

**Control Module for Modular Motors  
General Instructions**

**APPLICATION**

The MMC-421 plug-in control module is used in conjunction with MM-400, MM-500, MMR-400 and MMR-500 series of modular motors.

The module will accept a variable milliamp DC signal from a controller and accept a dry contact closure.

**Each MMC-421 package contains:**

- One (1) MMC-421 Control Module
- One (1) Module Label
- Six (6) 6"-18 gauge color coded wires with 1/4" Spade Connectors attached to one end
- One (1) Wiring Template

**Other Components Required:**

None

**Other Components That May Be Required:**

None

**SPECIFICATIONS**

**Control Signal Inputs:**

**Variable Milliamp DC,**

**Span** 2 mAdc to 20 mAdc (adjustable by span potentiometer), factory set for 4 to 20 mAdc.

**Start Point** 12% of span setting to 20 mAdc (adjustable by zero potentiometer).

**Maximum Input Signal** 25 mAdc.

**Input Impedance** 100 ohm for 2 to 20 mA current output controllers. Other impedances can be obtained by adding series or parallel resistors for controllers with other current outputs.

**Hysteresis (Dead Band)** Typically 8.3% of Span.

**Power Requirements:** 24 Vac +10/-15%, 50/60 Hz., 3.9 VA.

**Environment:**

**Ambient Temperature Limits,**

**Shipping and Storage** -40 to 160°F (-40 to 71°C).

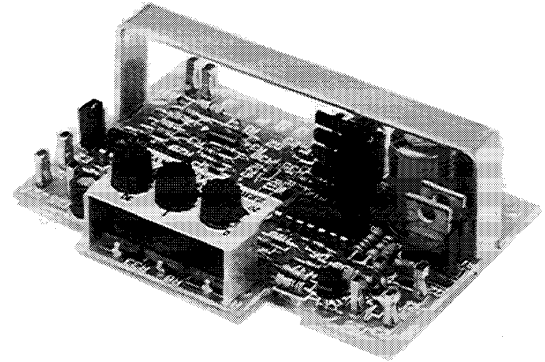
**Operating** -40 to 140°F (-40 to 60°C).

**Humidity,** 5 to 95% RH, non-condensing.

**Locations,** NEMA Type 1 indoor only when installed in MM or MMR series of motors without AM-232 gasket installed, NEMA Type 3R with AM-232 installed (AM-232 provided with MMR series of motors) and motor mounted vertically - top up.

**Motor Stroke:** The internal mechanical stop is factory set at 160°. The electrical stroke of the motor is adjustable from 90° to 160° by potentiometer on MMC-421. The direction of motor rotation can be reversed with respect to the input signal. Factory set for CW rotation with respect to "Load" or "Load, Normally Closed - CCW Spring Return" end of motor with increasing input signal.

**Connections:** The motor has 1/4" spade lugs. The MMC-421 includes 6" (152.4 mm) color coded leads crimped to 1/4" female disconnects. Field connections should be



made to color coded leads.

**Parallel Operation:** Do not parallel actuators.

**Mounting:** Plug-in mounting in the MM or MMR series of motors. MMC-421 is not position sensitive.

**Dimensions:** 1-1/8" high x 3-1/2" wide x 2-1/2" deep (28.5 mm x 89 mm x 64 mm) See Figure 1.

**PRE-INSTALLATION**

**Inspection**

Visually inspect the package for damage. If damaged, notify the appropriate carrier immediately. Visually inspect the device for obvious damage due to shipping. Return damaged products to place of purchase.

**Required Installation Items**

- Wiring diagrams
- Tools (not provided):  
Digital multimeter (DMM)  
Screwdriver

**INSTALLATION**

**Caution:**

Installer must be a qualified, experienced technician.

Disconnect power supply before installation to prevent electrical shock and equipment damage.

Make all connections in accordance with electrical wiring diagrams, and in compliance with national and local codes. Use copper conductors only that are suitable for 85°C. Use Class 1 wiring only.

Do not exceed the ratings of the device.

Avoid locations where excessive moisture, corrosive fumes

or vibration are present.

**Table-1 Terminal Description.**

Terminal	Description
TR1	24 VAC 50/60 Hz. Power Input
TR2	24 VAC 50/60 Hz. Power Input
3	I12, Input Current (mAdc) Two (-)
5	F
9	System Common (-)
17	I11, Input Current (mAdc) One (+)

**Mounting and Wiring**

1. Remove the motor cover by removing the four cover screws.

**Note:** If maximum output shaft rotation needs to be changed (factory set at 160°), see Adjustments before installing control module.

2. Pick up the control module by the metal installation handle. Install the MMC-421 control module into the motor wiring compartment by aligning the module and carefully pushing all the way onto the pins. Press in the area around both sides of the vertical part of handle, see Figures 2 and 3.

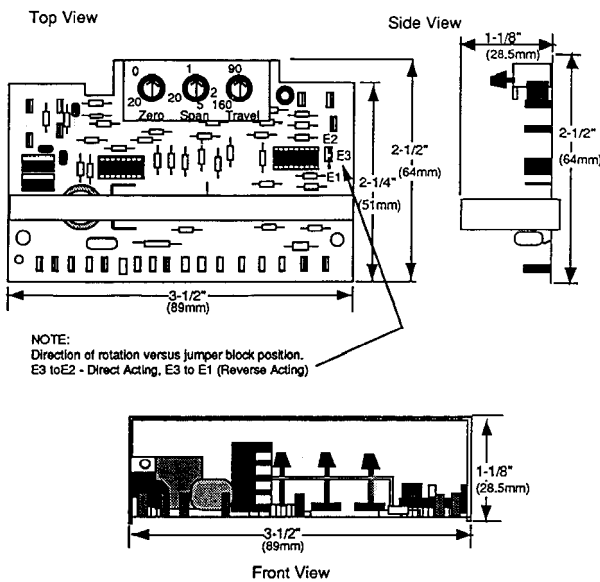


Figure-1 MMC-421 Plug-In control Module Dimensions.

3. Make the wiring connections in accordance with job wiring diagram, see Figures 5 through 7 and Table 2.

**Table-2 Wire Selection for Power Wiring to Motor or AM-231 Cover Transformer.**

Voltage	Wire size (AWG) (Suitable for 85°C)	Maximum Run # Feet (m)
24	18	80 (24.3)
	14	210 (64)
	12	265 (80.7)
120	14	2,340 (713)
208/240	14	4,070 (1,240)

# The maximum run is based on one motor being on the run. If more than one motor is on the run divide the maximum run length shown in the table by the number of motors to determine actual maximum run length.

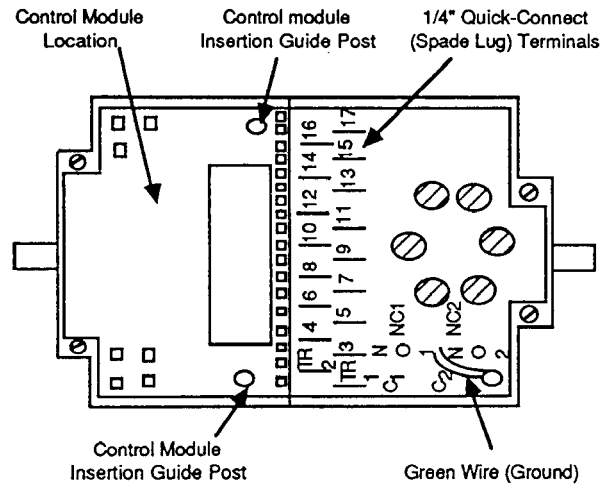


Figure-2 Terminal Board Connections and Control Module Location.

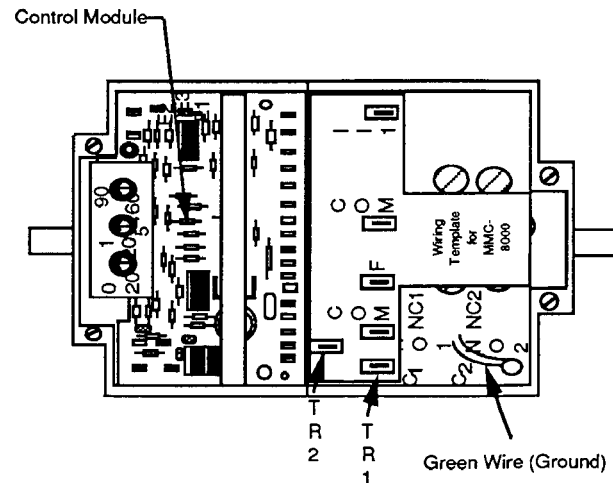


Figure-3 Terminal Board Connections with Wiring Template.

4. The field connections are made to 6" (152.4 mm) long color coded leads. Note: The color coded leads are supplied with MMC-421 and have 1/4" female disconnects crimped to them.
5. The template supplied can be used for easy terminal installation. Place the template over the terminal block (See Figure 3).
6. Install the leads to 1/4" spade lugs in the motor referring to Figures 5 through 7.
  - a. Power Wiring

**Caution:** Use one (1) 24 Vac transformer per motor.

- b. Control Wiring for mAdc Input Signal  
Use 18 gauge 2 - conductor twisted leads (TAC Part Number W-102) for runs up to 500 ft. (152 m) between motor and controller. Use a larger size on longer runs.

**Caution:** Use 18 gauge 2 - conductor shielded cable (twisted) when it is necessary to install the control leads in the same conduit with power wiring or when high RFI/EMI generating devices are near. Terminate the shield at the common terminal of the motor.

7. Install the wiring label included with MMC-421 control module on the inside of the motor cover so that the configuration of the motor can be determined at a later date.
8. Replace the motor cover and cover screws if the checkout is not being done at this time.

## ADJUSTMENTS

### MOTOR ADJUSTMENTS:

The mechanical stroke of motor is factory set for 160°. The mechanical rotation of the motor is adjustable to 75°, 90°, or 110° by use of the internal mechanical stop (See General Instructions F-23348).

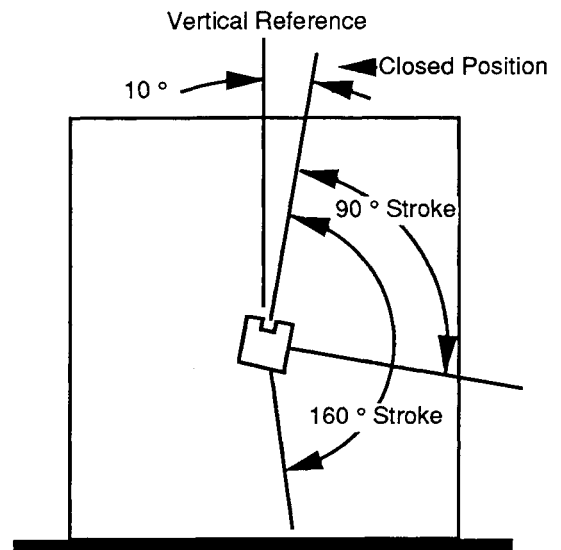
**Note:** Make sure the mechanical stroke is properly set before the control module is installed.

Other mechanical adjustments are made in the linkages.

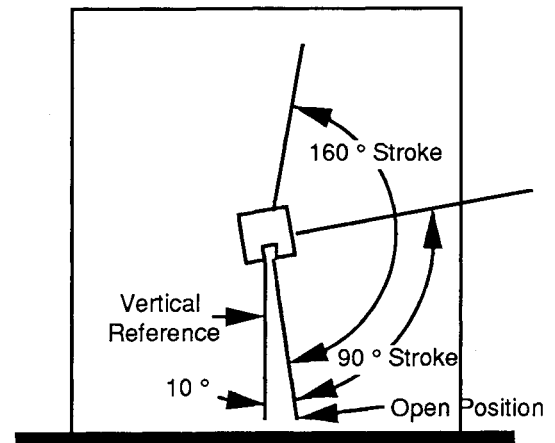
### MMC-421 CONTROL MODULE ADJUSTMENTS:

The MMC-421 control module provides the adjustments shown below. See Figure 1 for location of adjustments. In general the adjustments should be made in the order shown.

1. Jumper block to reverse the direction of motor rotation versus input signal.
2. Span potentiometer to adjust span of input signal required to drive motor full stroke.
3. Zero potentiometer to adjust zero or the start point of the motor.
4. Travel potentiometer to adjust the electrical travel of the motor. Note: The travel potentiometer can be adjusted at any time since it has no effect on other settings.



Motor stroke as viewed from the "Load" or "Load, Normally Closed-CCW" end of motor. The stroke is adjustable from 90° to 160° with the stroke adjustment potentiometer on the MMC-421.



Motor stroke as viewed from the "Optional" or "Optional, Normally Open-CW" end of motor. The stroke is adjustable from 90° to 160° with the stroke adjustment potentiometer on the MMC-421.

Figure-4 Motor Stroke.

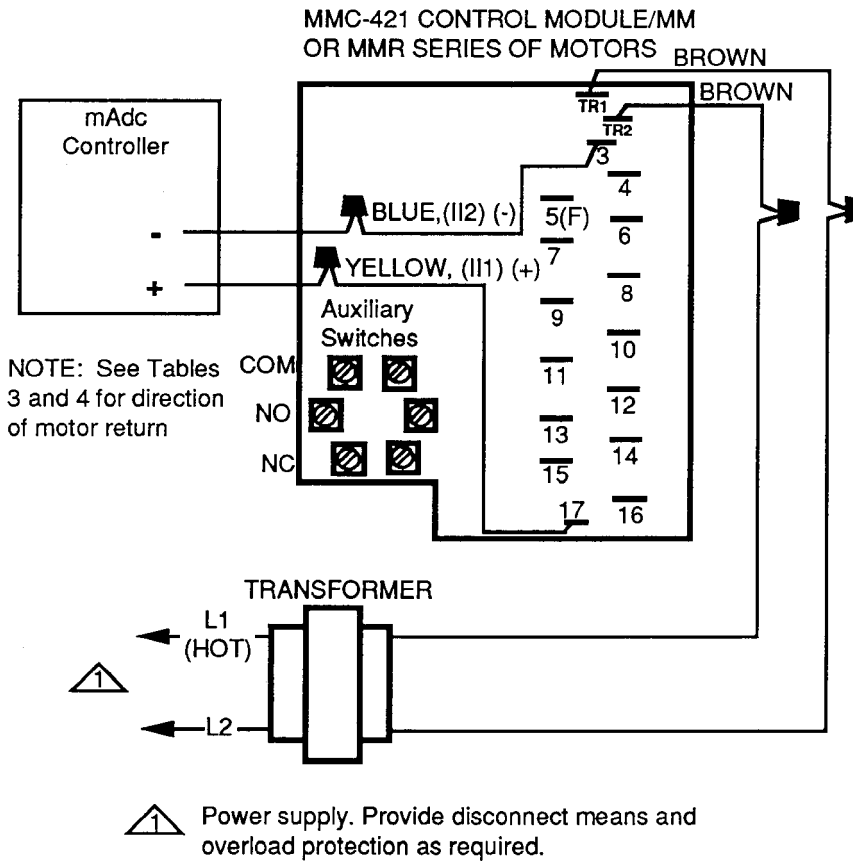


Figure-5 MMC-421 Control Module and MM or MMR Series of Motors Controlled from a mAdc Controller.

**Direction of Motor Rotation Versus Input Signal to MMC-421 Control Module**

The MM and MMR series of motors can have the load attached to either end of the motor. The ends of the MM and MMR-400 series of non-spring return motors are identified as the "Load" (end typically used for load) and "Optional". The ends of the MM and MMR-500 series of spring return motors are identified as the "Load, Normally Closed" (CCW spring return, end typically used for load) and the "Optional, Normally Open" (CW spring return). The direction of rotation versus input signal can be reversed by rotation jumper block (See Figure 1). See Tables 3 and 4 for the direction of rotation versus input signal and rotation jumper block position. Put the rotation jumper block in the correct position for the application.

**Table-4 Direction of Rotation of MM or MMR Series of Motors with the Rotation Jumper Block in Reverse Acting Position (E3 to E1).**

Signal	Normally Closed or Load End of Motor	Normally Open or Optional End of Motor
Decreasing mAdc Signal	Drives CW ("Open")	Drives CCW ("Closed")
Increasing mAdc Signal	Drives CCW ("Closed") *	Drives CW ("Open") *

\*This is also the normal or spring return position of the MM or MMR-500 series of spring return motors.

**Table-3 Direction of Rotation of MM or MMR Series of Motors with the Rotation Jumper Block in Direct Acting Position [Factory Set Position (E3 to E2)].**

Signal	Normally Closed or Load End of Motor	Normally Open or Optional End of Motor
Increasing mAdc Signal	Drives CW ("Open")	Drives CCW ("Closed")
Decreasing mAdc Signal	Drives CCW ("Closed") *	Drives CW ("Open") *

\*This is also the normal or spring return position of the MM or MMR-500 series of spring return motors.

## Span Adjustment and Zero Adjustment (Start Point) of Input Signal

**Note:** Control module is factory calibrated 4 to 20 mA. If other ranges are required, proceed as follows:

The span adjustment potentiometer should be set first since it has some effect on zero adjustment potentiometer. After the motor is powered and adjustable control signal mAdc is available the final settings can be made using the procedure shown below.

1. Turn the span adjustment potentiometer to the approximate required settings per the scale and zero adjustment potentiometer fully clockwise.
2. Attach a digital multimeter (DDM) to terminals 3 (-) and 17 (+). For mAdc conversion to VDC across terminals 3 and 17 see Table 5.
3. Adjust the input signal to MMC-421 until the desired zero (Start Point) voltage (VDC) is read on DMM.
4. Slowly turn the zero potentiometer in the decrease direction (CCW) until the motor starts and runs about 2 degrees from the zero position.
5. Slowly turn the zero potentiometer in the increase direction (CW) until motor just stops running (closes to zero position).
6. Adjust the input signal to MMC-421 until the desired end of stroke (Zero plus Span) voltage (VDC) is read on DMM. The motor should drive to or close to end of stroke position.
7. Slowly turn the Span potentiometer in the increase direction (CW) until the motor moves a couple of degrees toward zero position.
8. Slowly turn the Span potentiometer in the decrease direction (CCW) until the motor just stops moving (runs to end of stroke position).
9. Repeat steps 3 through 8 until the required results are obtained.

**Table-5 The VDC Voltage Across (100 ohm) Terminals 3 (I12) and 17 (I11) with mAdc control Signal.**

mAdc Control Signal	VDC Across Term. 3 & 17	mAdc Control Signal	VDC Across Term. 3 & 17
0	0	13	1.3
1	0.1	14	1.4
2	0.2	15	1.5
3	0.3	16	1.6
4	0.4	17	1.7
5	0.5	18	1.8
6	0.6	19	1.9
7	0.7	20	2.0
8	0.8	21	2.1
9	0.9	22	2.2
10	1.0	23	2.3
11	1.1	24	2.4
12	1.2	25	2.5

## Motor Stroke

The electrical stroke of the motor is adjustable from 90° to 160° by the use of the travel adjustment potentiometer on the MMC-421 control module (See Figure 1 and 4). The travel adjustment potentiometer setting does not affect the span or zero potentiometer settings. Clockwise rotation of the travel potentiometer increases the stroke. The mechanical rotation of the motor is also adjustable to 75°, 90°, 110° and 160° (See General Instruction F-23348). Make sure the mechanical stroke is equal or greater than desired electrical stroke. Typically only the electrical stroke needs to be adjusted since mechanical stroke is factory set for 160°. To set the electrical stroke:

1. Apply a control signal that drives the "Load" or "Load, Normally Closed-CCW" end of motor to the full open (CW) position. For Reverse Acting, signal should be ZERO (milliamp) value. For Direct Acting, signal should be ZERO plus SPAN (milliamp) values.
2. Adjust the travel adjustment potentiometer for the desired stroke between 90° and 160°.

## CHECKOUT

After the entire system has been installed and the motor has been powered up, the following checks can be made for proper system operation. Refer to the General Instructions sheet(s) for the motor and any accessories during the checkout procedure. Also refer to the Adjustment Section above.

### Go, No-Go Test (Two Position)

1. Remove the power from the motor. Disconnect the control leads from the motor.
2. Reconnect the power.
3. Jumper terminal 5 (red lead, F) to terminal 17 or 3. This is the same as a 20 mAdc input signal and should drive the motor to 20 mAdc position unless it already is in that position.
4. Remove jumper.
5. Check for proper operation of the system as the motor is operated.
6. Disconnect the power. Reconnect the control wiring and the power.

## MAINTENANCE

Regular maintenance of the total system is recommended to assure sustained optimum performance.

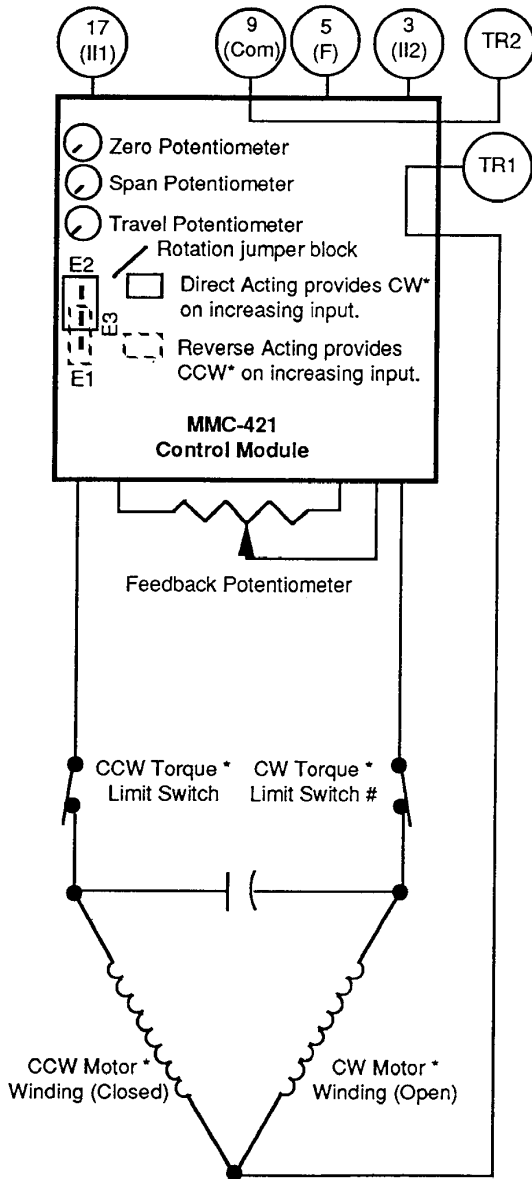
## FIELD REPAIR

None. Either replace MMC-421 and/or motor.

# THEORY OF OPERATION

## General Description of MM or MMR-400 Series of Motors

The MM and MMR-400 series of motors have a permanent split capacitor motor, see Figure 6. The capacitor causes the magnetic fields of the two coils to be out-of-phase which results in a rotating field that causes the rotor to turn. The power can be connected to either field coil. There is a phase shift and change in direction of rotation when the power to the coils is reversed. The motors are of the torque limiting type. That is when the motor is being driven in one direction and torque exceeds the trip point of the switch, the switch opens and stops the motor. Therefore the motor stops when the motor hits its internal mechanical stops, the valve seat or damper stops.

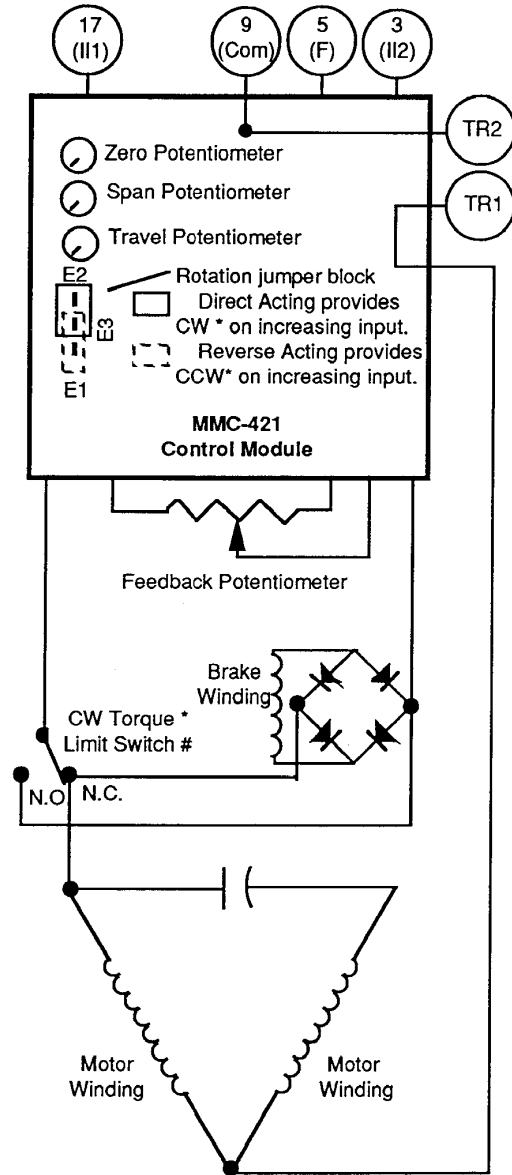


\* Direction of travel as viewed from "Load" end of the motor.  
 # The CW mechanical limit of the motor is adjustable to provide 75, 90, 110 and 160° travel.

Figure-6 Internal Schematic of MM or MMR-400 Series of Motors with MMC-421 Control Module.

## General Description of MM or MMR-500 Series of Motors

The MM and MMR-500 series of spring return motors have a capacitor type motor that drives the motor in one direction and spring that powers it in the other direction, see Figure 7. When power is applied to the motor coil, the brake winding is not powered releasing the brake allowing the motor to run. The torque limit switch wired to the motor coils operates the same as MM or MMR-400 series. To drive the motor in the spring return direction the brake winding is not powered which releases the brake allowing motor to spring return.



\* Direction of travel as viewed from "Load, Normally Closed -CCW" end of the motor.  
 # The CW mechanical limit of the motor is adjustable to provide 75, 90, 110 and 160° travel.

Figure-7 Internal Schematic of MM or MMR-500 Series of Motors with MMC-421 Control Module.

# THEORY OF OPERATION

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## Control Theory

The control signal; the settings of the zero, span and stroke potentiometers; rotation jumper block position and the feedback potentiometer in motor are the inputs to the electronic circuit. With a given input signal [zero, span and stroke potentiometers and rotation jumper block set (not varied)] there is only one motor position (feedback potentiometer position) that will balance the electronic circuit. As the value of the input signal changes, it unbalances the electronic circuit. The electronic circuit takes the unbalance and amplifies it to energize the triac switching to drive the motor in the correct direction to compensate for the input change. As the motor runs, the feedback potentiometer is repositioned to balance the electronic circuit and stop the motor rotation.

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