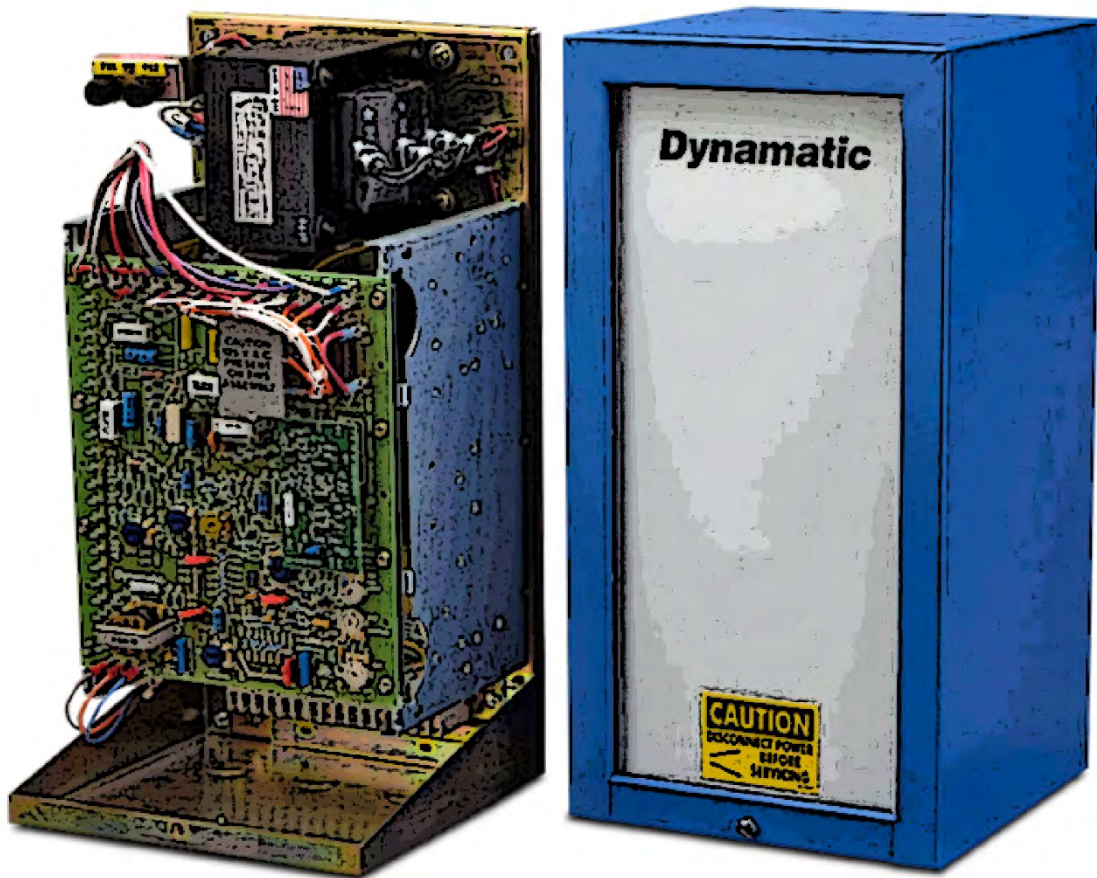


Dynamatic[®]

DRIVE SOURCE INTERNATIONAL, INC.

Mark III Controller Instruction Manual

Part Number IM-011-5008



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General Information	7
Introduction	7
Safety	7
Training	8
Receiving and Damage Claims	8
Warranty	8
Handling	8
Storage	8
Long Term Storage	9
Removal from Storage	9
General Description	10
Theory	10
Figure 1 Generalized Closed Loop System	10
Figure 2 Basic Velocity Control Loop.....	11
Power Supplies.....	11
Operational Amplifier (Summing Amplifier)	11
Figure 3 Schematic of Controller	12
Power Amplifier	13
Figure 4 Simplified Schematic Power AMP.....	13
Figure 5a SCR Firing Waveforms	13
Figure 5b Resistive Load.....	14
Figure 5c Inductive Load	14
Figure 6 Pulse Sequence	15
Figure 7 Pulse Generator Transfer Function.....	16
Phase Limit Circuit.....	16
Current Feedback Circuits	16
Velocity Feedback Circuit – Standard	17
Set up and Adjustment Procedure for Standard Controller	17
1. Preliminary Potentiometer settings with motor and control power off	17
2. Start-up with Motor and Control Power Off.....	17
Figure 8 Clutch Current	17
3. Current Limit	18
4. Minimum Bias	18
5. Maximum Speed	18
6. Damping	19

7. Special Adjustments (When required).....	19
Modifying Standard Controller (using jumpers on PCB).....	19
Logarithmic Acceleration/Deceleration.....	19
Figure 9 Logarithmic Acceleration/Deceleration.....	19
Logarithmic Acceleration and Normal Deceleration.....	20
Figure 10 Linear Acceleration	20
Low Gain Option	21
Current Control (Clutch Motor)	21
Adjustment Procedure.....	21
Cascading	21
Figure 11 simple cascade type arrangement.....	22
Table 1 proper potentiometer resistance.....	22
.25% Regulation (Internal Reset)	23
Figure 12 reset current for a step increase in load.....	23
Dancer Position Control.....	23
Figure 13 Payoff Drive.....	24
Figure 14 Take-up Drive	24
Tachometer Generator Follower Circuit.....	25
Figure 15 AC Tachometer Generator	26
Figure 16a acceptable tachometer without the use of an isolation transformer	26
Figure 16b acceptable method using a separately mounted G-2 generator.....	26
Figure 16c example of a system which requires the isolation transformer	27
Table 2 external attenuating resistor.....	27
DC Tachometer Generator.....	27
DC Tachometer Generator Feedback Voltage	28
Figure 17 jumpered for standard speed control.....	28
Table 3 typical maximum generator voltage	28
Figure 18 Connecting the negative generator lead	29
Configuration I	29
Configuration II	29
Maintenance	29
Preventive Maintenance.....	29
Corrective Maintenance	29
If unit will not run	29
If unit "Hunts"	30

If fuse blows on cold start.....	30
If unit runs only at full speed	30
If unit drifts in speed- check.....	30
Voltages required.....	30
Connection Diagram for Air Cooled Units.....	31
Connection Diagram for Water Cooled Units	32
Replacement Parts	33
Recommended Spare Parts.....	33



Please Observe the Following Safety Guidelines

Allow Installation and Service by Qualified Personnel Only: Electrical rotating equipment and associated controls can be dangerous. Therefore, it is essential that only trained personnel be allowed to work with this equipment, under competent supervision. The danger is when the equipment is not handled, installed, maintained or used properly. This equipment must be installed, adjusted and serviced only by qualified personnel familiar with the construction and operation of the equipment and the hazards involved. Failure to observe this precaution could result in personal injury and/or equipment damage.

Read Instruction and Warnings: These instructions should be read and clearly understood before working on the equipment. Become especially familiar with all safety instructions and procedures. Read and heed all danger, warning and caution notices contained in this manual and attached to the equipment and be sure to instruct others of their meaning and importance.

Danger, High Voltage Disconnect Power Before Servicing Equipment: Various component parts and terminals of the drive equipment are at or above line voltage when AC power is connected to the input terminals. All ungrounded conductors of the AC power line must be disconnected before it is safe to touch any internal parts of this equipment. Some control equipment may contain capacitors that retain a hazardous electrical charge for a period after power is removed. After power is removed, wait at least two minutes to allow capacitors to discharge before touching any internal parts of the equipment. Failure to observe these precautions could result in fatal injury.

Precautions When Working on Live Circuits: Stand on an insulating mat. Make a habit of using only one hand. Make sure that there is another person nearby in case emergency assistance is required.

Application of Equipment and Safety Devices: The adjustable speed drive and all components of the drive system, such as operator control devices, electrical power distribution equipment, the motor and mechanical power transmission equipment, must be properly selected and applied to assure a safe and reliable installation. Each individual installation has unique requirements for safety equipment such as emergency stop pushbuttons, pre-start alarms, motor and power disconnect devices and guards on mechanical power transmission apparatus. The party responsible for the overall design and operation of the facility must make sure that qualified personnel are employed to select and apply all components of the drive system including appropriate safety devices.

Hazard of personal injury or equipment damage exists if the drive and/or the driven machine are operated above their rated speed due to miss adjustment or electronic failure. Be sure to consider this factor in selecting gear ratios and safety devices.

Always Wear Safety Glasses: Safety glasses should be worn by all personnel involved in installing or maintaining the equipment. This applies equally to all electrical and mechanical workers. Other safety clothing should be selected as appropriate to the task and work environment.

Handle with Care: Handle the equipment carefully to avoid personal injury or damage to the unit.

Provide Appropriate Guards Around Moving Parts: Before operating the equipment, make sure that appropriate guards and other safety devices are in place. Refer to OSHA rules and regulations, paragraph 1910.219 for guards on mechanical power transmission apparatus.

Observe Requirements of the National Electric Code: All wiring must be in accordance with the National Electrical Code (NEC) and/or other codes as required by the authority having jurisdiction. The electrical connections completed by the installed must conform to the Instructions and diagrams supplied.

National Electric Code Article 430-102 requires a disconnecting means for each motor and controller located in sight from the motor, controller and driven machinery locations or capable of being locked in the open position if not located in sight. This disconnecting means is not included with the drive equipment unless specifically ordered.

Not for Use in Hazardous Locations: Unless specifically labelled as approved for such use, this equipment is not suitable for use in an explosive atmosphere or in a "Hazardous (Classified) Location" as defined in article 500 of the National Electrical Code.

Provide Adequate Ground Connections: For personnel safety and reliable equipment operation, firmly earth ground each piece of equipment as directed in this manual and shown on the connection diagrams provided. The ground conductor should be the same size as the incoming power wires or sized according to NEC table 250-95. A copper or aluminum conductor must be used. Grounded conduit connections are not adequate for use as equipment ground connections.

Instruction Material and Drawings: In addition to this manual, data sheets, drawings, supplementary instruction sheets may be included in the package of instruction material that is furnished for each drive. Be sure to save each of these items for future reference. The drawings and data included in this manual are generally representative of the product line, but do not accurately include every detail pertaining to specific equipment provided for an individual customer order. Drawings and data sheets which are identified by PRO/Serial number as pertaining to specific piece of equipment take precedence over this manual. Note: The information furnished may not cover changes made to the equipment after shipment. All data is subject to change without notice.

Technical Assistance: Please contact Dynamatic at 1-800-548-2169 or 262-554-7977

General Information

Introduction

This instruction manual contains the necessary information required for normal installation, operation and maintenance of the Mark III Controller. Please make it available to all maintenance and operating personnel.

Instructions provided in this manual are arranged in their normal order of use. Beginning with general information, the instructions proceed from receiving, handling and storage, through installation, start-up and adjustments to maintenance and trouble shooting. Written as a guide, these instructions do not cover or describe each detail or modification in the controller. Use this instruction manual in conjunction with any specific schematic, prints or instructions supplied with your controller. Certified drawings shall take precedence over printed instruction material if a difference in content occurs.

While every effort has been made to provide a complete and accurate manual, there is no substitute for trained, qualified personnel to handle unusual situations. If any questions arise regarding the operation or maintenance of this controller, please refer them immediately to Dynamatic Customer Service at 1-800-548-2169 or 262-554-7977.

Safety

With any electronic or electrical rotating equipment, potential safety hazards are present and require safeguards for proper use. This equipment must be installed properly, using safe procedures that meet the requirements of all applicable safety codes. The wiring must be in accordance with the National Electrical Code and all other local codes and regulations. Shaft guards, as well as protection for operating and maintenance personnel against high voltage and moving machine parts, is essential. Refer to OSHA rules and regulations, paragraph 1910.219, for guards on mechanical power transmission apparatus. Please heed these safety instructions.

DANGER, WARNING, CAUTION and special INSTRUCTION labels are applied to the equipment to remind you of the hazards that exist. Know your equipment before handling or working on it.

DANGER... is used where an immediate hazard exists. Failure to follow instructions could be fatal.

WARNING... means a possibility of injury to personnel, but not as severe as a Danger Warning.

CAUTION... is used to warn of potential hazards and unsafe practices.

INSTRUCTION... labels and notes are used when there is a need for special instructions related to safety, proper operation or maintenance.

Training

Training programs are an essential part of safe and correct operation. Training provides the know-how necessary to obtain top performance from your equipment. Dynamatic recognizes this fact and conducts training schools to educate your plant personnel in safe maintenance and operating procedures. There is a nominal charge for this service. Contact customer service at 262-554-7977 to set up a date.

Receiving and Damage Claims

The Mark III controller have been operated and tested at the factory prior to shipment. Specific test procedures are followed to assure the quality of your controller. Carrier approved packing methods assure safe shipment to your plant. Shipment is made F.O.B. from our factory, with the carrier assuming responsibility for your unit. Therefore, it is essential that you carefully inspect the shipment upon delivery to ensure that no damage or lost items have occurred in transit, Loss or damage is covered by the carrier, not by the product warranty. File a claim immediately with the carrier if any damage or loss is found. Should you require assistance in settling your claim with the carrier, contact Dynamatic. You will need the unit model number, serial number and your purchase order number for identification.

Warranty

Your new Mark III controller is covered by a one-year warranty against any manufacturing defect in either material or workmanship. Should the controller fail within the one-year warranty period, contact Dynamatic for a repair Return Material Authorization (RMA) form. Fill in all required information on the form and return the form with the controller to our Repair Service Department in Sturtevant, Wisconsin for warranty repair or exchange. Your controller will either be repaired or replaced with a previously repaired exchange controller. Freight charges both ways are your responsibility.

Handling

Then Mark III controller weigh only a few pounds and can be hand carried safely. Do not drop or subject the controller to shock or vibration. Do not stack heavy material on the controller. The printed circuit boards and other components may be mounted on an open panel making the controller very accessible to damage

Storage

Store the controller in a clean dry location with a non-corrosive atmosphere protected from sudden temperature changes, high levels of moisture, shock and vibration. Electrical components are delicate and easily damaged; provide adequate protection for them.

Ambient temperature should not exceed 40°C (104°F). The minimum temperature must remain above freezing and the dew point of ambient air. High temperature, corrosive atmosphere and moisture are detrimental to controller equipment.

Long Term Storage

The manufacturer's warranty covers repair or replacement of defective materials and rectification of faulty workmanship. It does not cover damage and deterioration that transpire during the storage period.

Some examples of deterioration due to storage are:

1. Corrosion of terminals and contacts
2. Breakdown of electrolytic capacitors
3. Moisture absorption within insulation and composition resistors.

These are not manufacturer's defects and will not be covered by the warranty policy. Refer questions to the Field Service Department in Sturtevant Wisconsin.

Removal from Storage

Before returning the controller to service after long time storage, it will be necessary to carefully inspect it for any signs of damage or deterioration. Correct any deficiency. Carefully inspect the controller for signs of moisture, especially with respect to transformers and composition resistors. If moist, the transformer will require thorough drying. Damp resistors will change impedance and affect performance of the controller; they should be replaced.

Corrosion is an important factor. Inspect terminals, plugs, sockets and contacts for signs of corrosion. If detected, cleaning will be necessary. Before applying power, make sure all connections are tight.

These procedures are given only as recommendations offered to aid our customers in preserving stored equipment. We cannot guarantee stored equipment, even if all suggestions are followed; damage or deterioration may still occur. Equipment storage is not covered by warranty.

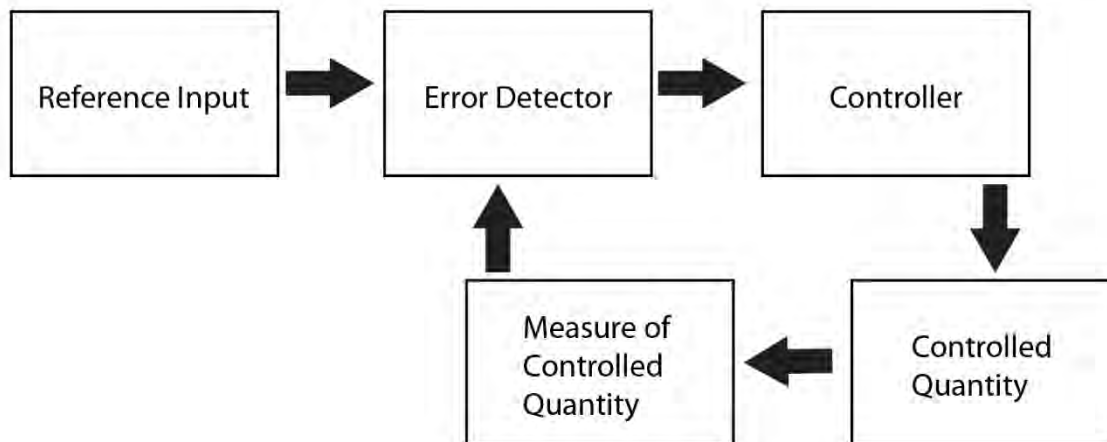
General Description

Theory

The Mark III controller is, basically, the electronic portion of an eddy current speed control system. The electronic circuits contained in this controller are connected and packaged in such a way as to provide maximum flexibility.

This control system utilizes feedback, or closed loops to linearize and stabilize its performance characteristics. A block diagram of a generalized closed loop system is shown in figure 1. The reference input sets the desired level of the controlled quantity. The controller provides the power, or energy, to modify the quantity to be controlled. The error detector determines if the actual level is high or low with respect to the reference level and feeds this information to the controller, which then modifies the controlled quantity accordingly.

Figure 1 Generalized Closed Loop System



An example of the closed-loop system used in the controller is the basic velocity control loop shown in Figure 2. Inspection show the *CONTROLLED QUANTITY* is shaft velocity, the *REFERENCE INPUT* is a potentiometer, The *ERROR DETECTOR* is a summing amplifier. The *CONTROLLER* is a combination of the power amplifier, the motor and eddy current clutch. *MEASURE of the CONTROLLED QUANTITY* is accomplished by means of the tachometer generator, which produces an output proportional to the shaft velocity.

In the operation of this system, the summing amplifier detects any difference between the desired speed (speed reference) and the actual speed.

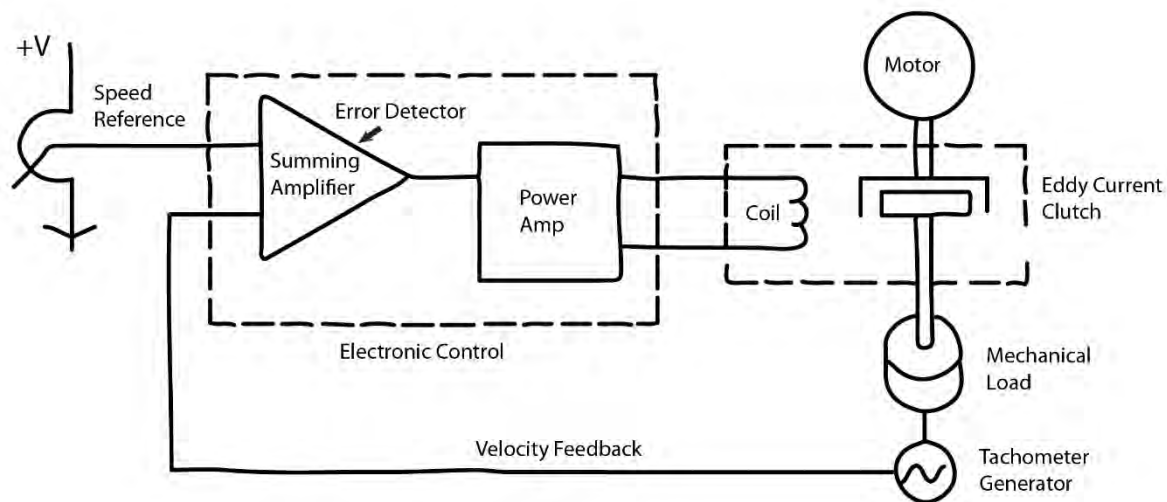
This is fed to the power amplifier, which modulates the clutch coil current. If the speed is too low, the coil current is increased, causing the eddy current clutch to transmit more torque to the load. This

results in an acceleration of the load shaft, which brings the speed up to the desired point. The opposite effect takes place for the case where the speed is too high.

In addition to the functions shown in the simplified block diagram, this universal control has many other features. Some of these are: current feedback circuits for stability, current limiting circuits for coil protection, regulated power supplies, isolation transformers for safety, reliability and noise immunity, and programmable reference circuits for universal applications.

The schematic diagram shown in Figure 3 shows all electronic functions of the controller. Each section will be described.

Figure 2 Basic Velocity Control Loop



Power Supplies

Transformer T2 provides 48 VAC C.T. for the regulated power supplies. The voltage shown, except for the unregulated +30 VDC, are obtained by zener regulators. This power supply has 30 ma of power available from the ± 15 VDC for external electronic functions

Operational Amplifier (Summing Amplifier)

This amplifier can accept a multitude of inputs from sources between -10 and +10 VDC. The resistors R69 to R74 and R43 to R48 provide balanced summing inputs to the positive (+) and negative (-) summing junctions of the amplifier. A positive voltage applied to the positive summing inputs will cause the amplifier output to move in the negative direction. The converse is true for the negative summing inputs. The gain of amplifier is a function of the ratio of the feedback resistors R63 and R49 to the input resistors at the summing inputs. The Minimum Bias potentiometer R77 provides a means of setting the minimum operating point of the controller.

The output of the summing amplifier provides an input to the pulse generator, which is the first stage of the power amplifier. Figure 4 shows a simplified schematic of the power amplifier.

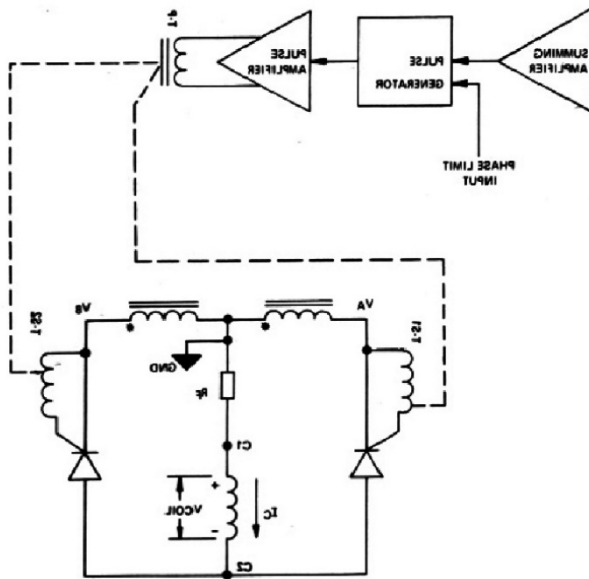
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+ ITEMS FURNISHED ONLY WHEN SPECIFIED
⊗ INDICATES START OF TRANSFORMER WINDING

Power Amplifier

The power amplifier utilizes a phase control technique with a pair of thyristors (SCR's) connected in a full-wave center tapped bridge circuit. In simplified form, the SCR's may be thought of as power switches which will stay in the off state until gated by a firing pulse. If the firing pulse occurs when the SCR has a positive anode voltage, the SCR will turn on and stay on until the current through the device goes to zero. This is known as commutating the device off. The SCR's switch their cathode voltage (V_A & V_B) to the coil load at varying electrical degrees, as shown in Figure 5a

Figure 4 Simplified Schematic Power AMP.



In Figure 5b, the SCR is turned on at 120° in the cycle and it stays on until the anode current goes to zero. This picture is true for a resistive load. The waveforms shown in Figure 5c show the load voltage going negative (shaded portions of the curves). This occurs in the case of an inductive load, such as the eddy-current coil. When the transformer voltage reaches zero, the current flowing in the coil represents an energy equal to $\frac{1}{2} LI^2$. This energy generates a voltage of a magnitude and direction to maintain the current flowing in the coil. The result is that the coil voltage will follow the sinusoidal transformer waveform in the negative direction until the next SCR is turned on.

Figure 5a SCR Firing Waveforms

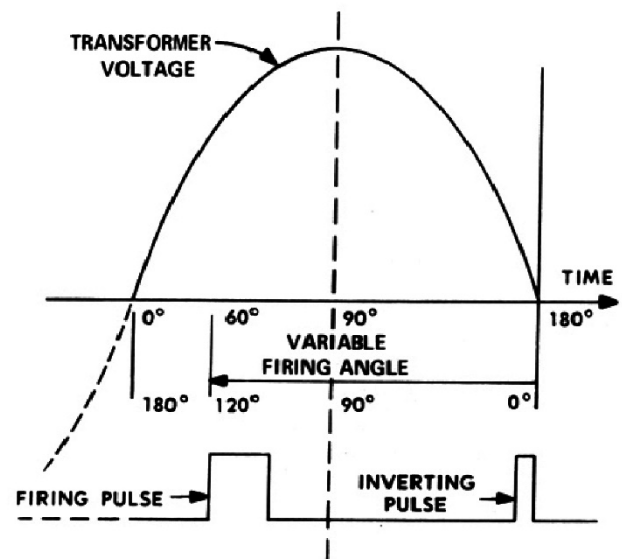


Figure 5b Resistive Load

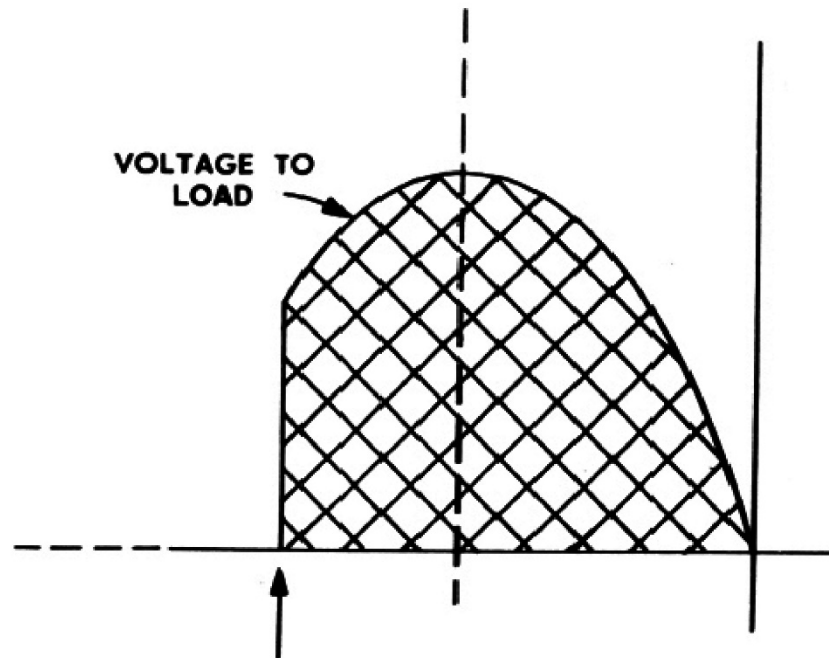


Figure 5c Inductive Load

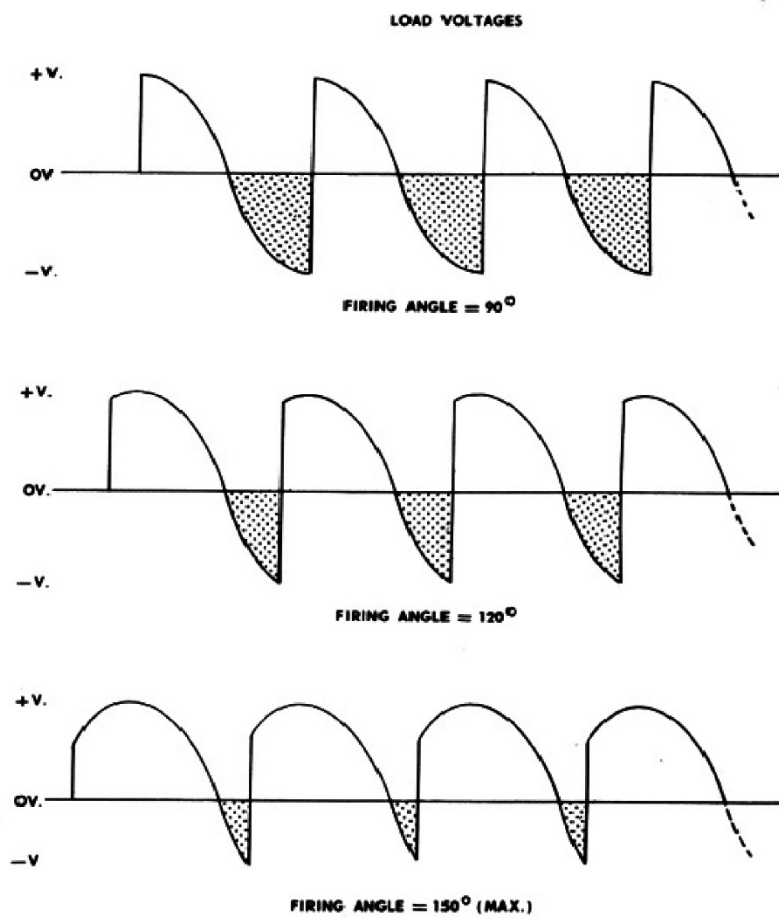
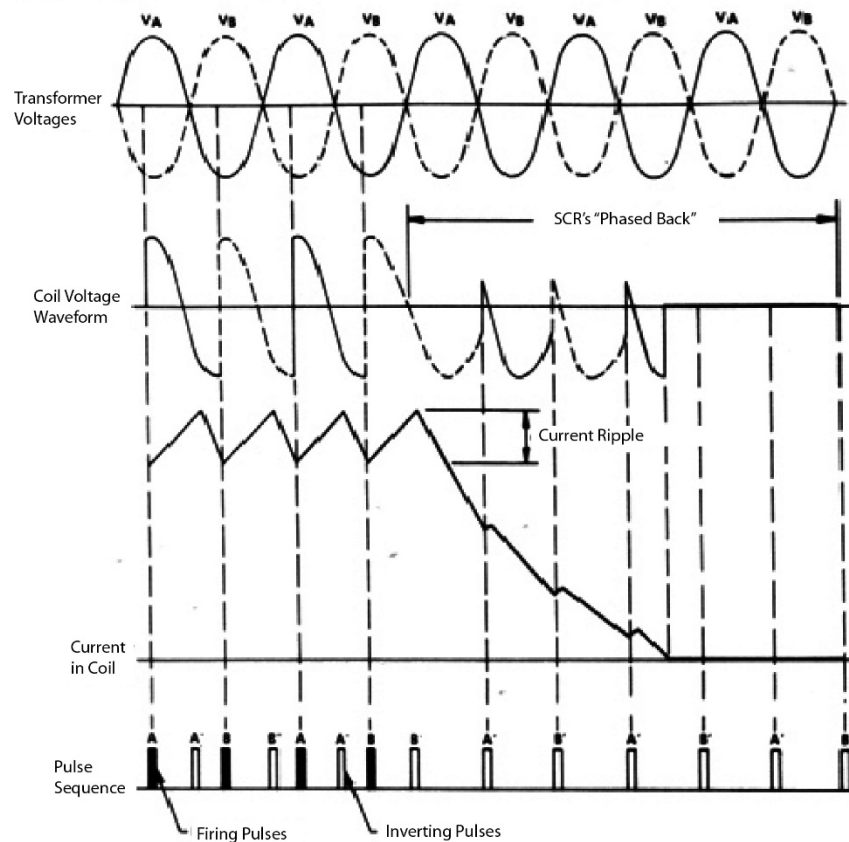


Figure 6 shows what happens when the SCR's firing pulses are phased back (firing angle is zero). The load voltage remains mostly negative. The slight positive peaks occur when each SCR is fired in turn by the inverting pulses while their anodes are slightly positive. This causes the load waveform to follow each anode excursion into the negative region until the coil energy is dissipated. The inverting pulses, which are shown in Figures 5 and 6, are merely stationary minimum firing pulses. They make certain a pulse will always be present in the phased back condition. This insures that the SCR will fire at a slightly positive voltage (Figure 6) and continues to conduct while the transformer voltage and load voltage are negative (inverted). SCR conduction while the transformer voltage is negative provides a fast decay of energy from the coil by pumping this energy back into the power lines. This INVERSION of coil energy results in a fast "Down Response Time" for coil current decay. Since the torque response follows current, this provides an improved down time for total system response.

Figure 6 Pulse Sequence

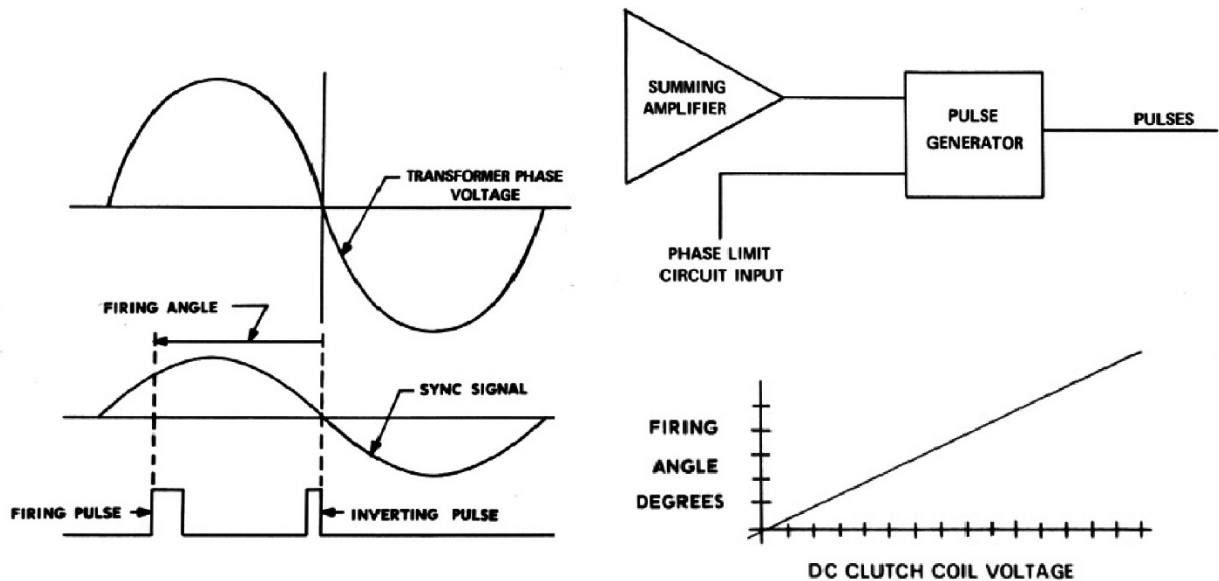


Both the moving firing pulse and the stationary inverting pulses are generated by the pulse generator (Figure 3 and 4). The transfer function of this pulse generator is shown in Figure 7. The inputs to the pulse generator are the summing amplifier output and the phase limit circuit. The firing angle and therefore the voltage output of the SCR bridge will follow the operational amplifier output. The pulse amplifier shown in Figures 3 and 4 raises the power level of the pulse generator output to drive the pulse transformer which fires SCR 1 and SCR 2.

The additional power circuit components shown in Figure 3 are described functionally below: R3-C1 and R2-C3 provide a shunt path across the SCR's for dv/dt suppression. F13, R4 and R16 provide a minimum

current for SCR latching. F30 is a suppressor across the clutch coil. F28 is switched across the clutch coil in the power-off mode to provide a decay path for the coil energy, thus protecting both the relay contacts and the coil. RF1 and RF2 provide a low resistance in series with the clutch or brake coil. The voltage across this resistance is proportional to the clutch or brake current and provides a current feedback sensor. The remaining E relay contacts switch the power circuit from the clutch to the brake (if used) when the E relay is de-energized.

Figure 7 Pulse Generator Transfer Function



Phase Limit Circuit

The phase limit circuit provides a means of adjusting the maximum output current of the controller. Potentiometer R56 is across the feedback resistors and sets the current feedback signal that is fed to the phase limit comparator circuit. When the coil current exceeds the set level, the comparator trips and the phase limit feeds a negative signal to the pulse generator. This signal overrides the operational amplifier input and limits the pulse generator output and, thus, the coil current.

Current Feedback Circuits

The Maximum Current Potentiometer R80 and the Damping Potentiometer R62 are across the current feedback resistors. R80 provides a means of proportional current feedback. This is used in current controls and to stabilize various specialized control systems. In general, the use of current feedback provides greater stabilization at the expense of system gain.

The Damping potentiometer R62 provides an AC coupled current feedback path. This provides for an adjustable dynamic stabilization with no degeneration in static gain or regulation. This provides a system with both high regulation and stable operation.

Velocity Feedback Circuit – Standard

The standard velocity feedback circuit utilizes an internal AC tachometer generator. This AC tach signal is isolated by transformer T3, which feeds the rectifier and filter circuit made up of diodes F23 to 26 and resistors R66, R67 and capacitor C24. The voltage across potentiometer R67 is adjusted to match the tachometer feedback to the reference voltage. Decreasing this voltage increases the output speed of the closed-loop velocity control, thus this potentiometer is called the Maximum Speed potentiometer.

Set up and Adjustment Procedure for Standard Controller

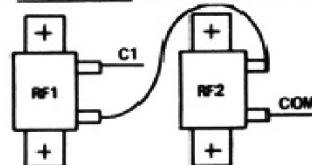
1. Preliminary Potentiometer settings with motor and control power off

Pulse Generator Bias (P.G. Bias)	R50	Factory Dial Dot	1
Minimum Bias (Min. Bias)	R77	0% Full (CCW)*	2
Maximum Current (Max. Cur)	R80	100% Full (CW)*	1
Damping (Damping)	R62	50% Full (CW)*	1
Current Limit (Cur Limit)	R56	Factory dial dot	1
Maximum Speed (Max Speed)	R67	0% Full (CCW)*	2
Speed (Speed)	R5	0% (CCW)*	

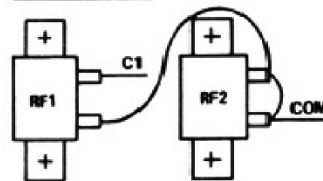
*CW- Clockwise *CCW- Counter Clock Wise / (1) Single turn (2) Twenty Turn

2. Start-up with Motor and Control Power Off

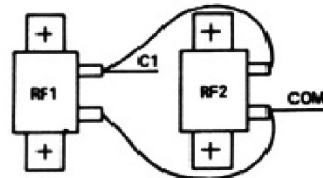
CONNECTIONS FOR (0 to 1.2) AND (2.51 to 3.5) AMP COILS



CONNECTIONS FOR (1.21 to 2.5) AND (3.51 to 7) AMP COILS



CONNECTIONS FOR (7.1 to 11) AMP COILS



NOTE: FOR UNDERLINED CURRENT VALUES RF1 AND RF2 ARE 1.5 OHMS EACH. ALL OTHER RF1 AND RF2 ARE 0.5 OHMS EACH.

A. Insert Jumpers in receptacles designated 6 to 7, 3, to 4, 16 to 12 and 21 to P1. Refer to Figure No. 3, schematic drawing.

B. Insure the feedback resistor (RF) mounted on panel is jumpered correctly for clutch current. See Figure 8. Hot Clutch Current rating can be found on the nameplate mounted on the clutch housing. **CAUTION:** Use clutch, not motor current.

C. Energize the control

Figure 8 Clutch Current

3. Current Limit

- A. Control power on, motor off.
- B. Remove suitcase shaped jumper located between the center arm of the Maximum Speed potentiometer and the 100K resistor input to the positive summing junction of the Operational Amplifier. These receptacles are numbered 16 and 12 respectively on the PCB. *CAUTION*: The following procedure will cause rotation of the output shaft, if motor is energized.
- C. Turn the external Speed potentiometer to 100% (full CW)
- D. Using a Voltmeter 0-50 VDC range, connect the meter leads to terminals C1 (Positive) and C2 (Negative) Adjust the Current Limit potentiometer until 33 VDC is attained on the meter. *
- E. As the coil heats up its resistance will rise. The coil voltage will also increase because only the current level is being controlled. At any temperature, the maximum sustained coil voltage should not exceed 45 VDC. *CAUTION*: Excessive sustained over voltage (greater than 45 VDC) on the coil, will reduce coil life. It is important that the re-adjustment of the Current Limit be made as soon as a sustained over voltage reading is noted on the meter. *
- F. Reconnect jumper across receptacle 12 and 16. Turn External Speed potentiometer to zero.

*Note: See supplement sheet S-5668 for coil voltages other than 45V.

4. Minimum Bias

- A. Control power and motor on
- B. The Minimum Bias potentiometer may be adjusted to attain any minimum rate of rotation between 0-20% of maximum speed
 - 1. For 0 RPM, turn the Minimum Bias CW until the output shaft just starts to rotate, then back off until output shaft stops rotating.
 - 2. For minimum speed greater than zero, turn the Minimum Bias CW until the desired speed is attained. Determine output speed by use of tachometer or stroboscope.

5. Maximum Speed

- A. Turn the External Speed potentiometer to 100.
- B. Adjust the Maximum Speed potentiometer until maximum desired output speed is attained. Determine output speed by use of tachometer or stroboscope.
- C. Since there may be some interaction between Minimum Bias and Maximum Speed, particularly if the minimum speed is other than zero, the Maximum Speed and Minimum Bias adjustment should be repeated until the desired speed range is attained.

6. Damping

- A. Turn the Damping potentiometer CCW until a hunting condition develops, then turn potentiometer CW until hunting condition is eliminated.

THE FORGOING PROCEDURE WILL NORMALLY BE SUFFICIENT TO ALLOW THE UNIT TO FUNCTION AS DESIGNED. IF PERFORMANCE OF UNIT IS NOT SATISFACTORY PROCEED AS FOLLOWS:

7. Special Adjustments (When required)

- A. Turn the External Speed, Minimum Bias and P.G. Bias potentiometer to zero (Full CCW)
- B. Using a voltmeter 0-3 VDC range, connect the meter leads to terminals C1 (positive) and C3 (negative) Turn the P.G. Bias CW until the meter needle just starts to deflect. Disconnect the meter.
- C. Repeat steps 3 through 6

Modifying Standard Controller (using jumpers on PCB)

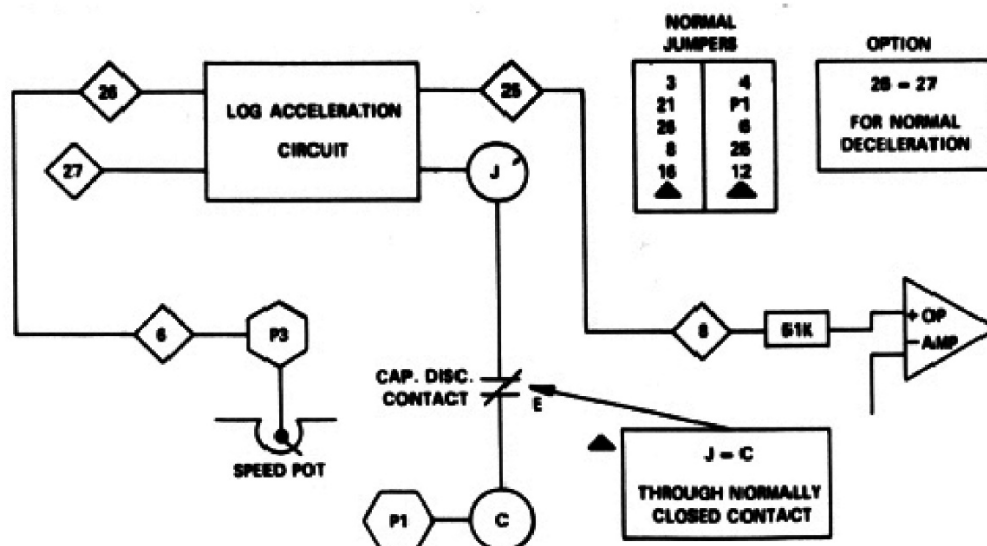
CAUTION: The following control functions are included as an integral part of the Mark III controller. These functions may be added to the circuit by following the recommended wiring procedure.

CAUTION: Wire jumpers are indicated for a standard controller. If other modifications have been supplied as pre-wired by Dynamatic.

Logarithmic Acceleration/Deceleration

Logarithmic Acceleration and Deceleration may be obtained by inserting jumpers between the paired receptacles (3, 4) (21, P1) (26, 6) (8, 25) and (16, 12).

Figure 9 Logarithmic Acceleration/Deceleration

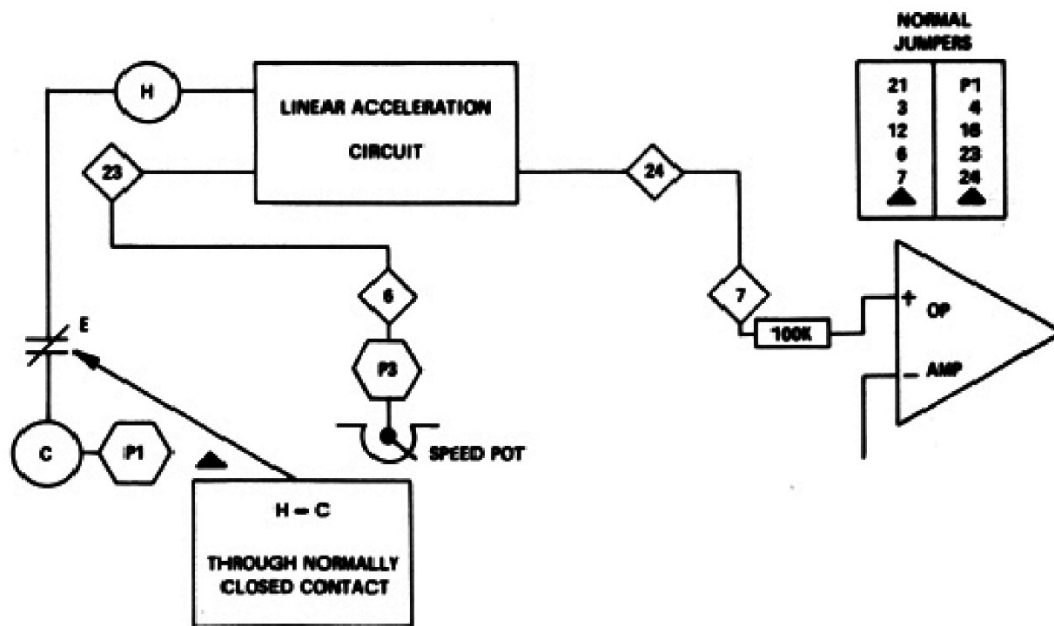


The acceleration and deceleration time may be varied between 5-20 seconds by adjusting the Logarithmic Acceleration Time potentiometer.

Logarithmic Acceleration and Normal Deceleration

In this configuration, the controller accelerates logarithmically, but decelerates normally following the Speed potentiometer, as it is turned down. This may be achieved by inserting suitcase shaped jumpers as in the Logarithmic Acceleration/Deceleration instructions and one additional jumper between the receptacle pair numbered (26, 27). This provides a discharge path through diode (F20) during deceleration.

Figure 10 Linear Acceleration



Linear Acceleration may be obtained by inserting the suitcase shaped jumpers between the following pairs of receptacles on the PCB, (P1, 21), (3, 4), (12, 16) and wire jumpers between (6, 23) and (7, 24).

The acceleration time, between 6 to 60 seconds, may be increased by turning the Linear Acceleration Time potentiometer clockwise.

Terminal “H” should be connected to signal common (P1) through a normally closed contact of a relay (usually the E relay) to discharge the capacitor when the Stop pushbutton is pressed.

Low Gain Option

If an extreme oscillation type load is attached to the Eddy Current Coupling and the normal control adjustments will not stabilize the system the control to the low gain configuration, simply add a suitcase shaped jumper between the receptacle pair numbered (4, 5). This will jumper the 5.1 meg ohm resistor in the amplifier feedback loop.

Current Control (Clutch Motor)

Current control may be obtained by inserting the suitcase shaped jumpers between the following paired receptacles on PCB (P1, 20), (P1, 19), (4, 5), (3, 4), (6, 7) and (1, 2).

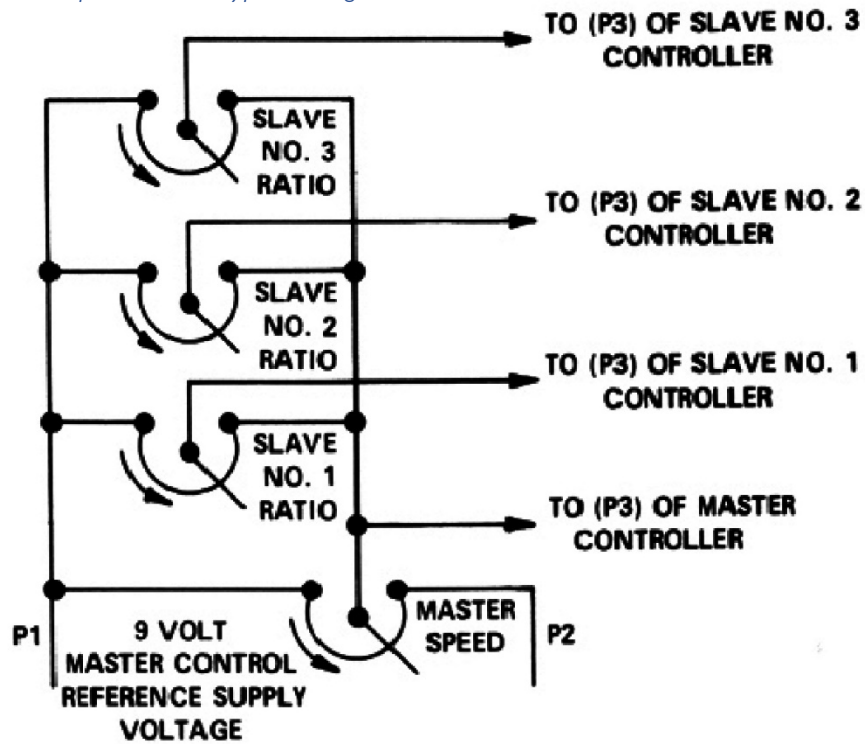
Adjustment Procedure

1. Connect a DC ammeter, (0-15 amp range) in series with the clutch coil. Attach the positive lead of meter to terminal C1.
2. Turn the External Current potentiometer to 100 (full CW) and the Maximum Current potentiometer (located on PCB) to 100 (full CW).
3. Using a voltmeter 0-50 VDC range, connect the meter leads to terminals C1 (positive) and C2 (negative). Adjust the Current Limit potentiometer until 33 VDC is attained on the meter.
4. As the coil heats up its resistance will rise. The coil voltage will also increase because only the current level is being controlled. At any temperature, the maximum sustained coil voltage should not exceed 45 VDC. *CAUTION:* Excessive sustained over voltage (greater than 45 VDC) on the coil, will reduce coil life. It is important that the re-adjustment of the Current Limit be made as soon as a sustained over voltage reading is noted on the meter. *
5. Turn the Maximum Current potentiometer CCW until maximum desired clutch current is attained on the DC ammeter.
6. Turn the Current potentiometer to zero. Adjust the Minimum Bias potentiometer until clutch current just starts to increase, then back off slightly. This will allow full adjustment of clutch current by turning the External Current potentiometer, if a minimum value of current other than zero is required, increase the Minimum Bias setting until the desired minimum current is attained on the meter. Repeat step 5 because the Maximum and Minimum Current adjustment will interact slightly.
7. Remove the ammeter and reconnect the clutch leads.

Cascading

From two to ten Mark III controllers may be connected to the same reference voltage supply in a simple cascade type arrangement as shown in Figure 11. Two conditions must be met in cascading: 1) the equivalent resistance of all potentiometers connected to the reference of all potentiometers connected to the reference voltage supply must be 1k ohm. 2) Any individual potentiometer resistance should not exceed 25K ohm.

Figure 11 simple cascade type arrangement



The proper potentiometer resistance for both Master and Slave units are shown for various cascade systems in Table 1.

Table 1 proper potentiometer resistance

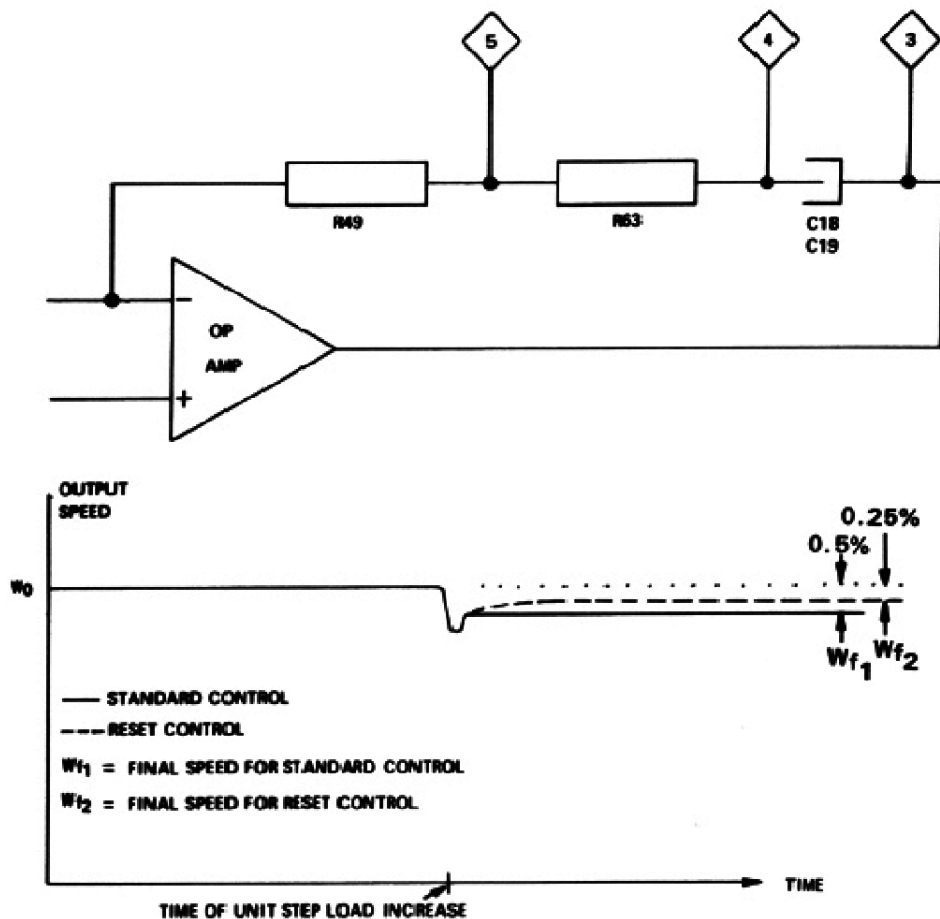
NO. Slave Units	1	2	3	4	5	6	7	8	9	10
Master Pot. Res.	25K Ω	2.5K	2K	2K	2K	22K	2K	2.5K	2.5K	2.5K
Individual Slave Pot Resistance	5K Ω	10K	10K	10K	10K	20K	20K	20K	20K	20K

*NOTE: See supplement sheet S-5668 for coil voltages other than 45V.

.25% Regulation (Internal Reset)

Adjust the controller as described in Potentiometer Adjustments for Standard Speed Controller. Then remove the suitcase shaped jumper between receptacles numbered 3 and 4. This place a capacitor in the summing amplifier feedback loop. This configuration integrates any error, which reduces steady state deviation and results in a regulation of 0.25%. This capacitive feedback does not affect the magnitude thermal drift. The effect of the reset current for a step increase in load is shown below.

Figure 12 reset current for a step increase in load



Dancer Position Control

The Dancer Position, or Velocity Damping, on-board modification has two *external* configurations, which correspond to two different application possibilities. These two, the Payoff and Take-up Drives, are complementary in nature. The Pay-off Drive will be discussed first. Figure 13 shows a simple Pay-Off setup.

The zero end of the Dancer potentiometer is connected to P2 and the 100 end to P1. This allows a speed up signal to be sent to the drive every time the dancer rises above its reference level. The zero end of

the Position potentiometer is connected to P2 and the 100 end of the Position potentiometer is connected to P1.

The Take-up Drive is similar, except that a drop in the dancer position will give a speed up signal to the Take-up Drive. This is accomplished by connection the zero end of the Dancer potentiometer to P1 and the 100 end of the potentiometer to P2. The zero end of the Position potentiometer is connected to P1 and the 100 end to P2. Figure 14 shows a simple Take-up setup.

Figure 13 Payoff Drive

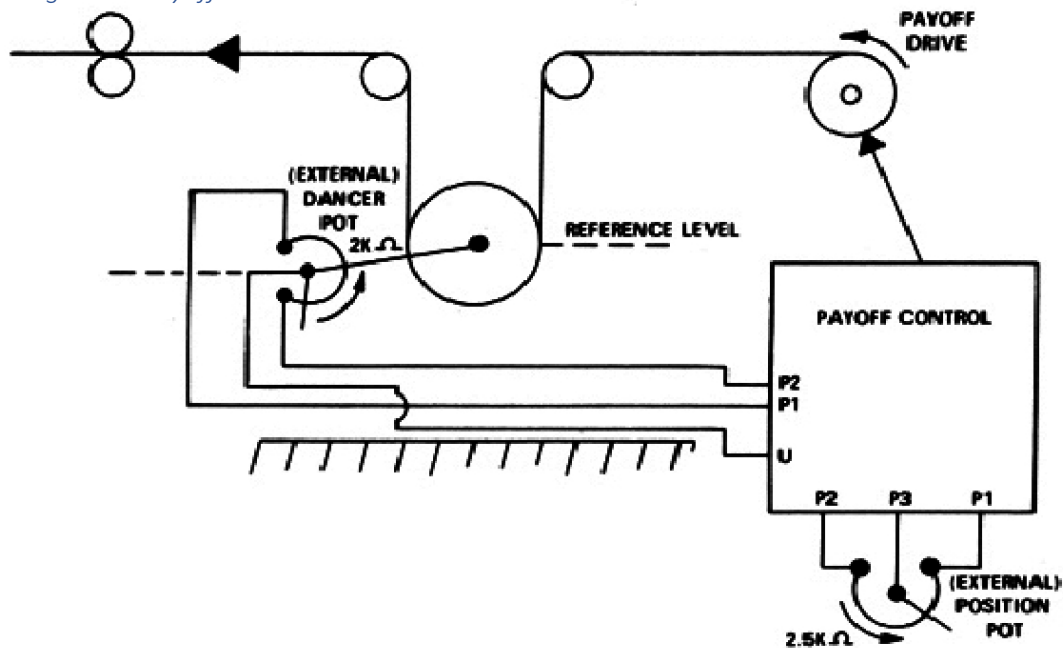
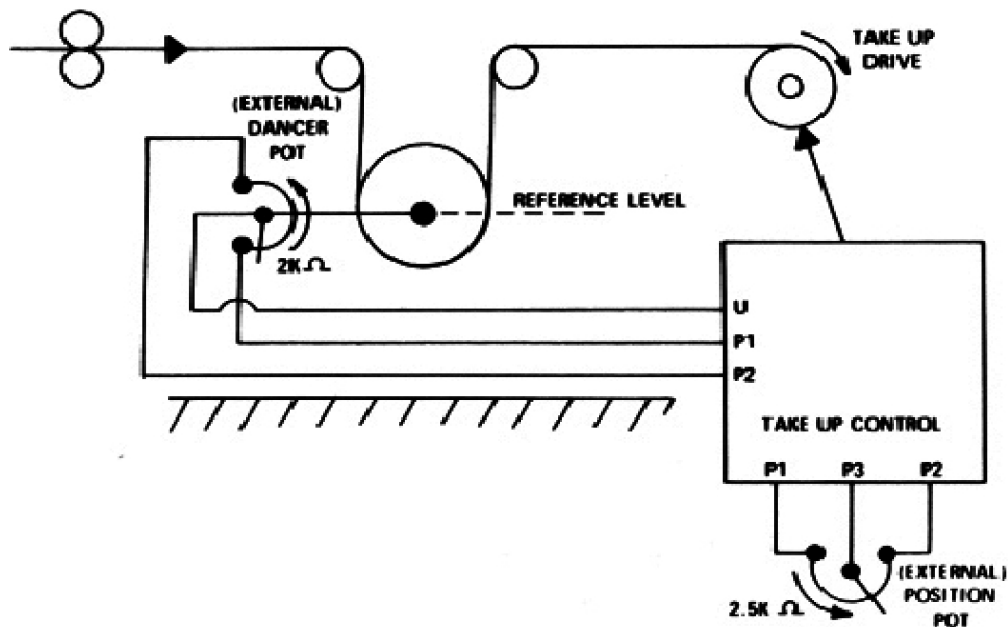


Figure 14 Take-up Drive



The on-board jumper connections for the two applications are identical. A list and explanation of these follows.

Dancer Position Jumper Connections	6-7
	14- Common (P1)
	4-3
	5-4 (Optional) with jumper in. gain is reduced
	9-P1
	10-P1
	19-P1
	20-P1
	37-38
	34-15
	15-17
	U-control terminal strip
	Control terminal strip-center arm of Dancer potentiometer

By jumpering point (6) and (7) the Position Reference potentiometer is hooked into the circuit. This external potentiometer allows the dancer reference level to be set. In the velocity damping circuit itself, (14) is jumpered to common (P1) and our position error signal comes in through U and (34) to (15). The output of the series R-C network appears at point (37) and is applied to the inverting input to the Operational Amplifier at point (38). Our position error signal is also fed directly into the inverting side of the Operational Amplifier by jumpering (15) to (17).

To adjust the controller for maximum stability, proceed as follows: Set the Damping potentiometer to zero; adjust the Maximum Current potentiometer until Maximum Clutch voltage is just achieved at the limit of the Dancer travel; adjust the Velocity Damping potentiometer to minimize Dancer oscillations. The value of the Dancer Position potentiometer should be 2.5K ohms, 2 watt. The value of the Dancer potentiometer should be 2K ohm, 2 watt.

NOTE: If stability cannot be attained with the above adjustments, add a 2 ohm 50 watt resistor in series with feedback resistors RF1 and RF2.

Tachometer Generator Follower Circuit

A tachometer follower circuit is supplied on the basic Printed circuit Board. This circuit, however, is supplied less an isolation transformer and should only be used when circuit common isolation is not required. A diagram (Figure 16a) shows a simple, acceptable tachometer follower application without the use of an isolation transformer. Figure 16b also shows an acceptable method using a separately mounted G-2 generator.

When nuisance interaction may result because of a common connection of system components, an isolation transformer is required and can be purchased as a Snap-on modification module. A simple example of a system which requires the isolation transformer appears in Figure 16c.

Figure 15 AC Tachometer Generator

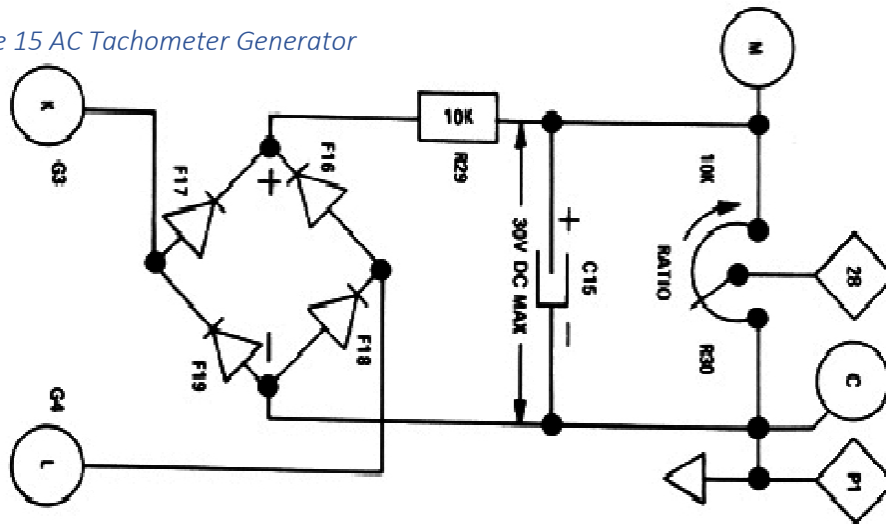


Figure 16a acceptable tachometer follower application without the use of an isolation transformer

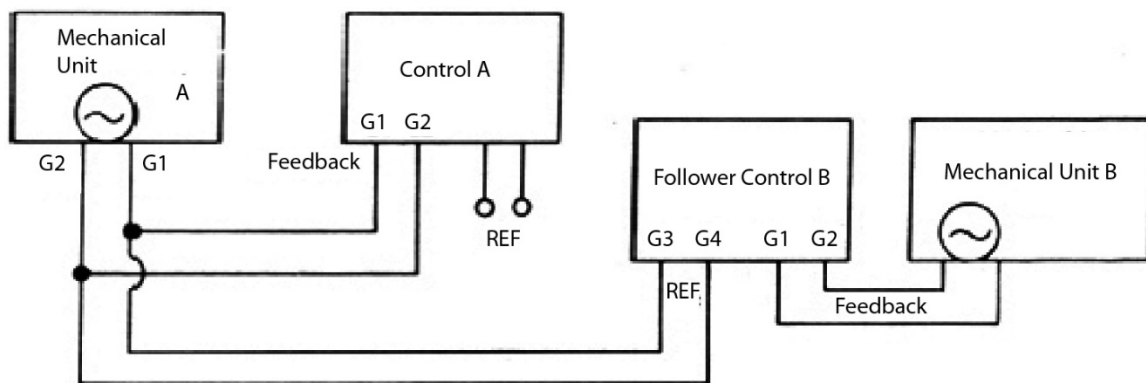


Figure 16b acceptable method using a separately mounted G-2 generator

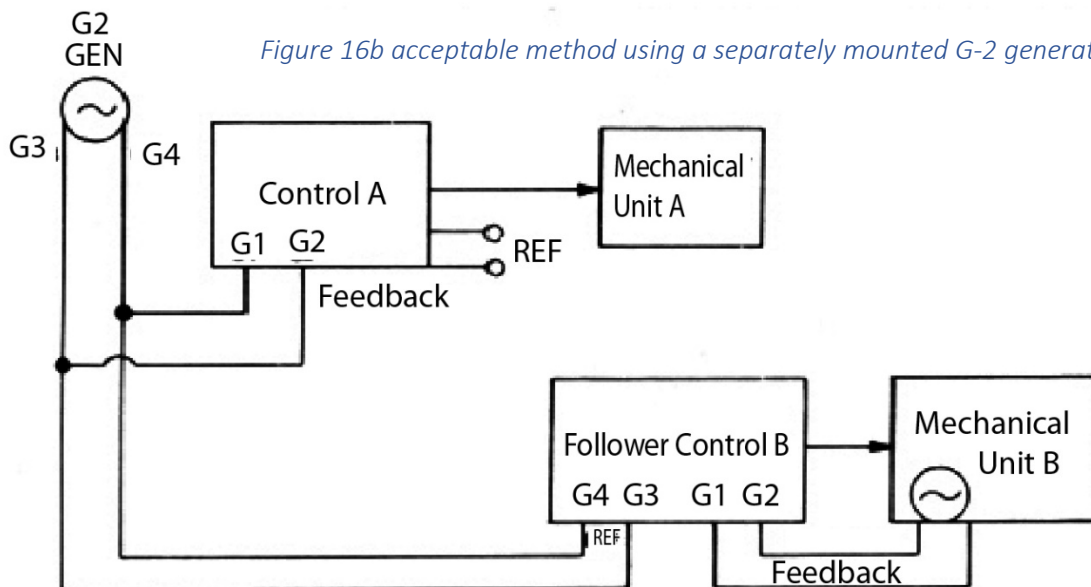
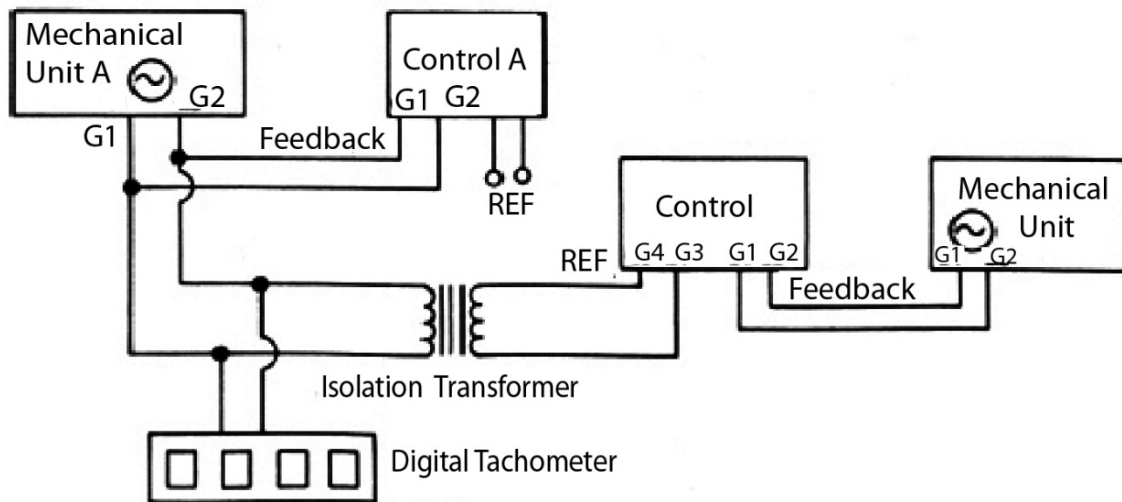


Figure 16c example of a system which requires the isolation transformer



Circuit operation requires an AC signal, either isolated or non-isolated, to be applied at G3 (K) and G4 (L). The positive DC voltage that appears at jumper point (28) can be varied by the 10K Ratio potentiometer (R-30). This DC voltage is then fed into the operational amplifier, through jumper point (7), and used as the speed reference voltage.

To connect the control for follower operation, jumper points (3 and 4), (16 and 12) and (18 and P1) with suitcase type jumpers and points (28 and 7) with a long jumper. Also connect the AC tachometer generator signal directly to terminals K and L on the printed circuit board.

CAUTION: The maximum generator voltage that can be applied safely to points K and L on the printed circuit board is 60 volts. For generators with greater than 60 volts output use an external attenuating resistor as shown in Table 2.

Table 2 external attenuating resistor

Max. Gen Output Voltage (Volts)	Attenuating Resistor	
	OHMS	WATTS
70	5K	1
80	8.2K	1
90	12K	1
100	18K	1
150	33K	1
180	43K	1
200	51K	1

DC Tachometer Generator

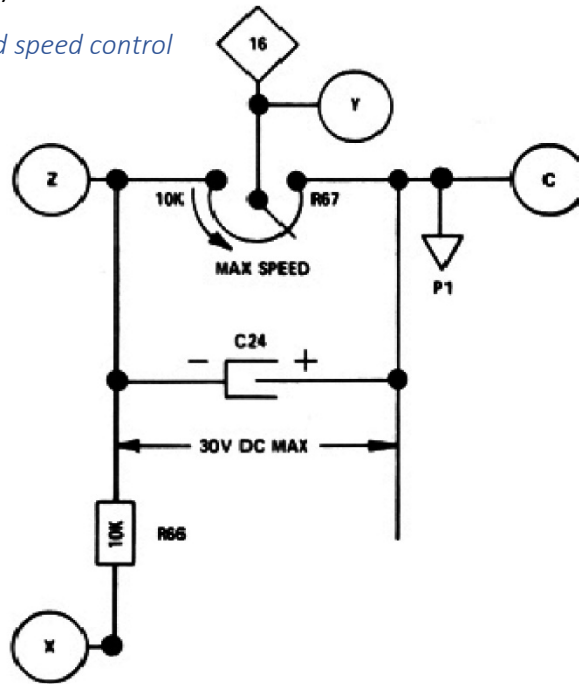
A DC Tachometer Generator may be used as a follower signal providing it is not common with other equipment which might impair the operation of the controller. The maximum generator voltage that the control will accept directly is 60 volts. If the DC Generator has over 60 volts output at top speed, use an external attenuating resistor as shown in Table 2.

Connect a DC generator to the follower circuit simply connect leads to terminals. K and L on the printed circuit board. (Polarity is of no concern because a full-wave bridge rectifier will direct current flow.)

DC Tachometer Generator Feedback Voltage

If it is desired, a DC tachometer may be used in place of the normally furnished AC tachometer for the speed control feedback signal. The main printed circuit board should be jumpered for standard speed control i.e. (6,7), (3,4), (16, 12) and (21, P1).

Figure 17 be jumpered for standard speed control



If maximum tachometer output is between 30-60 VDC, use configuration I. If the maximum output is 30 VDC or less use configuration II. Should the maximum output of the generator be greater than 60 VDC, an attenuating resistor external to the printed circuit board MUST be used.

Table 3 shows some typical maximum generator voltage and the proper value of external attenuating resistors to be used.

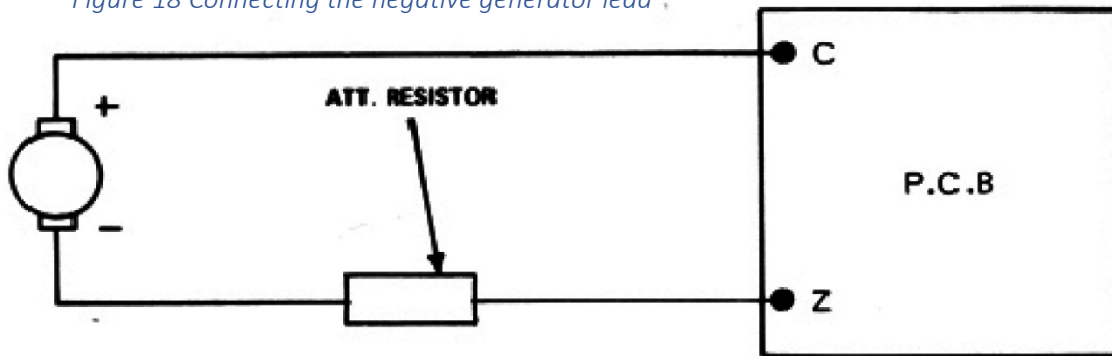
Table 3 typical maximum generator voltage

Max. Gen Output Voltage (Volts)	Attenuating Resistor & Wattage	
	OHMS	WATTS
70	15K	1
80	18K	1
90	22K	1
100	27K	1
150	43K	1
180	51K	1
200	62K	1

Connect the negative generator lead to the attenuating resistor and the positive generator lead to terminal "C" of the printed circuit board as shown in Figure 18. The attenuating resistor is then connected to terminal "Z" on the printed circuit board.

The voltage across R67 should not exceed 30 VDC or damage may result.

Figure 18 Connecting the negative generator lead



Configuration I (30-60 VDC Maximum Tachometer Output)

Connect the negative lead of the tachometer to terminal "X" on the printed circuit board and the positive lead to terminal "C". Adjust the Maximum Speed potentiometer for the desired maximum output speed.

Configuration II (Maximum Tachometer output less than 30 VDC)

Connect the negative lead of the tachometer to terminal "Z" on the printed circuit board and the positive lead to terminal "C". Adjust the Maximum Speed potentiometer for the desired maximum output speed.

CAUTION: Do not apply more than 30 VDC across the Maximum Speed potentiometer (R67)

Maintenance

WARNING: Turn off power to unit before making tests, except when taking voltage measurements. Only qualified personnel acquainted with electrical safety procedures should service the equipment.

Preventive Maintenance

Since controlled rectifier controls are relatively trouble-free, the main item of preventive maintenance is to clean out the control cabinet periodically, wither by vacuum cleaning or by utilizing an air hose.

Corrective Maintenance

If unit will not run- check:

1. Fuses and disconnect device
2. Incoming line Voltage
3. Relay operation
4. Voltage across outside terminals of speed pot R5- should be approximately 9 volts DC. Voltage from P1 to center arm of R5 should rise from 0 to 9 volts as pot is rotated from 0 to 100% end.
5. Transformer voltages (see your specific wiring diagram)
6. On water cooled units-operation of water pressure and temperature switches for proper adjustment settings and function
7. For open circuit in clutch field coil (C1 and C2)

If unit "Hunts" (erratic speed control) – check:

1. Damping setting. Readjust
2. Driven load on output shaft may pulse or reflect erratic load to the controller.

If fuse blows on cold start – check:

1. Short or ground in clutch coil. Resistance check and megger to ground (should be about 20 megohms to ground) *Caution:* Disconnect both leads of clutch coil before making resistance check. **Do Not** megger any portion of controller.

If unit runs only at full speed – check

1. Low voltage on G1 and G2 – should be approximately 40 – 65 volts AC at full speed
2. Return operator's speed pot R5 slowly to zero. If the drive suddenly stops, check for open circuit in R5.
3. Maximum Speed pot setting. Readjust.
4. The two rotating members of the drive may be locked together by foreign matter in the air (or water) gap. Remove excitation to clutch coil to check – output shaft should come to a stop.
5. Incorrect location of jumpers on PCB. (check schematic drawing)
6. G1 or G2 governor generator leads for open. (No voltage at terminals G1 and G2)

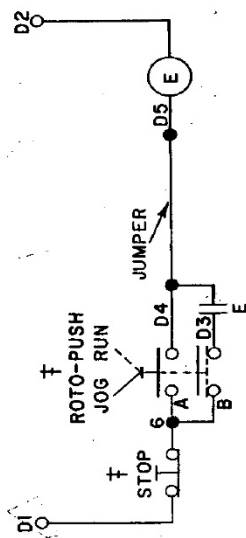
If unit drifts in speed- check

1. Loading on the drive may be excessive, particularly at low speeds so drive overheats and will, not pull the load.

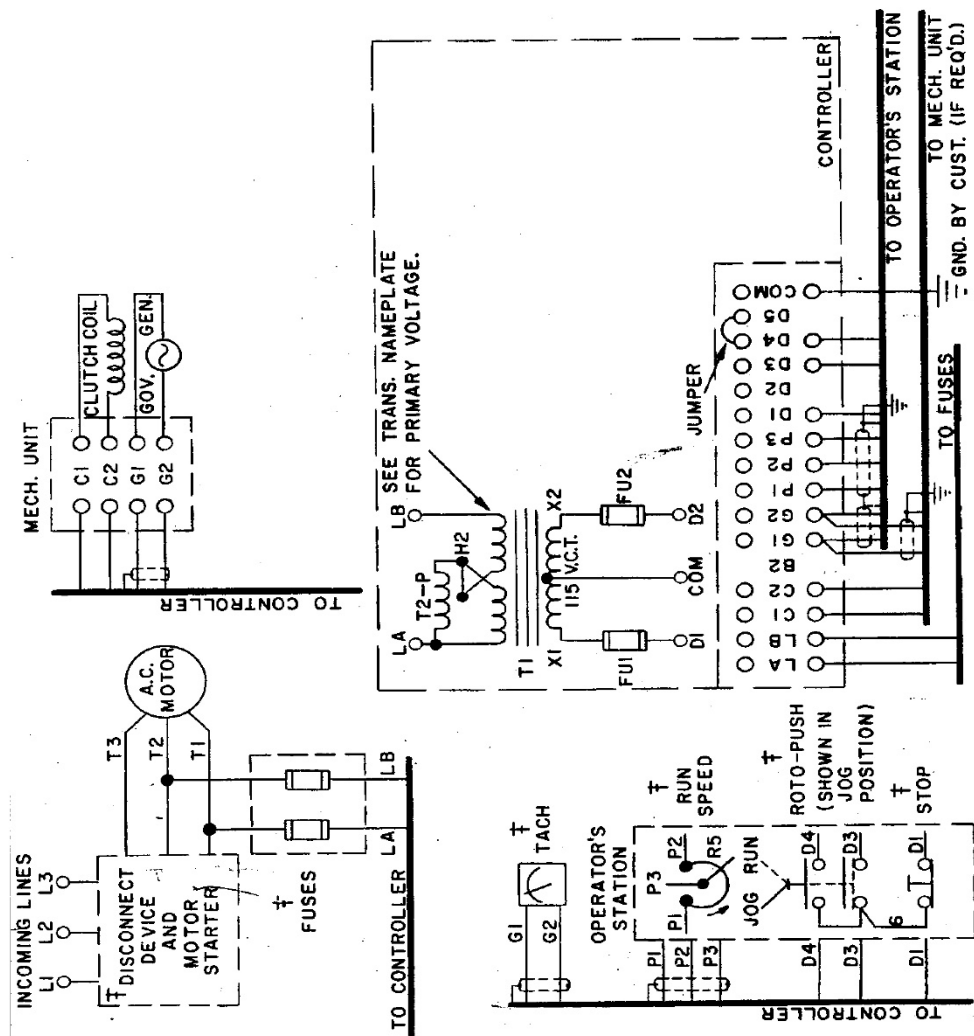
Voltages required

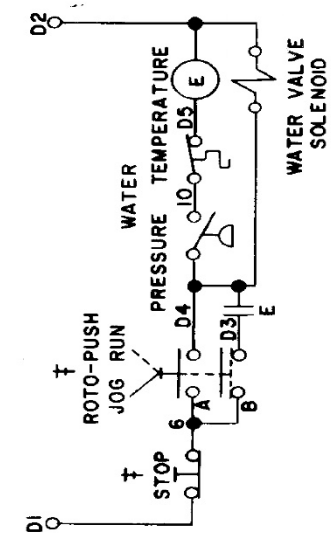
1. Approximately 9 volts DC across terminals P1 and P2
2. 52 volts DC across terminals C1 and C2 on terminal strip with full current to clutch coil (see coil rating). Current Limit Pot set at full CW.
3. 40 – 65 volts AC across G1 and G2 terminals when unit is running at full speed
4. See your specific wiring diagram for transformer secondary voltages.

Connection Diagram for Air Cooled Units



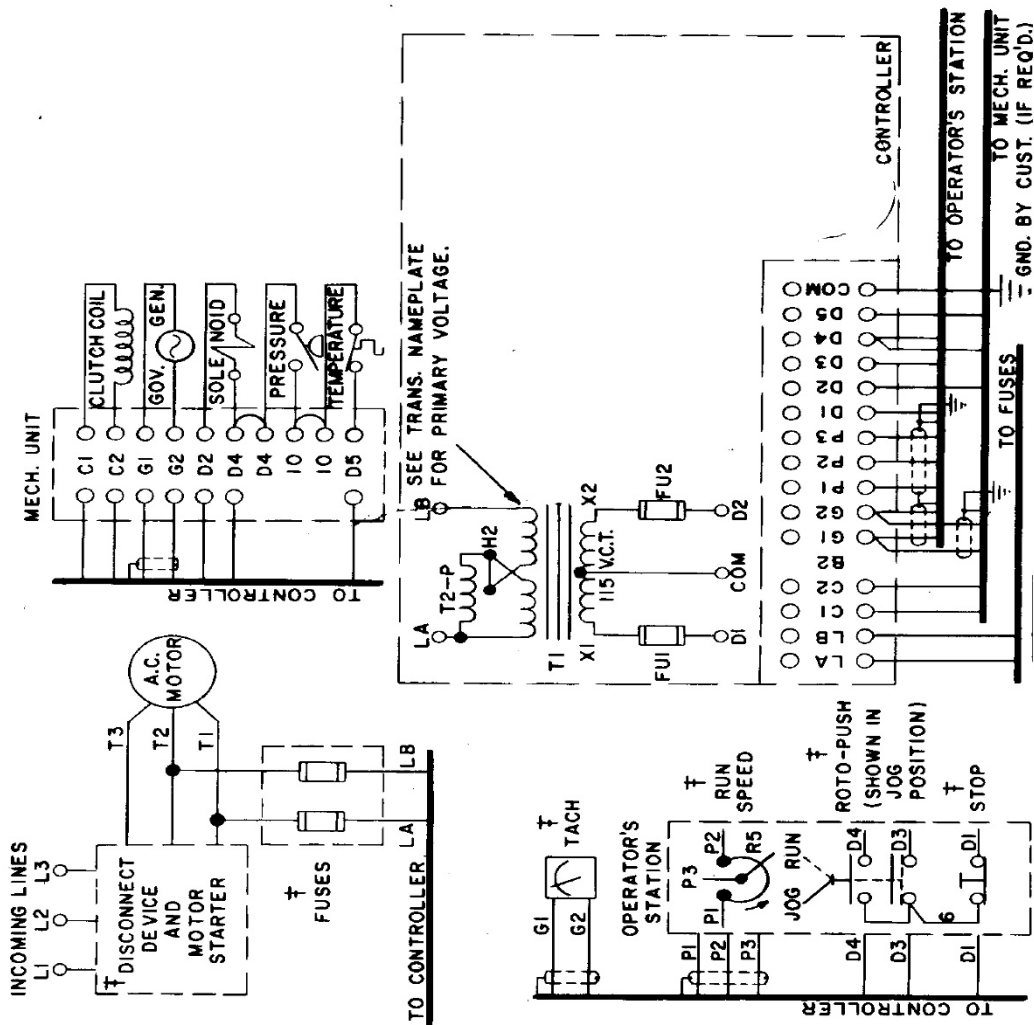
ROTO-PUSH CIRCUIT	
POSITION	JOG RUN
BUTTON	N D N D
O A	O X O X
O B	O O O X





Connection Diagram for Water Cooled Units

ROTO-PUSH CIRCUIT			
POSITION	JOG	RUN	
BUTTON	N	D	N D
	A	O	X O X
	B	O	X O X



Replacement Parts

All parts should be ordered from Drive Source International 1-800-548-2169. In ordering parts, determine the part number from the bill of material, drawings or diagrams, wherever possible. These contain parts lists of all parts ordinarily considered to be subject to replacement, but in case you are unable to find the part number, use one of the drawings as a reference.

Always show the part number, the AC motor serial number, and the Dynamatic clutch and control serial number. This will enable the factory to locate records in case you are unable to describe completely the part wanted.

Disconnect Switch Fuse rating for AC input to Mark III Controllers

DC Volts	Output Amps	Power Tans VA.	AC Input Current (Maximum)				Suggested (Max.) Input Fuse Rating (Instantaneous)			
			208/230V	390V	460V	575V	208/230V	309V	460V	575V
50	5.5	500	2.5A	1.3A	1.1A	.9A	10	3	3	3
50	11.0	1000	5.0	2.6	2.2	1.8	15	6	6	6
100	2.0	1000	5.0	2.6	2.2	1.8	15	6	6	6
100	5.5	1000	5.0	2.6	2.2	1.8	15	6	6	6
100	11.0	1000	10.0	2.6	4.4	3.6	25	15	10	10

Fuse Data Mark III Controller

Control Output		Fuse			Drawing Symbol
DC Volts	DC Amps	Part Number	Description		
50	5.5	32-28-4091	4 Amp	Type ABC	FU1 FU2
50	11.0	32-28-8091	8 Amp	Type ABC	FU1 FU2
100	20.	32-28-4091	4 Amp	Type ABC	FU1 FU2
100	5.5	32-28-4091	4 Amp	Type ABC	FU1 FU2
100	11.0	32-28-8091	8 Amp	Type ABC	FU1 FU2

Fuses (FU1 and FU2) No substitution. Replace defective fuse with an exact replacement in size and type.

Recommended Spare Parts

A Dynamatic Mark III Controller, if properly installed and operated under normal conditions, will require a minimum of maintenance. Subjecting the control to excessive heat or higher than rated voltages can shorten the life span. To avoid a possibility of "down time" it is recommended that a spare printed circuit board assembly (Dynamatic part number 15-235-2) be stocked.

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Email: sales@dynamatic.com Website: dynamatic.com