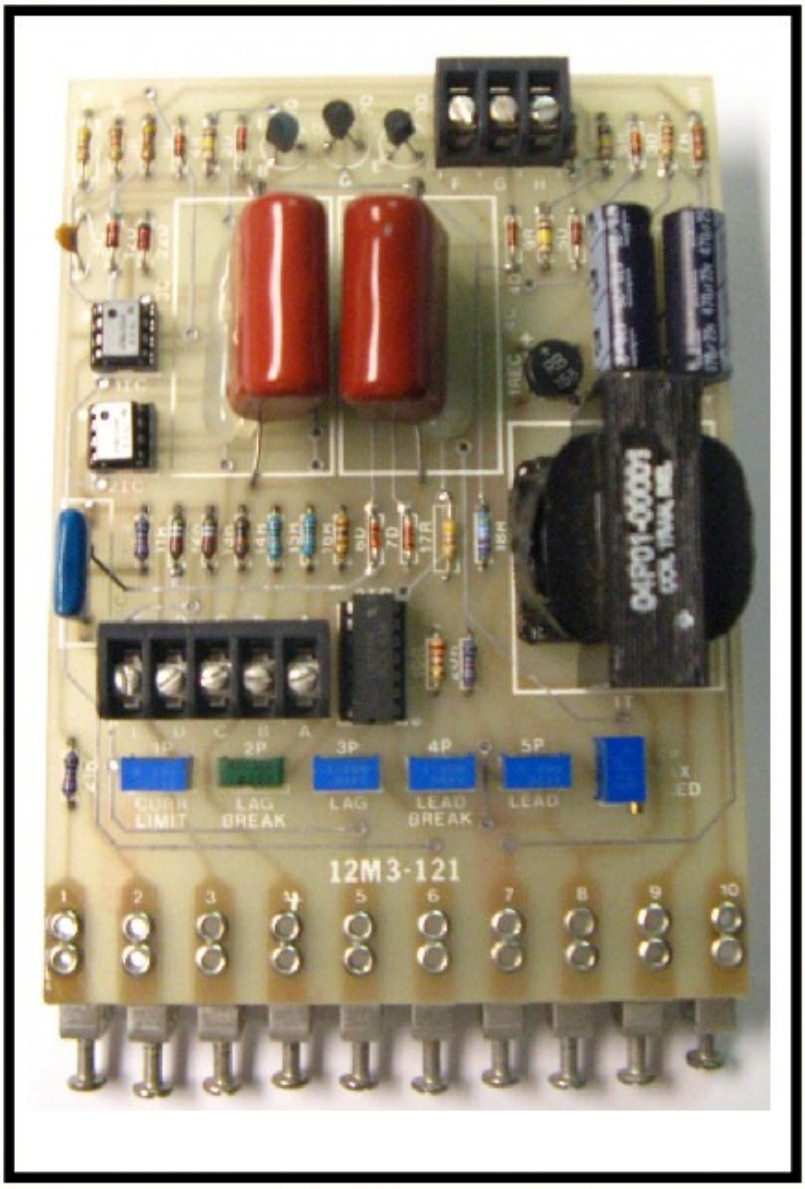
Trouble-shooting Manual
MODEL 234
PRECISION AMPLIFIER
PART NUMBER 12M03-00121-01



BENCH TEST

1. With all jumpers removed measure resistance on 1TB between the following terminals (values should be within 1%):
   - A - B 200K
   - B - C 200K
   - C - D 100K
   - D - E 50K
2. Connect an oscilloscope and a digital voltmeter to terminals 8 and 5, with 8 the common lead. Set the oscilloscope for 5V per division, on DC. Set the digital voltmeter to 20 volts full scale AC. Connect a 4.0K resistor between terminals 2 and 5. Jumper terminal 6 to terminal 7.
3. Turn all potentiometers CCW, except "Max Speed" which should be CW. Jumper terminal A to terminal E on 1 TB.
4. Apply 120V AC to terminals 9 and 10.
5. Apply 1.0 volts, 60 Hz to terminals 8 and 4. The output at terminal 5 should be approximately 0.1 to 0.12 volts. Turn "Max Speed" all the way CCW. The output should rise to 0.18 to 0.23 volts.
6. Advance "Lead" to the full CW position. The output should rise smoothly to 2.7 to 3.1 volts, and remain sinusoidal.
7. Monitor terminal 3, turn "Current Limit" full CW, and observe a smooth rise to the same reading as in step 6.
8. Advance "Lead Break" to the full CW position. The output should drop smoothly to 0.26 to 0.33 volts. Return "Lead Break" to CCW position.
9. Advance "Lag" to the full CW position. The output should drop to 0.15 to 0.20 volts.
10. Advance "Lag Break" to the full CW position. The output should rise to 2.3 to 2.6 volts.
11. Disconnect the 4.0K resistor from terminals 2 and 5. The output should become a square wave, 14 volts peak to peak.
12. Jumper F to G on 2TB. The top half of the square wave should drop to 0.7 volts. Move this jumper from G to H. The lower half of the square wave should drop to 0.7 volts. Remove jumper.
13. Remove jumper from 6 to 7. The output should go to essentially zero.

VOLTAGE CHECKS

1. The primary voltage of 1T, leads 1 and 2 (terminals 10 and 9), 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 8 (leads 4 and 5), and each AC input to the bridge rectifier 1 REC (leads 3 and 6). Voltage at the AC input to the bridge rectifier (leads 3 to 6) should be 20V AC.
3. +15V DC nominal between the positive end of capacitor 1C and terminal 8 (common).
4. +6V DC between the cathode of 1ZD and terminal 8 (common).
5. -15V DC nominal between terminal 6 and terminal 8 (common).
6. -6V DC between the anode of 2ZD and terminal 8 (common).

GEMINI MODEL 234 PRECISION AMPLIFIER

PART NUMBER 12M03-00121
SCHEMATIC DIAGRAM 12M03-00121-01

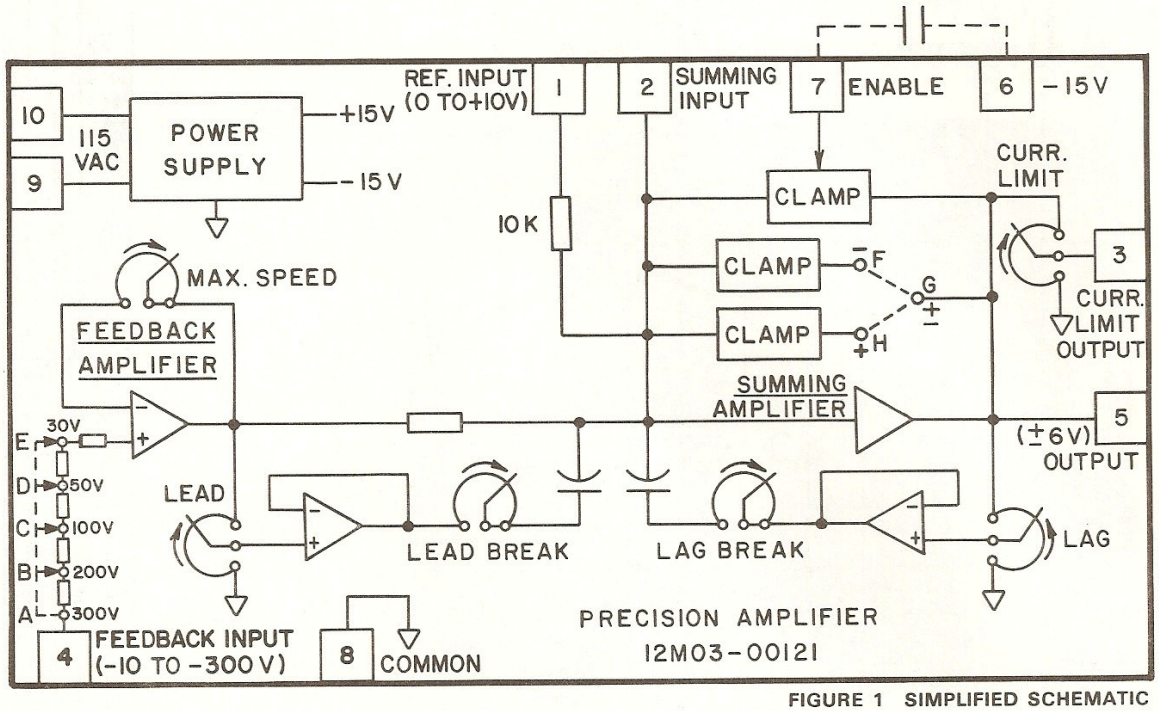


FIGURE 1 SIMPLIFIED SCHEMATIC

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

OUTPUT
- 0 to ± 6 volts at 5mA Maximum

INPUT
Reference: 0-1mA corresponding to full output
Feedback: 0-300 volts DC with on-board selection for 0-30, 0-50, 0-100, 0-200, 0-300 volt maximum

CURRENT LIMIT OUTPUT
- Adjustable from 0 to 6 volts nominal with internal 10K potentiometer

Summing junction:
Offset voltage
Typical: 60 microvolts
Maximum: 150 microvolts
Bias current
Typical: 1.2 Nanoamps
Maximum: 4.0 Nanoamps

ACCURACY
- Limited only by quality of reference and feedback, 0.01% maximum error typical

II. THEORY OF OPERATION

The Precision Amplifier Assembly is a high-gain, low drift amplifier for use in a precise-regulated, closed-loop feedback system. Its wide range of derivative and integral stability adjustments can be used to establish a gain versus frequency characteristic to satisfy most applications. It consists of the following elements as shown in the Simplified Schematic Diagram (Figure 1).

1. Power Supply
2. Feedback Amplifier
3. Lead Network
4. Summing Amplifier
5. Lag Network

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 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 nominal regulated positive and negative 6 volts is obtained from the positive and negative 15 volt supply using zener diodes 1ZD and 2ZD respectively.

2. **Feedback Amplifier.** A precision tachometer generator (or other isolated feedback) voltage is applied between terminal 4 and circuit common, terminal 8. Position of the jumper on 1TB selects the required scaling from 30 to 300 volts at maximum speed depending on the feedback voltage available.

   Clamping diodes 6D and 7D protect the precision feedback amplifier, 2IC, by limiting input voltages to the level of zener diodes 1ZD and 2ZD.

   Maximum Speed potentiometer, 6P, controls the gain of 2IC, and acts to set the maximum speed (or other controlled variable) of the drive.

   The output of the Feedback Amplifier is connected to the input of the Summing Amplifier, 1IC, through resistor 18R, as described below. Additionally, the output of the Feedback Amplifier is conditioned by the Lead Network described below and also fed to the Summing Amplifier.

3. **Lead Network.** The Lead Network prevents overshoot by providing an additional feedback proportional to the rate-of-change of feedback, through op-amp 3IC(A).

4. **Summing Amplifier.** Reference and Feedback signals are summed at the input, pin 2, of precision op-amp, 1IC. A precision plus 10 volt reference such as the REFLEX® Model 206 is connected to terminal 1 and applied to the input of 1IC through resistor 21R.

   A very small difference between Reference and Feedback signals causes the output to rise to a value regulated by the transistor clamps, 1Q and 3Q.

   The output polarity is selected by a jumper on 2TB for positive, negative or bi-directional output. Clamping the output prevents the amplifier from swinging in the wrong direction, with possible delays in response.

   Since the maximum output of the Summing Amplifier is regulated by the transistor clamps, the maximum voltage across Current Limit Potentiometer 1P is also limited and if used as the reference to a minor loop regulator, the adjustment of 1P can be used to limit the current, voltage, or other parameters controlled by the minor regulating loop.

   To allow operation of the Summing Amplifier, a negative 15 volts DC from any source with respect to circuit common must be applied to the "Enable" terminal 7. When this negative 15 volts is removed, field-effect switching transistor, 2Q, conducts, clamping the output of the Summing Amplifier to zero. This insures that the output is initially at zero.

5. **Lag Network.** Stability is achieved by reducing high frequency gain. Op-amp, 3IC(D), provides a buffered rate feedback, (integration) for the Summing Amplifier 1IC. This network also reduces noise output from the assembly.

COMPONENT LIST - ASSEMBLY #12MO3-00121-01

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)
1D - 7D	05P02-00001	Diode – Signal, 50mA, 200 PIV (1N4148)
1, 2 ZD	05P03-00005	Zener Diode – 6.8V, 500mW, 10% (IN5235)
1Q	05P04-00001	Transistor–PNP, Small Signal (2N3638A)
2Q	05P05-00001	Transistor - N Channel JFET (2N4093)
3Q	05P04-00002	Transistor - NPN, Small Signal (2N3392)
1, 2 IC	05P08-00005	Precision Op-Amp (Fairchild 714)
3 IC	05P08-00001	Quad Op-Amp (National-LM324)
1, 3, 4 5, 6 P	02P04-10301-00	Potentiometer – 10K, ½W (Beckman 72XR10K)
2P	02P04-25301-00	Potentiometer - 25K, ½W (Beckman 72XR25K)
1, 2 C	03P01-47102-01	Capacitor – 470MF, 25V, Electrolytic
3, 4 C	03P07-10610-00	Capacitor – 10MF, 100V, Film
5 C	03P06-10305-00	Capacitor – 0.01MF, 50V, Ceramic
6 C	03P07-47410-00	Capacitor – 0.47MF, 100V, Film

Symbol	Part #	Description (Acceptable Substitute)*
1, 17 R	01P01-47100-02	Resistor – 470, ¼W, 5%
2, 7 R	01P01-10200-02	Resistor – 1K, ¼W, 5%
3, 8 R	01P01-47200-02	Resistor – 4.7K, ¼W, 5%
4,6,9 R	01P01-10400-02	Resistor – 100K, ¼W, 5%
5 R	01P01-15300-02	Resistor – 15K, ¼W, 5%
10, 20, 21 R	01P02-10021-01	Resistor – 10K, ½W, 1%
11,12 R	01P02-49921-01	Resistor – 49.9K, ½W, 1%
13 R	01P02-10031-01	Resistor – 100K, ½W, 1%
14,15 R	01P02-20031-01	Resistor – 200K, ½W, 1%
16 R	01P01-10100-02	Resistor – 100, ¼W, 5%
18 R	01P02-49911-01	Resistor – 4.99K, ½W, 1%
19 R	01P01-22100-02	Resistor – 220, ¼W, 5%

*OR EQUAL

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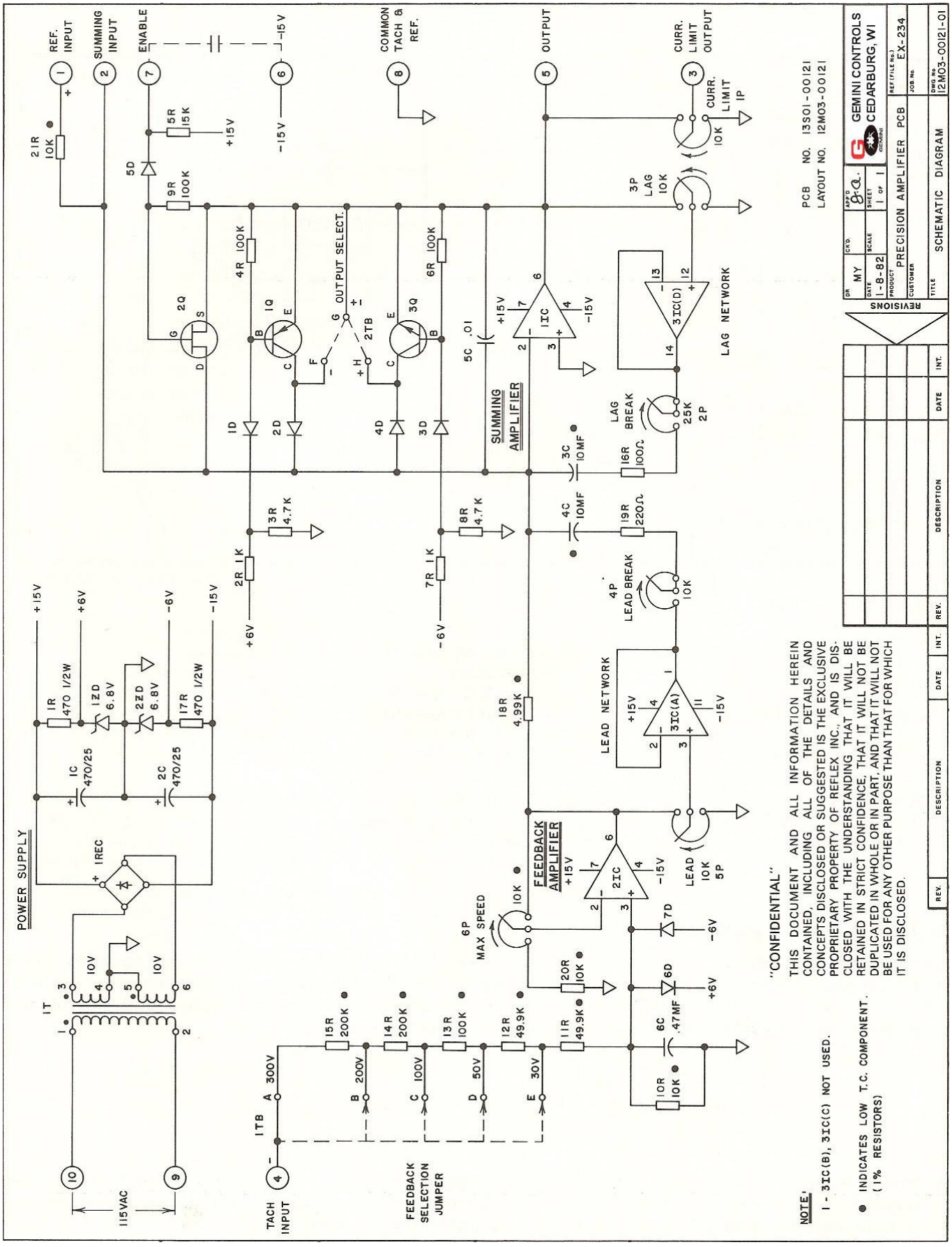
REF. INPUT
SUMMING INPUT
ENABLE
-15 V
COMMON TACH & REF.
OUTPUT
CURR. LIMIT OUTPUT
POWER SUPPLY
SUMMING AMPLIFIER
FEEDBACK AMPLIFIER
LEAD NETWORK
LAG NETWORK
OUTPUT SELECT.
MAX SPEED
LEAD BREAK
LAG BREAK
FEEDBACK SELECTION JUMPER
TACH INPUT
115VAC
PCB NO. 13501-00121
LAYOUT NO. 12M03-00121
GEMINI CONTROLS
CEDARBURG, WI
PRECISION AMPLIFIER PCB
EX-234
SCHEMATIC DIAGRAM
12M03-0012I-01
"CONFIDENTIAL"
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NOTE:
1 - 3IC(B), 3IC(C) NOT USED.
● INDICATES LOW T.C. COMPONENT. (1% RESISTORS)