



# Trouble-shooting Manual MODEL 206 PRECISION REFERENCE PART NUMBER 12M03-00102-01

## BENCH TEST

1. Connect a digital voltmeter and oscilloscope to terminals 5 and 8 (common). Adjust for 2V/Division DC, and move the zero line to the lowest division line on the oscilloscope.
2. Connect a 5K potentiometer from terminal 5 (CW) to terminal 8 (CCW) with the wiper connected to terminal 2.
3. Jumper terminal 6 to terminal 7.
4. Apply 120V AC through a variable autotransformer to terminals 9 and 10.
5. Measure the voltage from terminal 5 to 8 with the digital voltmeter. The range of adjustment with the "Calibrate" potentiometer should be at least 9.8 to 10.3 volts. Set it to 10.00 volts. Varying the input AC from 80 volts to 135 volts with the variable autotransformer should not change the 10.00 volt reading.
6. Set the 5K potentiometer CCW and both "Accel" and "Decel" times CCW. Move the oscilloscope lead from terminal 5 to terminal 3.
7. Turn the 5K potentiometer rapidly fully CW, while observing the oscilloscope trace. It should rise smoothly to 10 volts in approximately 2 to 3 seconds. Rapidly return the 5K potentiometer to the CCW position. The trace should return to zero, again in about 2 to 3 seconds.
8. Turn both "Accel" and "Decel" potentiometers to approximately 50%. Repeat step 7. The times should now be approximately 20 seconds.
9. Allow the output to rise to some positive value. Remove the jumper from 6 to 7. The output should immediately go to zero. Reconnect the jumper.
10. Bring the output to full value and short circuit pins 3 and 8 with a milliammeter. The short circuit current should be more than 40 mA and less than 60 mA.



# GEMINI MODEL 206 PRECISION REFERENCE

PART NUMBER 12M03-00102  
SCHEMATIC DIAGRAM 12M03-00102-01

## I. SPECIFICATIONS

### SUPPLY

- 120 Volts AC  $\pm$  10%
- 50/60 Hz, single phase

### AMBIENT TEMPERATURE

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

### INPUT

- 0 to 10 volts (or 10.24 volts)

### INPUT CURRENT REQUIREMENT

- .007 Microamperes maximum

### OUTPUT

- 0 to 10 volts (or 10.24 volts)
- 0 to 40 mA

### ACCURACY

- Typical error, 0.025% of full output
- Maximum error, 0.1% of full output

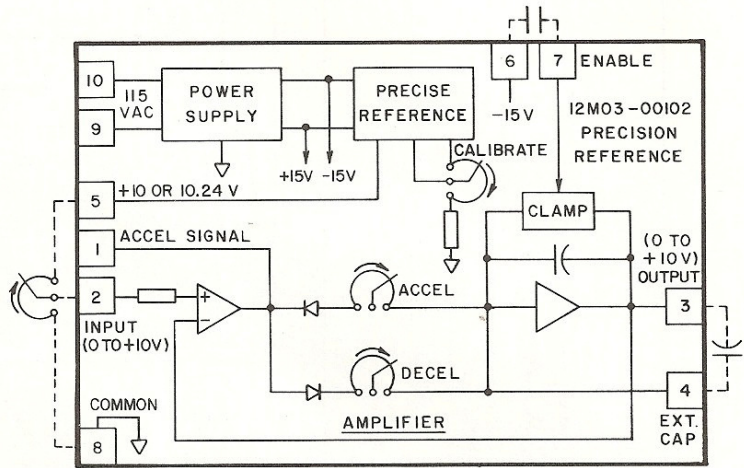


FIGURE 1 SIMPLIFIED SCHEMATIC

### TIMING ADJUSTMENT RANGE

- Acceleration, 2 to 40 seconds
  - Deceleration, 2 to 40 seconds
- } linear extendable

## II. THEORY OF OPERATION

The Precision Reference Assembly is a low-drift, temperature-independent control for use with precision single or multimotor drive systems. It converts step changes in input to a ramp output.

It consists of the following elements as shown in the Simplified Schematic Diagram (Figure 1).

1. Power Supply
2. Precise Reference
3. Amplifier

**1. Power Supply** – The power supply uses a center-tapped transformer with 12 volts on each side of center together with a bridge rectifier and two 2200 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.

**2. Precise Reference** – A temperature-stabilized zener diode, 41C, rated at a nominal 6.95 volts DC, with a change of output of less than 20 parts per million in 1000 hours and 2 parts per million per degree centigrade, provides the base reference for the control. The  $\pm$  15 volt supply provides power into pins 3 and 4 which is internally controlled by a solid-state thermostat to maintain a constant temperature for the internal zener diode.

The zener diode reference voltage (pins 1 and 2) is amplified and regulated by a composite amplifier composed of a precision op-amp, 51C, and transistors 4Q and 3Q to provide substantial current for the reference input potentiometer. Transistor 3Q acts as a sink for negative noise that might be picked up on the external lead to terminal 5.

The input reference voltage is adjustable over a narrow range by potentiometer 3P to 10.24 volts for use with digital dividing networks or 10.00 volts to simplify making reference current calculations.

**3. Amplifier** – The control assembly is basically a closed-loop feedback circuit in which the rate of change of output is controlled by internal adjustments. Normally the input and output voltages are equal. A change of the input reference causes an error on the input stage until the output, delayed with respect to time, is again equal to the input.

The output voltage is controlled by precision op-amp 2IC which regulates the output equal to the input. Comparison of output and input is made at pins 2 and 3 of 2IC. When the input voltage at terminal 2 is changed, a difference exists between the input pins 2 and 3 of op-amp 2IC. 2IC saturates in a direction determined by the polarity of the difference and drives 1IC to an output regulated by the zener diode clamps 1ZD and 2ZD.

A signal that changes linearly with time is generated by the action of the composite amplifier consisting of op-amp 3IC and transistors 2Q and 5Q which charges or discharges capacitor 3C at a constant rate proportional to the magnitude of current into or out of the summing junction at pin 2 of 3IC.

Separately adjustable rates of Acceleration and Deceleration are selected by diodes 1D and 2D respectively. When an error signal exists at the input of 2IC with pin 3 positive with respect to pin 2, the output of 1IC swings negative establishing a voltage which is in turn divided by "Accel Time" potentiometer, 1P, and resistor 9R. The voltage across 9R is applied to pin 2 of 3IC through a 1.2 megohm resistor, 10R.

As the voltage across 9R is increased by counter-clockwise adjustment of 1P, the charging rate of capacitor 3C is increased, decreasing the time for output voltage to reach the desired level.

When the output at terminal 3 (pin 2 of 2IC) is equal to the input voltage at terminal 2 (pin 3 of 2IC) the output of 2IC drops to a value just sufficient to regulate the output equal to the input within specified limits regardless of external variations.

When the input reference potentiometer is turned down, all polarities reverse and capacitor 3C is discharged at a rate governed by the setting of "Decel Time" potentiometer, 2P.

Overload protection for the output is provided. When the sum of the voltage drops across 8R due to the output current plus base to emitter drop of 2Q becomes larger than the forward drop of the three diodes (3D, 4D, and 5D) in series, base drive to 2Q is limited, thus limiting output current.

Transistor 5Q, provides a discharge path for capacitor 3C and also acts as a sink for negative noise pulses that might be picked up on the external lead from the output terminal 3.

To allow operation of the assembly, a negative 15 volts DC from any source with respect to circuit common must be applied to terminal 7. When this negative 15 volts is removed, field-effect switching transistor, 1Q, discharges capacitor 3C, allowing the output to be reset to zero at a rapid rate.

#### COMPONENT LIST - ASSEMBLY #12MO3-00102-01

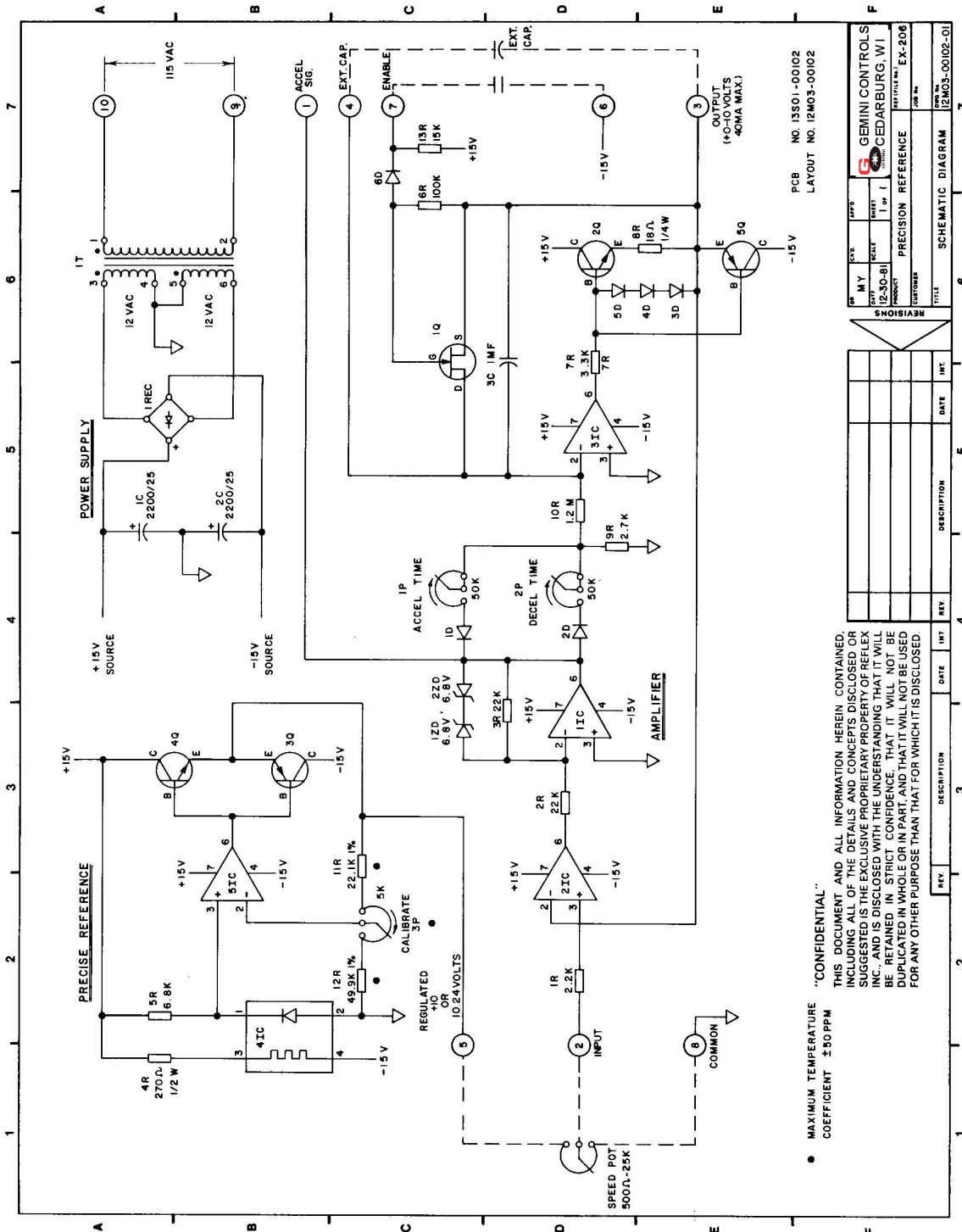
Symbol	Part #	Description (Acceptable Substitute)*	Symbol	Part #	Description (Acceptable Substitute)*
1T	04P01-00005	Transformer - 120V AC PRI, two 12V AC SEC @ 200 mA (Signal-PC 24-200)	1R	01P01-22200-02	Resistor - 2.2K, ¼W, 5%
1 REC	05P01-00003	Rectifier Bridge - 50V, 1A (EDI - PF 50)	2R, 3R	01P01-22300-02	Resistor - 22K, ¼W, 5%
1-2 ZD	05P03-00005	Zener Diode - 6.8V, 500 mW, 10% (1N5235B)	4R	01P01-27101-02	Resistor - 270 Ohm, ½W, 5%
1-6D	05P02-00001	Diode Signal, 50 mA, 200 PIV (1N4148)	5R	01P01-68200-02	Resistor - 6.8K, ¼W, 5%
1Q	05P05-00001	Transistor - N Channel JFET (2N4093)	6R	01P01-10400-02	Resistor - 100K, ¼W, 5%
2Q	05P04-00008	Transistor - NPN, Darlington (GE-D40K1)	7R	01P01-33200-02	Resistor - 3.3K, ¼W, 5%
3Q, 5Q	05P04-00001	Transistor - PNP, small signal (2N3638A)	8R	01P01-18000-02	Resistor - 18.0K, ¼W, 5%
4Q	05P04-00002	Transistor, NPN, small signal (2N3392)	9R	01P01-27200-02	Resistor - 2.7K, ¼W, 5%
1IC	05P08-00011	Op-Amp (LM 741)	10R	01P01-15500-02	Resistor - 1.5M, ¼W, 5%
2, 3, 5IC	05P08-00005	Precision Op-Amp (Fairchild 714)	11R	01P02-22121-01	Resistor - 22.1K, ½W, 1%
4IC	05P08-00010	Precision Reference (National LM399)	12R	01P02-49921-01	Resistor - 49.9K, ½W, 1%
1P, 2P	02P04-50301-00	Potentiometer - 50K, ½W (Beckman 72XR50K)	13R	01P01-15300-02	Resistor - 15K, ¼W, 5%
3P	02P04-50201-00	Potentiometer - 5K, ½W (Beckman 72XR5K)			
1C, 2C	03P01-22201-00	Capacitor - 2200MF, 15V, Electrolytic			
3C	03P07-10510-00	Capacitor - 1.0MF, 100V, Film			

\*OR EQUAL



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REV	DESCRIPTION	DATE	INT	REV	DESCRIPTION	DATE	INT

DESIGN	DATE	BY	CHKD	APP'D	REV

PCB NO. 13S01-00102  
LAYOUT NO. 12M03-00102

● MAXIMUM TEMPERATURE COEFFICIENT ±50PPM

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PRECISION REFERENCE EX-206

**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 12V 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 24V AC.
3. +10V DC (adjustable with "calibrate" potentiometer from 9.8 to 10.3 volts) between terminals 5 and 8 (common).
4. +15V DC nominal between the positive end of capacitor 1C and terminal 8 (common).
5. -15V DC nominal between terminal 6 and terminal 8 (common).