906)
1IC	05P09-00012	Quad NAND Gate (4093)
2-5IC	05P09-00009	Counter-up/down (4029)
6IC	05P09-00013	Digital to Analog Converter - 8 bit (0800)
7,8IC	05P10-00003	Voltage to Frequency Converter (4151)
9-12IC	05P08-00005	Precision Op-Amp (Fairchild 714 HC)
13,14IC	05P08-00009	Precision Op-Amp (ICL 7650 CTV)
1-4Q	05P04-00002	Transistor-NPN, Small Signal (2N3392)
1P	02P04-50201-00	Potentiometer - 5K, ½W (Beckman 72XR5K)
1-4SW	09P01-00004	Switch - DIP, 4-SPST (ACCO-DSS4)
1,2C	03P01-47102-01	Capacitor - 470MFD, 25V, Electrolytic
3-6C	03P01-10001-00	Capacitor - 10MFD, 15V, Electrolytic
7C	03P07-22410-00	Capacitor - 0.22MFD, 100V, Film
8C	03P07-47410-00	Capacitor - 0.47MFD, 100V, Film
9C	03P06-47105-00	Capacitor - 470PF, 50V, Ceramic
10C	03P07-33210-00	Capacitor - .0033MFD, 100V, Film
11-15C	03P07-10310-00	Capacitor - 0.01MFD, 100V, Film
16C	03P06-10305-00	Capacitor - 0.01MFD, 50V, Ceramic
17C	03P07-10210-00	Capacitor - 0.001MFD, 100V, Film
18,19C	03P06-50005-00	Capacitor - 50PF, 50V, Ceramic
1-9R	01P01-10300-02	Resistor - 10K ¼W 5%
10-12R	01P01-22200-02	Resistor - 2.2K ¼W 5%
13R	01P01-22300-02	Resistor - 22K ¼W 5%
14,15R	01P01-47300-02	Resistor - 47K ¼W 5%
16-18R	01P02-49921-01	Resistor - 49.9K ¼W 1%
19,20R	01P02-20031-01	Resistor - 200K ¼W 1%
21,22R	01P02-60411-01	Resistor - 6.04K ¼W 1%
23-25R	01P02-15021-01	Resistor - 15.0K ¼W 1%
26,27R	01P02-13321-01	Resistor - 13.3K ¼W 1%
28-30R	01P02-49911-01	Resistor - 4.99K ¼W 1%
31-33R	01P02-10031-01	Resistor - 100K ¼W 1%
34R	01P02-40231-01	Resistor - 402K ¼W 1%
35-37R	01P02-22121-01	Resistor - 22.1K ¼W 1%
38-39R	01P02-20011-01	Resistor - 2.0K ¼W 1%

* OR EQUAL



VOLTAGE CHECK

1. The primary voltage of 1T, leads 1 and 2 (terminals 20 and 19), should be 120V AC.
2. The secondary voltage of 1T, leads 3 and 4 and leads 5 to 6 should be 10V AC. These can be measured between circuit common, terminal 18 (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 between terminals 15 and 18 (common).
4. –15V DC between terminals 16 and 18 (common).
5. +6V DC nominal (5.5 to 6.5 volts) between terminals 13 and 18 (common).
6. –6V DC nominal (5.5 to 6.5 volts) between terminals 14 and 18 (common).