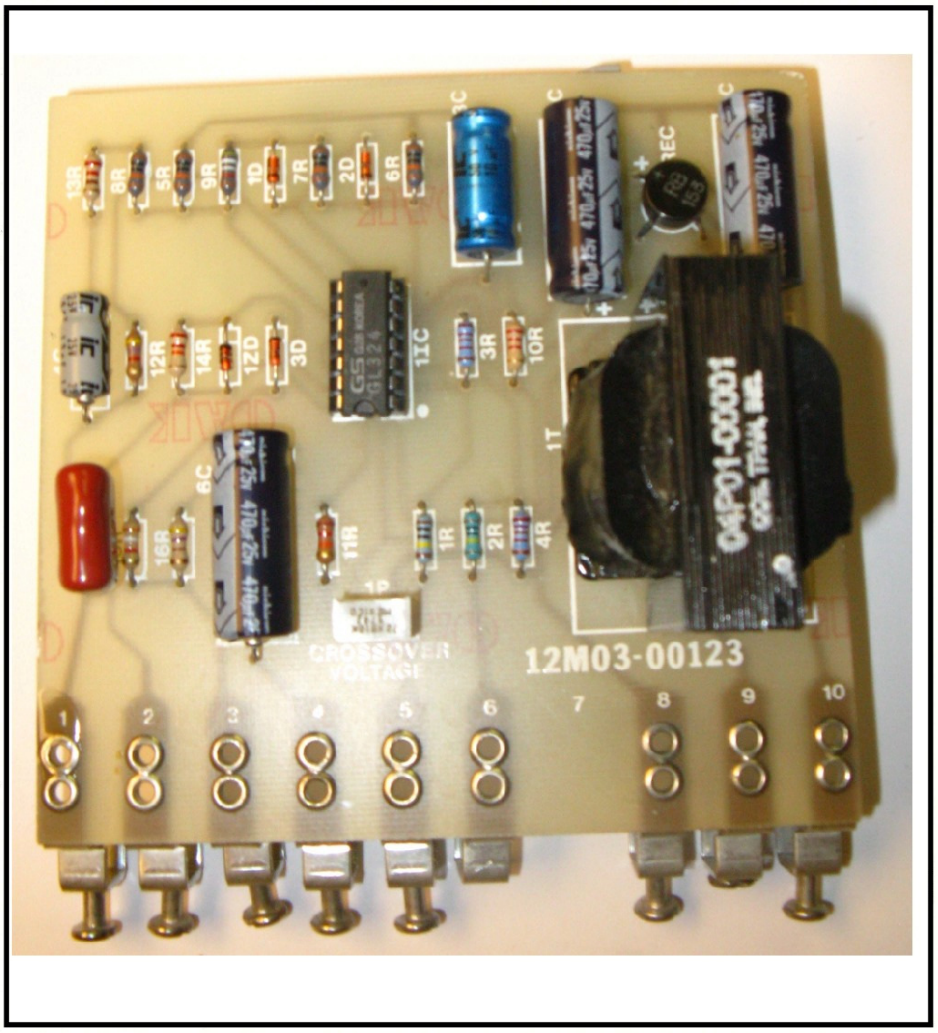
Trouble-shooting Manual
MODEL 221
CROSSOVER ASSEMBLY
PART NUMBER 12M03-00123-01

BENCH TEST

1. Set the "CROSSOVER VOLTAGE" pot to full CW. Jumper terminal 9 to terminal 5 and terminal 10 to terminal 6.
2. Apply 120 VAC to terminals 9 and 10.
3. With an oscilloscope and a digital voltmeter (DVM) monitor terminals 2 (HI) and 8 (LO). The scope should display a sine wave pattern of about 2 volts peak-to-peak and the DVM should read –1.0 to –2.0 VDC.
4. Turn the "CROSSOVER VOLTAGE" pot to its 50% position. The DVM should now read 0.0 to 1.0 VDC, and in its' AC mode, the DVM should read a ripple voltage of less than 0.5 VAC.
5. Turn the "CROSSOVER VOLTAGE" pot to its full CW position. The AC reading on the DVM should now be less than 0.05 VRMS and the DC reading should be 0.5 to 0.2 VDC.
6. Jumper terminal 4 to terminal 8 and using the DVM on terminal 3 (HI) and 8 (LO), the readings should be –1.0 to –2.0 VDC and less than 0.05 VAC.



TEST MATERIAL REQUIRED:

1 – 120 VAC cord with plug and spade lugs
3 – Clip leads
1 – Oscilloscope (Tektronix 2213 or equal)
1 – Digital Voltmeter (Beckman HD-110 or equal)

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 1 REC (leads 3 to 6) should be 20V AC.
3. +15V DC nominal between the positive end of capacitor 1C and terminal 8 (common).
4. –15V DC nominal between the negative end of capacitor 2C and terminal 8 (common).

GEMINI MODEL 221 CROSSOVER ASSEMBLY

PART NUMBER 12M03-00123-01

SCHEMATIC DIAGRAM 12M03-00123-01

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

INPUT
- 0 to 250 volts DC from motor armature circuit

OUTPUT
- Connects to Model 216 Power Converter (Positive 0.6 to negative 6 VDC nominal at terminal 2)

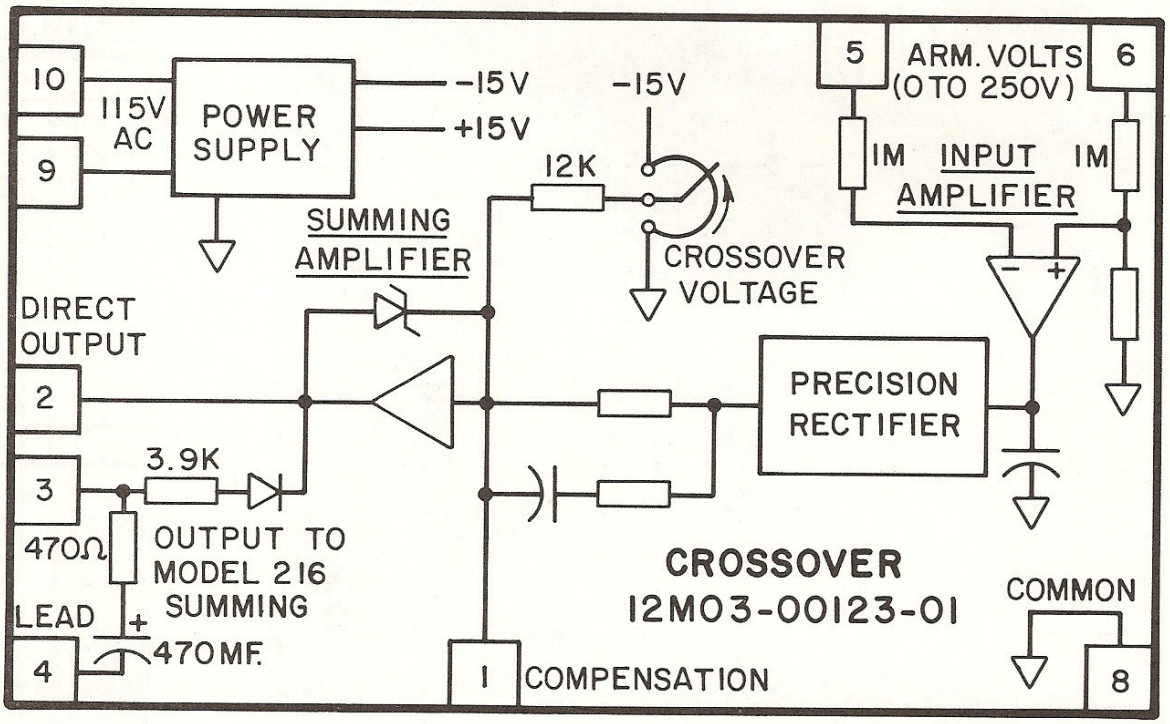


FIGURE 1 SIMPLIFIED SCHEMATIC

II. THEORY OF OPERATION

The Model 221 Crossover Assembly is designed to provide extended speed range of a DC Motor Drive when used with the Model 216 Power Converter.

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

1. Power Supply
2. Input Amplifier
3. Precision Rectifier
4. Summing Amplifier

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.

2. **Input Amplifier** – Differential amplifier, 1IC(A), is impedance isolated from the armature power loop by 1 megohm input resistors, 1R and 2R. Its nominal 5 volt output at 250 volts input is filtered and applied to the input of a Precision Rectifier.

   To maintain clearance requirements dictated by national codes, the input voltage on terminals 5 and 6 must be limited to 250 volts.

3. **Precision Rectifier** – An absolute value amplifier consisting of 1IC(B) and 1IC(C) and associated components provides a nominal output of 1 mA positive to the summing junction at pin 13 of the Summing Amplifier, 1IC(D), when the armature voltage is 250 volts, regardless of polarity.

4. **Summing Amplifier** – The "Crossover Voltage" potentiometer, 1P, provides a reference current of approximately zero to 1 mA negative to the summing junction at pin 13 of 1IC(D). When the output of the Precision Rectifier exceeds this input reference, the output of the Summing Amplifier swings negative. There is no change in output until the armature voltage reaches a value determined by the setting of the "Crossover Voltage" potentiometer, usually rated armature voltage of the DC motor.

   The maximum output at terminal 2 is limited to negative 6 volts nominal by the clamping action of zener diode 1ZD. The output of terminal 3, with respect to system common terminal 8, is connected to the "Summing" input of the Model 216 Power Converter (terminal 13). The negative signal from the Crossover circuit applied to the summing input, subtracts from the positive reference signal into terminal 15, reducing field current by an amount proportional to the output of the Crossover Assembly.

   A "Lead" network consisting of capacitor 6C and resistor 16R is used to improve system stability when the current feedback mode is used on the Model 216 Power Converter. The current signal is obtained by connecting terminal 4 on this assembly to the current feedback terminal 12 of the Model 216 Power Converter.

   CAUTION: SINCE THE MODEL 216 POWER CONVERTER DOES NOT HAVE LINE ISOLATION, NO PART OF ITS CIRCUITRY OTHER THAN THE 115 VOLT AC SUPPLY POWER SHOULD BE CONNECTED TO ANY PART OF THE MAIN DRIVE CIRCUITRY UNLESS AN ISOLATION TRANSFORMER IS USED ON THE AC INPUT (TERMINALS 3 AND 7).

COMPONENT LIST - ASSEMBLY #12MO3-00123-01

Symbol	Part #	Description (Acceptable Substitute)*
1T	04P01-00001	Transformer – 120V AC PRI, two 10V SEC. @ 220 mA (Signal-PC 20-220)
1REC	05P01-00003	Rectifier Bridge – 50V, 1A (EDI-PF50)
1D-3D	05P02-00001	Diode, Signal–50mA, 200 PIV (1N4148)
1ZD	05P03-00005	Zener Diode – 6.8V, 500mW, 10% (1N5235B)
1IC	05P08-00001	Quad Op-Amp (National-LM324)
1P	02P04-10301-00	Potentiometer – 10K, ½W (Beckman 72XR10K)
1, 2, 6C	03P01-47102-01	Capacitor – 470MF, 25V, Electrolytic
3C	03P02-10002-00	Capacitor – 10MF, 25V, NP, Electrolytic
4C	03P01-15001-00	Capacitor – 15MF, 16V, Electrolytic
5C	03P07-10510-00	Capacitor – 1.0MF, 100V, Film

Symbol	Part #	Description (Acceptable Substitute)*
1R, 2R	01P02-10041-01	Resistor – 1.0M, ½W, 1%
3R, 4R	01P02-22121-01	Resistor – 22.1K, ½W, 1%
5R-8R	01P02-10031-01	Resistor – 100K, ½W, 1%
9R	01P02-49921-01	Resistor – 49.9K, ½W, 1%
10R	01P01-22200-02	Resistor – 2.2K, ¼W, 5%
11R	01P01-12300-02	Resistor – 12K, ¼W, 5%
12R	01P01-47200-02	Resistor – 4.7K, ¼W, 5%
13R	01P01-22100-02	Resistor – 220 Ohm, ¼W, 5%
14R	01P01-22300-02	Resistor – 22K, ¼W, 5%
15R	01P01-39200-02	Resistor – 3.9K, ¼W, 5%
16R	01P01-47100-02	Resistor – 470 Ohm, ¼W, 5%

*OR EQUAL

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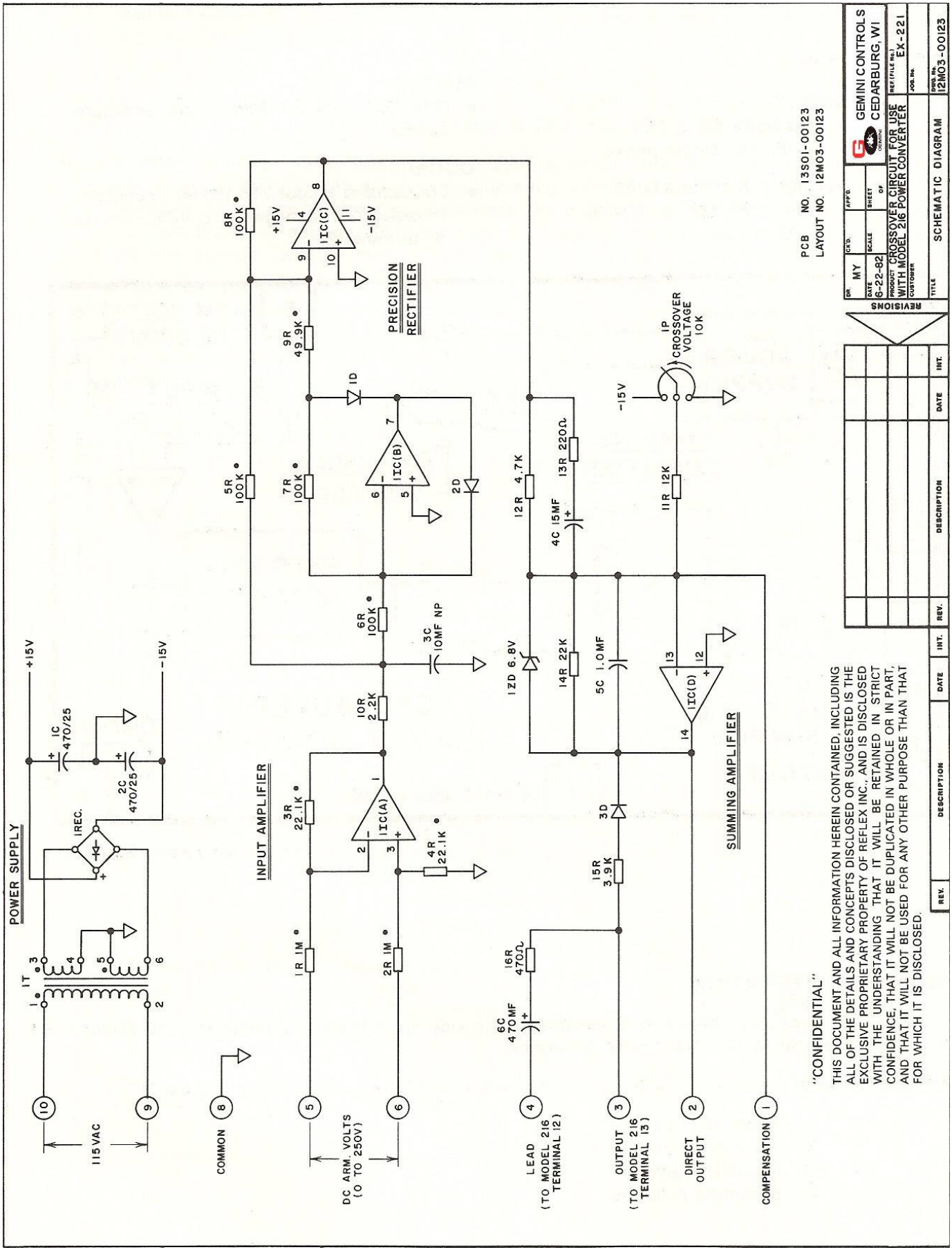
POWER SUPPLY
+15V
-15V
1C 470/25
2C 470/25
IREC.
1T
115 VAC
INPUT AMPLIFIER
IC(A)
1R 1M
2R 1M
3R 22.1K
4R 22.1K
10R 2.2K
6R 100K
3C 10MF NP
PRECISION RECTIFIER
IC(B)
IC(C)
5R 100K
7R 100K
8R 100K
9R 49.9K
1D
2D
SUMMING AMPLIFIER
IC(D)
12R 4.7K
13R 220Ω
4C 15MF
14R 22K
5C 1.0MF
1ZD 6.8V
15R 3.9K
3D
16R 470Ω
6C 4.70MF
11R 12K
1P CROSSOVER VOLTAGE 10K
COMMON
DC ARM. VOLTS (0 TO 250V)
LEAD (TO MODEL 216 TERMINAL 12)
OUTPUT (TO MODEL 216 TERMINAL 13)
DIRECT OUTPUT
COMPENSATION
PCB NO. 13501-00123
LAYOUT NO. 12M03-00123
REVISIONS
REV. DESCRIPTION DATE INT.
DR MY CK'D APP'D
DATE 6-22-82 SCALE SHEET OF
CUSTOMER
PRODUCT CROSSOVER CIRCUIT FOR USE WITH MODEL 216 POWER CONVERTER
REF (FILE No.) EX-221
JOB No.
TITLE SCHEMATIC DIAGRAM
DWG. No. 12M03-00123
GEMINI CONTROLS
CEDARBURG, WI
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