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Contraves Goerz Corporation

INSTRUCTION MANUAL
FOR THE
120-60-CGSM
HIGH POWER AMPLIFIER
WITH
SCALED CURRENT LIMIT

IM-5607F

VOLUME I

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1.0 GENERAL DESCRIPTION

Contraves Goerz Model 120-60-CGSM is a differential input, bridge output, direct coupled, linear switching power amplifier.

The amplifier, as shown in Figure 1, is functionally composed of a differential input, single-ended output, high gain pre-amp driving the power stage. The pre-amp has internal frequency compensation for 6 db/octave roll off, a balance adjustment, loop gain, and input signal level adjustments. The capability for mounting all components necessary for velocity or position loop compensation is present. The power stage has a single-ended input and bridge output (floating load) with the output stage operating Class D for high efficiency and full motor reversal capability with large back EMF's. Individual current limit adjustments are provided for load protection.

The maximum output voltage of 120 volts enables fast response with inductive loads and permits extremely high speeds with any motor. The peak output current of 60 amps ensures the rapid acceleration and deceleration capability required in high response systems.

The main advantages of this amplifier are the high output power capability and the negligible internal dissipation during all operating conditions.

Utilization of switching techniques has permitted a size reduction and an increase in efficiency over the Class B output stages of the CG series of amplifiers.

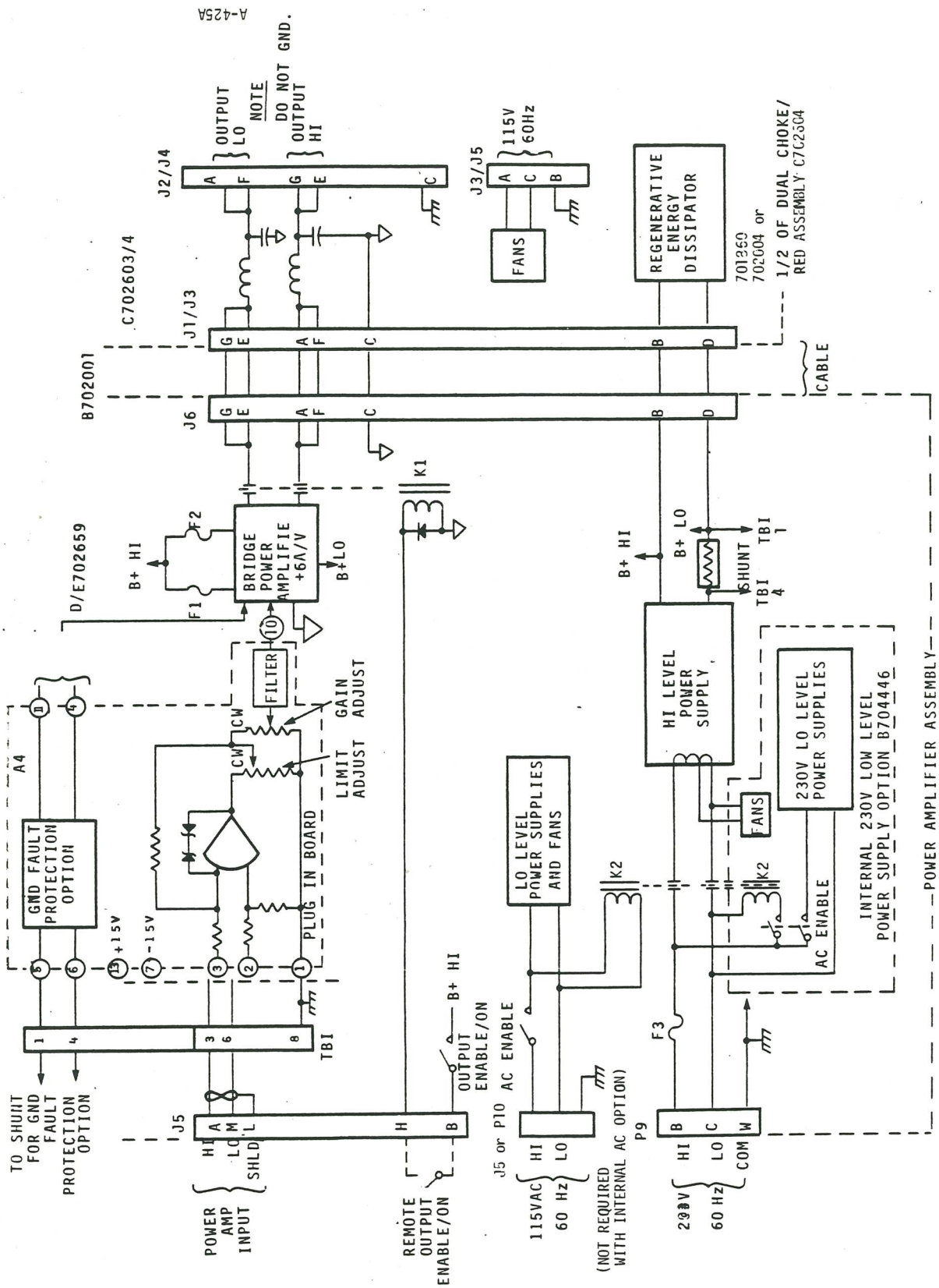

Figure 1. Power Amplifier Block Diagram

2.0 SPECIFICATIONS

2.1 MAXIMUM RATINGS

Output Voltage	120 volts (function of line voltage and power supply droop)
Output Current	
Continuous	24 amps at 110 V
Peak	60 amps at 100 V (5 seconds maximum at 50% duty cycle)
Scaled	Adjustable from 5 to 60 amps for 10 volts input
Minimum Load Inductance	0.003 Henries
Common Mode Input Voltage	±15 volts
Operating Temperature Range	0 to 50 degrees C
Storage Temperature Range	-65 to +135 degrees C

2.2 ELECTRICAL CHARACTERISTICS

2.2.1 POWER STAGE -

Power Stage Current Gain	6 amp/volt
Output Current Limit Adjustment Range (Individual)	±10-60 amps
Power Output	6 KW
Form Factor (4 mh)	1.01
Frequency Response inductance	200 Hz max., 100 Hz typical (function of load and resistance)
Efficiency	90%
Cooling	Forced Air

2.2.2 PRE-AMP OPERATIONAL AMPLIFIERS -

	(for servo compensation, scaling and current command limiting)
DC Open Loop Voltage Gain	100,000
Small Signal, Unity Gain Bandwidth	0.7 MHz
Common Mode Rejection	At least 70 db
Offset	Adjustable to zero
Input Resistance (Differential)	1 Megohm
Input Bias Current	200 na
Input Offset Current	20 na
Average Temperature Coefficient of Input Offset Voltage	5 microvolts/degrees C
Average Temperature Coefficient of Input Offset Current	0.5 nanoamperes/degree C
Offset Voltage Drift wtih time	180 microvolts/24 hours

2.2.3 PRE-AMP COMPENSATION AND SCALING ADJUSTMENTS -

Gain	Adjustable between 0.5 and 6 amps per volt for up to 10 volts of input
Current Command Limit	Adjustable between 5 and 60 amps

2.2.4 INPUT AND OUTPUT -

Signal Inputs	15 Kohm impedance	
HI	J5-A	On standard
LO	J5-M	switching
Shield	J5-L	amplifier chassis

Power Output	Choke Assembly filtered bridge output (Do not ground)
HI	J2/J4 - G&E } On Dual Channel Choke
LO	J2/J4 - A&F } Assembly
	J2 - B,C&D } On Single Channel
	J2 - E,F,G } Choke Assemblies
Sensing	For positive input J5-A (HI) and J5-M (LO), output J6-G, E (HI) and J6-A,F (LO) is negative

3.0 OPERATION

3.1 EXTERNAL CONNECTIONS

3.1.1 AC POWER -

As shown in Figure 1, 115 or 230-volt, 50/60 Hz power is required on connector J5 or P10 of the Power Amplifier Assembly. This connection supplies power for fans, low level DC supplies, and control relays. When the internal 115/230 VAC is used for these functions, AC power is not required on the J5 or P10 connector. The HI level power supply receives its power through connector P9 of the Power Amplifier Assembly.

Choke Assemblies with the Regenerative Energy Dissipator require 115/230-volt, 50/60 Hz power for fans on connector J3/J5.

3.1.2 INTERCONNECTING CABLE -

The Power Amplifier Assembly output on connector J6 should be connected by a cable to either connector J1 or J3 of the Dual Channel Choke Assembly as shown in Figure 1.

3.1.3 LOAD CONNECTIONS -

As shown in Figure 1, one side of the load is connected to pins A and F, and the other side of the load is connected to pins G and E of either J2 of J4 of the Choke Assembly. Neither side of the load may be connected to ground.

3.1.4 INPUTS -

The input command for the power amplifier is on J5 connector pins A (HI) and M (LO) and can be configured into any desired circuit as on the plug-in board.

3.2 ADJUSTMENTS

3.2.1 BALANCE -

The amplifier balance (zero output for zero input) can be adjusted with R-69.

3.2.2 CURRENT COMMAND LIMIT -

The limit on the input current command is set by adjustment of R11 on the preamp plug-in compensation card. CW rotation increases the current command limit. The scaling or gain should be set prior to this adjustment.

3.2.3 SCALING OR GAIN -

The input scaling is set by adjusting R12 to obtain a scaling equivalent to full scale current (current command limit) for a 10-volt DC signal.

3.2.4 OUTPUT CURRENT LIMIT -

The output current limit adjustment potentiometers are R57 and R71. Full CW adjustments result in 60-amp peak limits. R71 controls the current from pin G to F (-CL) at the output connector J6. The output limits are set slightly greater than the input limited current command.

3.2.5 COMPENSATION AND PREAMP -

The preamp plug-in card lends itself to additional inputs and system compensation circuitry. Either an active second order lag filter or an active notch filter can be configured on this card. Additional compensation circuitry is associated with operational amplifier AR6 on the main PC board.

3.3 TURN-ON PROCEDURE

1. Provide main power to P9 or J7.
2. Ensure that a load is connected to the Choke Assembly and that the Choke Assembly is connected to the Power Amplifier Assembly.
3. Provide for local control.
   a. Close the External path between P5-B and P5-H.

b. 115 VAC 50/60 Hz line P5-C-HI and P5-P-LO or P10 on power amplifier (if required) and 115/230 VAC, 50/60 Hz on P3/P5 of choke assembly.

c. Amplifier Input:
P5-A-HI
P5-M-LO
P5-L-SHLD

d. Be sure the AC ENABLE front panel switch is in the OFF position. This switch is an alternate action switch and is off when it's button is extended outward.

e. Plug in P3 or P5 connector and activate 115 VAC (if used).

f. Depress the AC ENABLE switch.

g. Depress the OUTPUT ON switch.

3.4 TURN-OFF PROCEDURE

1. Depress the OUTPUT OFF switch.
2. Depress the AC ENABLE switch.
3. Turn power off to the P3 or P5 connectors (if used).

3.5 REGENERATIVE ENERGY (OPTION)

As described in Section 1.0, the power stage acts as a switch to deliver energy to the load. Because of this, it will not dissipate stored energy. The energy is instead returned to the power supply and stored in the filter capacitors (regenerative action).

This regenerative energy must not exceed 40 joules in the 120-60-CGSM, or the power supply voltage will exceed the voltage rating of the power transistors.

The stored energy of the load is:

$$E = 1/2\ Li^2 + 1/2\ J\omega^2 K$$

where:

L = Load inductance, Henries
i = Load current, amps
J = Load inertia, ft-lb-sec^2
ω = Load speed, rad/sec
K = conversion constant, 1.36 joules/ft-lb

Example: the energy returned to the power supply from a system with the following characteristics

i max = 60 amps
L = 0.005 Henry
J = 1 ft-lb-sec^2
ω = 5 rad/sec

is:

$$E = 1/2\ (0.005)(60^2) + 1/2\ (1)(5^2)(1.36) = 9 + 17 = 26 \text{ joules}$$

which is within the capability of the standard Model 120-60-CGSM.

3.6 MODE CONTROL

The following are required for power amplifier front panel control (Local mode):

3.6.1 AC ENABLE SWITCH -

The top portion of the AC ENABLE switch serves as a service indicator indicating that AC power is available at the P9 connector.

The AC ENABLE front panel switch is an alternate action switch which is off when its button is extended out (even with the OUTPUT ON indicator switch). When depressed, the lower portion of the AC ENABLE switch illuminates and the AC contactor energizes turning power on.

In remote control, depressing this switch enables remote application of AC Power.

3.6.2 CONNECTION -

Connection is required from J5-B, to J5-H LO; this can be accomplished at mating connector P5.

The OUTPUT ON indicator will light when the output is on.

Remote control can be accomplished for OUTPUT ENABLE by providing a switch between J5-B and J5-H.

4.0 INSTALLATION

The power amplifier should be installed in such a position that free flow of air at 200 CFM is available at the sides and rear of the chassis, at a temperature less than 50 degrees C.

Connect the chassis as shown on Figure 1 and the interface as discussed in Section 3.3.

5.0 TROUBLESHOOTING

5.1 POWER AMPLIFIER

Operability of the power amp may be quickly verified by listening for the 2-KHz switching frequency. (See Section 5.3, Ground Fault Current Interrupt.)

The capability of the unit may be verified by connecting a 0 to 1 ohm, and a 3 to 10 MH dummy load to the output terminals and observing that the amplifier outputs 6 amps/volt of input (when the preamplifier is set up for a gain of 1 V/V). The input signal for testing should be a sine wave of about 10 Hz since the unit is fused to allow peak currents of 60 amps but continuous currents for 24 amps.

If the unit is not operating, the AC input power should be removed at the P9 plug or the J7 connector and the AC input fuses, F3, checked. If the DC supply voltage does not measure about 120 VDC, check the operation of the bridge rectifier by removing the two DC fuses, A2F1 and A2F2, and look for an unloaded output about 120 VDC with less than 10 volt peak to peak 120-Hz ripple across filter capacitors C1 and C2.

If the DC voltage is present and the amplifier is not switching, power should be disconnected and fuses A2F1 and A2F2 removed and checked. If only one of these fuses is blown, the amplifier may have torque in only one direction.

If the DC fuses continue to blow when replaced, the power stage may be damaged. The upper portions of the power bridge may be checked for a short by using an ohmmeter with no power to the unit. Connect the ohmmeter (+) lead to B+ and the other lead to each output. On the X1 range of resistance, the meter should read an open circuit for a good bridge leg. Reversal of the leads should indicate a conducting diode.

The lower portion may be checked by connecting the (-) lead of an ohmmeter to ground and the (+) lead to each output. On the X1 range of resistance, the meter should read an open circuit for a good bridge leg. Reversal of the leads should indicate a conducting diode.

5.2 REGENERATED ENERGY DISSIPATION (OPTION)

The switching amplifier can be equipped with a regenerated energy dissipator (R.E.D.). As seen in Section 3.5 the power stage acts as a switch to deliver energy to or from the load. Because of this, it will not dissipate stored energy. Stored energy is returned to the power supply and stored in the filter capacitors (regenerative action). Because of high load current, high inductance, high load inertia, or high load speeds, the regenerative energy may exceed the maximum regenerative energy requirements of the amplifier. In this case, regenerated energy dissipation is required.

The regenerated energy dissipation circuit is designed to provide high reliability and ease of adjustment. The circuit is equipped with a pushbutton switch, an adjustment potentiometer, and a neon indicator. The regenerated energy dissipation circuit is a factory set circuit, however, if it becomes necessary to adjust the circuit the procedure is as follows:

CAUTION

DO NOT DEPRESS THE BUTTON FOR LONG PERIODS OF TIME AS DAMAGE TO R.E.D. UNIT MAY RESULT!

Depress the R.E.D. test button. This provides a simulated effect of a power supply increase as a result of regenerative energy. As the test button is depressed, the indica-

tor should blink or illuminate continuously. If the indicator does not come on at all during the above test, or remains on without the test button depressed, adjustment of the R.E.D. circuit is required. Turn off power, connect +137 VDC via an external power supply in place of the main +120 VDC power supply. Adjust R2 (R.E.D. PC card) until indicator just illuminates. Remove the external power supply and turn power ON. Depress the TEST button an observe that indicator blinks or illuminates continuously, and remains off without the test button depressed.

NOTE

The R.E.D. indicator, pushbutton switch, and potentiometer may be located inside the power supply chassis on some amplifier modules.

5.3 GROUND FAULT CURRENT INTERRUPT (OPTION)

When the switching power amplifier is equipped with a ground fault current interrupt circuit, a short to ground on the amplifier's output terminals inhibits switching. This circuit is intended as a failure detecting circuit and should only inhibit switching when a short from output to ground is sensed. The ground fault current interrupt circuit may be reset by turning AC power off to the unit. At this time the output should be checked for possible shorts to ground. Uninhibited switching or normal operation of the amplifier should result when the AC is enabled once again (with no shorts to ground at the amplifier's output terminals).