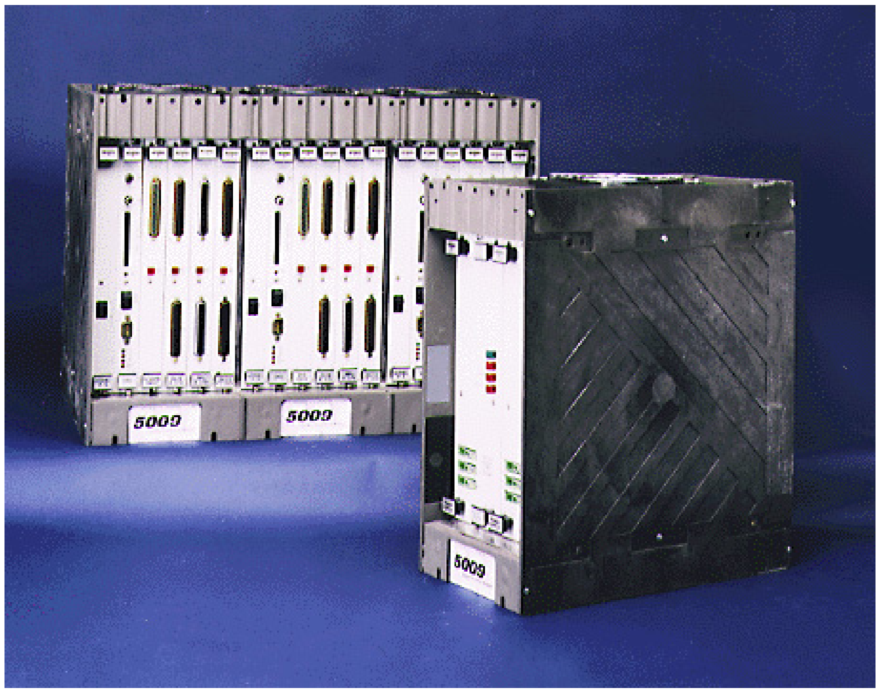
Product Manual 26320V2
(Revision B)
Original Instructions



MicroNet™ TMR 5009C
Digital Control System

Volume 2
Installation/Hardware Manual

Manual 26320 consists of 3 volumes (26320V1, 26320V2, 26320V3).

Installation/Hardware Manual

⚠ **General Precautions**	**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.** **Practice all plant and safety instructions and precautions.** **Failure to follow instructions can cause personal injury and/or property damage.**

⚠ **Revisions**	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual 26311 , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:** **www.woodward.com/publications** **The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

⚠ **Proper Use**	**Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.**

⚠ **Translated Publications**	**If the cover of this publication states "Translation of the Original Instructions" please note:** **The original source of this publication may have been updated since this translation was made. Be sure to check manual 26311 , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.**

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

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Illustrations and Tables

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This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE **Battery Charging Device**	**To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.**

Electrostatic Discharge Awareness

NOTICE **Electrostatic Precautions**	**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:** • **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).** • **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.** • **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.** **To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Installation Notes

Unless otherwise specified, this equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

Suitability for installation of this equipment for installation in Class I, Division 2, Group A, B, C, D hazardous locations is indicated by the presence of a third party safety agency logo along with the hazardous area classification affixed to the equipment model to which it pertains. Absence of a hazardous area classification indicates the equipment is only to be installed or used in ordinary (non-hazardous) locations.

Relay modules—such as Discrete Termination Modules (F/T Relay–Discrete In)—are NOT suitable for use in hazardous locations and must be located in a non- hazardous area or use a suitable method of protection approved by the local safety authority.

Wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction. UL approved branch circuit protection not exceeding 250% of rated full load input current for the 5009C main power supply must be provided and must be acceptable for the applicable area classification.

⚠WARNING

EXPLOSION HAZARD—This equipment is not suitable for use in Class I, Division 2 hazardous locations if an F/T Relay module is installed in the cabinet. It is to be used in Ordinary or non-hazardous locations only.

Substitution of components may impair suitability for Class I, Division 2.

Do not remove or install power supply, modules, or other equipment while the circuit is live unless area is known to be non-hazardous.

Do not connect or disconnect equipment while circuit is live, unless area is known to be non-hazardous.

⚠AVERTISSEMENT

RISQUE D'EXPLOSION—La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2.

Ne pas enlever ni installer l'alimentation électrique, les cartes, ou d'autre équipement pendant que le circuit est sous tension avant de s'assurer que la zone est non dangereuse.

Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereux.

WARNING	**If the equipment is used or applied in a manner not specified here-in, the protection provided by the equipment may be impaired.**

WARNING	**HIGH VOLTAGE—If 125 Vdc is present on the DTM terminal blocks, there will be 125 Vdc on the discrete module cables. If power cannot be removed from the DTM, extreme care must be taken to avoid contact with the cables.**

NOTICE	**To comply with CE Marking under the European Low Voltage Directive (LVD), the maximum external circuit voltage for both the Discrete Inputs and Relay Output circuit are limited to 18–32 Vdc maximum.**

Chapter 1.
General Information

The technical documentation for the 5009C control system consists of the following volumes:

Volume 1—provides information on system application, control functionality, fault tolerant logic, control logic, PID setting instructions, and system operation procedures.

Volume 2—provides hardware descriptions, mechanical and electrical installation instructions, hardware specifications, hardware troubleshooting help, and basic repair procedures.

Volume 3—provides installation procedures for the 5009C control's personal computer based interface software program (PCI), information on all PCI features and modes (Program, Service and Run), and a lists of the control's Modbus® * registers and DDE tag names.

*—Modbus is a registered trademark of Schneider Automation Inc.

This volume provides hardware description, installation, and troubleshooting information for the Woodward 5009C Control System. It includes:

- A list of all system hardware
- A description of all hardware
- Mechanical installation instructions
- Electrical installation instructions
- Troubleshooting Guide, including diagnostic tests
- Maintenance procedures (module replacement)

This hardware manual applies to all 5009C control systems but does not include information that is unique to your system only.

Chapter 2.
Hardware Description

Introduction

The 5009C digital control system can be provided in a number of hardware configurations; with different power supply configurations, with or without a cabinet and with or without an OpView™ operator control station. Because this manual addresses all configurations, many of the following hardware descriptions may not apply to your 5009C system. Refer to Table 3-1 for a complete listing of standard and optional system components.

When a cabinet is included with a system, the control is shipped fully assembled within the cabinet. When a system is provided without a cabinet, it is shipped disassembled. After a control system is received each item must be located and installed via this manual's instructions.

Main Control Chassis

Figure 2-1 shows a 5009C control system's main chassis. The system is housed in a chassis which may be mounted (by flanges on its back side) either to a panel or within a cabinet. This chassis consists of three six-slot kernel sections. Each kernel section is isolated from the other two. With this configuration the failure of any one section will not cause a shutdown.

Each kernel section includes a kernel power supply, a CPU, an analog I/O module, and a discrete I/O module. Slot-to-slot logic and power connections are made through an etched-circuit motherboard located on the back of the chassis. See Figure 2-1. The motherboard and modules are all VERSA module Eurocard (VME) type. I/O connections are made through cables from the front of the modules to termination modules in the cabinet. See Figures 4-21 and 4-22 for an overview of the main chassis, control modules, and termination modules.

From a module connector standpoint, any I/O module can be installed in any of the chassis slots designated for I/O modules. However, when the application software is designed, each module is assigned to a specific slot, thus the software expects each specific I/O module to always be in its designated slot.

The 5009C control chassis is cooled by forced air. In order not to starve modules of air flow, either a module or a blank module must be installed and secured in each slot. Cooling fans are located on the top of the main chassis; with one fan per 6-slot card rack. The power supply chassis contains two cooling fans: one on top and one on the bottom of the chassis. See Figure 2-1. These fans run any time the 5009C chassis is powered up.

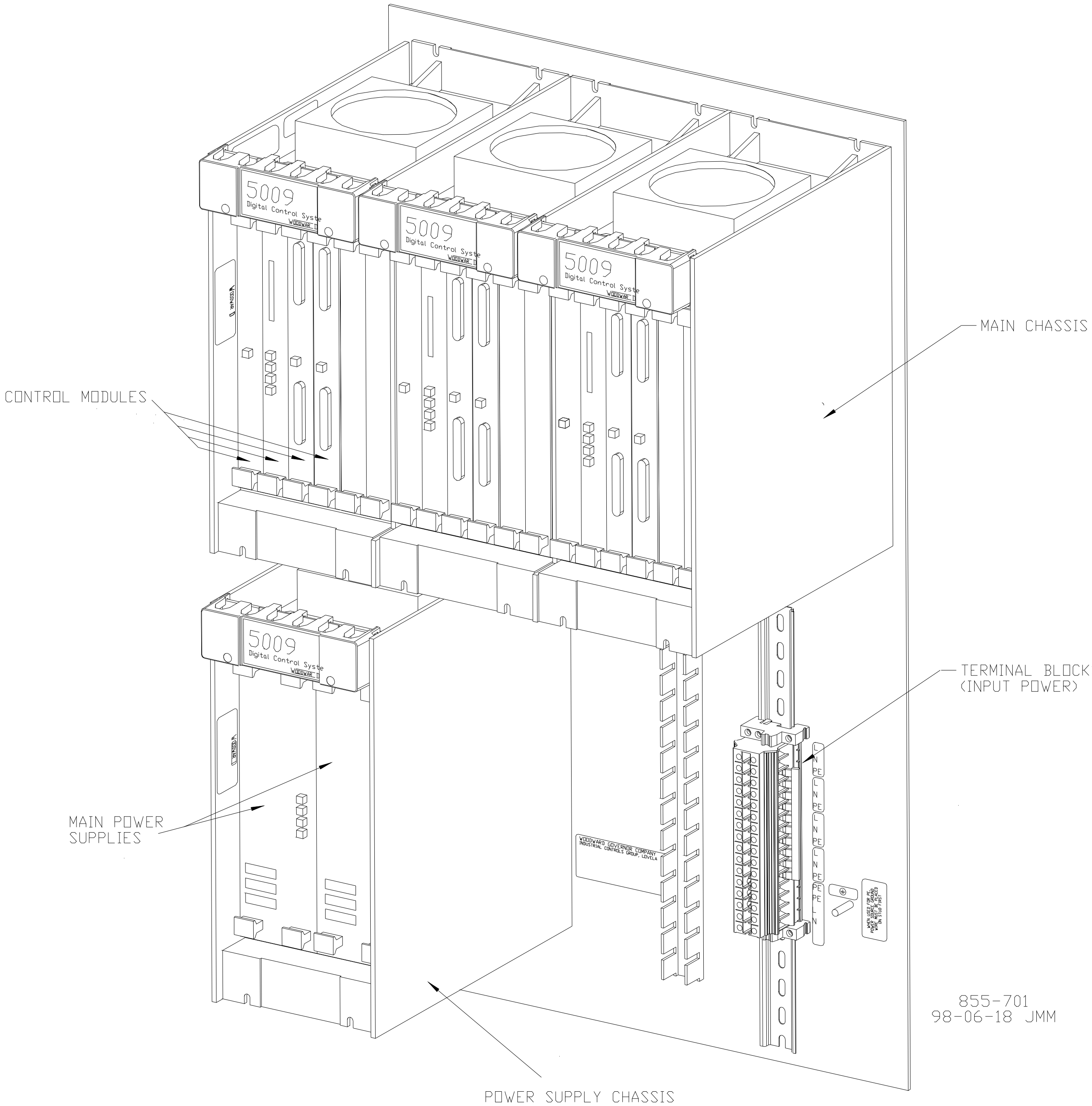


Figure 2-1. Control and Power Chassis

System Power Supplies

The 5009C control contains two types of power supplies; main power supplies and kernel power supplies. The control's power chassis contains two plug-in main power supplies, which provide 24 V to each kernel section (A, B, C) of the 5009C control. Mounted in the main control chassis are three Kernel Power Supplies, which convert 24 V to 5 V at 10 A for their kernel's CPU and I/O modules.

The system's main power supplies are housed in a chassis that may be mounted (by flanges on its back side) either to a panel or within a cabinet. See Figure 2-1. This chassis contains slots for two 5009C main power supplies, and allows any main power supply to be used in either slot. A motherboard located on the back of the chassis allows the two main power supplies to form a fault-tolerant power system providing six separately regulated, 24 V, 6 A outputs (three from each power supply) to the control. The six separate outputs are then wired together to provide load-shared Pwr "A", Pwr "B", and Pwr "C" outputs. Each output provides up to 6A that are wired to the MicroNet™ TMR chassis (reference Figure 3-3). Power output regulation, including line, load, and temperature effects, is better than ± 5%.

When both main power supplies are running, current sharing circuitry balances the load to reduce heat and improve reliability of the power supplies. In the event one supply needs replacement, this feature also ensures bumpless hot replacement of the power supplies, without disrupting the operation of the control. Latent fault detection is used to detect and report any power supply failures to the CPU's in the control.

Input power connections are made to the main power supply through terminals on the front of the power supplies. For convenience, when a system is provided with a cabinet, input power connections are made through panel mounted Phoenix type terminal blocks. See Figure 4-23. A standard 50-pin ribbon cable is used for connecting the power supply chassis to the 5009C control chassis.

A set of two main power supplies are provided with each system. Each power supply set can consist of any two of the three available power supply models, and in any combination. For instance, a set of one 24Vdc power supply and one 120 Vac power supply may be used to power the 5009C control depending on whichever power source is available. Different models of power supplies allow the control to interface with different input source voltages.

Main power supplies are available in the following models:

LVDC –	18-32 Vdc
AC/DC –	88–132 Vac or 100–150 Vdc
HVAC/DC –	180–264 Vac or 200–300 Vdc

Each Main Power Supply has four LEDs to indicate power supply health (OK, Input Fault, Overtemperature, Power Supply Fault). Refer to Chapter 5 of this manual for detailed explanations of all LEDs.

Module Descriptions

Physical Description

All chassis mounted control modules are VME-type (VERSA module Eurocard) modules.

Modules slide into card guides in the 5009C control's chassis and plug into the motherboard. All modules have their circuitry on a single printed-circuit board. Each module has a front panel extending from the bottom to the top of the cabinet.

The modules are held in place by two screws: one at the top and one at the bottom. Also at the top and bottom are two handles which, when toggled, move the modules out just far enough for the boards to disengage the motherboard connectors. Each module is protected with a molded plastic cover to prevent accidental component damage.

Kernel Power Supply Module (A1)

Each Kernel Power Supply module receives 24 Vdc from the main power supplies and provides regulated 5 Vdc and 5 V pre-charge power sources to the other kernel modules (CPU and I/O modules). The 5 Vdc power source is used by each module in the kernel section to power its microprocessor. The 5 V pre-charge power supply is only used as a pre-charge power source to allow all I/O modules to be hot replaceable. The 24 Vdc power from the main power supplies is routed through this module to the other kernel modules to allow all kernel power to be completely removed when this module is not installed. This module's health and operation is monitored and verified by its respective kernel CPU.

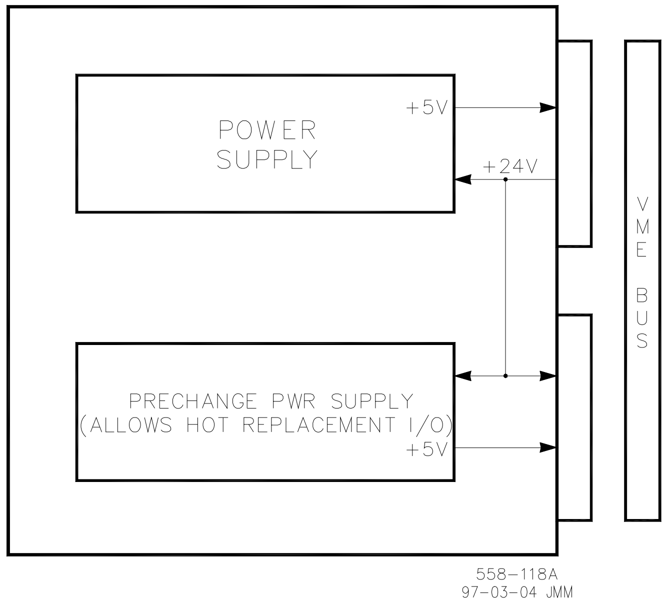


Figure 2-2. Kernel Power Supply Block Diagram

Central Processor Unit (CPU) Module (A2)

This module, following the instructions of the application program, controls the circuits of the 5009C control so that they perform all the required control and sequencing functions. There are three CPU modules provided with each system. Figure 2-3 is a diagram of a 5009C CPU module. Each CPU utilizes a Motorola 68040 microprocessor to perform its data processing. The VME bus arbitrator block controls the VME bus and determines what device may use the bus when there is a conflict.

An RS-232 Serial Port is located on the front of each CPU to interface with the PCI engineering workstation or other RS-232 compatible devices.

The CPU has a PCMCIA (Personal Computer Memory Card International Association) slot on its front panel. The PCMCIA slot is used to down load application files to the CPU module.

The CPU module has a battery to power the Real Time Clock, even when power to the control is off. This battery is not user-replaceable. During normal operation onboard circuitry keeps the battery charged at all times. Once the battery is fully charged (16 hours) the battery will continue to run the clock for a minimum of three months without power to the control. Should the CPU not be powered for several months and the battery loses it's charge, the Real Time Clock will need to be set once the CPU is powered up. The module will automatically recharge the battery once powered. See the battery specifications in Chapter 6.

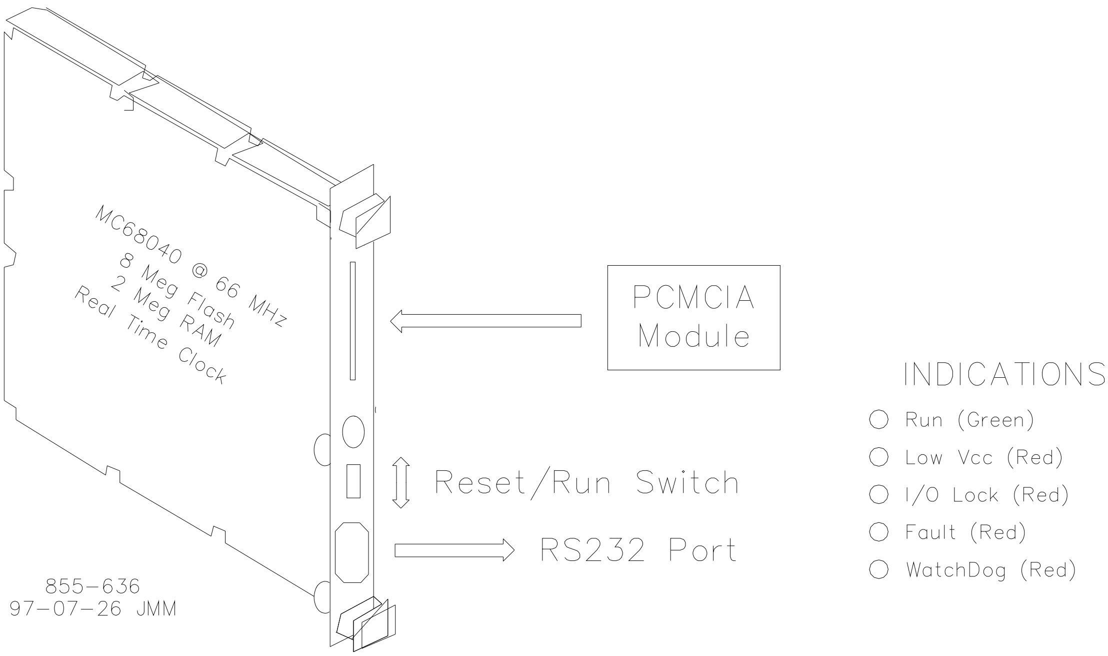
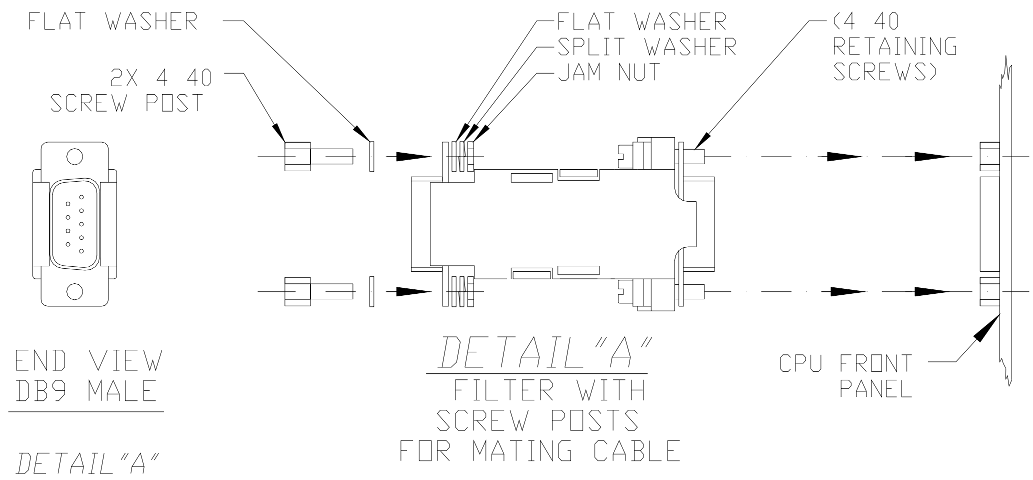


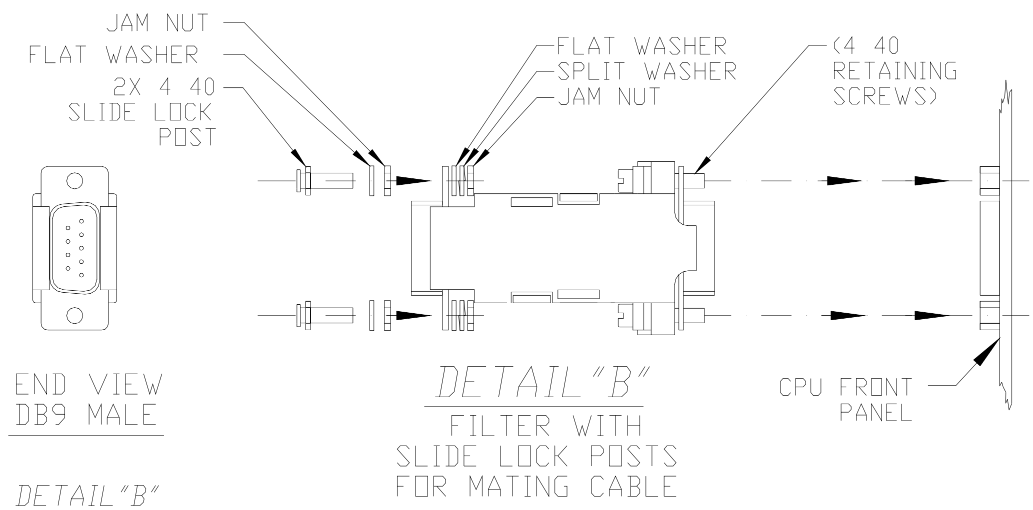
Figure 2-3. CPU Module

CPU Port Filter Assembly

The CPU module's front serial port is sensitive to cable noise. Noise form external sources (relays, breakers, ESD, etc.) couples onto the attached serial cable, and into the CPU. Noise of this nature can cause temporary CPU failures. Three filter assemblies (one per CPU) are provided with each system to protect the CPU from external system noise. These filter assemblies are shipped separately from the control and can be easily installed if use of the CPU port is required.



1. REMOVE CAUTION LABEL AND 3810-063 PROTECTIVE CAP FROM CPU FRONT PANEL.
2. SELECT PKG WITH SCREW POSTS AND SLIP FLAT WASHER OVER THREADS. INSERT THROUGH FILTER MOUNTING FLANGE.
3. ASSEMBLE FLAT WASHER, SPLIT WASHER, AND JAM NUT ONTO SCREW POST THREADS AND TIGHTEN TO SNUG FIT.
4. USING 4-40 RETAINING SCREWS ON FEMALE END OF FILTER, FASTEN ENTIRE ASSEMBLY TO CPU 9 PIN SUB"D" CONNECTOR. TIGHTEN TO SNUG FIT ONLY.



1. REMOVE CAUTION LABEL AND 3810-063 PROTECTIVE CAP FROM CPU FRONT PANEL.
2. SELECT PKG WITH SLIDE LOCK POSTS. SLIP FLAT WASHER OVER THREADS FOLLOWED BY JAM NUT, TIGHTEN TO SNUG FIT. INSERT THROUGH FILTER MOUNTING FLANGE.
3. ASSEMBLE FLAT WASHER, SPLIT WASHER, AND JAM NUT ONTO SCREW POST THREADS AND TIGHTEN TO SNUG FIT.
4. USING 4-40 RETAINING SCREWS ON FEMALE END OF FILTER, FASTEN ENTIRE ASSEMBLY TO CPU 9 PIN SUB"D" CONNECTOR. TIGHTEN TO SNUG FIT ONLY.

CONTENTS:

2) PKGS - 1635-053 HEX SCREW POSTS
1) PKG - 1635-007 SLIDE LOCK POSTS
1) 1752-070 EMI FILTER

855-705
03-1-7

Figure 2-4. CPU Communications Port Filter Kit Installation Instructions

MPU and Analog I/O Module (A3)

Each analog module contains circuitry for four speed sensor inputs, eight analog inputs, four analog outputs, and two proportional actuator outputs. An on-board micro-controller scales inputs and outputs using calibration constants stored in EEPROM, and schedules outputs to occur at the proper time. Refer to Figure 2-5. This module includes no potentiometers and requires no calibration. When a channel or module fault is detected, the control annunciates the fault, disables the channel or module and does not use the channel/module's data in system calculations or control.

Each CPU sends and receives information to and from its respective MPU & Analog I/O module via the VME bus. Each input value is stored in a register and addressed by the CPU as required. Outputs are driven by the CPU, through the module's associated output drivers.

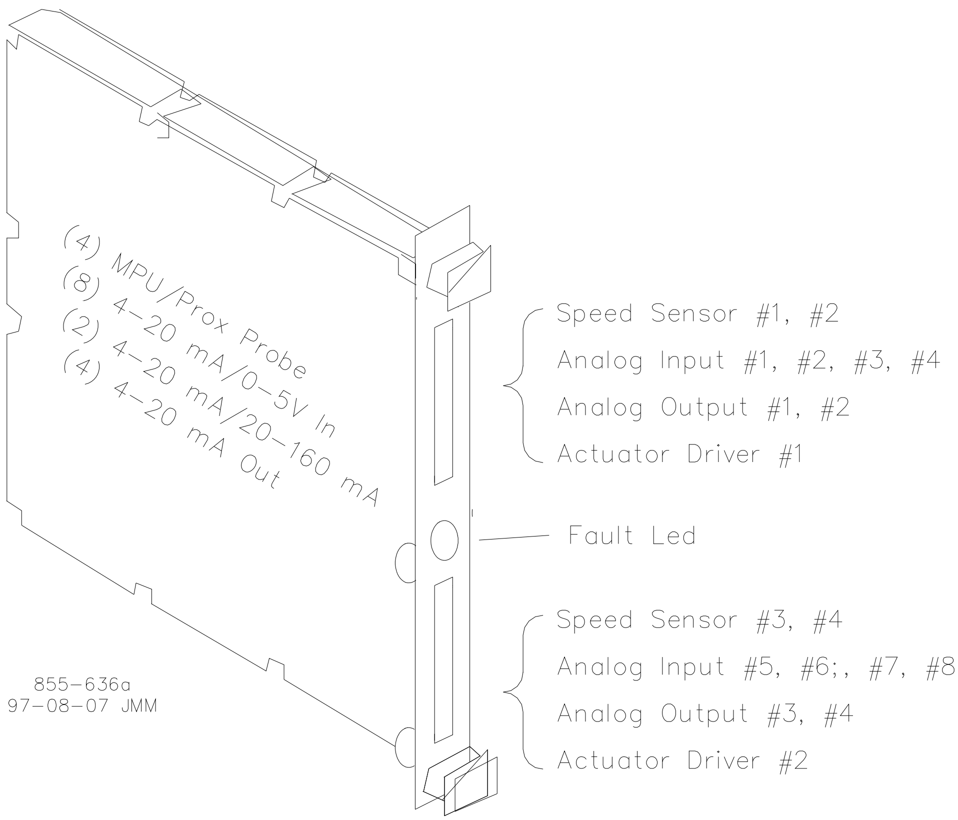


Figure 2-5. MPU and Analog I/O Module

Analog Termination Modules

Analog Termination Modules (ATMs) mount external to the 5009C chassis on a standard DIN rail. The analog termination modules are used to connect analog field wiring to the 5009C control. An ATM houses circuitry to:

- route each input signal to the system's three independent (rack mounted) analog modules
- produce each output signal by summing the three independent analog modules' respective outputs

Two ATMs are provided and used with each 5009C control. Refer to Figure 4-22 for an overview of modules and ATMs used. Each ATM connects to the control's three independent "MPU & Analog I/O" modules through individual cables, and provides a common cage-clamp terminal connection for customer field wiring. An ATM contains circuitry for two speed sensor inputs, four analog inputs, two analog outputs, and one proportional actuator output.

Because of the differences between sensing circuitry required to interface with passive (MPUs) and active (proximity) probes, separate ATM terminations are provided for each probe type. This allows a simple method of field selecting the type of speed input based on the type of probe used. Depending on an MPU's limitations, each MPU input can be jumper-configured to allow it to drive either two or three inputs (some MPUs cannot drive three inputs). See Chapter 6 of this manual for MPU input impedance information. A fused 24 Vdc source, with isolation diodes on the power, common, and output source lines, is provided for each speed input to power system proximity probes. Each ATM contains circuitry to interface with 12 V or 24 V proximity probes.

Analog inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers.

All analog and actuator output circuits allow each kernel to contribute one third of the output's total current. For dual coil actuators, kernels A and B drive one coil and kernel C drives the second coil. Current readback circuitry identifies failed modules and allows the remaining outputs to be adjusted accordingly.

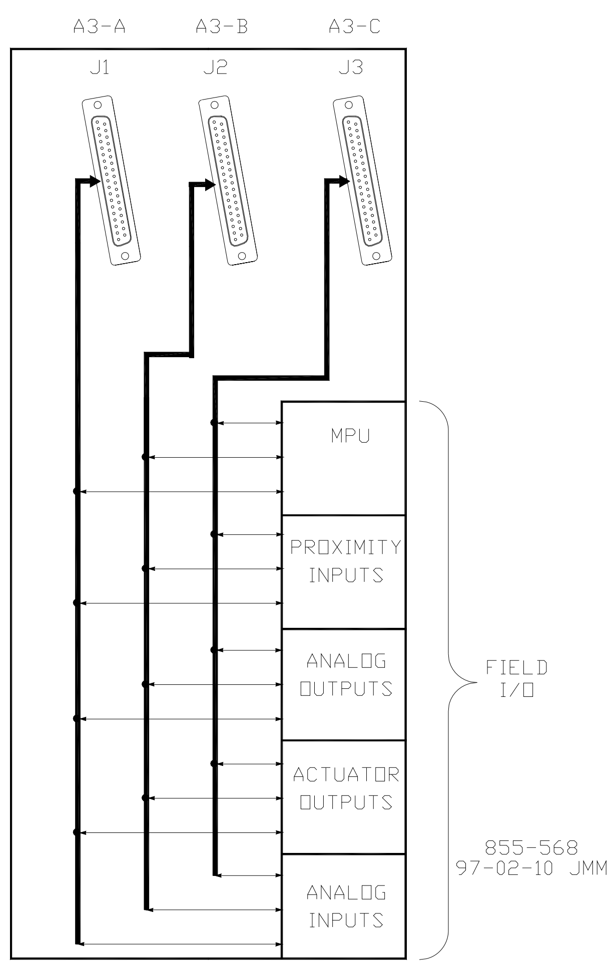


Figure 2-6. Analog Termination Module Diagram

Discrete I/O Module (A4)

Each Discrete input/output (I/O) module receives status information from 24 discrete inputs, controls 12 relay outputs and provides latent fault detection for each relay output. Field wiring is isolated from the 5009C circuitry through optical isolators on each input channel, and relays on each output channel.

Figure 2-7 is a diagram of the Discrete I/O module. Each CPU sends and receives information to and from its respective Discrete I/O module via the VME bus. Each input status is stored in a register and addressed by the CPU as required. Output commands are driven by the CPU to the Discrete I/O module's associated output latches. These latches control the state of output drivers to energize and de-energize relays. Output Relays are located on the Discrete Termination Modules.

Each output channel has a readback buffer that stores and indicates the status of the output driver and associated relays. The CPU compares this status to the value written to the channel and generates a fault signal if these values are different.

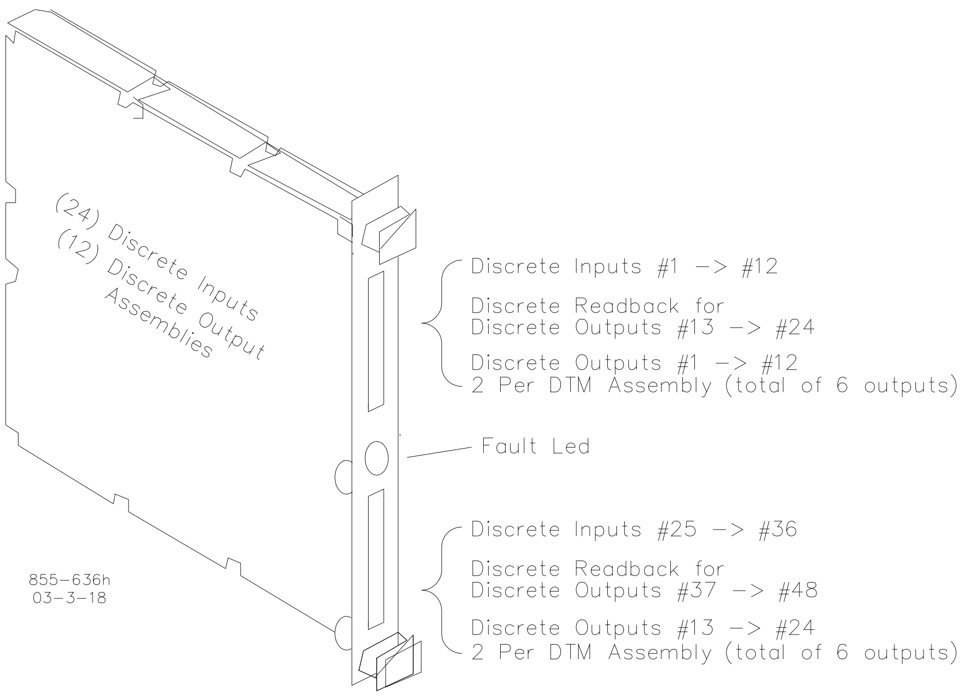


Figure 2-7. Discrete Input/Output Module

Discrete Termination Modules (F/T Relay Module)

Discrete Termination Modules (DTMs) mount external to the 5009C chassis on a panel or in a cabinet. The discrete termination modules are used to connect discrete field wiring to the 5009C control. Four DTMs are provided and used with each 5009C control. Refer to Figure 4-22 for an overview of modules and DTMs used. Each DTM connects to the control's three independent Discrete I/O modules through individual cables, and provides a common cage-clamp terminal connection for customer field wiring. A DTM contains circuitry for six contact inputs, three relay outputs and houses circuitry to:

- route each contact input signal to the system's three independent (rack mounted) discrete modules
- provide an open / closed contact output based on associated discrete module commands
- indicate the health of all relays (latent fault detection)

⚠WARNING

This equipment is not suitable for use in Class I, Division 2 hazardous locations if an F/T Relay module is installed in the cabinet. It must be used in ordinary or non-hazardous locations only.

Discrete input power (contact wetting voltage) can be supplied by the 5009C control or from an external source. The 5009C control provides an isolated 24 Vdc power source for contact wetting. The external source may be 24 Vdc or 125 Vdc (North American installations only). Separate discrete input terminals are provided based on the level of contact wetting voltage used. See Figure 4-9.

NOTICE

To comply with CE Marking under the European Low Voltage Directive (LVD), the maximum external circuit voltage for both the Discrete Inputs and Relay Output circuit are limited to 18–32 Vdc maximum.

The discrete output relays are mounted on sockets, with 18 relays per DTM. Six relays, are used to create each relay output (normally open and normally closed contacts) and allow latent fault detection. See Figure 4-18. This configuration allows independent testing of each relay output (latent fault detection) without concern of relay position. Customer power is connected to one side of the configuration and load to the other.

Discrete outputs can be configured to use latent fault detection to identify output relay failures without affecting operation. When the contacts are closed, they are periodically opened in pairs, to ensure that they are in the correct state, and that they change state. When they are open, they are periodically closed individually, to ensure that they close. Any failures are annunciated, and further testing is disabled.

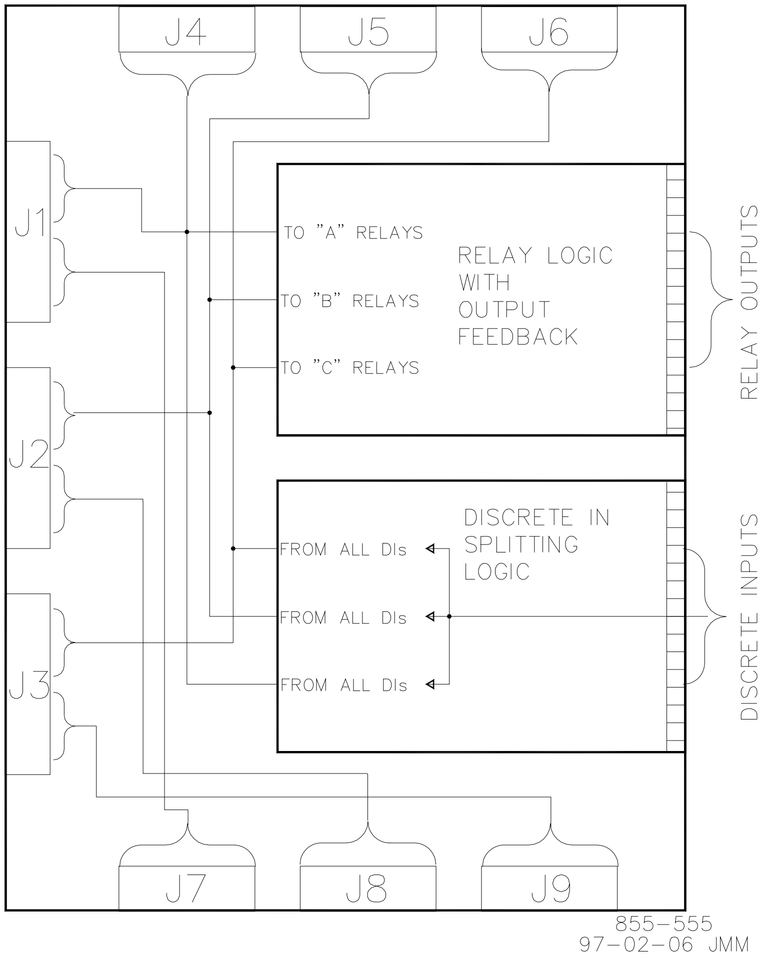


Figure 2-8. DTM Block Diagram

SIO Module (A/B105)

The SIO module is provided with the system. This control system is capable of utilizing two SIO modules at any time. These modules are installed in slot 5 of the A and B kernels. Each SIO module includes four serial ports. Ports 1 and 2 are RS-232 communications based ports only. Ports 3 and 4 can be configured for RS-232, RS-422, or RS-485 communications. Refer to Chapter 4 of this volume for port related communication capabilities.

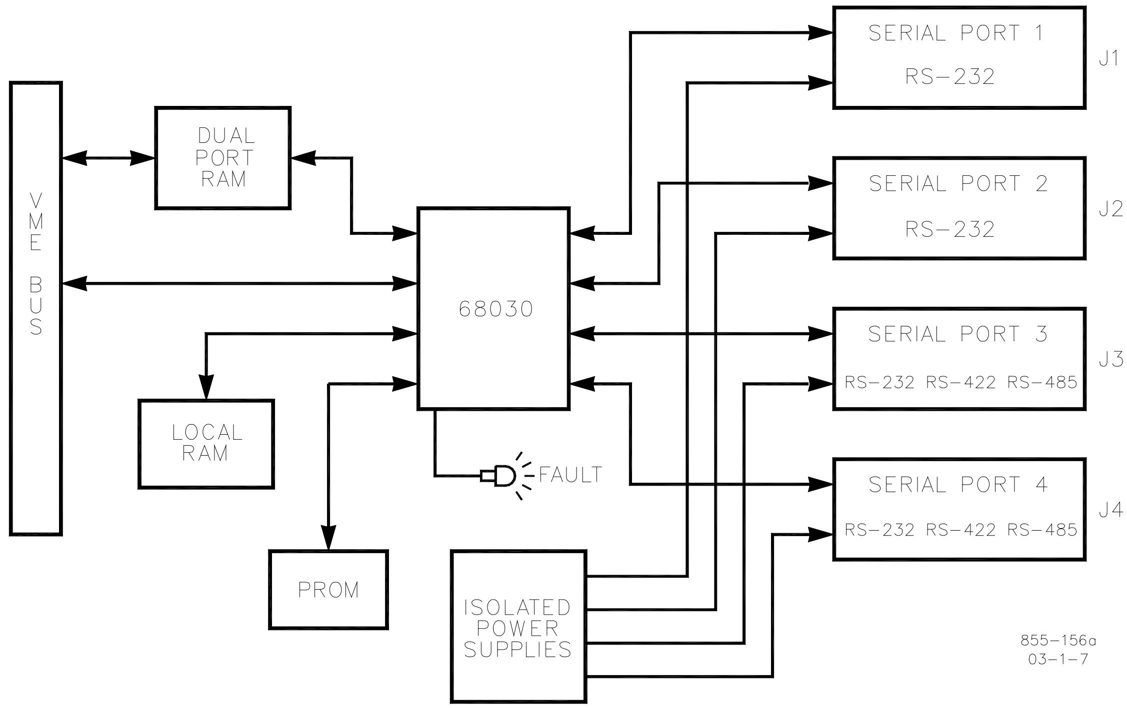


Figure 2-9. SIO Module Block Diagram

Two Channel Actuator Module (A/C106)

The 2 Channel Actuator Module's circuitry is divided into two channels. Each channel incorporates an output current driver and two position resolver feedbacks. Because the 5009C is a redundant controller, two actuator drivers from separate modules provide control for each actuator / valve whether wired separately to dual actuator coils or wired in parallel to a single actuator coil. The redundancy is managed in the application program and Actuator Module microprocessors so that the two output drivers share load unless a problem is detected. If one of the drivers goes out of operation, the remaining driver will assume the required load. When redundant drivers are implemented, as in the 5009, only one resolver feedback is available per channel for direct control. Even though only one position input can be used per channel, the availability of two channels allows for redundant feedback.

When pilot valves are used, the signal must be connected on the second LVDT input of the card. The Pilot signal can be redundant, if send to card A106 and card C106. If physically, only one LVDT signal is available, the excitation can only be taken from one card, but the signal can be put in parallel

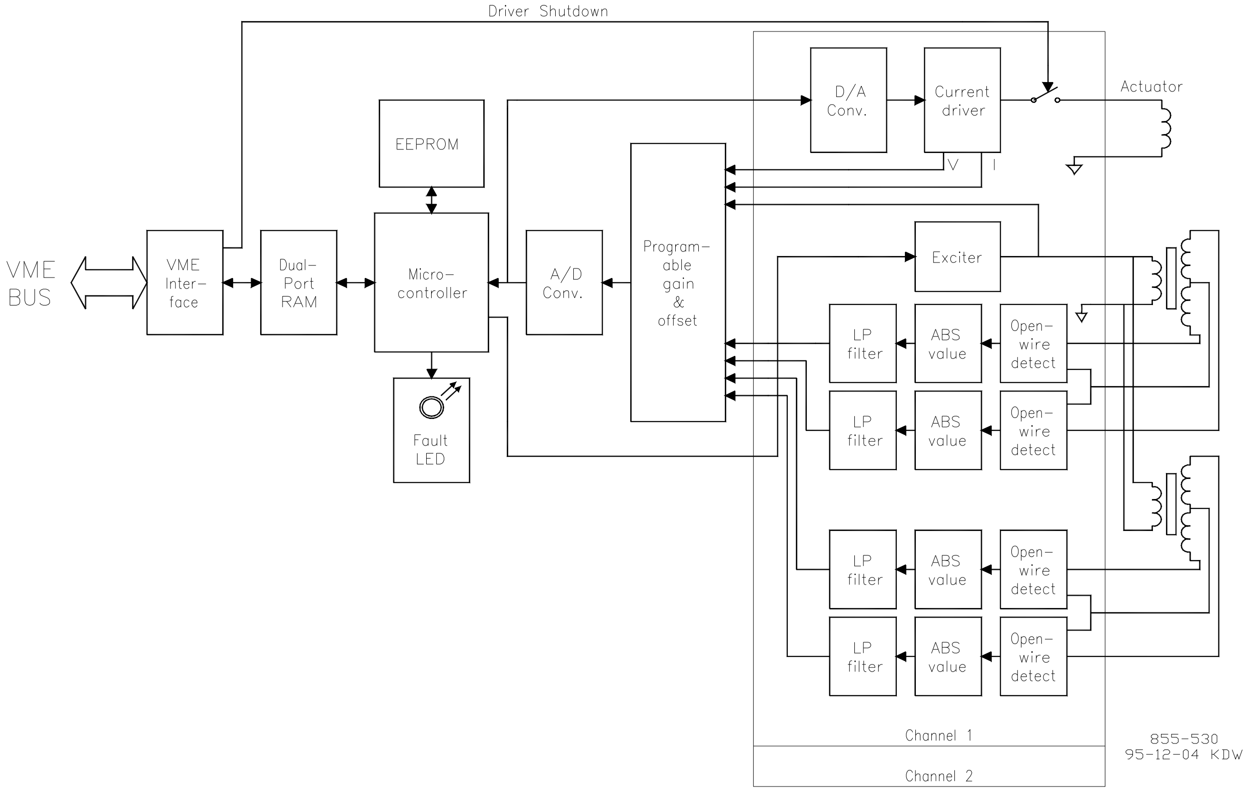
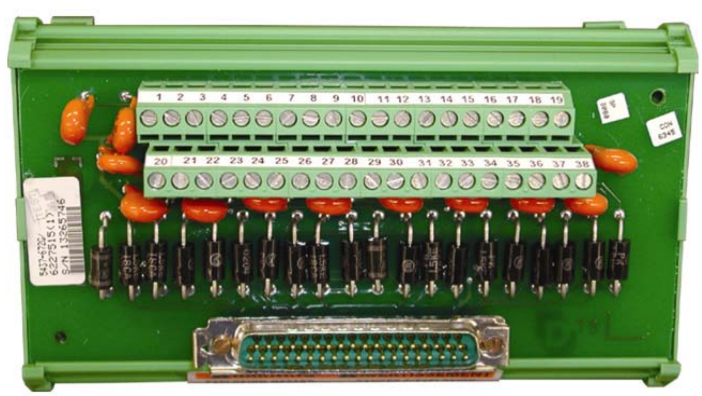


Figure 2-10. 2 Channel Actuator Controller Module Block Diagram

2 Channel Actuator Field Termination Module



Actuator Field Termination Modules (FTMs) mount external to the 5009C Main and / or Expansion Chassis on a standard DIN rail. The Actuator Field Termination Modules provide screw-type terminals used to connect actuator field wiring to the 5009C control. Each Actuator I/O module is connected through a gray discrete cable to one Actuator FTM. A low-density discrete (gray) cable must be used to connect the Actuator Module to the Actuator FTM. Do not use an analog (black) cable. An Actuator FTM houses circuitry to drive two actuator outputs according the module's range and to read four LVDT or RVDT position feedbacks.

Cabinet (optional)

If a cabinet is included with the system, a standard floor mount, front access cabinet is provided. Input Power and field cable access are available through the bottom of the cabinet. When a cabinet is included with a system, the control is shipped fully assembled within the cabinet. The cabinet's weight is approximately 600 lbs (272.4 kg) including control. The provided cabinet meets NEMA 12 ratings. Refer to Chapter 6 of this Volume for all Cabinet material specifications. Refer to Figures 4-21a and 4-21b for control cabinet diagrams. This panel is a UL Listed industrial control panel.

Chapter 3.
Mechanical Installation

Storage

Store 5009C control and associated parts between –20 and +70 °C (–4 and +158 °F) at a maximum relative humidity of 90% non-condensing. If power supplies are to be stored for a long time, apply operating power to them at least once every 18 months. See Chapter 6, Hardware Specifications.

Unpacking

Unpack each part of the system carefully. Check the units for signs of damage, such as bent or dented panels, scratches, or loose or broken parts. If any damage is found, notify the shipper immediately.

When a cabinet is included with a system, the control is shipped fully assembled within the cabinet.

When a system is provided without a cabinet, it is shipped as major components. After a control system is received each item must be located and installed via this manual's instructions. The following items should be removed from the packing carton (s) and checked to make sure you have all the necessary components before attempting to assemble and install the system. Refer to Table 3-1 and Figure 3-1.

Table 3-1. System Components

Designation	Description	Qty	Remarks
	Cabinet (including Power Interface Panel)	1	Optional
U1	Main chassis	1	Standard
U2	Power Chassis	1	Standard
PA1, PA2	Main Power Supply Module	2	Standard
A1	Kernel Power Supply Module	3	Standard
A2	CPU Module	3	Standard
A3	MPU & Analog I/O Module	3	Standard
A4	Discrete I/O Module (24 In/12 Out)	3	Standard
A5	SIO Module	2	Standard
ATM-1, 2	Analog Termination Module	2	Standard
DTM-1, 2, 3, 4	Discrete Termination Module (F/T Relay–Discrete In)	4	Standard
U3	OpView	1	Optional
W1-A	Power Chassis to Main Chassis Cable (1 ft/30 cm)	1	Standard
W1-B	Power Chassis to Main Chassis Cable	1	Standard
W2, 3, 6, 7, 10, 11	Analog I/O Cable (10 ft/3 m)	6	Standard
W4, 5, 8, 9, 12, 13	Discrete I/O Cable (10 ft/ 3 m)	6	Standard
W14 - W19	DTM to DTM Cable (6"/15 cm)	6	Standard
W20	Control to PCI Cable (10 ft/3 m)	1	Standard
MISC. - A	ATM Ground Terminals (used on DIN rail)	2	Standard
MISC. - B	CPU Comm. Port Filters	3	Standard

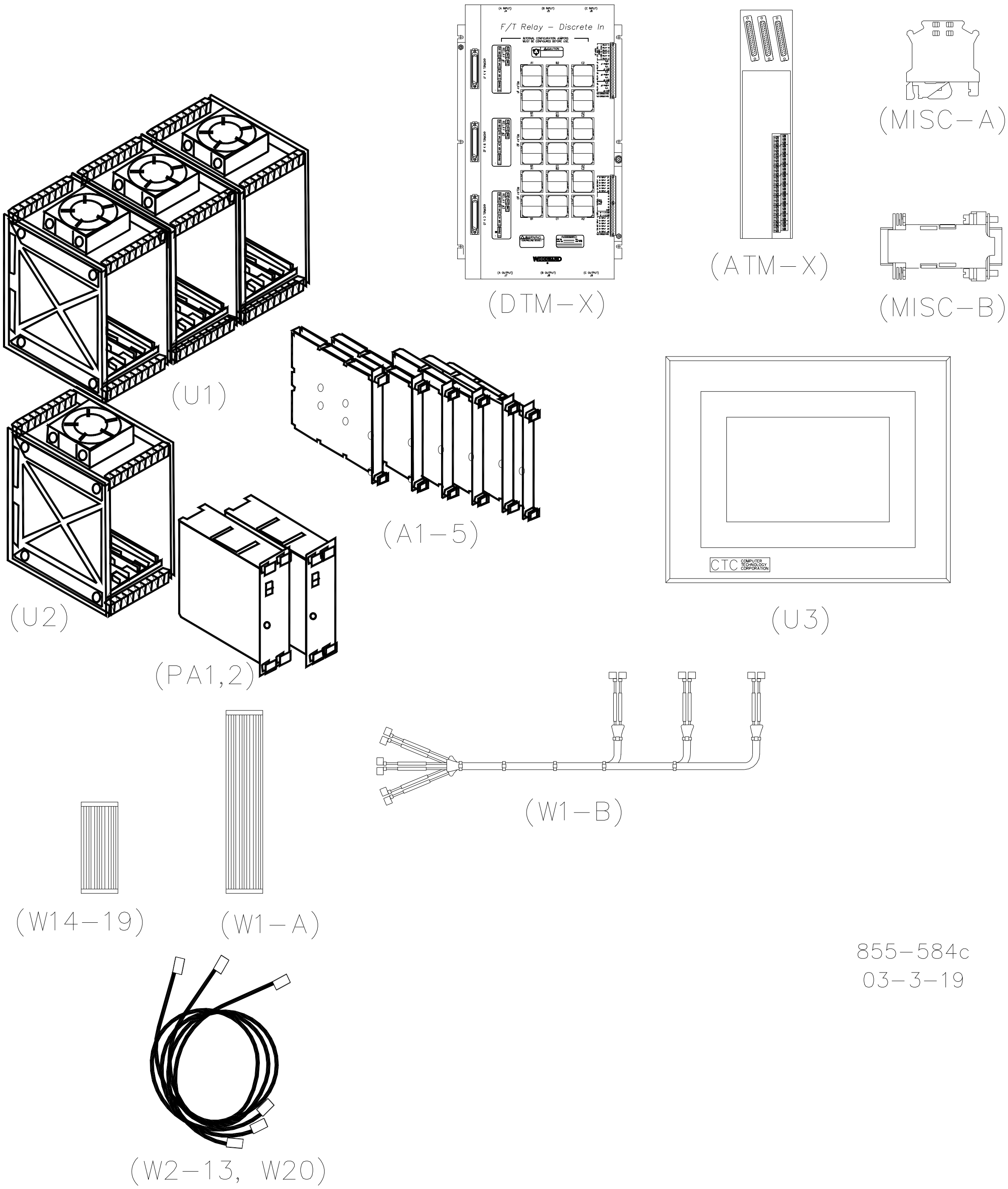


Figure 3-1. Hardware Identification

Unit Location

Consider the following when selecting a location for mounting the 5009C unit(s) (see Chapter 6, Hardware Specifications):

- Make sure the 5009C unit(s) are mounted in a dry location, protected from water and condensation (Pollution Degree II environment).
- The 5009C control must be used in a power installation environment rated at Overvoltage II.
- Make sure the ambient temperature of the system location is not lower than 0 °C (32 °F) or higher than 55 °C (131 °F) (46 °C for cabinet installations) and that the relative humidity is not over 90%, non- condensing.
- Provide adequate ventilation for cooling the units. If the units must be mounted near heat-producing devices, shield them from the heat.
- Do not install the units or their connecting wires near high-voltage/high-current devices or inductive devices. If this is not possible, shield both the system connecting wires and the interfering devices or wires.
- If the selected location does not already have a conductor to a good earth ground, provide one.
- Unless otherwise stated, this equipment is suitable for Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

IMPORTANT	**The F/T Relay Module is suitable for use in non-hazardous locations only.**

Use the following procedures to install a system in the selected location. Installation procedures are included to for systems provided with and without a cabinet. Systems sold with cabinets are provided with all hardware (except the Rolling Restart Station) mounted internal to the cabinet.

Install Cabinet (If included)

If a cabinet is included with the system, it MUST be secured to the floor using a standard floor mount. The cabinet provides front access. Input Power and field cable access is available through the bottom of the cabinet. When a cabinet is included with a system, the control is shipped fully assembled within the cabinet. The cabinet's weight is approximately 272 kg (600 lb) including control.

1. Mark cabinet and mounting bolt locations. See Figure 3-2.

2. Depending on mounting method, drill mounting holes or install floor mount bolts.

3. Position the cabinet in the desired location and secure to the floor using the appropriate size bolts.

4. Route all power and field cables through the bottom of the cabinet. For EMI reasons, it is recommend that all analog input and output wiring be separated from all power and discrete input/output wiring.

5. Connect Cabinet to earth ground using a 10 mm² (8 AWG) or larger wire or braid.

⚠WARNING	**ELECTROCUTION HAZARD—Leakage current exceeds 3.5 mA. The grounding conductor is required for safety.**

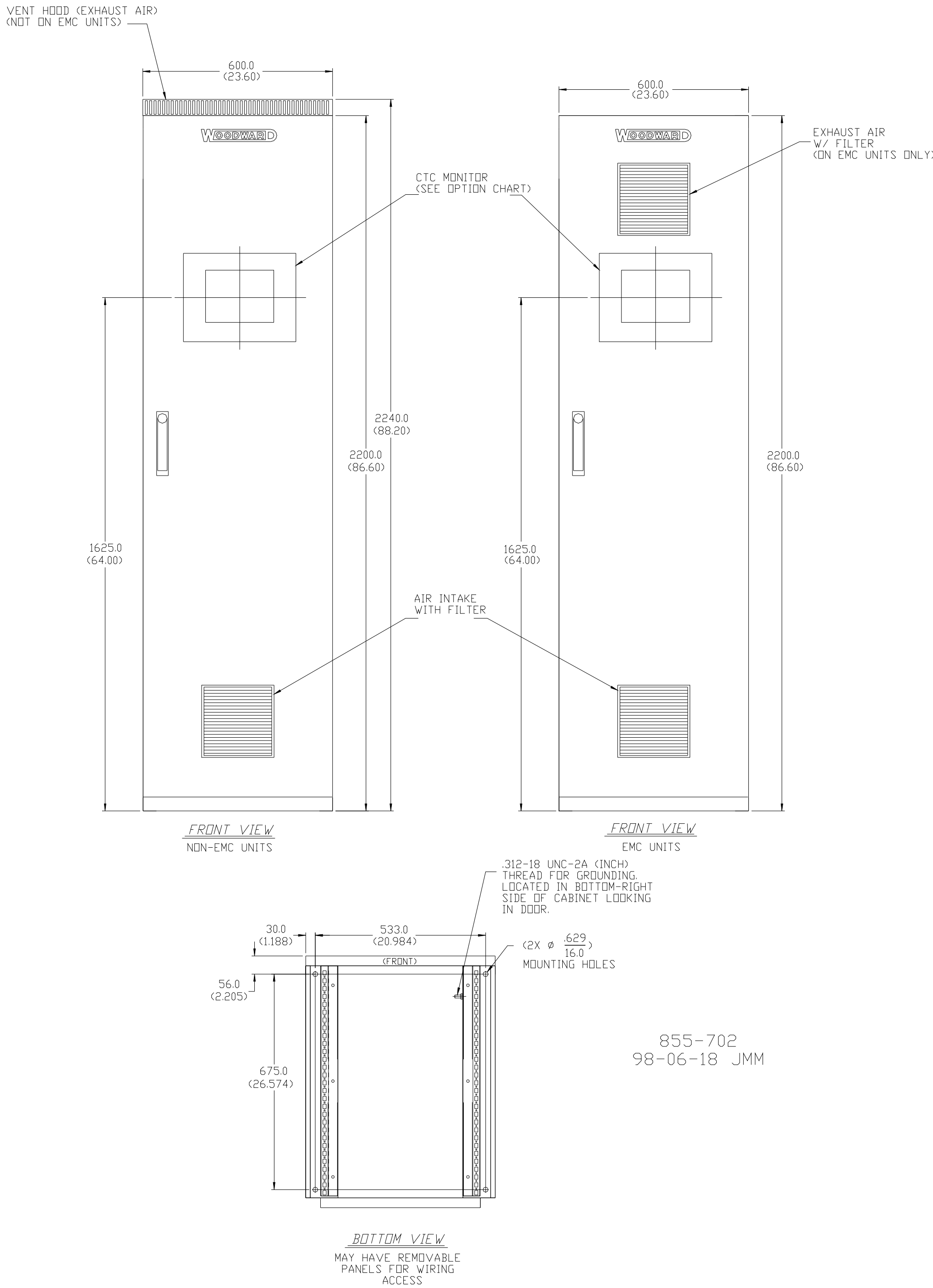


Figure 3-2. Cabinet Dimensions

Before beginning installation successfully identify all components and read this entire chapter.

Install 5009C Control and Power Chassis

In a panel or bulkhead:

1. Mark control chassis, and power chassis mounting hole locations, taking care to leave sufficient space between each chassis and walls, objects, etc. for easy access. Based on system design, the power chassis must be mounted between 50 and 200 mm (2 and 8 inches) directly below the "A" or "C" main chassis sections. See Figure 2-1.

2. Drill and tap mounting holes using a # 21 (0.156 – 0.164") drill bit, and a 10-32 tap.

3. Connect the W1-B cable between both the control and power chassis. Refer to Figure 3-3. Quick connect terminals allow for easy cable installation.

4. Place each chassis in position, insert 10-32 mounting screws into the tapped holes, and tighten them securely. (Socket head screws, with flat washers and locking devices are recommended.)

5. Verify that both the control and power chassis are at earth ground potential, and if they are not, connect them to earth ground via a 3 mm² (12 AWG) or larger yellow/green wire or braid.

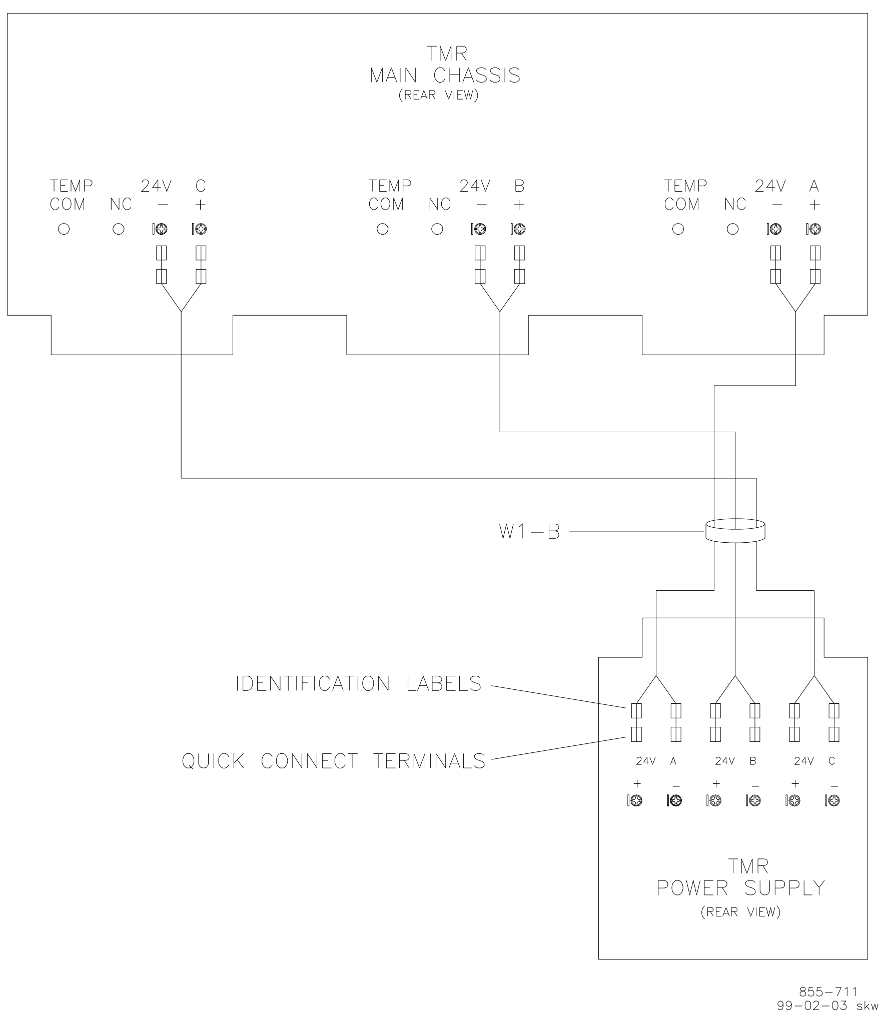


Figure 3-3. Chassis-to-Chassis Power Cable W1-B

Install Modules

The following procedure describes the proper method of installing a 5009C module.

1. Verify that the power to the 5009C control is turned off.

2. Take care that each module is installed in the correct slot; there are no keys to keep a module from being installed in the wrong slot. To aid proper module placement, the module slots are labeled with the slot number. Refer to Figures 3-4, 3-5 and 3-6.

3. Align the circuit board edges in the card guides and push the module into the slot until the connector on the module and the connector on the motherboard make contact.

4. With even pressure exerted at the top and bottom of the module, firmly push the module into place.

5. Tighten the two screws that secure the module in place (one at the top and one at the bottom).

NOTICE

If resistance is encountered when installing a module, do not force the module. Remove the module and check the connectors for bent contacts or foreign objects. Forcing a module into place may break the connector.

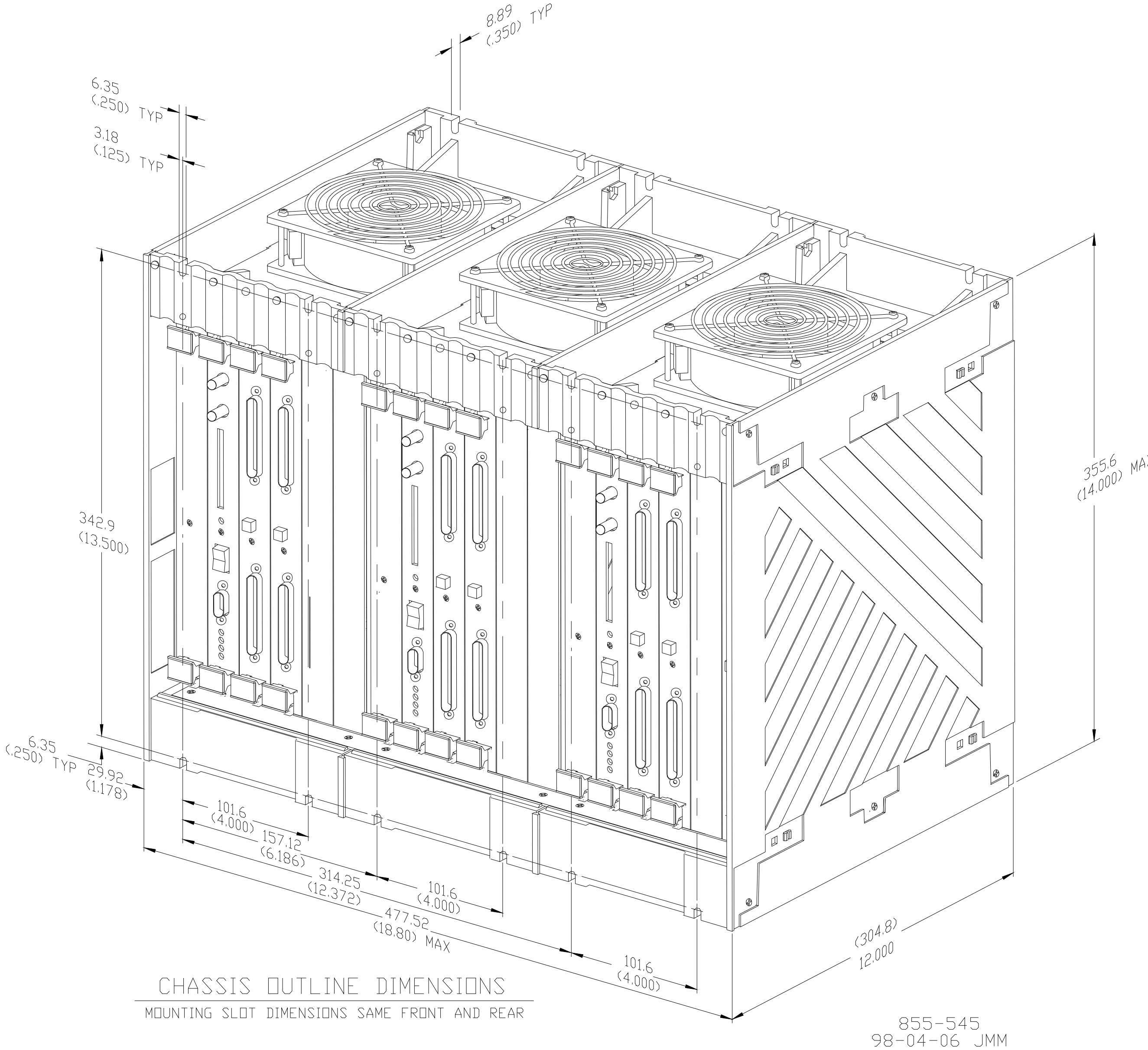


Figure 3-4a. Outline Drawing of 5009C Main Chassis

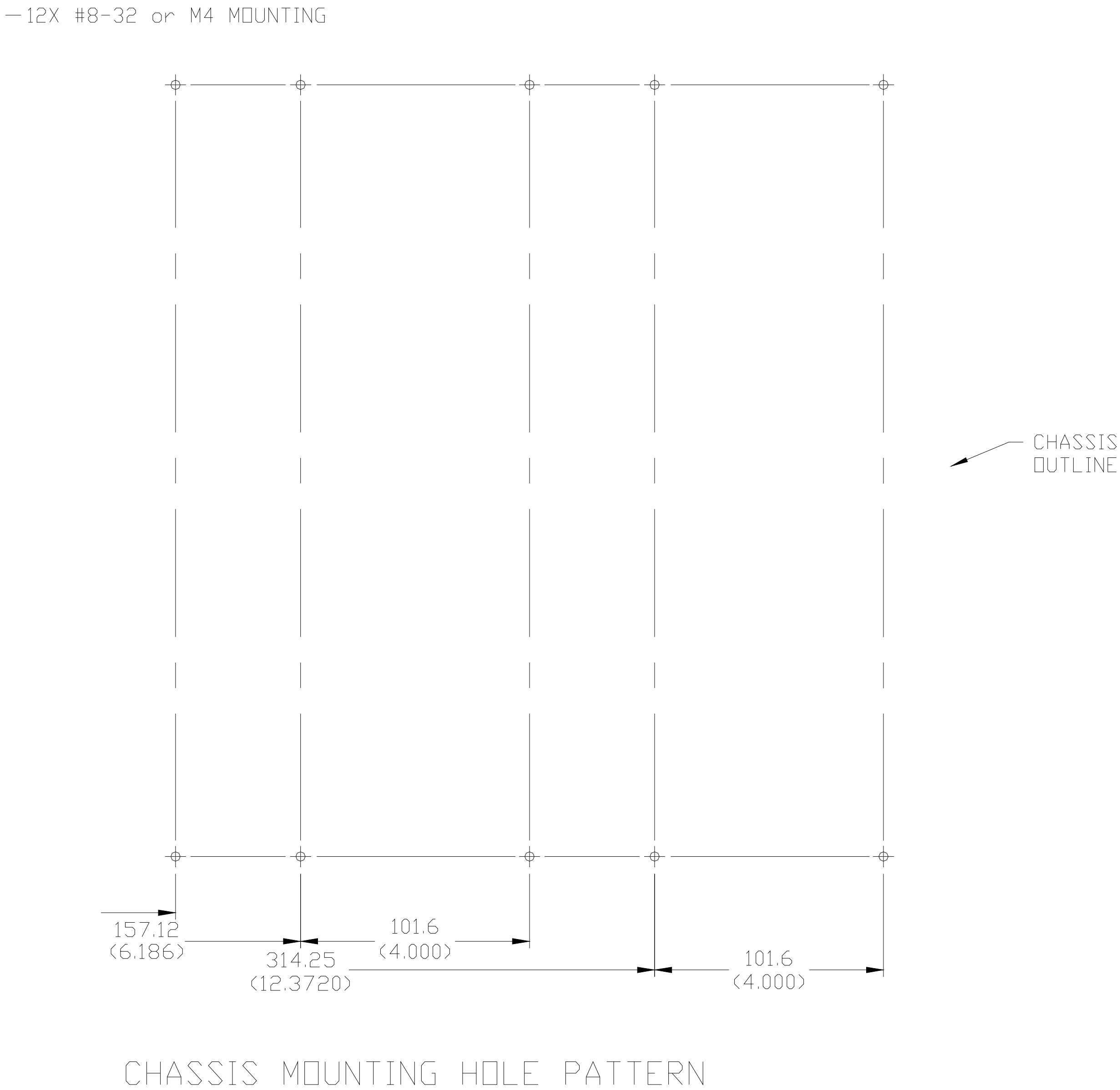
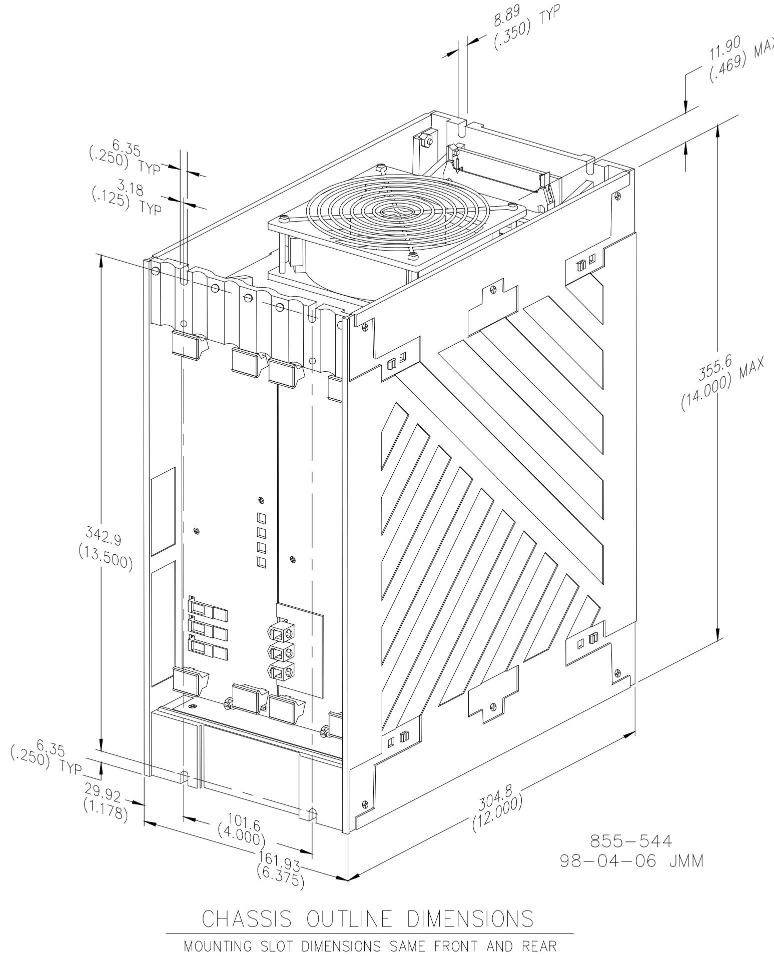


Figure 3-4b. Outline Drawing of 5009C Main Chassis



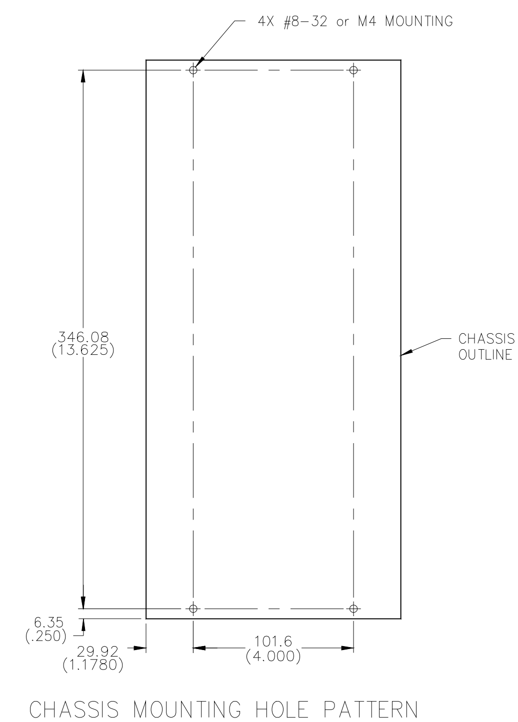


Figure 3-4c. Outline Drawing of 5009C Power Chassis

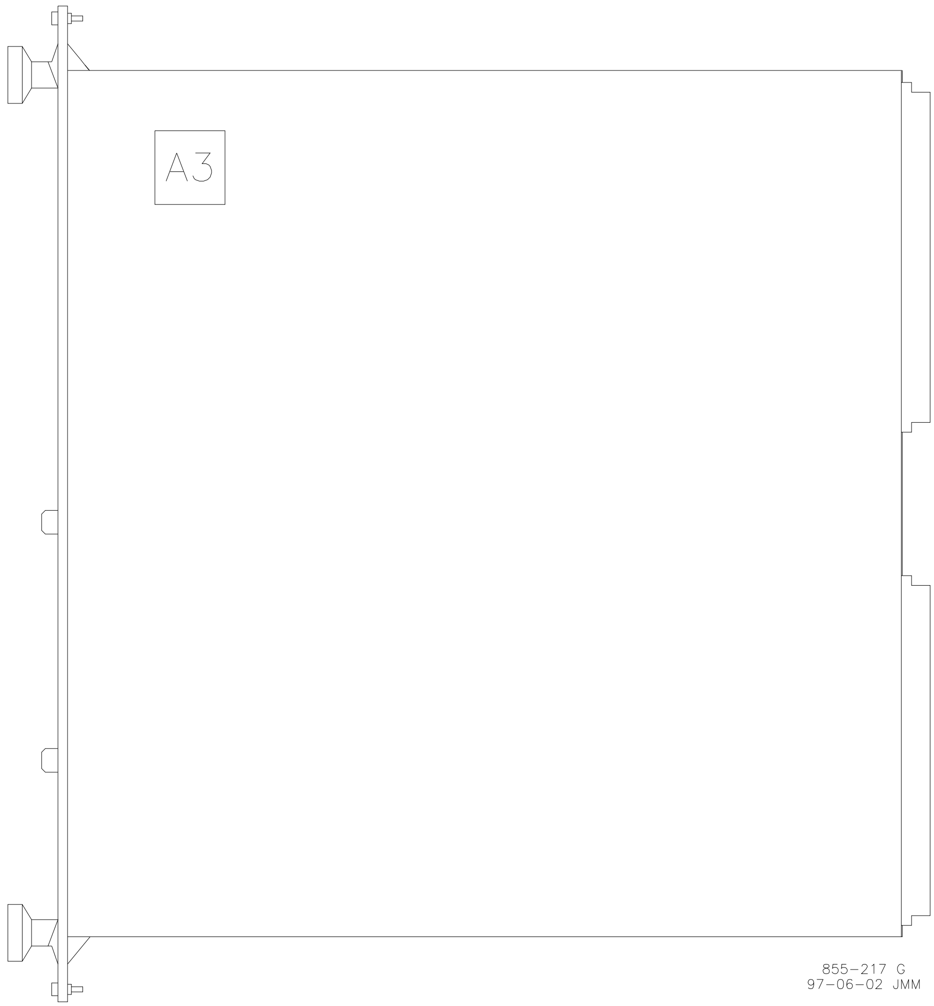


Figure 3-5. Outline Diagram of Module with Label

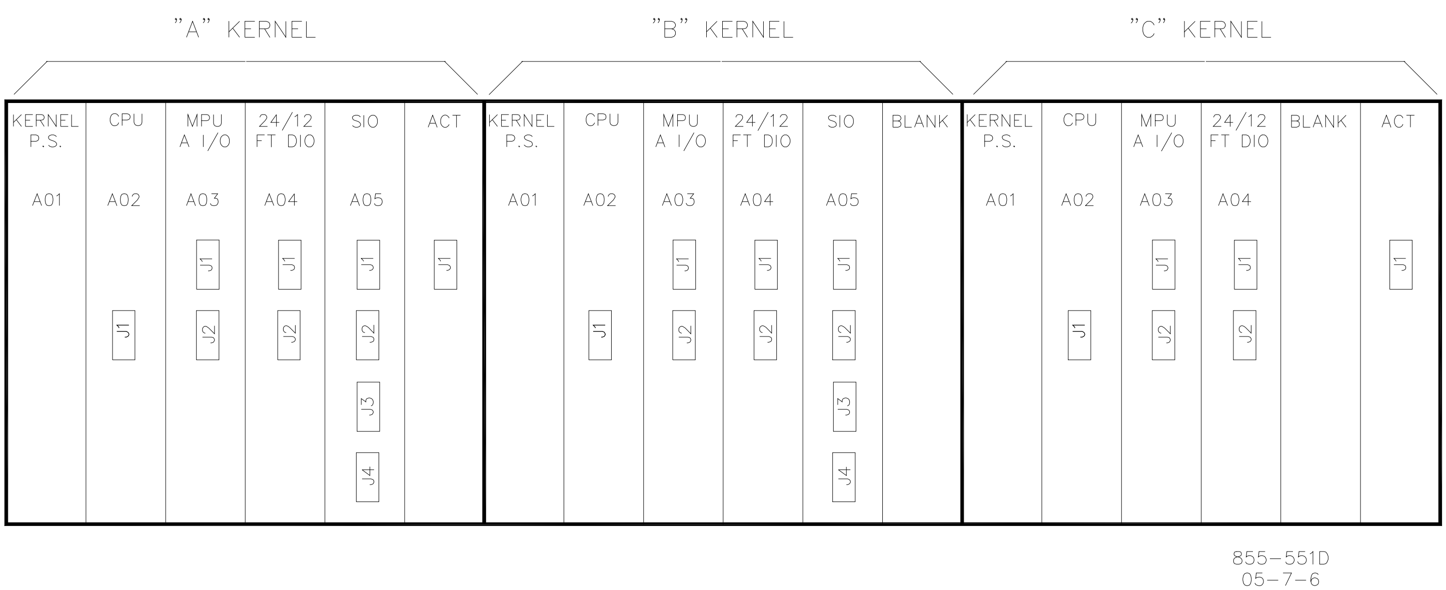


Figure 3-6. Module Location Diagram

Install Analog Termination Modules

The system's ATMs mount on a standard DIN rail (not provided). Mount ATMs within the length of the provided cable from the control's main chassis, leaving adequate service loop.

1. Obtain a DIN rail strip. Cut it to the desired length and mount it to a panel. Leave sufficient space between the DIN rail and walls, objects, etc. for easy access.

2. Drill and tap at least two holes per foot (1 hole every 15 cm) and install DIN rail, using the appropriate screws and washers.

3. Verify that the DIN rail is at earth ground potential (connected to a panel that is at earth ground potential). If the DIN rail is not at earth ground potential

4. connect it to earth ground via a 12 AWG (4.0 mm²) or larger green/yellow wire or braid; keeping the wire/braid as short as possible.

5. Snap the ATMs onto the DIN rail.

6. Snap the included ground terminals (Misc A) onto the DIN rail next to the ATMs. See Figure 3-8.

7. Connect a 12 AWG (4.0 mm²) green/yellow wire between each ground terminal and ATM terminal "Chassis Ground". This wire should be kept as short as possible and be no longer than six inches (15 cm) in length.

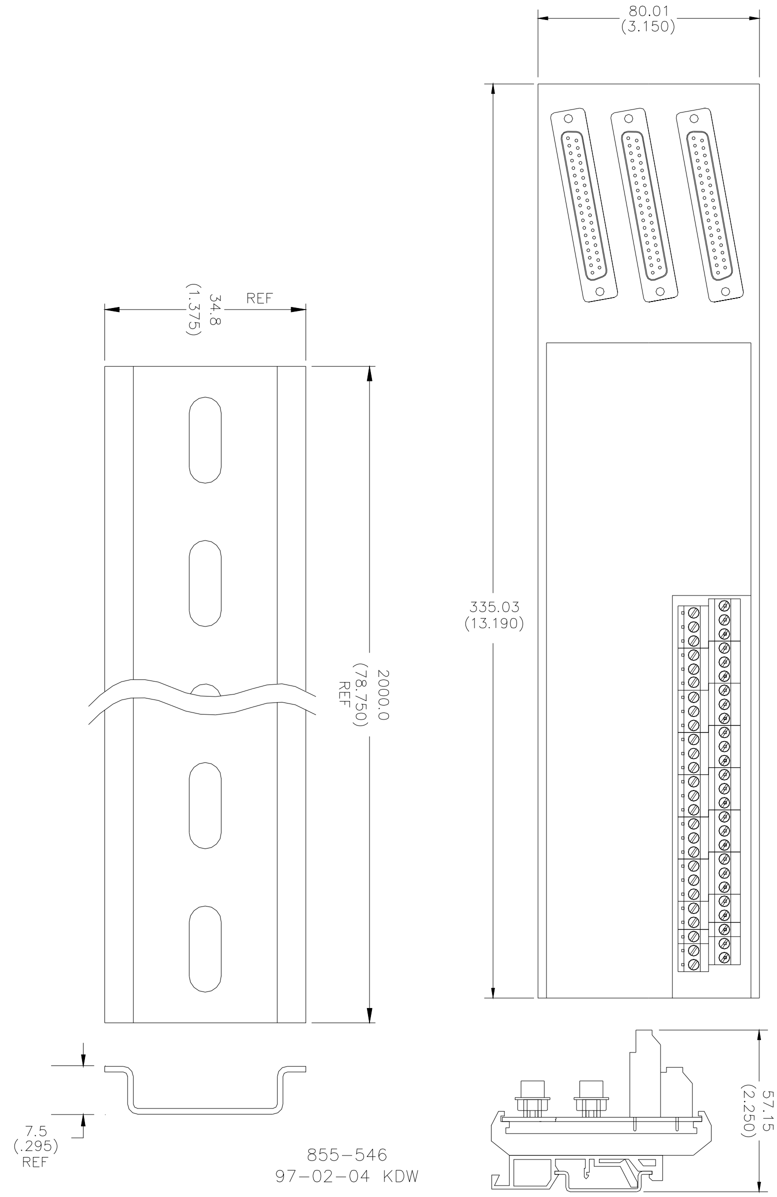


Figure 3-7. DIN Rail & ATM Outline Drawing

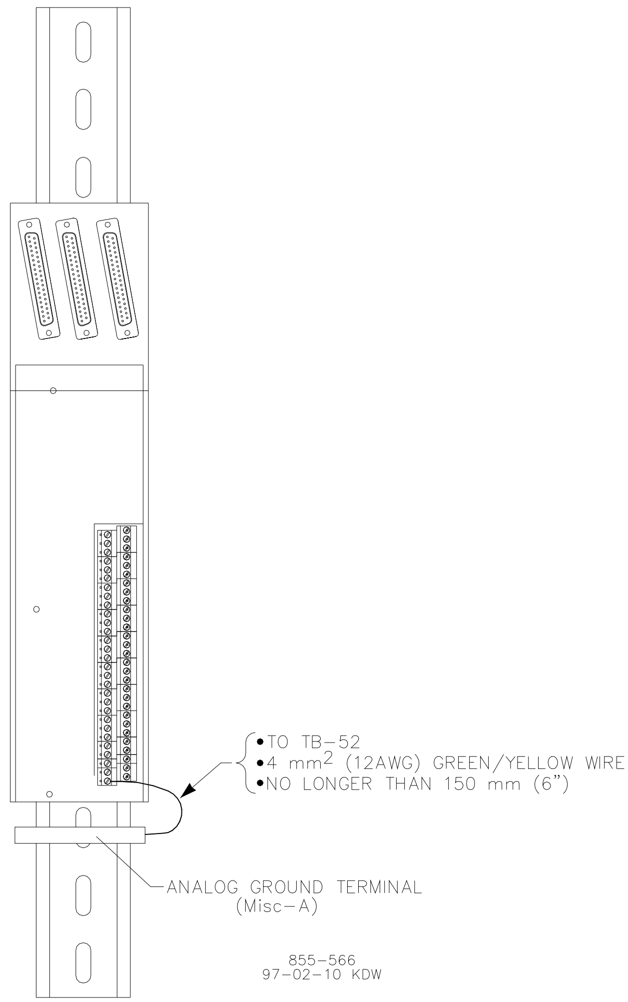


Figure 3-8. ATM Grounding Diagram

Install Discrete Field Termination Modules

Mount DTMs within the length of the provided cable from the 5009C main unit, leaving adequate service loop.

For each DTM:

1. Mark DTM mounting hole locations, taking care to leave sufficient space between the DTM and walls, objects, etc. for easy access. The master DTMs (1, 3) must be mounted directly above the slave DTMs (2, 4); within a maximum distance.

2. Drill and tap mounting holes.

3. Place the DTM in position, insert mounting screws into the tapped holes, and tighten them securely.

4. If the panel the DTMs are mounted on is not at earth ground potential connect it to earth ground via a 12 AWG (4.0 mm²) or larger green/yellow wire or braid; keeping the wire/braid as short as possible.

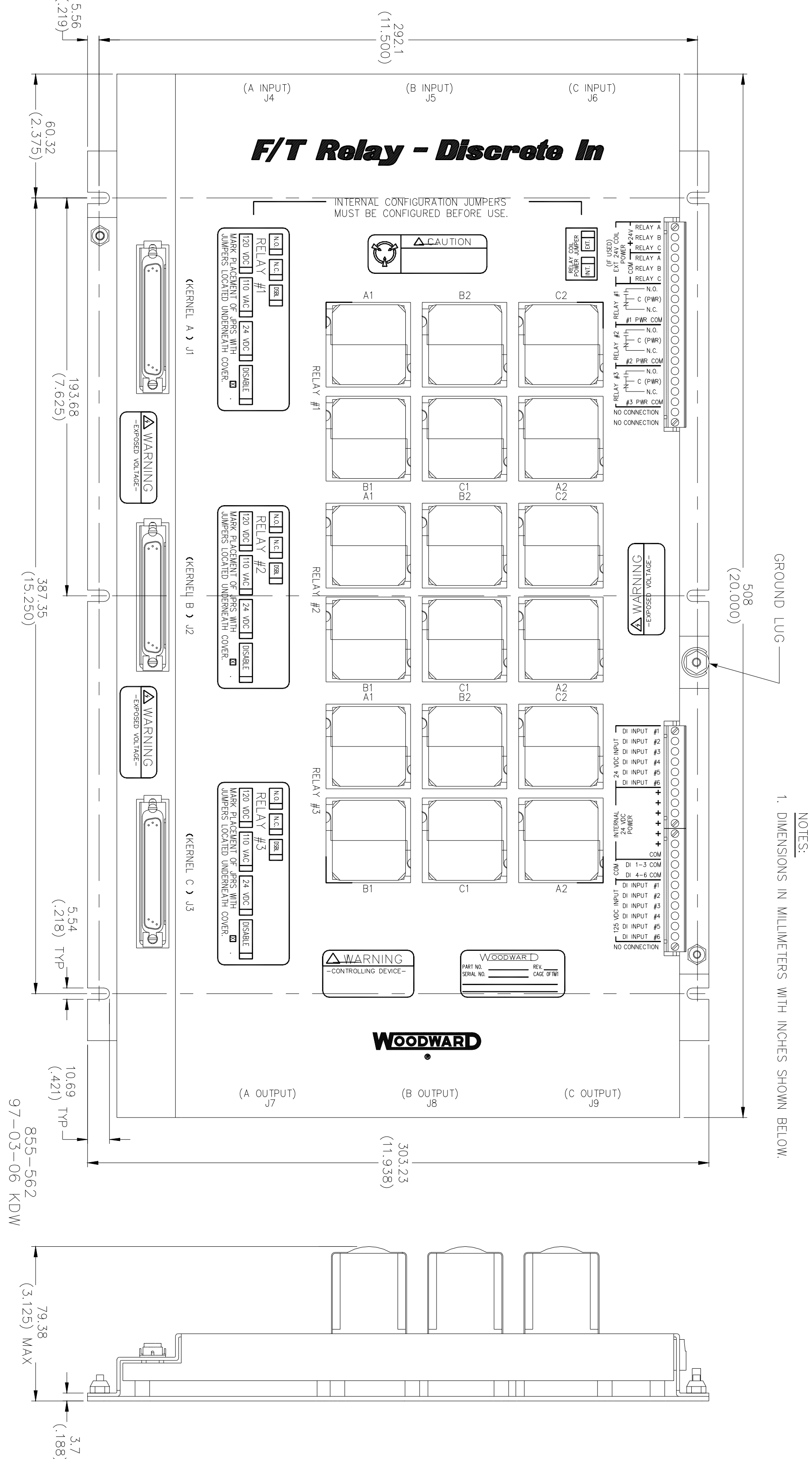


Figure 3-9. DTM Outline Drawing

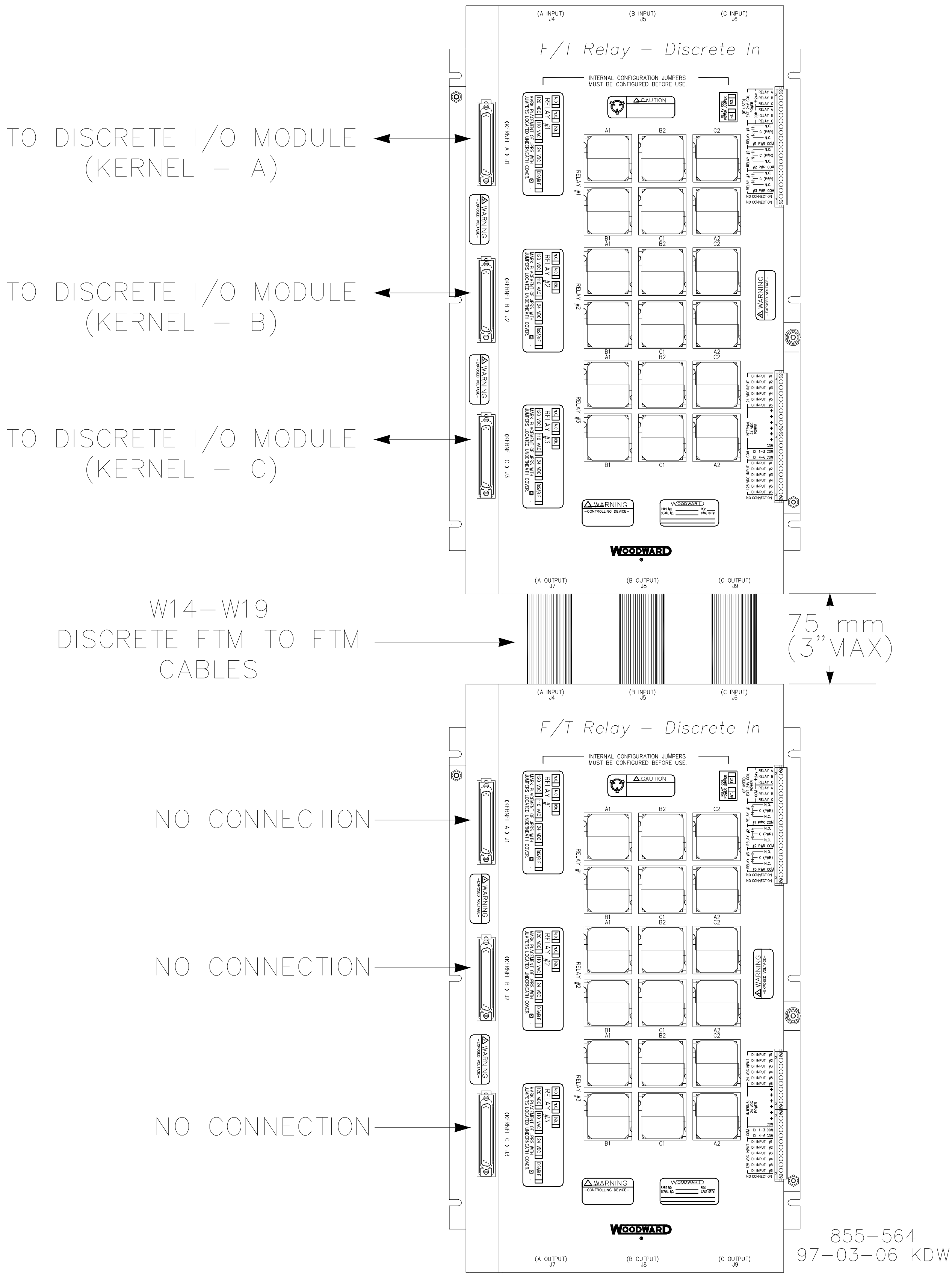


Figure 3-10. DTM Mounting Configuration

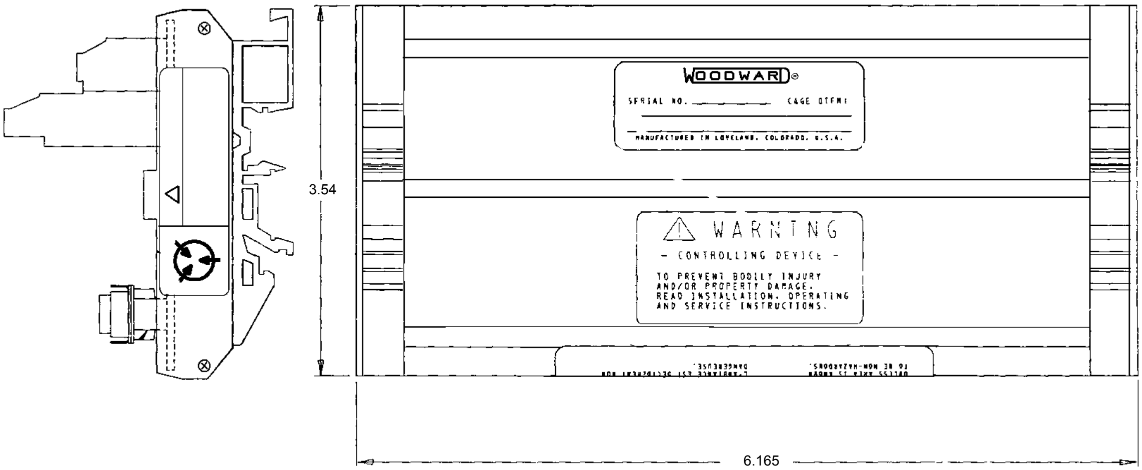


Figure 3-11. Actuator Field Termination Module Dimensions

Chapter 4.
Electrical Installation

Introduction

⚠WARNING	**Before installation read all information and warnings on pages v and vi of this volume.**

Electrical ratings, wiring requirements, and options are provided to allow a customer to fully install the 5009C control into a new or existing application. Field wiring must be rated at least 75 °C for operating ambient temperatures expected to exceed 50 °C.

Wiring for Class I, Division 2 installations must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

After the system has been mechanically installed read this chapter thoroughly before proceeding. Perform system electrical installation by stepping through this chapter's instructions in sequence. Start with cabinet installation instructions, step to the system cables instruction, then step to the next set of instructions, etc.

The PCI software wiring list must be created to assist in electrical installation (see Volume 3). The wiring list will determine what inputs are hooked up to what terminal blocks and how the accessories are wired into the control.

Cabinet (if included)

A standard floor mount, front access cabinet is provided. Input Power and field cable access is available through the bottom of the cabinet. Locate cabinet in control room or place of operation. See Chapter 6 for environmental specifications.

1. Route all power and field cables through the bottom of the cabinet. For EMI reasons, it is recommended that all analog input and output wiring be separated from all power and discrete input/output wiring.

2. Connect a grounding cable, 10 mm² (8 AWG) or larger, from an acceptable earth ground to the cabinet frame.

System Cables (if cabinet is not included)

If the system was provided with a cabinet, no cable installation is required, and you can go directly to the Input Power installation instructions.

After the 5009C control and power chassis have been correctly mounted, and with no power connected to the system:

1. Connect cable W1 between the main chassis and power supply chassis. The W1 power supply cable is a standard 50-pin, 12" (305 mm) long ribbon cable. Install the P1 connector into the main chassis receptacle and the P2 connector into the power supply chassis receptacle. Each connector is keyed to ensure proper alignment. Install cable by firmly pressing each connector into its receptacle until the fasteners are closed. Refer to Table 3-1 for cable identification and to Figure 4-22 for cable connection diagram.

2. Connect cables W14, W15, and W16 between discrete field termination modules DTM-1 and DTM-2. These cables are standard 34-pin ribbon cables. Install these cables prior to mounting the DTM or remove cover to provide access. Cable connectors are not marked or keyed, therefore care must be taken not to twist cables between DTMs. Install cable by firmly pressing each connector into its receptacle until the fasteners are closed. Refer to Table 3-1 for cable identification and Figure 4-22 for cable connection diagram. After cable installation replace DTM covers.

3. Connect cables W17, W18, and W19 between discrete field termination modules DTM-3 and DTM-4. These cables are standard 34-pin ribbon cables. Install these cables prior to mounting the DTM or remove cover to provide access. Cable connectors are not marked or keyed, therefore care must be taken not to twist cables between DTMs. Install cable by firmly pressing each connector into its receptacle until the fasteners are closed. Refer to Table 3-1 for cable identification and Figure 4-22 for cable connection diagram. After cable installation replace DTM covers.

4. Connect cables W2 through W13 between the 5009C chassis modules and field termination modules. These cables are standard jacketed cables with 37 or 61-contact subminiature D-type connectors on both ends. Analog cables have a black outer jacket. Discrete cables have a gray outer jacket. Install the P1 connector into the chassis mounted module receptacle, and the P2 connector into the termination module receptacle. Refer to Table 3-1 for cable identification and Figure 4-22 for cable connection diagram. When installing cables, secure each connector's slide latch by sliding it down.

Shields and Grounding

If the panel that the control chassis and termination modules are mounted on is not at earth ground potential connect it to earth ground via a 4.0 mm² (12 AWG) or larger, green/yellow wire or braid, keeping the wire/braid as short as possible.

An individual shield termination is provided at the terminal block for each of the speed sensor inputs, actuator outputs, analog inputs, analog outputs, and communications ports. All of these inputs and outputs should be wired using shielded, twisted-pair wiring. The shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block. The exposed wire length, beyond the shield, should be limited to one inch. Relay outputs, contact inputs, and power supply wiring do not normally require shielding, but can be shielded if desired.

For compliance with EMC standards, it is required that all analog and discrete input/output wiring be separated from all power wiring.

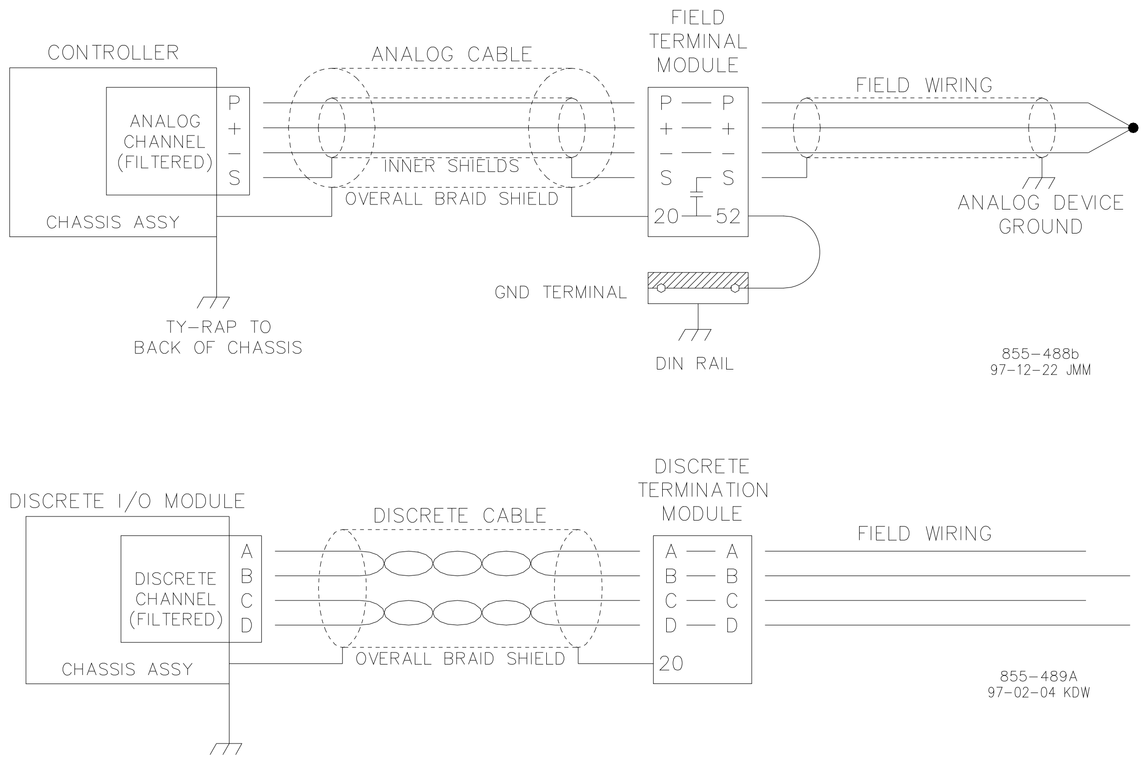


Figure 4-1. Shield Termination Diagram

Input Power

Branch circuit fuses, breakers, and wiring must have applicable safety approval and be selected according to applicable codes and area classifications. The system disconnect MUST be in easy reach of the operator and marked as a disconnect device. Each main power supply must have its own branch circuit rated fuse, or circuit breaker with a rating no more than 250% of the maximum rated current of the power supply (see Table 4-1). Do not connect more than one main power supply to any one fuse or circuit breaker. Use only the wire sizes specified in Table 4-1, or equivalent metric sizes which meet local code requirements.

Each 5009C control requires a power source capable of a certain output voltage and current. For AC sources, this power rating is stated in Volt-Amps (VA). The maximum VA of a source can be calculated by taking the rated output voltage times the maximum output current at that voltage. This value should be greater than or equal to the 5009C control VA requirement.

Note that control's main power supplies are not equipped with input power switches. For this reason, some means of switching input power to each main power supply must be provided for installation and servicing. A circuit breaker meeting the above requirements or a separate switch with appropriate ratings may be used for this purpose. An appropriately sized fuse or circuit breaker must be provided for each 5009C power supply. Refer to Table 4-1 for recommended fuse ratings, circuit breaker ratings and wire sizes. Use only time-delay fuses or circuit breakers to avoid nuisance trips. A fixed wiring installation is required. Power supply leakage current exceeds 3.5 mA so a protective earth ground connection is required.

Table 4-1 also provides each power supply's holdup time specification, which is the time the supply will continue to operate within specification after its input power is interrupted. This information may be useful in specifying Uninterruptible Power Supply (UPS) systems.

Table 4-1. Fuse/Breaker Requirements

Input Voltage and Frequency Range	Rated Maximum Current	Actual Maximum Current	Maximum Power	Maximum Fuse/C.B. Rating	Wire Size mm²/AWG	Wire Temp. Rating (°C)*	Hold Up Time (Minimum)
18–32 Vdc	32 A	22 A	400 W	30 A	8 / 10	90	7 ms @ 24 V
100–150 Vdc	5.8 A	4.0 A	400 W	10 A	2.5 / 14	90	7 ms @ 120 V
88–132 Vac 47–63 Hz	13 A	9.1 A	800 VA	15 A	2.5 / 14	90	1 cycle @ 120 V
180–264 Vac 47–63 Hz	6.5 A	4.4 A	800 VA	10 A	2.5 / 14	90	1 cycle @ 220 V
200–300 Vdc	2.9 A	2.9 A	600 VA	10 A	2.5 / 14	90	7 ms @ 200 V

*Wire Temp ratings specified are for 55 °C cabinet ambient.
All fuses listed above are "slow blow".

Significant inrush currents are possible when current is applied to the main power supply. The magnitude of the inrush current depends on the power source impedance, so Woodward cannot specify the maximum inrush current. Time-delay fuses or circuit breakers must be used to avoid nuisance trips.

The 5009C control includes a set of two main power supplies. Input power ratings are identified in Table 4-1 and on each power supply's front panel. Refer to Chapter 6 of this Volume for all power supply specifications.

When a cabinet is supplied with the system, input power connections and PE ground are made through panel mounted Phoenix type terminal blocks. These terminal blocks accept wires from 0.08–2.5 mm² (20–8 AWG). For a good connection the inserted wires should have the insulation stripped back by about 6 mm (1/4"). Refer to Figure 4-23 for a wiring diagram of the cabinet's input power terminals.

When a cabinet is not supplied with the system, input power connections and PE ground are made through terminals on the front of each main power supply. These terminals accept wires from 0.08–2.5 mm² (20–8 AWG) wire. For a good connection the inserted wires should have the insulation stripped back by about 8 mm (1/3"). Figure 4-23 displays a 120 Vac/150 Vdc or a 220 Vac power supply's input terminals. The 24 Vdc power supply model uses larger copper input terminals to accommodate the required 10 mm² (8 AWG) wire. A green/yellow wire must be used for PE ground connection. Fixed wiring installation is required for power supplies.

IMPORTANT

Each main power supply provides three separate 24 Vdc outputs rated for 0–6 A each. To preserve system integrity, it is recommended that the control's three isolated 24 Vdc outputs be kept isolated from each other at all times. If the control's 24 V power is used to power external devices, the system's three 24 V outputs must not be tied together. If these outputs are tied together, and a short circuit occurs, it will shut down the entire 5009C control. External devices requiring 24 Vdc power must be connected to only one of the power supplies.

Externally powered analog inputs or outputs and external relay coil power must be supplied by and IEC rated or NFPA 70 (NEC) Class 2 power supply as required by local authority having jurisdiction.

Speed Sensor Inputs

The 5009C control uses speed sensing probes mounted off of a gear connected or coupled to the turbine's rotor to sense turbine rotor speed. Any of the control's four speed channels accept passive magnetic pickup units (MPUs), 12 Vdc proximity probes, or 24 Vdc proximity probes. It is not recommended that gears mounted on an auxiliary shaft coupled to the turbine rotor be used to sense turbine speed. Auxiliary shafts tend to turn more slowly than the turbine rotor (reducing speed sensing resolution) and have coupling gear back-lash, which results in less than optimum speed control. For safety purposes it is also not recommend that the speed sensing device sense speed from a gear coupled to a generator or mechanical drive side of a system's rotor coupling.

An application may use any combination of the accepted speed probes. All speed sensing inputs use the same programmed gear ratio and number of teeth to calculate speed, thus the speed probes used should sense speed from the same gear. The 5009C control can sense and control turbine speed from a single speed probe, however, it is recommended that all applications use multiple speed probes to increase system reliability.

A passive MPU provides a frequency output signal corresponding to turbine speed by sensing the movement of a gear's teeth past the MPU's pole piece. The closer the MPU's pole piece is to a gear's teeth and the faster the gear turns the higher a passive MPU's output amplitude will be. The 5009C control must sense an MPU voltage of 1 to 25 Vrms for proper operation.

Depending on an MPU's limitations, each input channel can be jumper configured to allow an MPU to drive either two or three inputs (some MPUs cannot drive three inputs). Wire jumpers must be installed to allow an MPU to drive into all three inputs. When the jumpers are not installed, only two input modules are driven by a MPU. With proper MPU, gear size, and MPU-to-gear clearance, speed measurement should be capable down to 100 Hz. Standard MPU clearance is recommended to be 0.25 to 1.02 mm (0.010 to 0.040 inch) from tooth face to pole piece. For information on selecting the correct MPU or gear size, please refer to Woodward manual 82510. See Figure 4-2 for wiring schematic.

A proximity probe may be used to sense very low speeds. With a proximity probe, speed can be sensed down to 0.5 Hz. The 5009C control can be programmed to turn on or off a turbine turning gear using a relay output programmed as a speed switch. See Figure 4-3 for proximity probe wiring schematic.

Because of differences between the sensing circuits required to interface with passive (MPUs) and active (proximity) probes, separate terminals are provided for each type. This allows a simple method of field selecting the type of speed input based on the type of probe used. Short-circuit protected 12 Vdc and 24 Vdc sources, with isolation diodes on the power, common, and output source lines, are provided with each speed input to power system proximity probes.

Each channel's prox return input accepts 5–28 Vdc. Alternatively with either 12 Vdc or 24 Vdc open collector probes. When interfacing to open collector type probes a pull-up resistor between the four voltage terminal and the proximity return terminal is required.

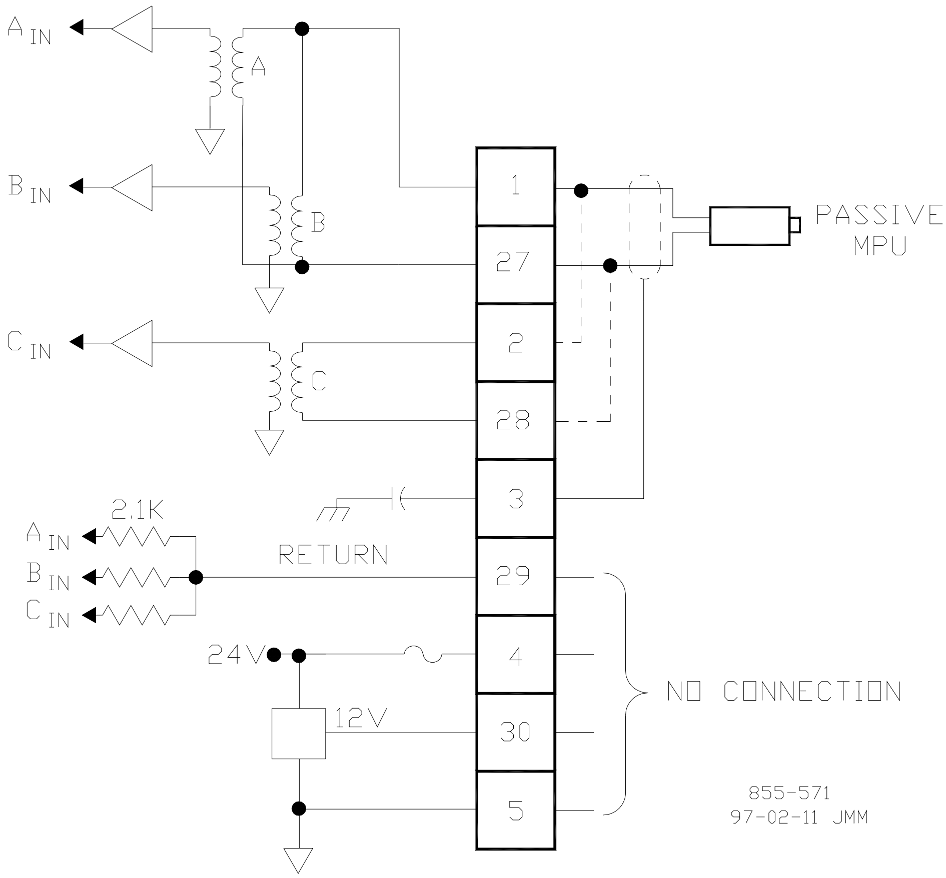


Figure 4-2. Example MPU Interface Wiring Diagram

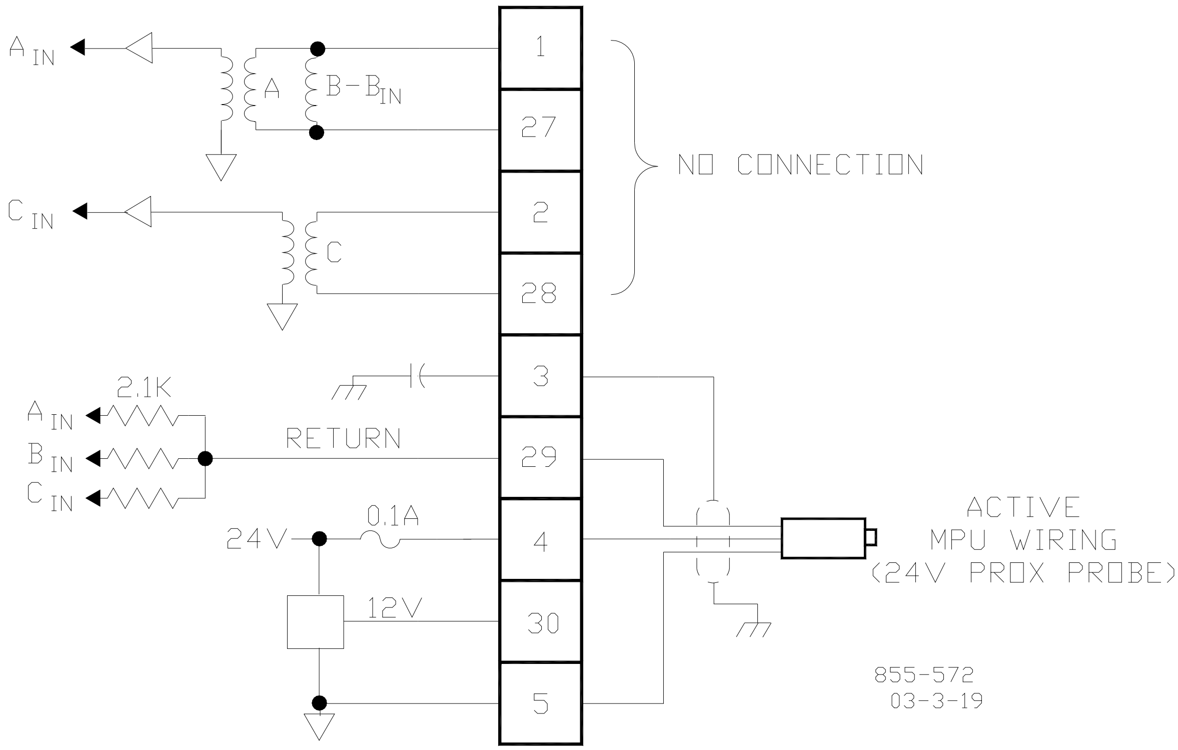


Figure 4-3a. Example 24 V Proximity Probe Wiring Diagram

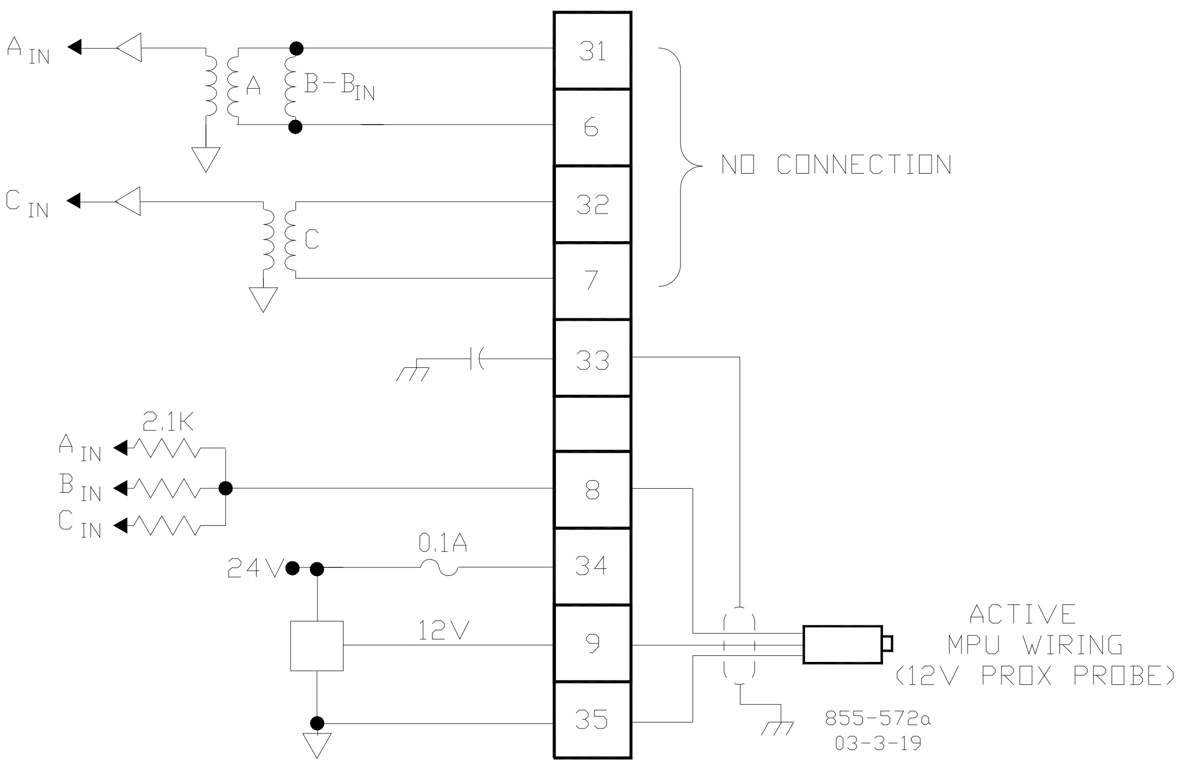


Figure 4-3b. Example 12 V Proximity Wiring Diagram

Each ATM connects to the control's MPU & Analog I/O modules through individual cables, and provides a common cage-clamp terminal connection for customer field wiring. Figures 4-2 and 4-3 illustrate the different input wiring configurations based on the type of speed sensing probes used.

Wiring Notes:

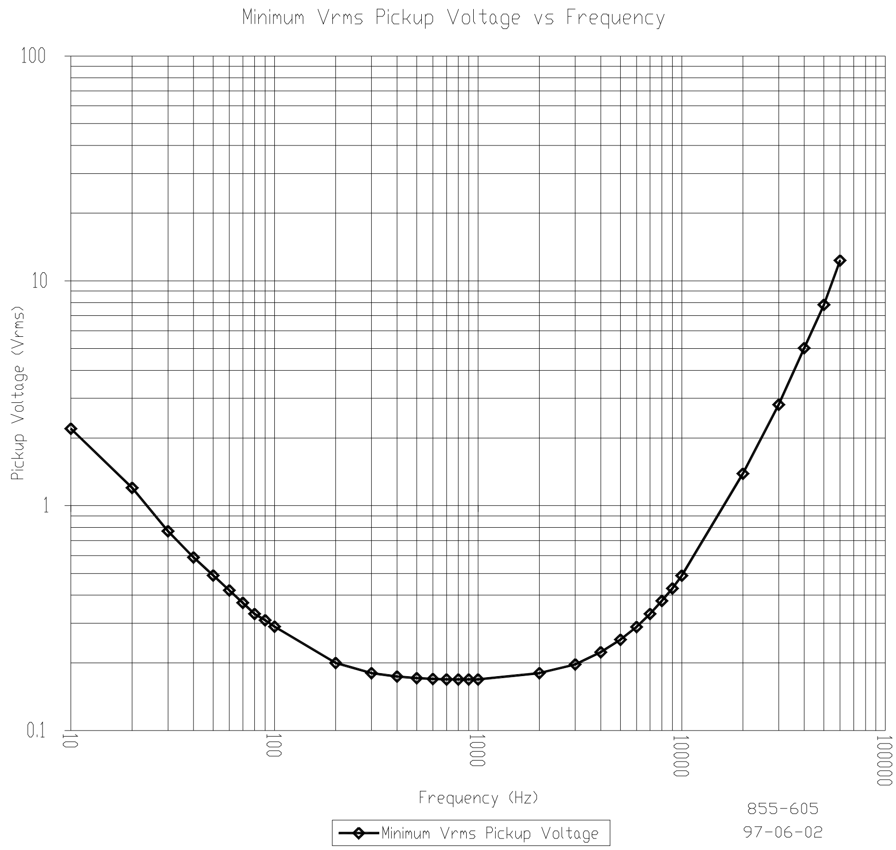
- Refer to Figures 4-24 and 4-25 for Speed Sensor wiring connections on the ATMs.
- Each Speed input channel can only accept one MPU or one Proximity probe at a time.
- MPUs only—Jumpers must be added to each channel as shown in Figure 4-2 to allow the "C" analog module to sense speed.
- Proximity Probes only—Individual 12 Vdc and 24 Vdc sources, with isolation diodes on the power, common, and output source lines, are provided with each speed input to power system proximity probes (100 mA fuses are used on the 24 V output, the 12 V is current limited to 100 mA and located on the ATMs).
- Proximity Probes only—External pull-up resistors are required when interfacing with an open collector type of proximity probe.
- It is recommended that twisted shielded wiring be used between each probe and ATM.
- Shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block. The exposed wire length, beyond the shield, should be limited to 25 mm (1").
- ATM terminals accept wires from 0.08–2.5 mm² (27–12 AWG).

IMPORTANT — **If the speed signals are not within the following limits, the 5009C control will respond with a speed sensor frequency error during the program checking procedure.**

(TxMxR)/60 must be < 25 000 Hz

T = Gear Teeth
M = (Overspeed Test Limit Setting x 1.02)
R = Gear Ratio

IMPORTANT — **If the MPU device is not providing a voltage greater than 1.5 Vrms, the MPU device should be moved closer to the gear where speed is being monitored. The following graph shows the minimum voltage necessary to detect speed at the various frequencies.**



Analog Inputs

The control accepts eight 4–20 mA current inputs, with each of the control's two ATMs accepting four inputs. All analog inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. Because inputs are not fully isolated, care must be taken in their application and maintenance to avoid "ground-loop" type problems. All analog inputs have 200 Vdc common mode rejection isolation. If interfacing to a non-isolated device which may have the potential of reaching over 200 Vdc with respect to the control's common, the use of a loop isolator is recommended to break any return current paths, which could result in erroneous readings.

All eight analog inputs are programmable. When an analog input is used, the chosen input must be wired to and configured within the control's program to function. Refer to Volume 3 of this manual for a complete list of programmable analog input options.

A 24 Vdc power supply is available from the 5009C control to power external transducers or other auxiliary devices. Isolation is provided through diodes on the power and common lines. This 24 Vdc output is capable of providing 24 Vdc with +10% regulation. Power connections are be made through terminals located on system ATMs.

Wiring Notes:

- Refer to Figures 4-24 and 4-25 for Analog Input wiring connections on the ATMs.
- Only 4–20 mA signals are accepted.
- A jumper is required between a channel's circuit common terminal and "IN (–)" terminal when interfacing to a loop powered transducer.
- All analog inputs have an input impedance of 200 Ω.
- Each 24 Vdc source terminal has an internal 100 mA fuse in series with it (located on the ATM). To meet CENELEC ratings, power for sensors and contacts must be supplied either by the 5009C power supplies, or the external power supply outputs must be rated for 30 Vdc or less and have its outputs fused with appropriate sized fuses (a maximum current rating of 100/V, where V is the supply's rated voltage or 5 A, whichever is less).
- It is recommended that 0.75 mm² (20 AWG) or larger twisted/ shielded wire be used between each transducer and ATM.
- Shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block. The exposed wire length, beyond the shield, should be limited to 25 mm (1").
- Do not place shielded wires in the same cable conduit with high-voltage or large-current-carrying cables.
- Cable shields must be electrically continuous from the signal source to the point the signal wire enters the 5009C Analog Termination Module.
- ATM terminals accept wires from 0.08–2.5 mm² (27–12 AWG).

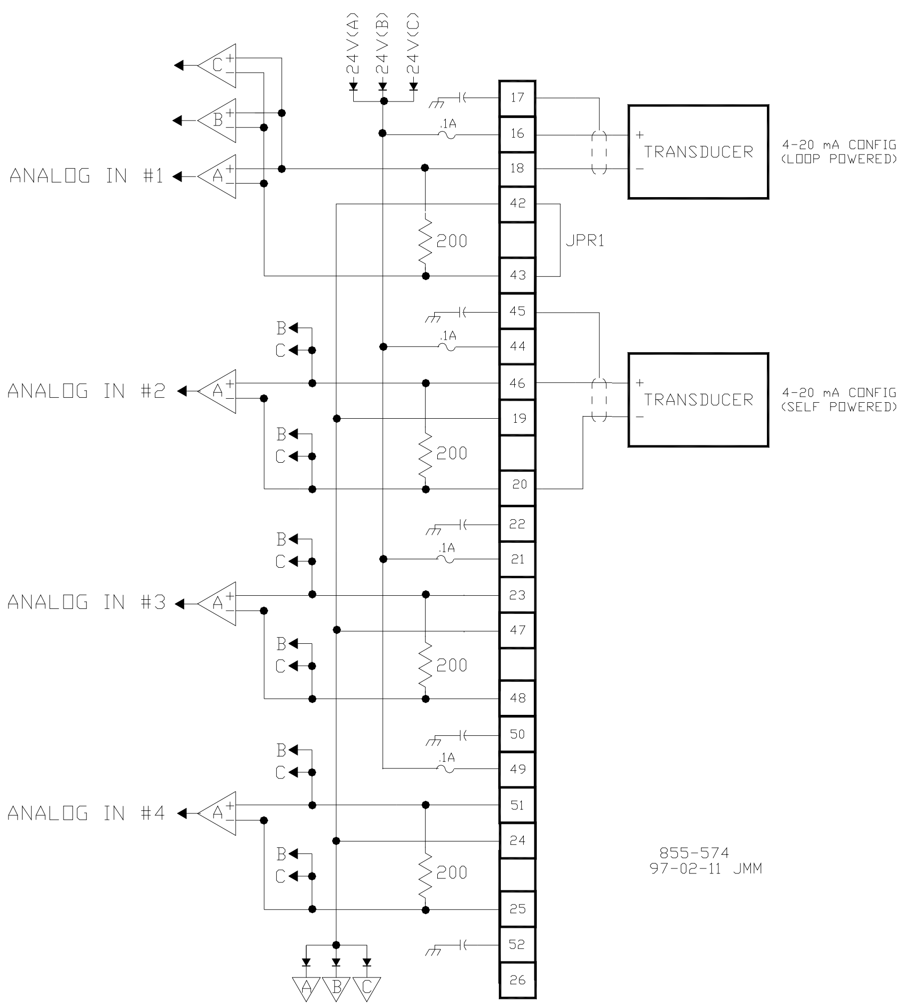


Figure 4-4. Example Analog Input Wiring Diagrams

Analog Outputs

The control has four 4-20mA current output drivers, with two outputs per ATM. Applications using analog outputs must, within the control's program, have the desired analog value assigned or configured to a specific output. Refer to Volume #3 of this manual for a complete list of programmable analog output options.

Wiring Notes:

- Refer to Figures 4-24 and 4-25 for Analog Output wiring connections on the ATMs.
- Only 4–20 mA signals are output.
- All analog outputs can drive into a maximum of 600 Ω.
- It is recommended that 0.75 mm² (20 AWG) or larger twisted/ shielded wire be used between each meter (or DCS input) and ATM.
- Shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block. The exposed wire length, beyond the shield, should be limited to 25 mm (1").
- Cable shields must be electrically continuous from the signal source to the point the signal wire enters the 5009C Field Terminal Module.
- ATM terminals accept wires from 0.08–2.5 mm² (27–12 AWG) wire.
- Analog outputs are not isolated; care should be taken when interfacing to other non-isolated devices to prevent wiring faults. The use of an isolator is recommended.

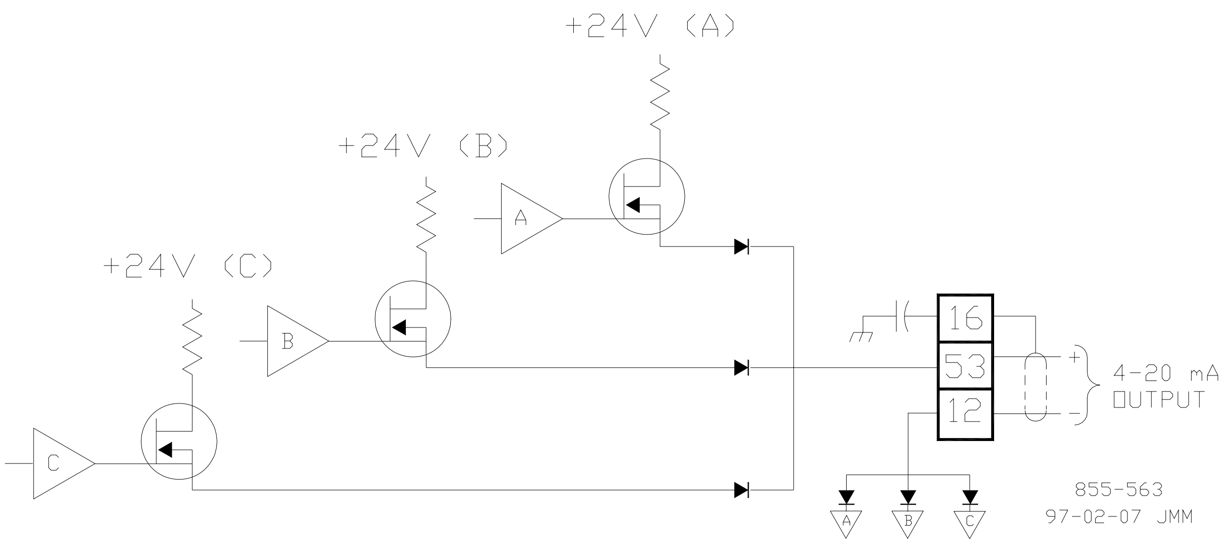


Figure 4-5. Example Analog Output Wiring Diagram

Actuator Outputs from Combo Card

The control has two proportional actuator output drivers (one output per ATM). The actuator output drive currents can be programmed to interface with Woodward Governor Company actuators (typically 20–160 mA drive currents) or non-Woodward actuators (4–20 mA drive currents). Each actuator output can be individually configured to interface with Woodward or non-Woodward type actuators.

Each actuator output can also be configured to drive single- or dual-coil actuators. When configuring an output to drive into either type of actuator, the output must be wired correctly (See Figures 4-6 and 4-7), and the control's program configured for the correct type of actuator. See Volume 3 for details on programming actuator outputs.

Dither is selectable through the system's engineering workstation, and is available for either output. Dither is a low frequency (25 Hz) signal consisting of a 5 millisecond pulse modulated onto the control's DC actuator-drive current to reduce stiction in linear type actuators. Woodward TM-type actuators typically require dither. See Volume #3 of this manual for details on adjusting dither.

Wiring Notes:

- Refer to Figures 4-24 and 4-25 for Actuator Output wiring connections to the ATMs.
- When configured to drive a single coil actuator, user-supplied jumpers are required between terminals 14 & 15 and terminals 44 & 45.
- Maximum impedance for a 4 to 20 mA actuator output driver is 360 Ω (actuator impedance + wire resistance).
- Maximum impedance for a 20 to 160 mA actuator output is 45 Ω (actuator impedance + wire resistance).
- Each actuator driver senses its drive current to allow over- and under-current alarms and shutdowns. Refer to Volume 1 of this manual for details on defaulted values and changing them.
- It is recommended that 0.75 mm² (20 AWG) or larger twisted/shielded wire be used between each actuator and ATM.
- Shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block. The exposed wire length, beyond the shield, should be limited to 25 mm (1").
- Do not place shielded wires in the same cable conduit with high-voltage or large-current-carrying cables.
- Cable shields must be electrically continuous from the signal source to the point the signal wire enters the 5009C Analog Terminal Module.
- ATM terminals accept wires from 0.08–2.5 mm² (27–12 AWG) wire.
- Actuator outputs are not isolated, so they should be not be connected to non-isolated devices.

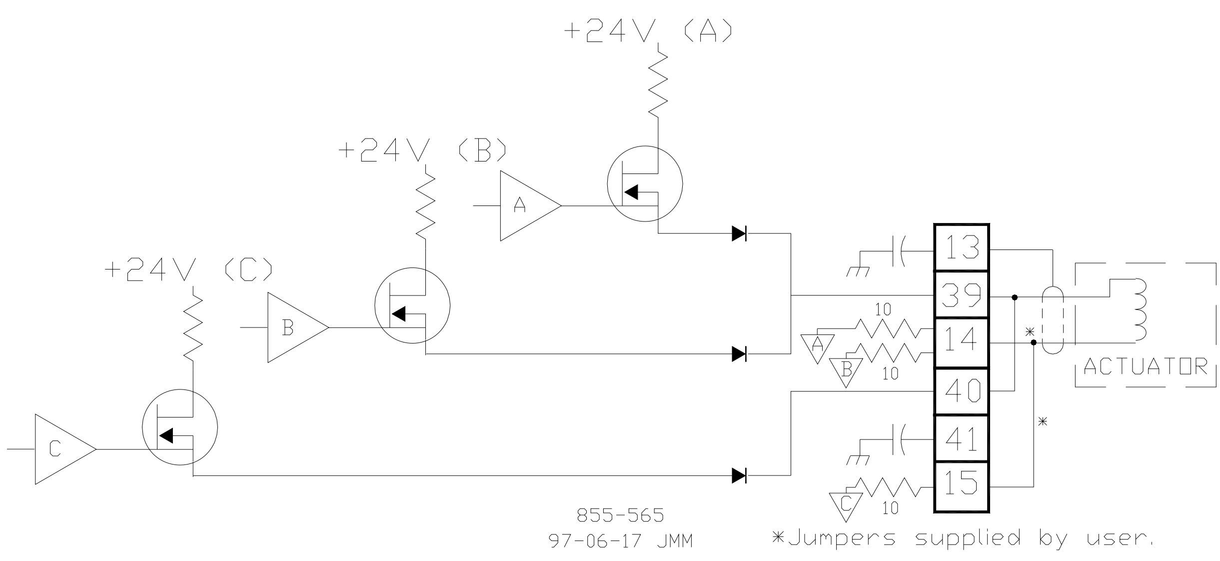


Figure 4-6. Example Single Coil Actuator Wiring Diagram

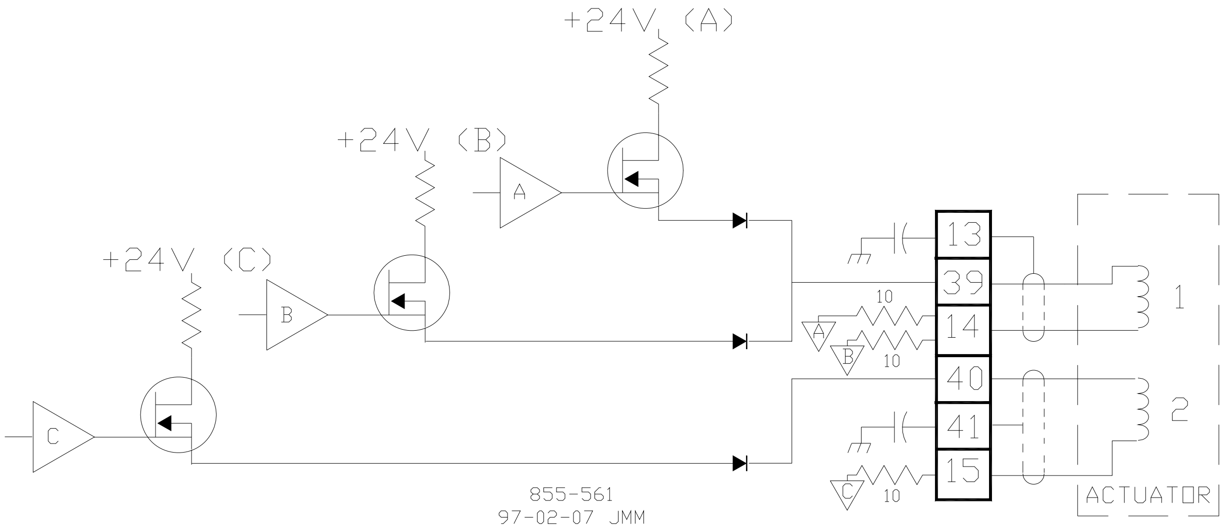


Figure 4-7. Example Dual Coil Actuator Wiring Diagram

Actuator Outputs from Actuator Cards

The 5009C Control is designed to use redundant actuator outputs for each actuator or servo. Actuator output field wiring terminations are made at the terminal strips provided on the Actuator Field Termination Modules. Each Actuator FTM has termination points for two actuator output drivers and two RVDT or LVDT position feedback devices. Although each FTM may drive two actuator outputs, for reasons of redundancy the two actuators driving a single valve will originate from different FTMs. When redundant actuator outputs are used, redundant position resolver feedbacks are not supported. For a dual coil actuator, one driver should be wired to each coil. For a single coil actuator, wire the redundant drivers in parallel to the coil. Refer to Figure 4-9 for supported position resolver schematics and Table 4-2 and Figure 4-8 for available termination points.

Wiring Notes:

- Refer to Table 4-2 and Figure 4-8 for Actuator Output FTM terminal assignments.
- Figure 4-9 gives resolver schematics.
- Maximum impedance for a 20 to 160 mA actuator output is 45 Ω (actuator impedance + wire resistance).
- Each actuator driver senses its drive current to allow over- and under-current alarms and shutdowns. Refer to Volume 3 of this manual for details on defaulted values and changing them.
- It is recommended that 0.75 mm² (20 AWG) or larger twisted/shielded wire be used between each actuator and Actuator FTM.
- Shields should be connected to earth ground one point such as an intermediate terminal or the analog device, as well as terminated at the control terminal block. The exposed wire length, beyond the shield, should be limited to 25 mm (1”).
- Do not place shielded wires in the same cable conduit with high-voltage or large-current-carrying cables.
- Cable shields must be electrically continuous from the signal source to the point the signal wire enters the 5009C Analog Terminal Module.
- Actuator FTM terminals accept wires from 0.08–2.5 mm² (27–12 AWG) wire.
- Actuator outputs are not isolated, so they should be not be connected to non-isolated devices.

Actuator 1			Actuator 2	
SHLD	1		SHLD	20
DRVR +	2		DRVR +	21
DRVR -	3		DRVR -	22
SHLD	4		SHLD	23
EXC +	5		EXC +	24
EXC -	6		EXC -	25
SHLD	7		SHLD	26
FDBK 1A +	8		FDBK 1A +	27
FDBK 1A -	9		FDBK 1A -	28
SHLD	10		SHLD	29
FDBK 1B +	11		FDBK 1B +	30
FDBK 1B -	12		FDBK 1B -	31

Table 4-2a. Actuator Output and Position Feedback Termination Points

When 5009C is configured to use Pilot valve LVDT signals, FBBK 2 must be used.

Connection must be done according Table 4-2b.

Actuator 1			Actuator 2	
SHLD	4		SHLD	23
EXC +	5		EXC +	24
EXC -	6		EXC -	25
SHLD	13		SHLD	32
FDBK 2A +	14		FDBK 2A +	33
FDBK 2A -	15		FDBK 2A -	34
SHLD	16		SHLD	35
FDBK 2B +	17		FDBK 2B +	36
FDBK 2B -	18		FDBK 2B -	37

Table 4-2b. Pilot Position Feedback Termination Points

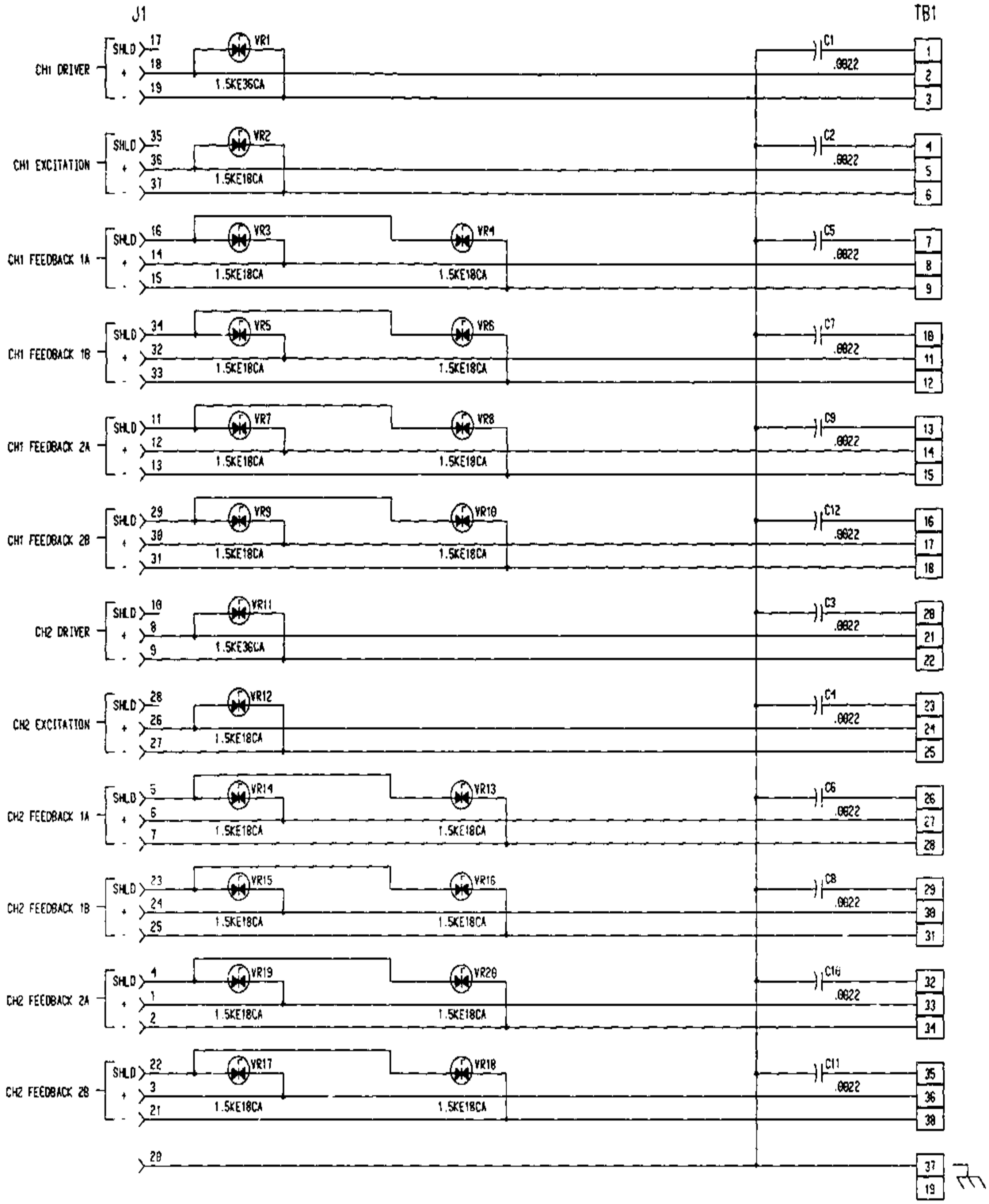


Figure 4-8. Actuator FTM Circuitry and Wiring Diagram

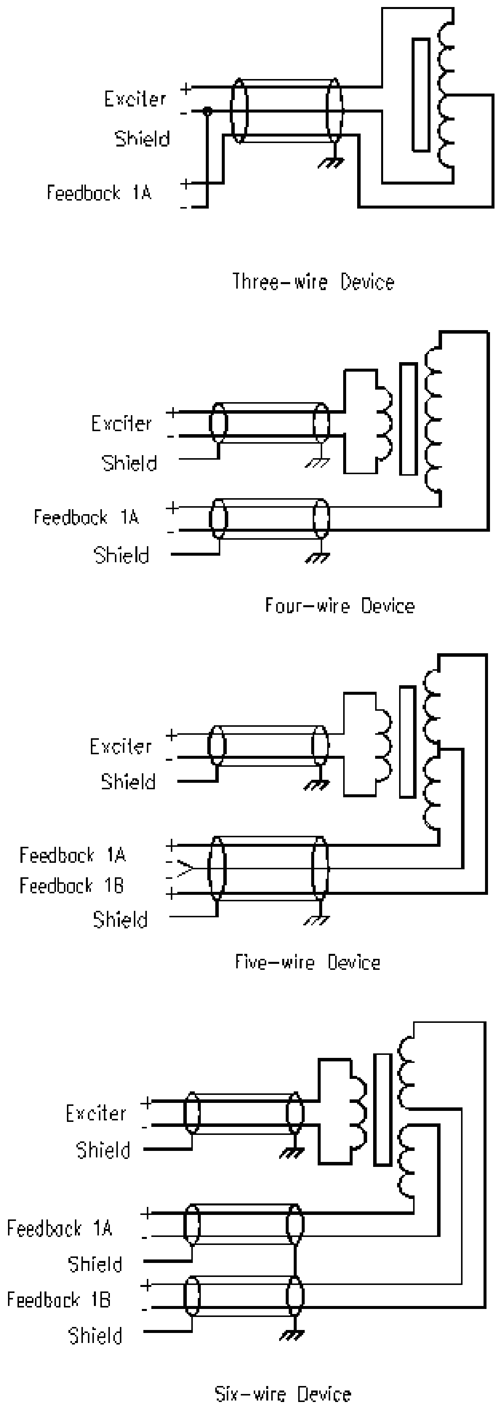


Figure 4-9. 5009C Compatible Position Resolver Schematics

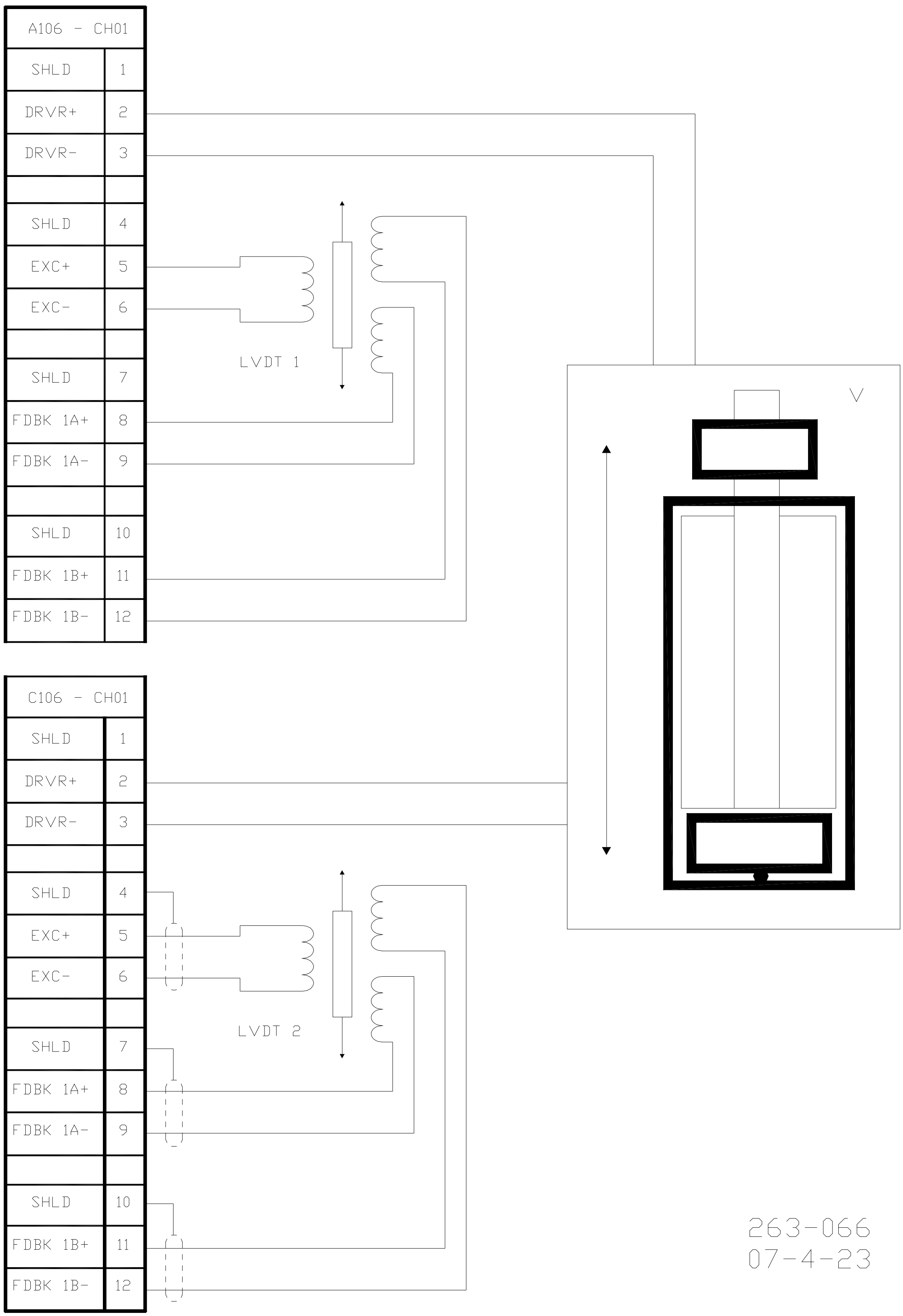


Figure 4-10a. Example of Single Loop with Dual Coil and Two LVDTs Type (A–B)/(A+B) on Cylinder Valve

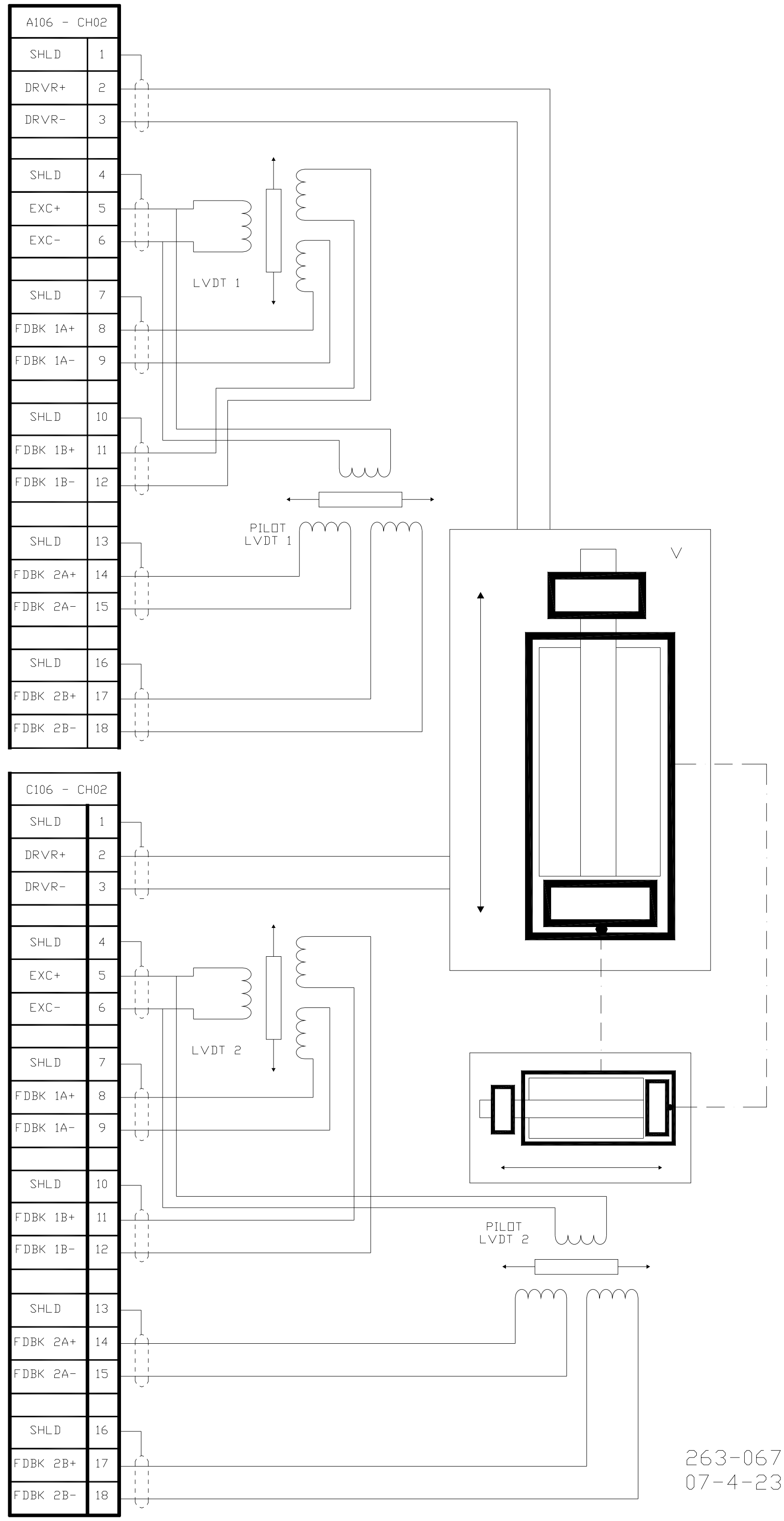


Figure 4-10b. Example of Dual Loop with Dual Coil and Two LVDTs Type (A–B)/(A+B) on Cylinder Valve and Two VDTs Type (A–B)/(A+B) on Pilot Valve

DTM Contact Inputs (F/T Relay–Discrete In)

The 5009C control accepts 24 contact inputs. Each of the control's four Discrete Termination Modules accept six contact inputs. Of the 24 contact inputs available, Seven have functions already assigned to them (preset) and cannot be changed, the other 18 are user-configurable. The Preset Contact Inputs are:

- External Emergency Shutdown #1
- External Emergency Shutdown #2
- External Reset
- External Start
- Raise Speed Setpoint
- Lower Speed Setpoint
- Halt/continue start Sequence

The control will initiate an emergency shutdown any time the External Emergency Shutdown contact input is opened. This input is typically tied into the system's trip string. Before starting, the External Emergency Shutdown input must have an external contact or switch wired to it and it must be closed. The external reset contact can be used to remotely clear latched alarms and trip conditions. The raise and lower speed setpoint inputs can be used to remotely raise and lower speed or load.

Applications requiring external contact inputs must have the desired function assigned or configured to a specific input. Refer to Volume 3 of this manual for a complete list of programmable contact input options. If the 5009C control is configured for a generator application two of the contacts must be configured for the Generator and Utility breaker inputs. The Generator Breaker contact must be wired so it is closed when the generator breaker is closed. The Utility Tie Breaker contact must be wired so it is closed when the utility tie breaker is closed.

Normal Contacts must change state for a maximum of 160 milliseconds and a minimum of 80 milliseconds for the control to sense and register a change in state.

ESD contact (#1 and 2) must change state for a maximum of 20 milliseconds and a minimum of 10 milliseconds for the control to sense and register a change in state.

Contact wetting voltage can be supplied by the control or from an external source. 24 Vdc contact wetting voltage is available on each DTM (with isolation diodes on the power and common lines). Optionally, an external 18–32 Vdc power source or an external 100–150 Vdc power source can be used to source the circuit wetting voltage. (The DTM's CE marking only applies to the 24 V option.) Because all discrete inputs are fully isolated, a common reference point must be established between the input opto-isolators and the contact wetting power source. If the 24 Vdc internal power source is used as for contact wetting, jumpers are required between DTM terminals 33 & 34, and terminals 33 & 35. If an external power source is used for contact wetting, the external source's common must be connected to the DTM's discrete input commons (terminals 34 & 35).

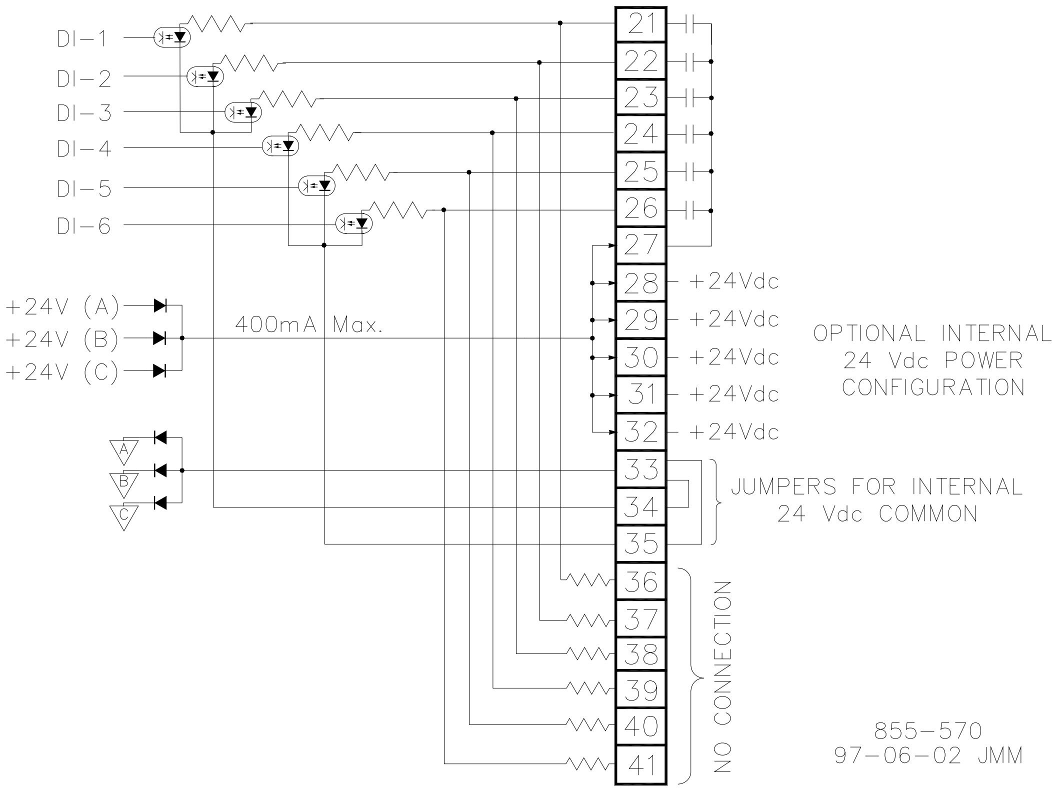


Figure 4-11. Optional Internal 24Vdc Contact Wetting Configuration

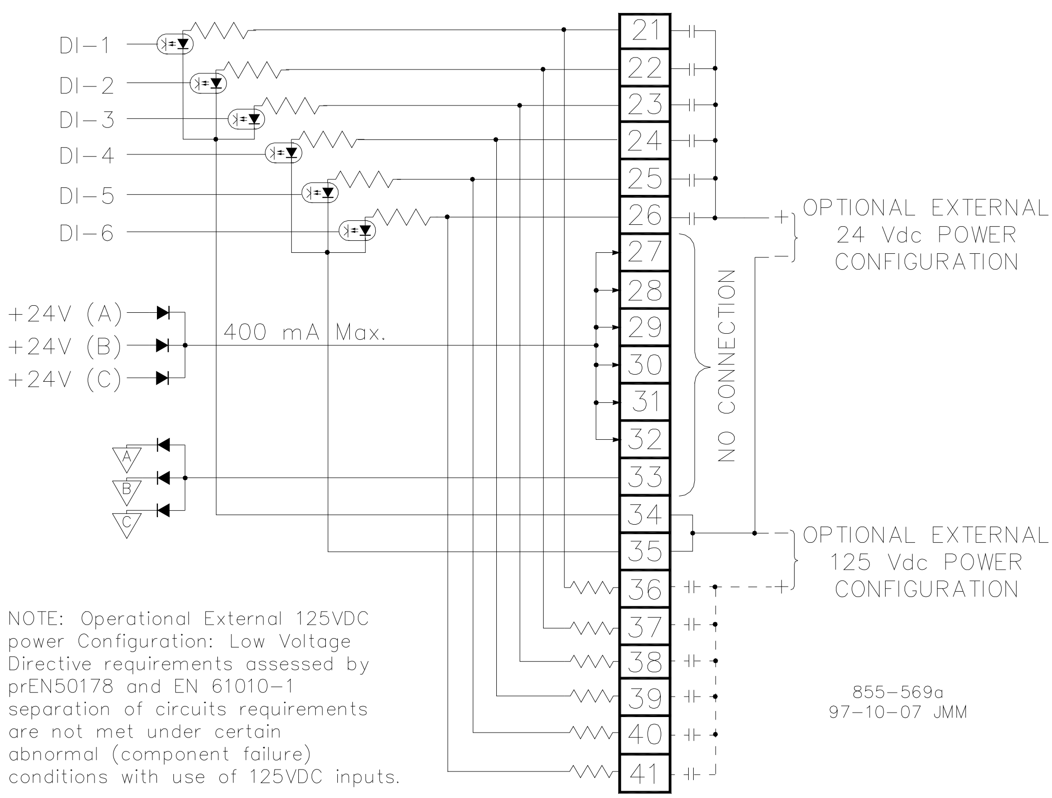


Figure 4-12. Optional External Contact Wetting Configurations

⚠WARNING **HIGH VOLTAGE—If high voltage discrete inputs are used, and there is 125 Vdc on the DTM terminal blocks, there will be 125 Vdc on the DTM cables and cable connectors. All modules should be installed and cables connected before wiring the DTM.**

Wiring Notes:

- Refer to Figures 4-26 through 4-28 for Contact Input wiring connections to the DTMs.
- All contact inputs accept dry contacts.
- The internal 24 Vdc power source, an external 18–36 Vdc power source or an external 100–150 Vdc power source can be used for circuit wetting. (The DTM's European CE Compliance only applies to the 24 V option.)
- If the 24 Vdc internal power source is used as for contact wetting, jumpers are required between DTM terminals 33 & 34 and terminals 33 & 35.
- If an external power source is used for contact wetting, the external source's common must be connected to the DTM's discrete input commons (terminals 34 & 35). To meet CE ratings, power for sensors and contacts must be supplied either by the 5009C power supplies, or the external power supply outputs must be rated for 30 Vdc or less and have its outputs fused with appropriate sized fuses (a maximum current rating of 100/V, where V is the supply's rated voltage or 5 A, whichever is less).
- Each contact input pulls 13 mA @ 24 Vdc (13 mA @ 120 Vdc) when closed, and requires at least 4 mA @ 14 Vdc (4 mA @ 70 Vdc) to recognize a closure command.
- Verify that the correct input terminals are wired to with respect to the level of contact wetting voltage used.
- The combined current draw through terminals 27, 28, 29, 30, 31, and 32 cannot exceed 400 mA or the Discrete I/O module's on-board power converter will current limit.
- It is recommended that 0.75 mm² (20 AWG) or larger wire be used between each discrete input and the DTM.
- DTM terminals accept wires from 0.08–2.5 mm² (27–12 AWG) wire.
- If 125 Vdc Contact Power is used, the Power Supply must meet IEC 6164-1, Overvoltage Category II.
- With the use of 125 Vdc contact power, it is recommended that the contact power be removed before connecting or disconnecting any 5009-to-DTM cable.

DTM Relay Outputs (F/T Relay Outputs)

There are twelve relay outputs available from the 5009C control, with three outputs per DTM. Of the available relay outputs, three are dedicated to functions, and the other nine are user-configurable. The dedicated outputs are:

- Shutdown relay #1
- Shutdown relay #2
- Alarm relay

The remaining nine relay outputs can be programmed to energize upon a function change of state or an analog value level. Applications requiring programmable relay outputs must have the desired switch condition or specific analog value assigned to them within the control's program. Refer to Volume 3 of this manual for a complete list of programmable relay output options.

The 5009C control system does not have the capability to provide circuit power to external circuits interfacing with a relay output. All external circuits interfacing with control relay outputs must have circuit power provided externally. All relays are dust-tight, magnetic blow-out type relays with Form-C type contacts.

Refer to Chapter 6 of this volume for all relay ratings.

Latent Fault Detection

Because a fault tolerant system can tolerate a single fault, it is possible for this fault to go undetected. This is called a latent fault. If another fault occurs when a latent fault exists, it could cause a shutdown. This is why it is important to detect latent faults in a fault tolerant system.

Each relay output can be individually configured to use latent fault detection to identify relay failures without affecting a relay output's state. A fault tolerant relay configuration consists of 6 relays, driven by two discrete outputs from each kernel. The relays are configured in three legs of two relays each. See Figure 4-15. Customer circuit power is connected to one side of the resulting configuration, and customer load to the other side. Field selectable jumpers, located on system DTMs, are provided to allow each output's latent fault detection logic to be compatible with the circuit being interfaced to.

Six individual relays make up one relay output. When a relay output is closed, the contacts of all six relays are closed. Because of the series-parallel configuration that the relays are in, the failure of any two individual relays will not cause the output to be open. The relay output would continue to be closed. Once a relay output is closed, the output's individual relays are periodically opened and re-closed, to ensure that they were in the correct state, and that they change state.

When a relay output is open, the contacts of all six relays are open. Because of the series-parallel configuration that the relays are in, the failure of any one relay will not cause the output to be closed. The relay output would continue to be open. Once a relay output is open, the output's individual relays are periodically closed and re-opened one by one, to ensure that they were in the correct state, and that they change state. Position readback circuitry allows the state of each relay contact to be detected. Any failures are annunciated, and further testing is disabled without affecting the state of the relay output contact or control operation.

Latent fault detection (LFD) is not usable with all applications or circuits. The control's LFD logic can only work with circuits using voltages between 18–32 Vdc, 100–150 Vdc, or 88–132 Vac. For LFD to work, a small leakage current is passed through the circuit's load. See Figure 4-18. Depending on the size of the load, the leakage current may be enough to cause a load to be on or active, when a relay contact is open. In this case, the individual relay's LFD logic may be disabled, eliminating the leakage current.

If LFD is desired, but the leakage current is too great for the load, an external resistor may be connected in parallel with the circuit's load to shunt some of the leakage current away from the load. To prevent failure of a load to de-energize, careful consideration should be given, to ensure that the voltage developed across the load due to leakage current is below the load's drop-out voltage.

With LFD, when a relay contact is closed, no difference in operation is experienced; the relay output appears as a closed contact. However, when a relay contact is open, it appears to the interfaced circuit as a large resistor instead of an open contact. Thus a small amount of current is leaked to the load, resulting in a developed voltage across the load. In most cases this has no bearing on the customer's circuitry, because such a small amount of voltage is developed across its load. However, when a relay output is used with a very high resistance load (low current load), enough voltage may be developed across the load to prevent it from de-energizing.

To verify if Latent Fault Detection can be used with a relay output:

1. Verify that circuit the relay output is used with has a voltage level of 18–32 Vdc, 100–150 Vdc, or 88–132 Vac. If circuit voltage is not within these ranges, disable the relay output's latent fault detection by placing the relay jumpers in their disable state. See Figure 4-16.

2. Use the graph below (Figures 4-13, 4-14, or 4-15) which corresponds to the circuit's voltage level to determine if the voltage developed across the load (due to the leakage current) is lower than the load's drop-out voltage level.
   - Acquire the resistance of the load (relay, motor, solenoid, etc.) to be driven by the relay.
   - Acquire the load's minimum drop-out voltage.
   - From the bottom of the graph, follow the line corresponding to the load's resistance, up until it intersects the circuit power line. At this point the corresponding voltage level (on the left of the graph) is the level of voltage that will be developed across the load due to leakage current.

3. If the developed load voltage (from the graph) is less than the load's drop-out voltage, latent fault detection can be used with the circuit.

4. If the developed load voltage is greater than the load's drop-out voltage, it is recommended that latent fault detection be disabled, or that a resistor be connected in parallel (shunt) with the load. A correctly sized resistor connected in parallel with the circuit load will decrease the developed load voltage below the load's drop-out voltage level. Using the corresponding LFD graph and the load's minimum drop-out voltage, perform the above procedure in reverse (See Step #2) to determine an acceptable shunt resistance. When selecting a shunt resistor also verify that its voltage and wattage ratings meet that of the circuit.

LFD Verification Example:
Circuit Power = 110 Vac
Load Resistance = 200 Ω
Load drop-out voltage = 25 Vac

Using the graph in Figure 4-14, the intersection point between the 200 Ω load resistance line and the 110 Vac line was found. From this intersection point it was determined that the voltage developed across the load due to leakage current (when the relay is open) is approximately 7.5 Vac. This voltage level is lower than the load's 25 Vac drop-out voltage, thus Latent Fault detection can be used with this example circuit.

If, however, the load resistance was 1200 Ω, the intersection would be approximately 29.5 Vac too high for LFD. By following the graph along the 25 Vac line to the 110 V line, a total load resistance of 900 Ω is needed. By placing a properly rated 3600 Ω resistor in shunt with the load, (1200//3600⇨900) LFD can be used.

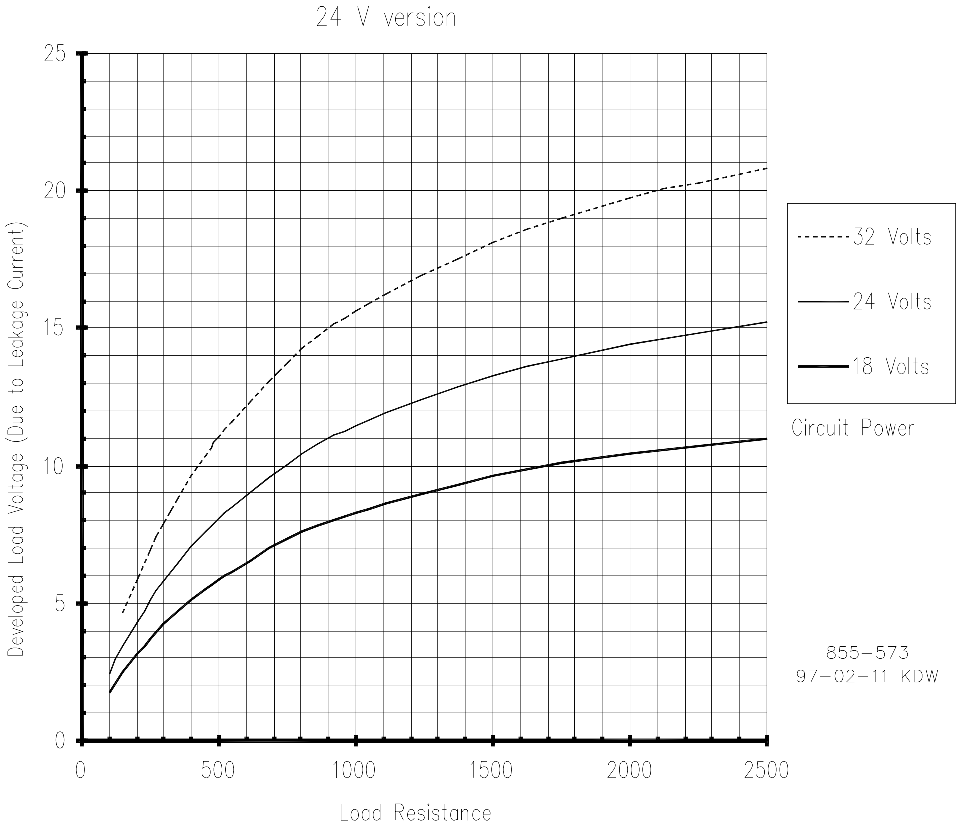


Figure 4-13. Latent Fault Detection Verification Graph—18–32 Vdc Circuitry

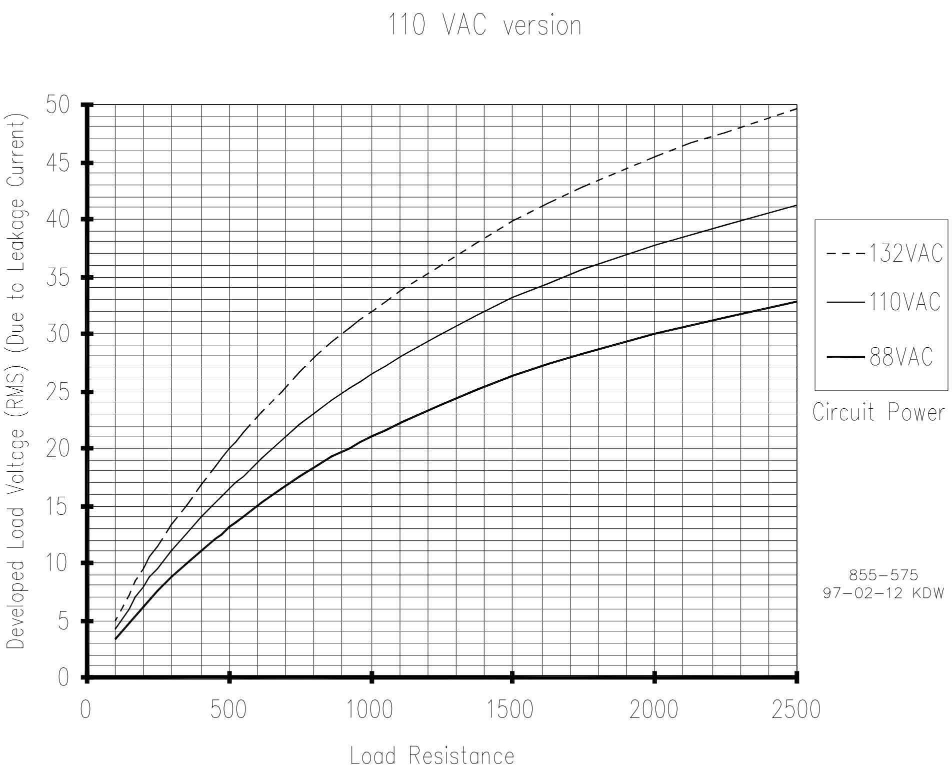


Figure 4-14. Latent Fault Detection Verification Graph—88–132 Vac Circuitry

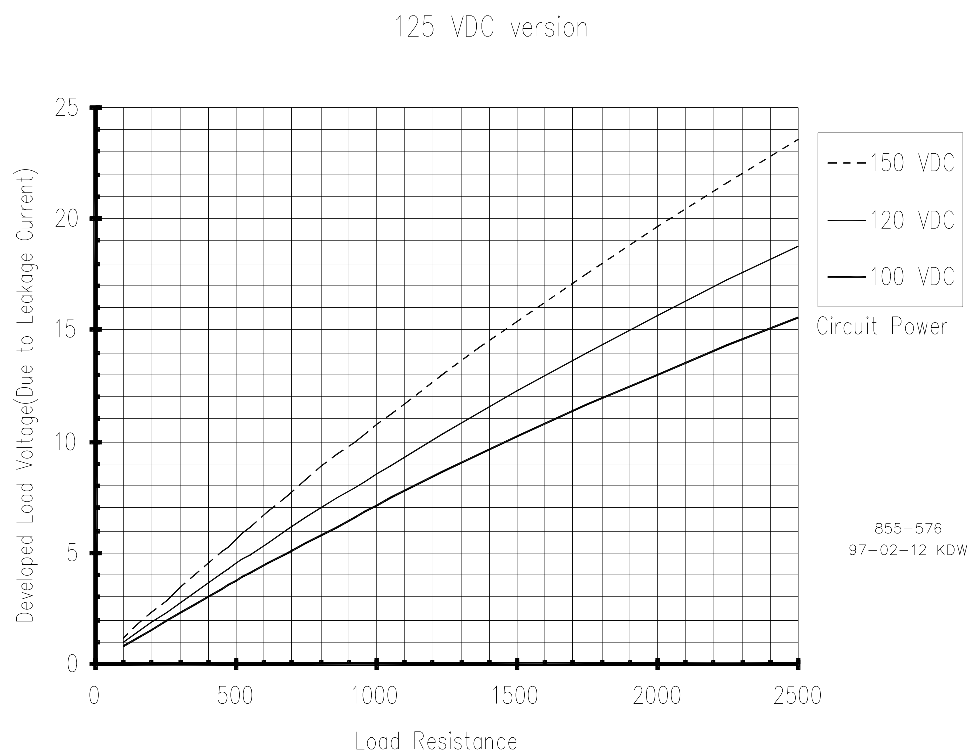


Figure 4-15. Latent Fault Detection Verification Graph—100–150 Vdc Circuitry

Relay Jumper Configurations

Relay coil power should be supplied by the control. Three independent isolated sources are diode selected (High Signal Selected) to power each DTM's relay coil. Jumper banks (four jumpers in one package) are provided on each DTM to allow field selection of internal or external relay coil power. See Figures 4-16 and 4-18. If external relay coil power is supplied, the relay coil power jumper bank must be moved from its defaulted INT. position to the EXT. position.

A DTM includes terminals and internal jumpers to allow its relay coils to be powered by an external power source. This relay coil power configuration was designed for systems which may not have the power sourcing capability to power all system modules and relays (custom designed systems). The 5009C however, has sufficient power to supply all unit modules and relays.

IMPORTANT	**To retain circuit integrity if an external power supply is used for relay coil power, it must be an isolated 24 Vdc source, with ±5% regulation. When using an external power source for relay coil power, it is recommended that a start-up routine be utilized to remove the source during system power-up and power down. This routine will guarantee that no relay is inadvertently energized due to system power-up surges. (By using the DTM's internal relay coil power this start-up routine is automatically performed.)**

With this system's power configuration it is recommended that the control's internal power be used to supply the DTM's relay coils at all times.

Field configurable jumpers are used on DTMs, to allow a relay's latent fault detection logic to be compatible with different levels of circuit power and to choose which set of relay contacts to test (normally open or normally closed). Each relay output has two banks of jumpers (multiple jumpers in one package).

One jumper-bank (a set of nine jumpers) is used to match the latent fault detection (LFD) circuit with the circuit voltage being interfaced with. The second jumper bank (a set of four jumpers) is used to select which set of relay contacts (N.O. of N.C.) is tested by the LFD logic. During operation, only one set of relay contacts (normally open or normally closed) can be tested. The set of relay contacts tested should be same set of relay contacts used by the circuit interfaced to. Refer to Figure 4-16. LFD can be jumper configured to be compatible with the following circuit voltages:

- 18–32 Vdc circuit power (meets CE & UL ratings)
- 88–132 Vac circuit power (meets UL ratings only)
- 100–150 Vdc circuit power (meets UL ratings only)

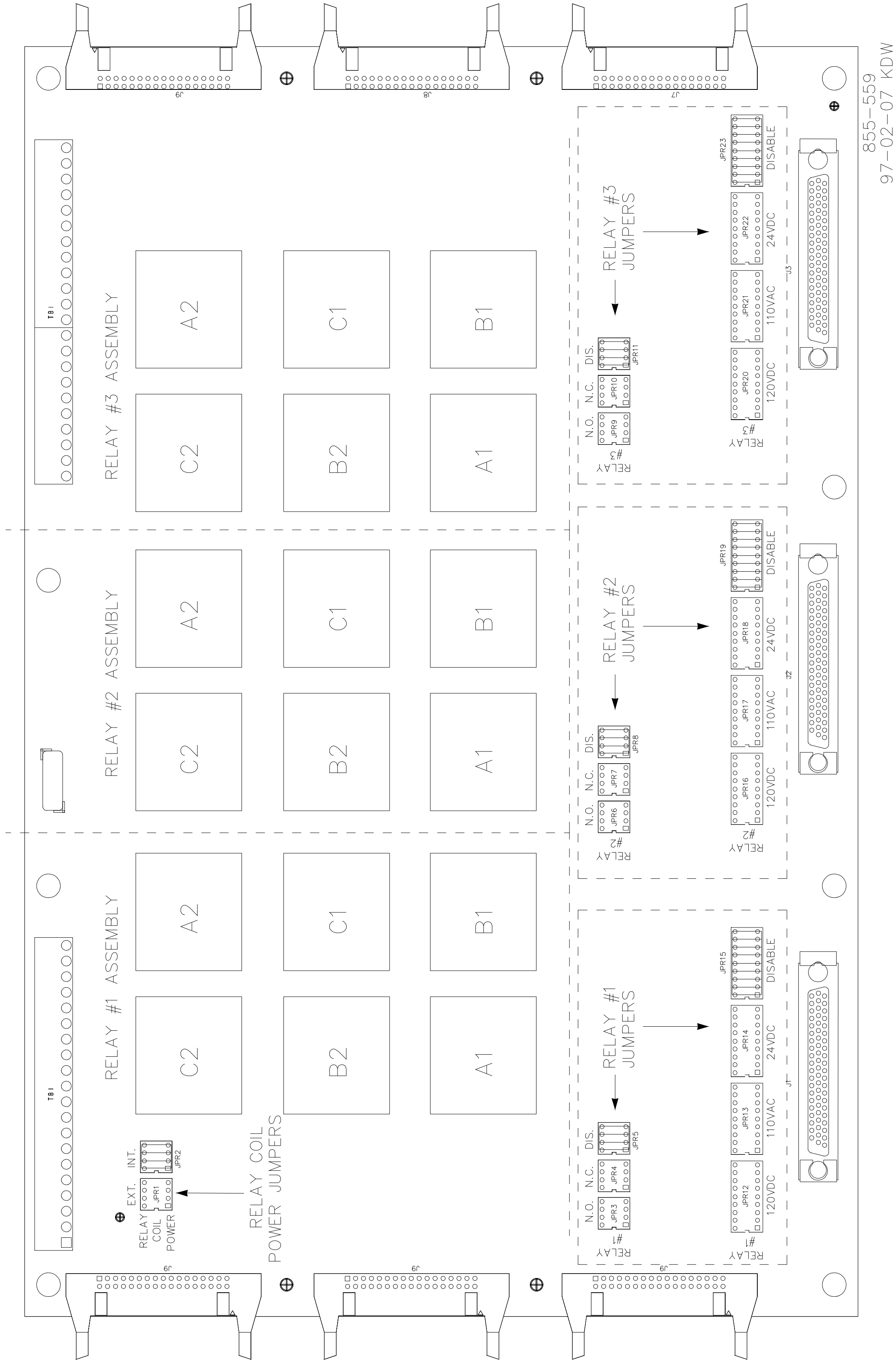


Figure 4-16. Jumper and Relay Location Diagram

After all jumper-banks have been correctly positioned, mark the placement of each jumper-bank on the DTM cover labels, located on each DTM's outer cover. See Figure 4-17.

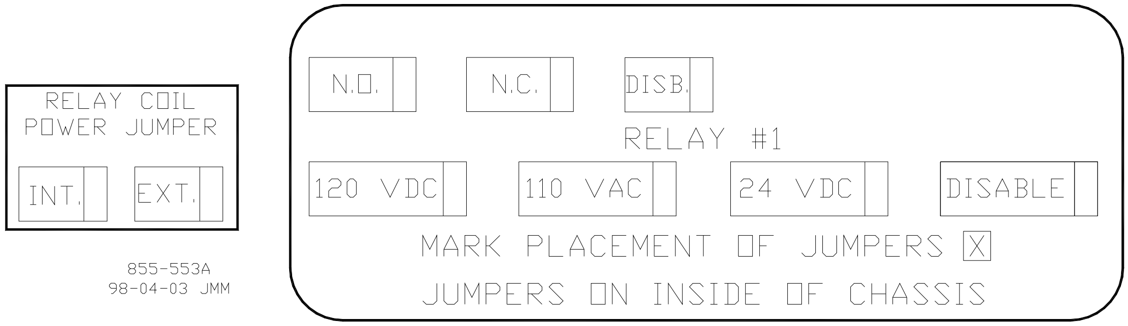


Figure 4-17. DTM Labels

Wiring Notes:

- Refer to Figures 4-26 through 4-29 for relay output wiring connections to the DTMs.
- Verify that each set of relay contacts meet the power requirements of the circuit which it is being used with. Interposing relays are required in cases where the interfaced circuit demands relay contacts with a higher power rating. If interposing relays are required, it is recommended that interposing relays with surge (inductive kick-back) protection be used. Improper connection could cause serious equipment damage.
- Verify system power is off before removing or installing any DTM jumper. All jumpers are fragile, use caution when removing and installing DTM jumper-banks.
- Select internal or external relay coil power. If the control's internal power is used verify that the DTM's "Relay Coil Power Jumper" bank is in the INT. position. If external relay coil power is supplied, move the DTM's "Relay Coil Power Jumper" bank to the EXT. position and verify that the external source is fully isolated. (Mark the DTM's label to indicate jumper position.)
- Verify if Latent Fault Detection (LFD) can be used with each relay output.
- If LFD cannot be used with the relay output, verify that the relay's LFD jumper-banks are in their Disable positions. (Mark the DTM's label to indicate jumper position.) Alternatively an external resistor can be wired in parallel with the load to allow LFD to be used with the relay output. In this case it is the customer's responsibility to calculate the required resistor ratings and install it.
- If LFD can be used with the relay output, move the relay's LFD jumper- bank to the correct circuit power position. Also select which set of relay contacts (NO or NC) are to be tested by the LFD logic. Mark the DTM labels to indicate jumper positions.

WARNING	**HIGH VOLTAGE—Relay circuit power is also present on a DTM's relay and cable connectors. When using high voltage relay circuit power, it is recommended that care be taken not to touch exposed connectors when replacing relays or cables. If possible remove relay circuit power from all DTM relays before replacing any DTM relay or cable.**

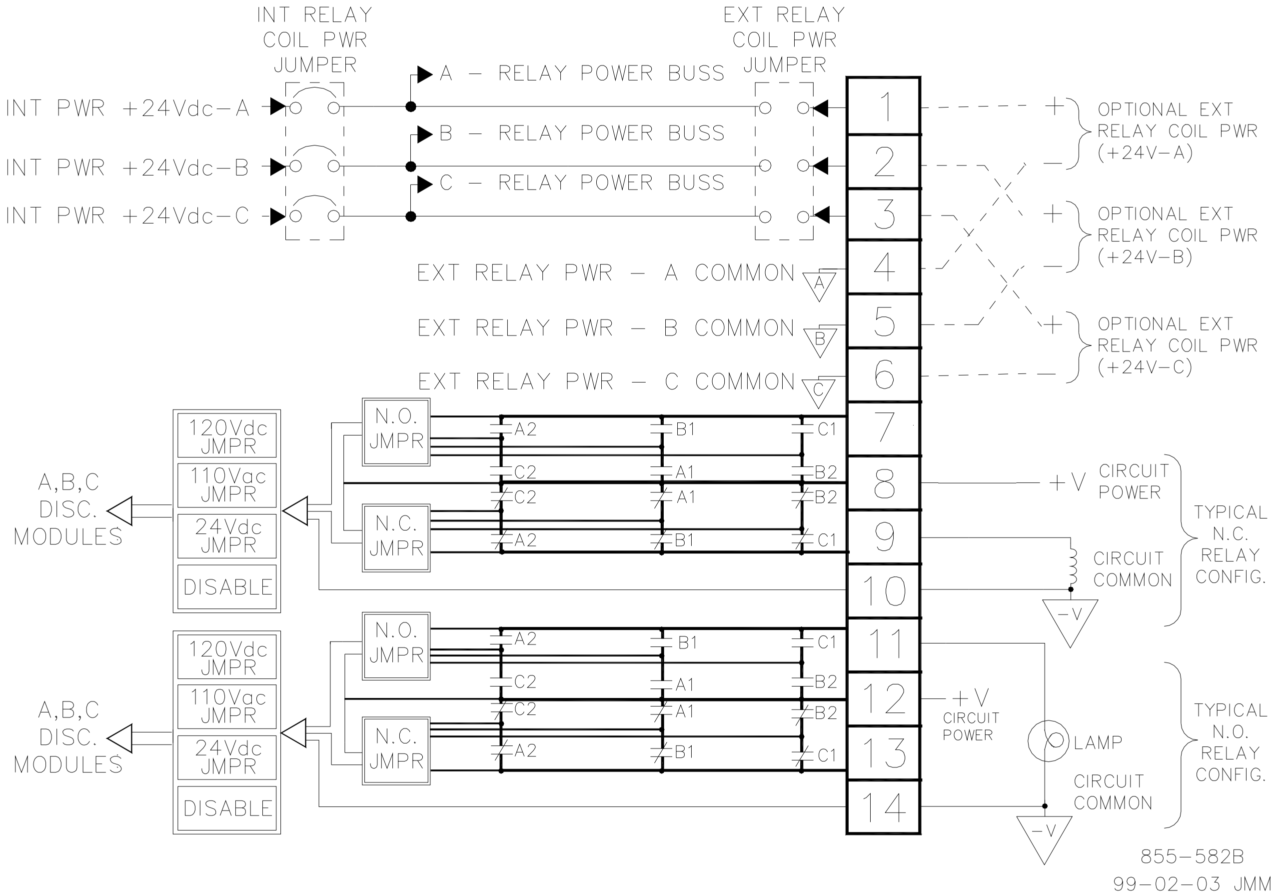


Figure 4-18. Example Relay Output Wiring Diagram

Serial Communications

Each control has a minimum of three serial communication ports, one on each CPU. Serial Input/output (SIO) modules are provided in the A and B kernel section to increase communication reliability, redundancy, and the number of available communication ports.

When an SIO card is installed in a kernel, the CPU communication port on the same kernel cannot be used anymore for Modbus communication. CPU-C port can only be used as a PCI interface port. CPU-B can be configured as a PCI backup, Modbus #2 port 2 (if no SIO_B installed) or printer.

Modbus #1 and Modbus #2 each have two communication ports connected. It is recommended that these two ports used for the same Modbus (#1,#2), have the same settings.

Port configurations:

- CPU-A (RS-232 only) functions as a Modbus #1 port 1 communication port, or is disabled, if SIO-A is installed.
- CPU-B (RS-232 only) functions as a Modbus #2 port 2 communication port (unless SIO-B is installed), Alarm/Trip printer driver port. It can also be configured to automatically become the PCI interface port if CPU-C fails.
- CPU-C port (RS-232) functions as a DDE communication port for PCI.
- SIO-A Port 1 (RS-232) functions as an Alarm/Trip Printer driver port.

- SIO-A port 2 (RS-232) functions as an interface port to Woodward's servPanel program.
- SIO-A port 3 (RS-232/422/485) functions as Modbus #1 port 1.
- SIO-A port 4 (RS-232/422/485) functions as Modbus #2 port 1 or DDE communication for PCI.
- SIO-B Port 1 (RS-232) functions as an Alarm/Trip Printer driver port
- SIO-B port 2 (RS-232) functions as an interface port to Woodward's servPanel program.
- SIO-B port 3 (RS-232/422/485) functions as Modbus #1 port 2 or DDE communication for PCI.
- SIO-B port 4 (RS-232/422/485) functions as Modbus #2 port 2.

All communication ports can interface with other devices via RS-232 communication. RS-232 communication is limited to a distance of 15 m (50 ft). In cases where a device which is being interfaced to is located a distance of greater than 15 m (50 ft) from the control, it is recommended to use SIO cards. It is possible also to use RS-232 to RS-422/485 converters. CPU communication ports are considered less reliable than SIO port. As a consequence, if Modbus communication is used as a main interface device, it is recommended to use SIO cards. If Modbus redundant lines are required, it is recommended to use SIO cards.

RS-422 and RS-485 communication support multidropping (multiple slaves on a single communication line); RS-232 communication does not.

To allow an RS-232 based port to reach farther than 15 m/50 ft, a Model 285 Superverter from Telebyte Technology Inc. of Greenlawn NY, or equivalent, can be used as an RS-422 or RS-485 interface converter. RS-422 and RS-485 communications also support multidropping (multiple slaves on a single communications line); RS-232 communications does not.

Each SIO module includes four serial ports. Ports 1 and 2 are RS-232 communications based ports only. Ports 3 and 4 can be configured for RS-232, RS-422, or RS-485 communications. With the use of RS-422 or RS-485 communications, the control can interface with a device through serial communications up to 1219 m (4000 ft) from the control. Alternatively one or two SIO modules may be installed within the control's chassis.

Figures 4-19 and 4-20 show the control's communication port connections. The 5009C control can simultaneously communicate with up to four Modbus based devices via the CPU-A port, CPU-B port, SIO-A port 3, and SIO-B port 3 using ASCII or RTU Modbus transmission protocols. Refer to Volume 3 of this manual for a list of all the Modbus commands and parameters available.

The CPU-C port is dedicated for DDE communications and is intended to be used as the main interface with the system engineering workstation (PCI program software loaded onto a computer). Optionally port 4 on any installed SIO module may also be used for DDE communications. Refer to Volume 3 of this manual for details on DDE communications and the PCI program. An RS-232 based null-modem cable (W20) is provided with the system to use when interfacing between a computer and the control. Upon a failure of the CPU-C port or kernel-C CPU, the control can be configured to use the CPU-B port as the PCI interface port.

Three port filter assemblies (one per CPU) are provided with each system to protect the CPU from external system noise. These filter assemblies are shipped separately from the control and can be easily installed if use of the CPU port is required. Refer to Chapter 2 of this volume for installation instructions.

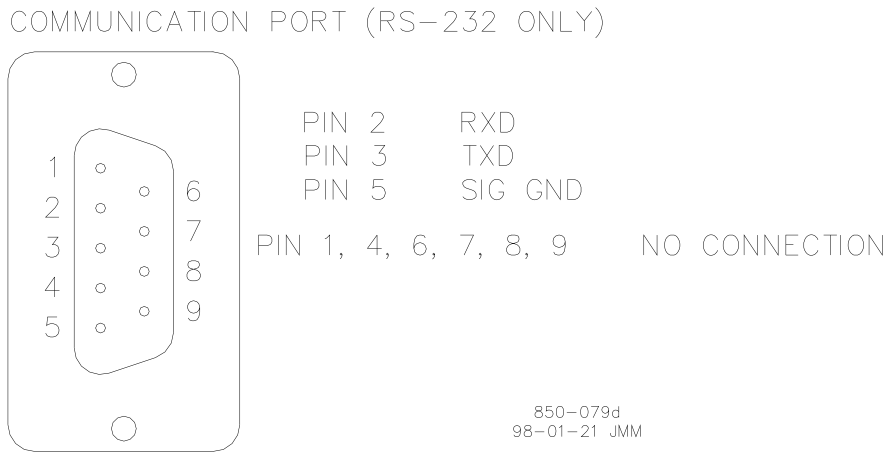


Figure 4-19. CPU Communications Port

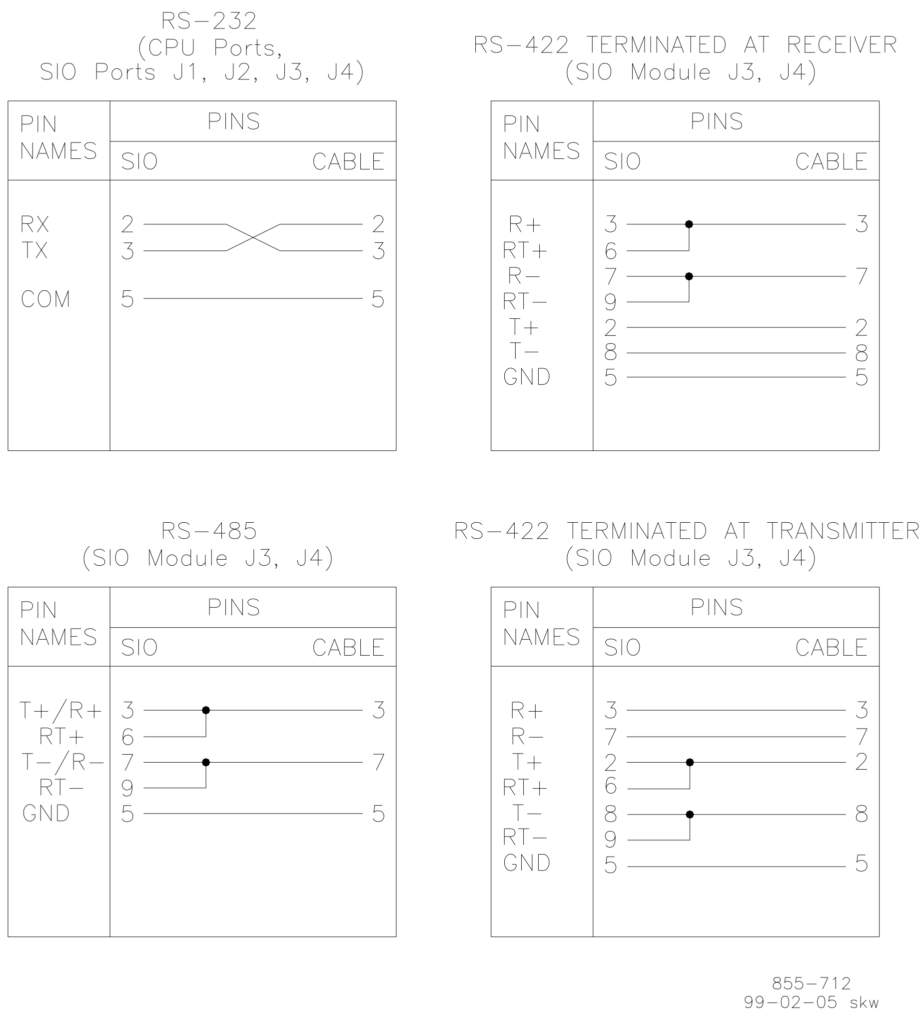


Figure 4-20. Typical Communications Cable Connections

Printer

Optionally a line printer can be utilized with the 5009C control to print alarms as they occur, and upon command, the system's last 100 Alarms, or the systems last 20 trips. The CPU-B port or an SIO module's Port 1 are the only ports which have the capability to interface with a line printer. Before the CPU-B port will correctly function with a serial printer it must be configured for this function through the control's PCI engineering workstation. Refer to Volume #3 of this manual for information on configuring the CPU-B port, and printing alarm and trip lists.

See Figure 4-30 for a diagram of the required printer communications cable. If an operator interface is provided with the system, optionally a line printer can connected to the OpView for alarm documentation.

Control Wiring Diagrams

When installing a system, follow all I/O specific wiring notes (covered earlier in this chapter) and general wiring notes below. For ease of identification system notes are displayed within a triangle on each wiring diagram. The number that appears in a triangle pertains to a wiring note. The subsequent sheets of the plant wiring diagram each represent a field termination module or panel. Refer to Table 3-1 and Figure 3-1 for device identification.

Wiring Notes

1. Refer to Table 4-1 for input power ratings.
2. Refer to Chapter 6 for input power ratings.
3. Customer supplied wiring.
4. Optional Wiring (dependent upon system options).
5. Read and follow all Wiring notes, instructions, and recommendations within this chapter when electrically installing a system.
6. Confirm each connection before operating unit.
7. All analog inputs must be isolated from earth ground.
8. Follow authorized standards for conduit loading and sealing.
9. All wires to terminal blocks shall have wire markers, marked with associated terminal number.

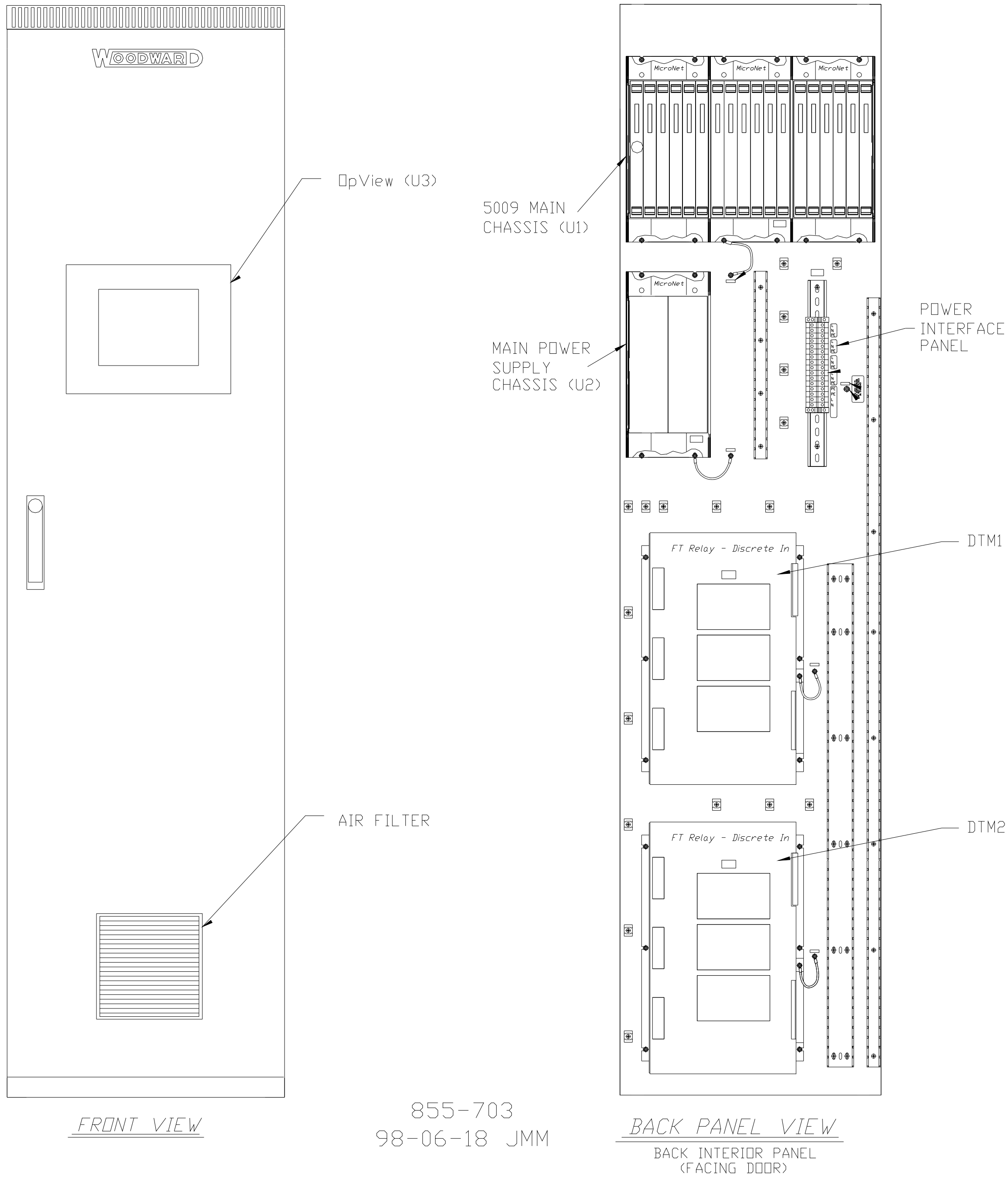


Figure 4-21a. Cabinet—Device Location Diagram

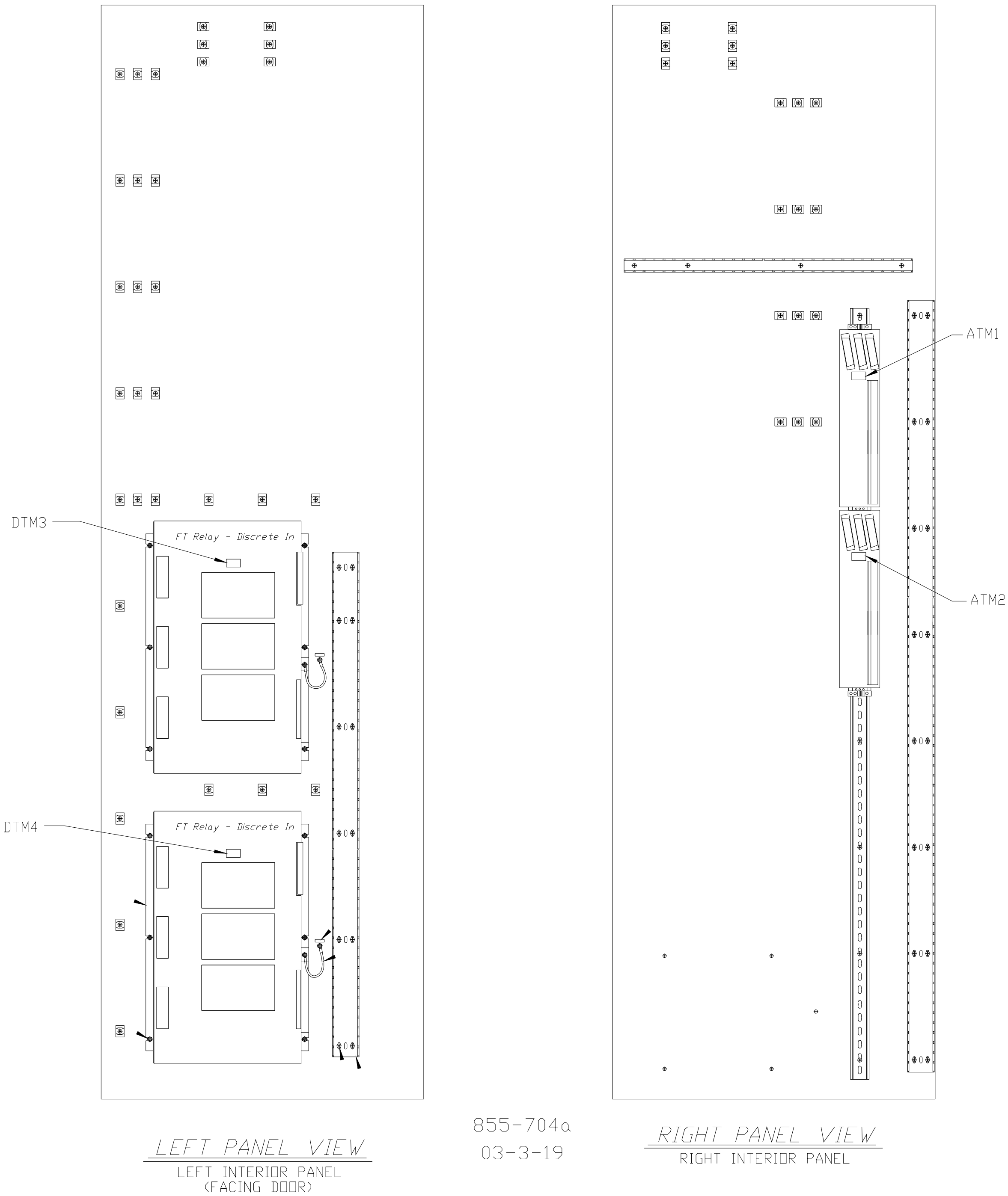


Figure 4-21b. Cabinet—Device Location Diagram

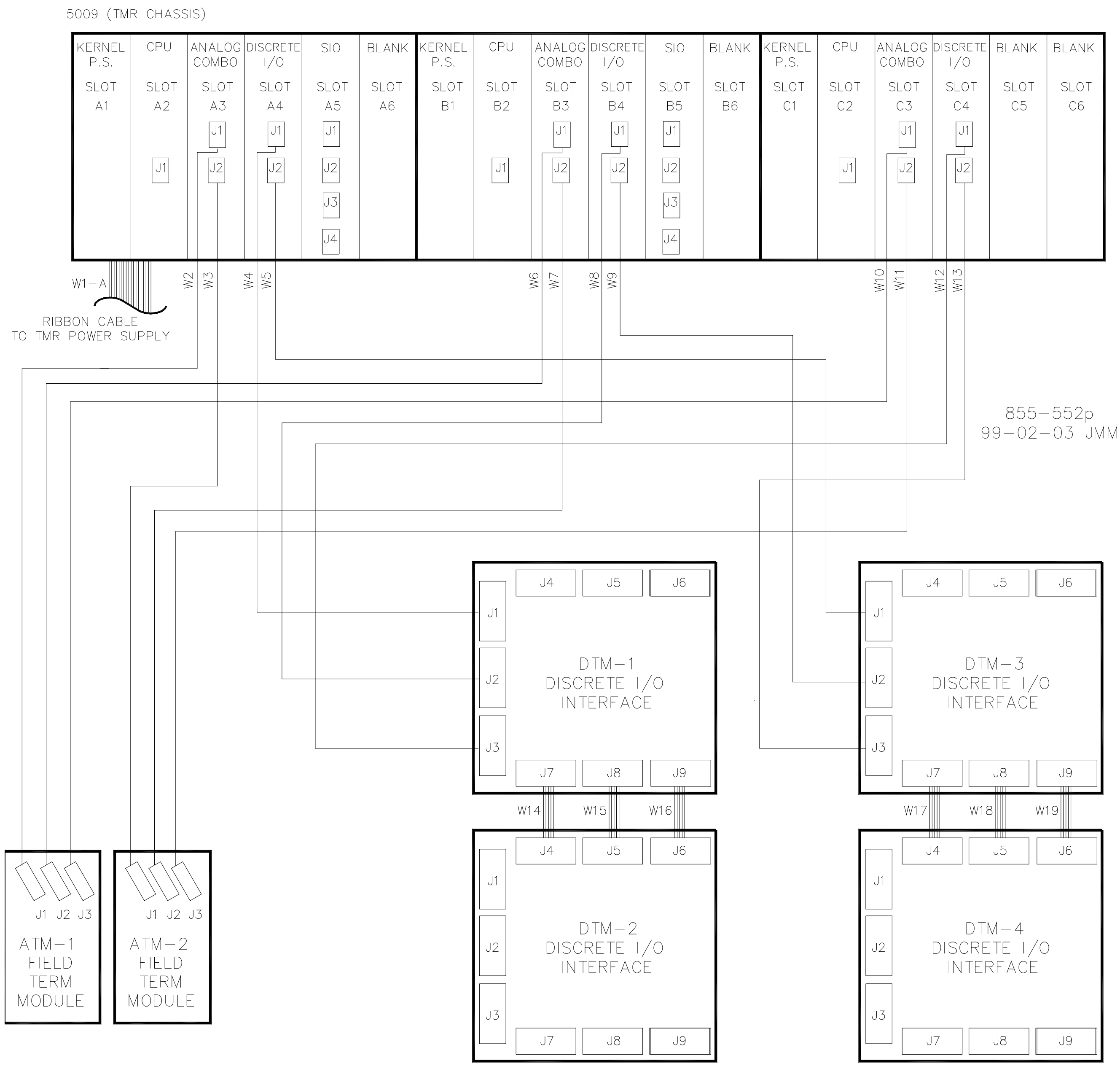


Figure 4-22. System Cable Layout Diagram

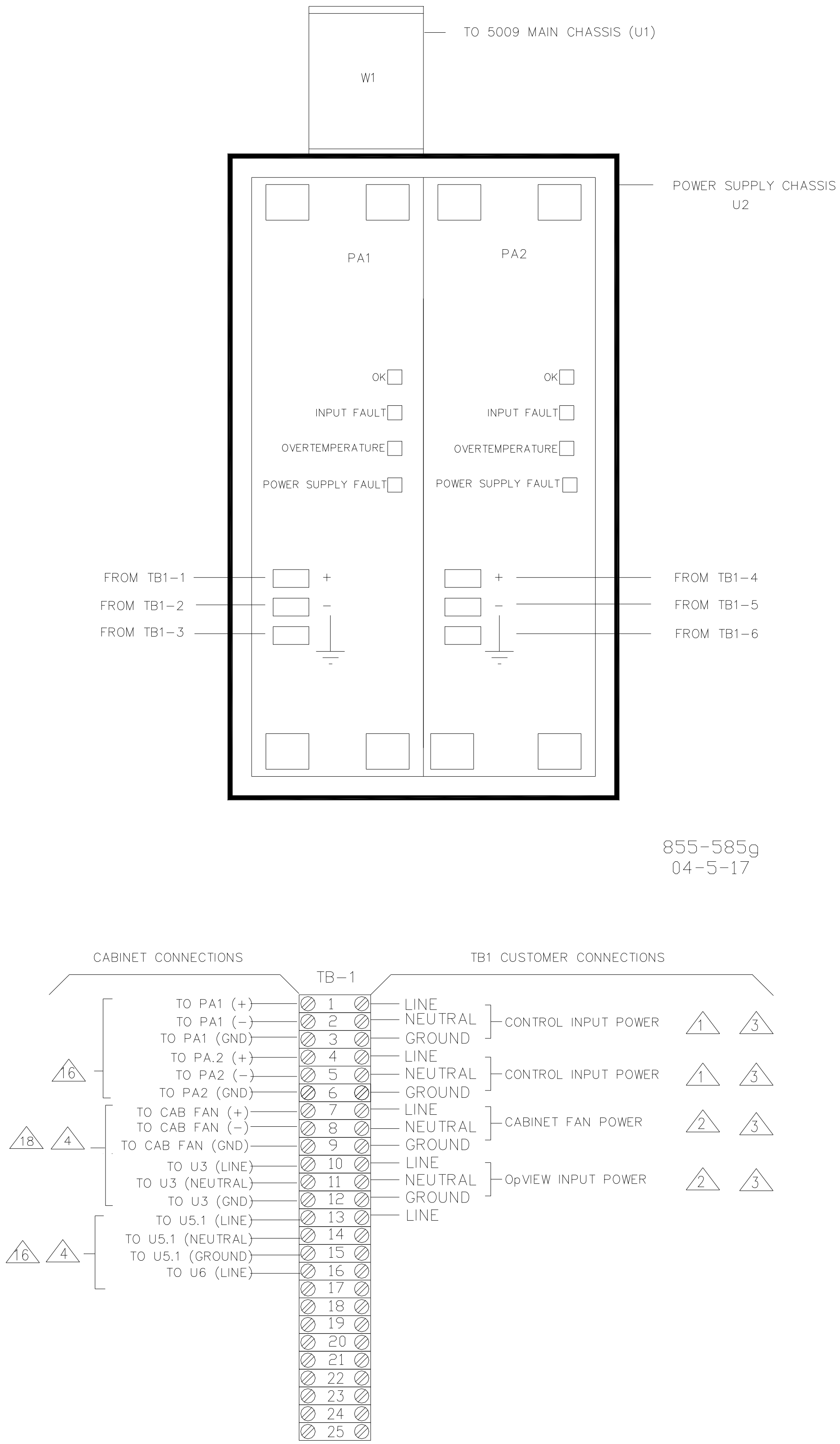


Figure 4-23. Power Supply Wiring Diagram

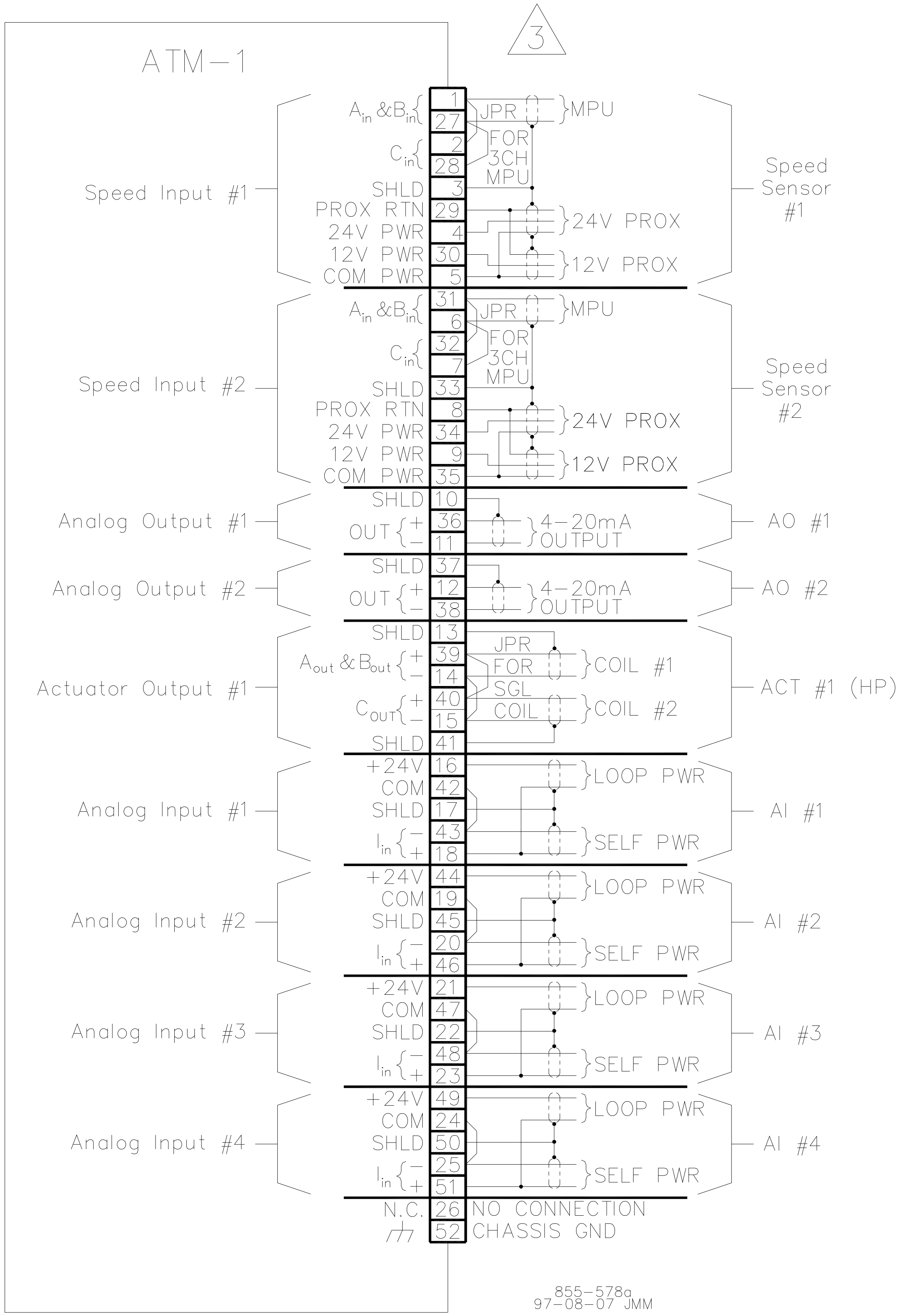


Figure 4-24. ATM–1 Wiring Diagram

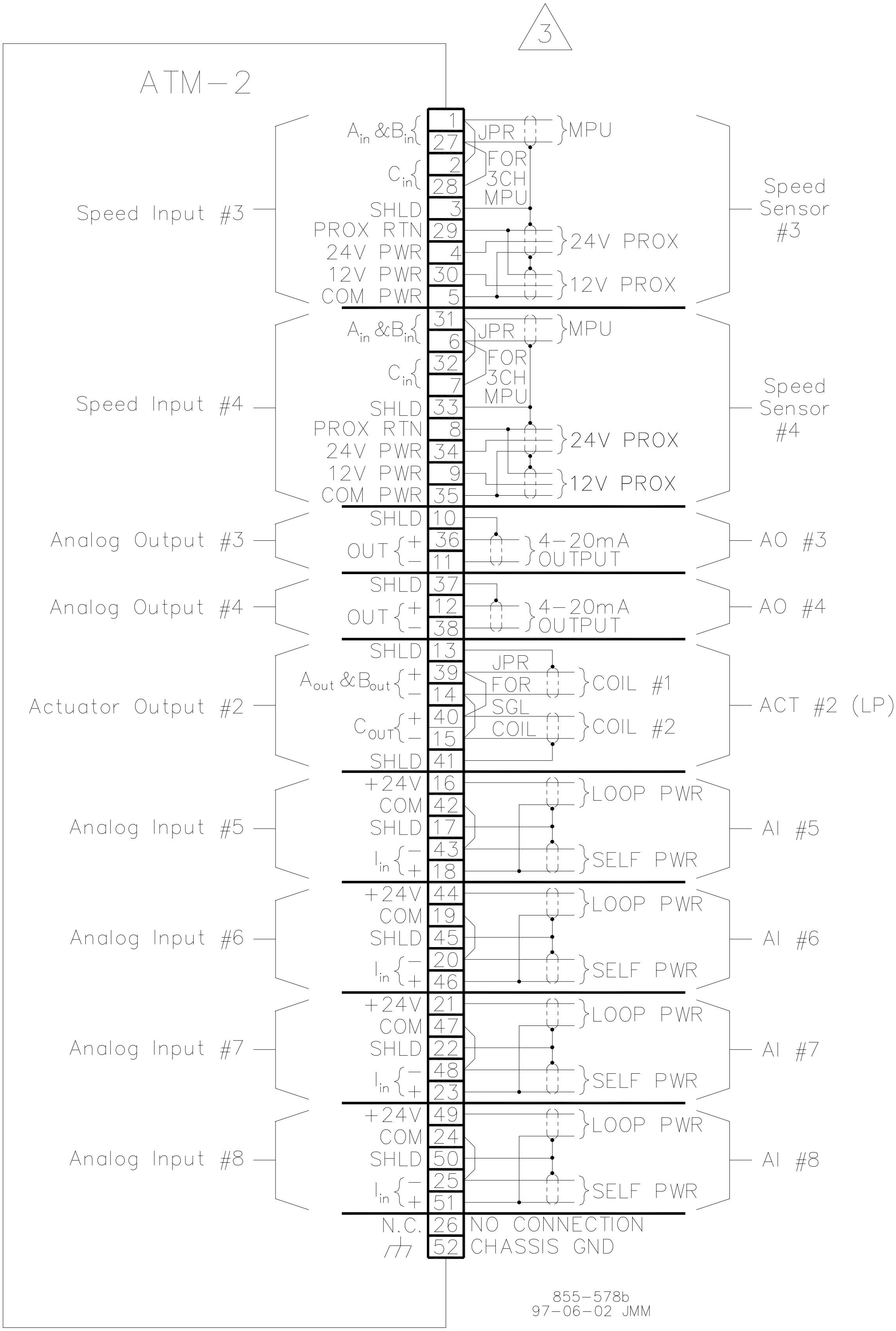


Figure 4-25. ATM–2 Wiring Diagram

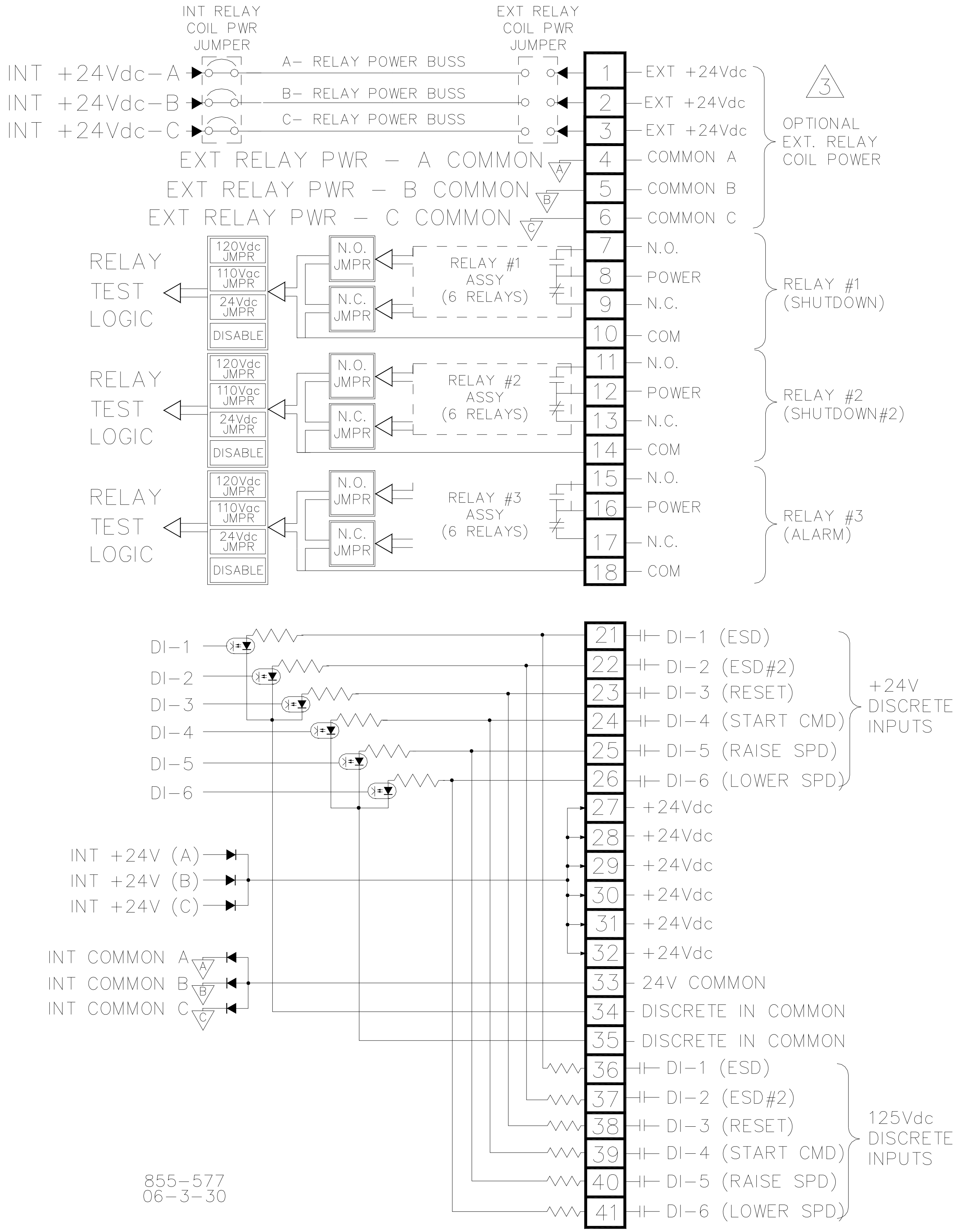


Figure 4-26. DTM–1 Wiring Diagram

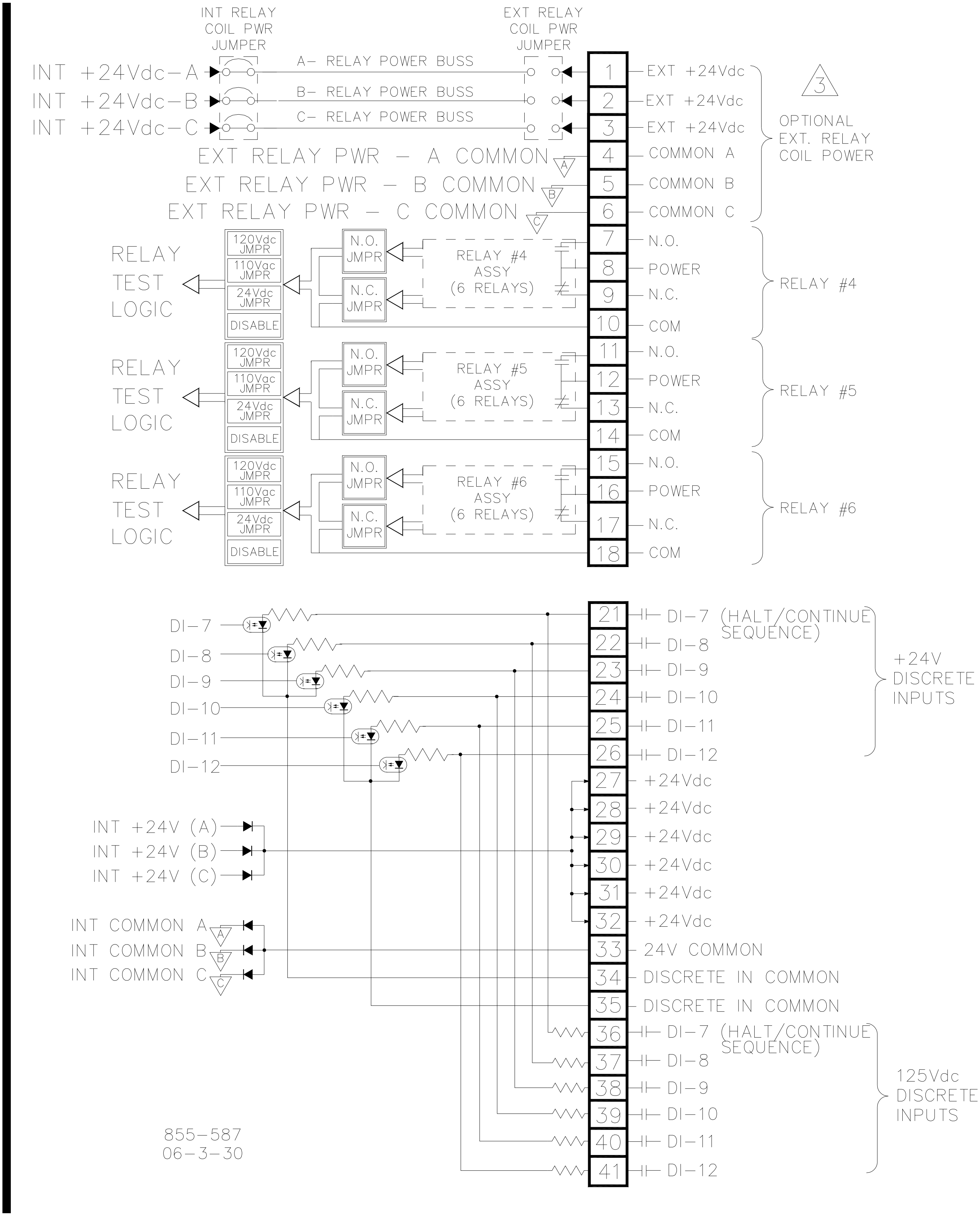


Figure 4-27. DTM–2 Wiring Diagram

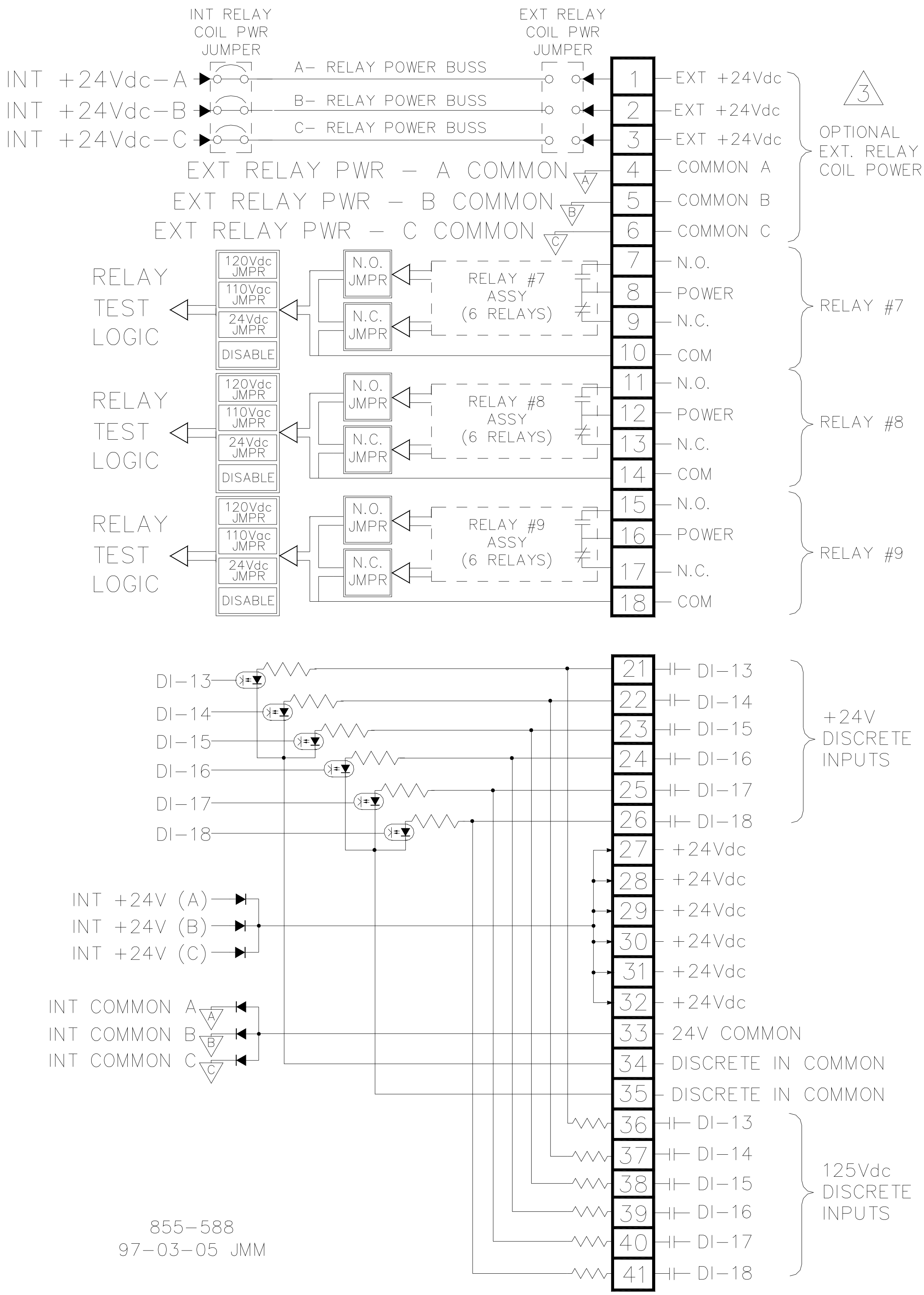


Figure 4-28. DTM–3 Wiring Diagram

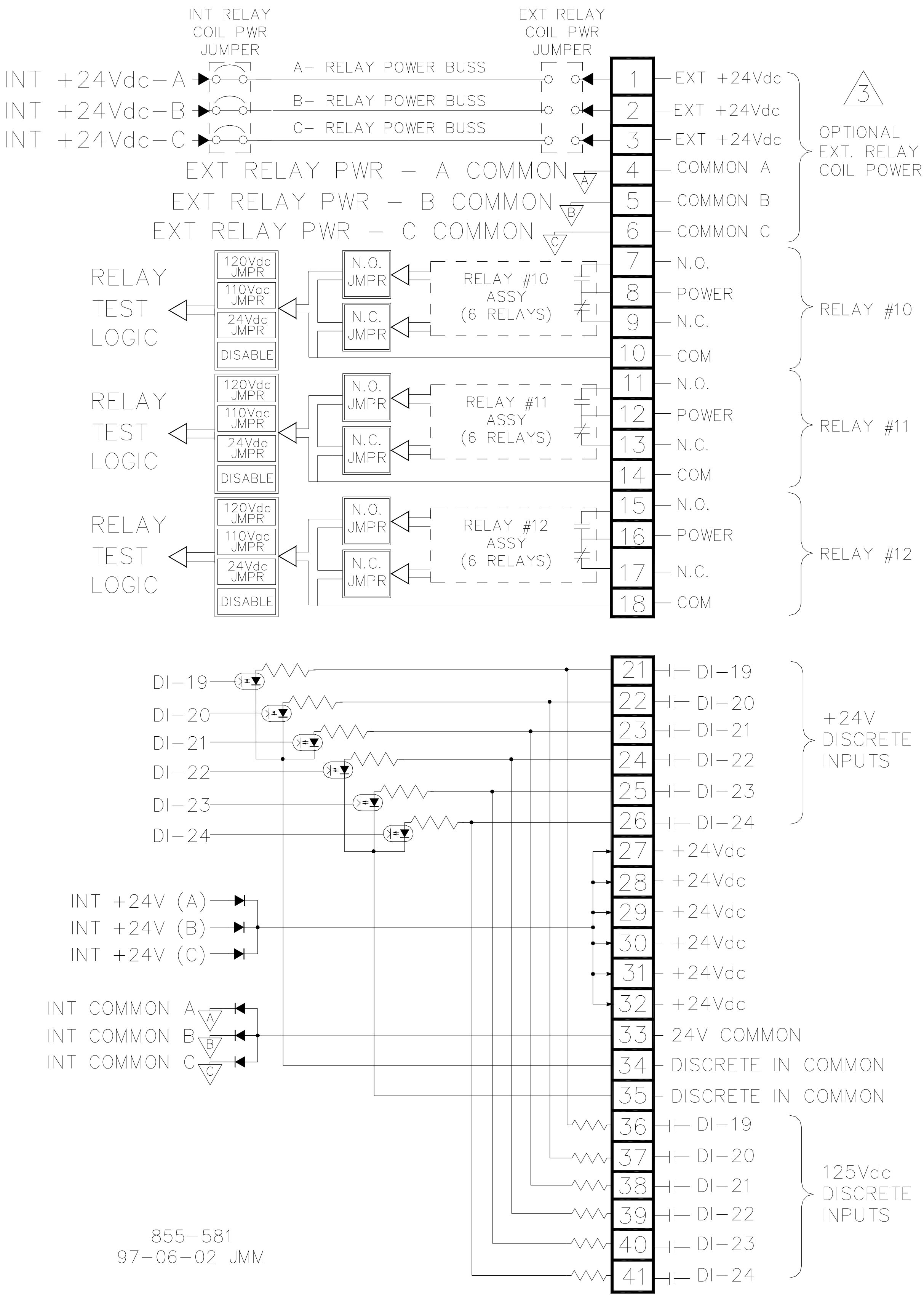


Figure 4-29. DTM–4 Wiring Diagram

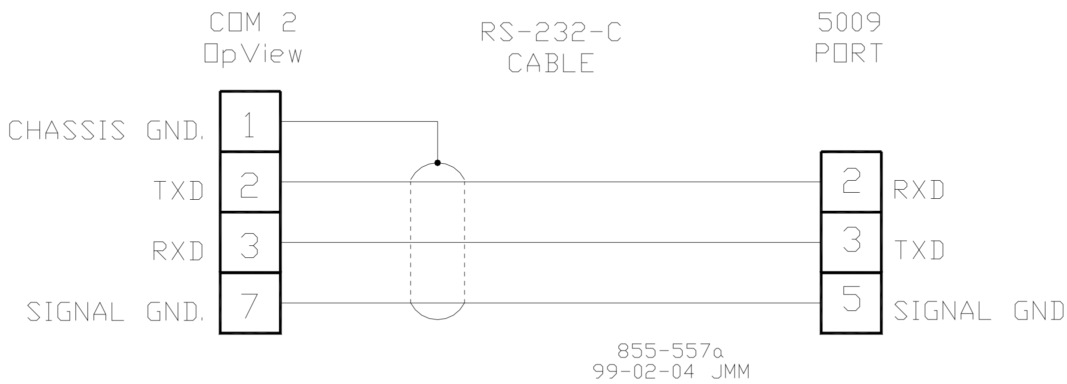


Figure 4-30. OpView Cable Diagram

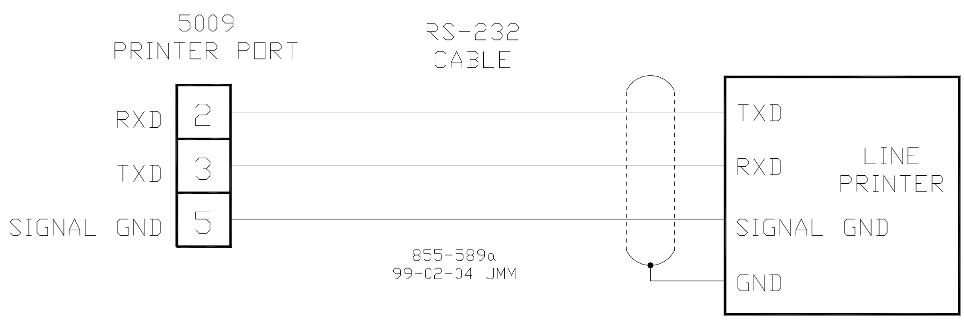


Figure 4-31. Optional Alarm Printer Diagram

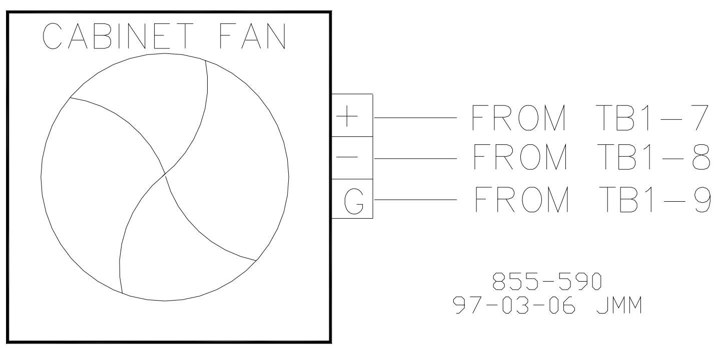


Figure 4-32. Cabinet Fan Diagram

System Power-Up

If at any time during this procedure the defined or expected result is not achieved, step to Chapter 5 of this volume and begin system troubleshooting.

1. Turn the power for one power supply on and verify that the power supply's green LED is the only power supply LED on.

2. Turn the power for second power supply on and verify that the power supply's green LED is the only power supply LED on.

3. Momentarily toggle the A, B, and C-Rack's CPU RESET switch up (press the switch's top half), then back to its normal down position (press the switch's bottom half).

At this point the system will perform off-line diagnostics, this diagnostics testing could take a couple of minutes. When all CPUs have synchronized and completed their diagnostic tests, no red LEDs should be on, and the control will begin running the application program.

IMPORTANT	**When the RESET switch is toggled to the down position the CPU's red Fault and Watchdog LEDs should go out and the green RUN LED should go on. At this time the CPU is performing the self-diagnostics and boot-up processes. If only one CPU has been reset (other CPUs still failed) the 5009C will wait for another CPU to boot-up before both CPUs will go to a running state.**

⚠WARNING	**Improperly calibrated devices can cause turbine damage and possible personnel injury or death. Before starting the turbine for the first time, and periodically thereafter, verify the calibration of all external input and output devices.**

Chapter 5.
Troubleshooting and Module Replacement

Introduction

This chapter provides detailed information on system hardware, gives tips to assist in solving hardware related issues, and includes module replacement instructions. Once a system problem is annunciated, this chapter can be utilized as a troubleshooting guide to assist problem finding and if necessary module replacement.

Because testing all functions of an individual module is beyond the scope of this manual, when the results of the procedures indicate that a module may be faulty, replace the suspected module with a module known to be good. This will help verify that the cause of the problem actually is in the suspected module.

If after following this chapter's guidance the cause of a problem cannot be found, contact the Woodward technical assistance group.

NOTICE **Only qualified service personnel should perform the following module replacement procedures.**

Main Power Supply

System diagnostic routines continuously monitor each main power supply for proper operation. If a fault condition is detected, the fault is annunciated, and the supply's output disabled. If necessary, use the power supply's front panel LEDs to assist in diagnosing a related problem. If all supply LEDs are turned off (not illuminated), it is probable that input power is not present and verification should be made.

Main Power Supply LED descriptions:

OK LED—This green LED turns on to indicate that the power supply is operating and no faults are present.

INPUT FAULT LED—This red LED turns on to indicate that the input voltage is either above or below the specified input range. If this LED is on, check the input voltage and correct the problem. Long-term operation with incorrect input voltages may permanently damage the power supply. Once the input voltage is within the supply's input specifications, this LED will turn off. Refer to Table 4-1 for power supply input specifications.

OVERTEMPERATURE LED—This red LED gives an early warning of a thermal shutdown. The LED turns on to indicate when the internal power supply temperature reaches approximately 80 °C. If the internal supply temperature rises further to approximately 90 °C the supply will shutdown. Because of the many variables involved (ambient temperature, load, thermal conductivity variations) there is no accurate way of predicting the time between the indication of Overtemperature (LED illuminated) and power supply shutdown. If this LED is turned on, verify that the fan in the power supply chassis is turning and is free of dust or other obstructions and that the temperature around the power supply is less than 55 °C. If the power supply is cooled down without delay, it can recover from this situation without shutting down. This LED will turn off once the internal supply temperature decreases below approximately 75 °C.

POWER SUPPLY FAULT—This red LED turns on when one of the supply's three power converters has shut down. If this LED is on, check for a short circuit on external devices connected to the control's power supply. Once the short circuit is removed, the supply may resume normal operation. If no short circuit is found, try resetting the supply by removing input power for one minute. Once input power has been restored, if the power supply is still not functioning, verify that the supply is properly seated to the motherboard connector, if still not functioning, replace the supply.

Each main power supply must have its own branch circuit rated fuse or circuit breaker. A main power supply module has internal fuses, however these fuses do not protect the supply's input circuitry, and will only open in the event of a component failure internal to the power supply. If any of the supply's internal fuses are open, replace the supply.

To Replace a main power supply (PA1, PA2):

1. Read all warnings on pages v and vi of this Volume before replacing any module.
2. Remove input power from the power supply being replaced.
3. Unscrew front panel mounting screws, and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down.
4. Remove module by pulling straight out.
5. Install a new power supply by aligning the circuit board edges in the card guides and push the unit into the slots until the connectors on the modules and the connectors on the motherboard make contact.
6. With even pressure exerted at the top and bottom of the supply's front panel, firmly push the unit into place.
7. Tighten the screws that secure the module in place (two at the top and two at the bottom).
8. Re-apply power to the input of the power supply.

Kernel Power Supply (A1)

Each kernel section of the MicroNet™ TMR control contains one kernel power supply module located in the first slot of the kernel. This module receives 24 Vdc from the main TMR supply and regulates it to 5 Vdc, 10 A for the rest of the kernel section. The kernel power supply also creates a 5 V precharge voltage. There are no switches on this module. A Fault LED is on the front panel of the power supply. It will illuminate if a problem occurs with the 5 V or 5 V precharge.

The kernel power supply module also assists in CPU to CPU communications. If the control reports a CPU to CPU communication fault, the affected kernel power supply module may need to be replaced.

⚠WARNING

The MicroNet Kernel Power Supplies must have all modules in that kernel removed before installing or removing a Kernel Power Supply.

With this control the removal of any single kernel will not cause a shutdown. However, if other faults are present within other kernels, those faults combined with any faults created by the removal of this kernel power supply may cause a system shutdown.

To Replace a Kernel power supply module:

1. If the control is running and on-line, use the system engineering workstation to verify that the other CPUs are running without faults. Correct all other CPU faults within the other kernel sections before replacing a kernel's power supply.

2. Switch the respective kernel's CPU Reset switch to its reset position (push top of switch in).

3. Remove all kernel modules except for the Kernel Power Supply. Unscrew each module's captive screw fasteners and release the modules from their motherboard connectors by pressing their top handles up and their bottom handles down. To simplify this procedure it is recommended that the released modules be left within their respective rack slots, with their respective cables attached.

4. Unscrew the Kernel Power Supply module's captive-screw fasteners, and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down. Remove the module by pulling straight out and place it into a conductive plastic bag (Woodward P/N 4951-041).

5. Install the replacement supply module by aligning the circuit board edge in the card guides and push the module into the slots until the connector on the module and the connector on the motherboard make contact.

6. With even pressure exerted at the top and bottom of the supply's front panel, firmly push the supply module into place. Tighten the two screws that secure the module in place (one at the top and one at the bottom).

7. Re-insert all kernel modules one at a time. With even pressure exerted at the top and bottom of each module's front panel, firmly push the module into place. Tighten the two screws that secure each module in place (one at the top and one at the bottom).

8. Reset the kernel CPU by toggling its reset switch (press the top half of the switch in, then press the bottom half of the switch in). At this point the kernel CPU will perform off-line diagnostic tests for approximately 60 seconds then re-synchronize with the other control CPUs.

CPU Module

System diagnostic routines continuously monitor each CPU for proper operation. If a fault condition is detected, the fault is annunciated and the CPU is locked out of all voting. If necessary, use the CPU module's front panel LEDs to assist in diagnosing a related problem. If all CPU LEDs are turned off (not illuminated), it is probable that input power is not present and verification should be made. If only one CPU module has all of its LEDs off, it is probable that the kernel power supply is not functioning. The CPU module has the following indicators and switch:

RUN LED—This green LED turns on when the CPU is operating and no faults are present.

I/O LOCK LED—This red LED turns on when a major CPU or I/O module hardware fault has been detected. When a major fault is detected, the fault is annunciated, all discrete outputs are locked in a de-energized state and all analog output signals locked to zero current. The reason for a hardware fault can be viewed through the engineering workstation. After the problem has been corrected, perform a CPU reset to unlatch the I/O lock logic.

LOW VCC LED—This red LED turns on when the Kernel power supply's +5 Vdc output is out of its specified limits. If this LED is on and remains on after a CPU reset, replace the Kernel power supply.

WATCHDOG LED—This red LED turns on if the CPU stops executing the application program. After the problem has been corrected, perform a CPU reset to unlatch the watchdog LED logic.

RUN/RESET Switch—This switch resets the CPU and I/O modules (Kernel) when in the RESET position (obtained by pressing the switch's top half). When in the RUN position (obtained by pressing the switch's bottom half) the CPU performs a boot-up sequence, then the Kernel functions normally. To reset the Kernel momentarily toggle this switch to the Reset position, and return it to the Run position.

To Replace a CPU module:

1. Read all warnings on pages v and vi of this Volume before replacing any module.

2. If the control is running and on-line, use the system engineering workstation to verify that the other CPUs are running without faults.

3. Switch the CPU's Reset switch to its reset position (push top of switch in).

4. Disconnect any communication cable.

5. Unscrew the CPU module's captive-screw fasteners and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down.

6. Remove the module by pulling straight out and place it into a conductive plastic bag (Woodward P/N 4951-041).

7. Install the replacement CPU by aligning the circuit board edge in the card guides and push the module into the slots until the connector on the module and the connector on the motherboard make contact.

8. With even pressure exerted at the top and bottom of the module's front panel, firmly push the module into place.

9. Tighten the two screws that secure the module in place (one at the top and one at the bottom).

10. Switch the CPU's Reset switch to its normal position (push bottom of switch in).

Analog and Discrete I/O Modules

Each I/O Module has a red Fault LED controlled by the CPU, that is turned on when the system is reset. During initialization of an I/O module, which occurs after every CPU reset, the CPU turns the Fault LEDs on. The CPU then tests each I/O module using diagnostic routines built into software. If the diagnostic test is not passed, the LED remains on. If the test is successful, the LED goes off. If the Fault LED on a module is illuminated after the diagnostics and initialization have been run, the module may be faulty or in the wrong slot.

If during normal control operation all Kernel I/O modules have their Fault LEDs on, check the Kernel CPU for a failure. If during normal control operation, only one module's Fault LED is turned on or flashing, replace this module. A flashing LED indicates that a certain module failure has occurred, and is used by factory technicians to locate module faults. When a module fault is detected, its outputs are disabled or de-energized.

Each Analog I/O Module has a fuse on it. This fuse is visible and can be changed through the bottom of the plastic cover of the module. If this fuse is blown, replace it with a fuse of the same type and size (24 Vdc/.1 A).

To Replace an Analog or Discrete I/O module:

1. Read all warnings on pages v and vi of this Volume before replacing any module.

2. If the control is running and on-line, use the system engineering workstation to verify that the other CPUs are running without faults.

3. Unscrew the module's captive-screw fasteners, and release the module from the motherboard connectors by pressing the top handle up and the bottom handle down. At this point the module should be unseated from the motherboard connector, but still within the control rack.

4. Disconnect both module I/O cables. The I/O cables use a slide latch (to disengage slide the latch up). To eliminate the possibility of causing a system trip when replacing a module always un-seat the module before disconnecting the I/O cables. (A system trip is possible if a number of the cable connector pins are shorted to chassis ground.)

5. Remove the module by pulling straight out and place it into conductive plastic bag (Woodward P/N 4951-041).

6. Install the replacement module by aligning the circuit board edge in the card guides and pushing the module into its slot. To reduce the number of system alarms, take care not to allow the module to become in contact with the motherboard connector.

7. Re-connect both module I/O cables. The I/O cables use a slide latch (to secure cable, slide the latch down). To eliminate the possibility of causing a system trip when replacing a module always connect the I/O cables before seating the module to the motherboard. (A system trip is possible if a number of the cable connector pins are shorted to chassis ground.)

8. With even pressure exerted at the top and bottom of the module's front panel, push the module into place until the module connector is firmly within the motherboard's module receptacle. Once properly installed the module Fault LED will be illuminated until the module is re-initialized by the control. Upon installing the module, the control performs module diagnostic tests for a few seconds, and if all test are passed, re-initializes the module (turning off the module Fault LED).

9. Tighten the two screws that secure the module in place (one at the top and one at the bottom).

IMPORTANT

If the module's Fault LED does not turn off after the module has been installed for at least one minute, it may be necessary to re-seat the module more firmly. To re-seat a module follow step #3 of the above procedure to release the module from the motherboard, then re-install the module by following procedure steps #8 and #9.

Serial Input/Output (SIO) Module (Optional)

Two Serial Input/Output (SIO) modules are installed within the control chassis. The SIO modules are installed in slot 5 of kernels A and B. Ports 1 and 2 are RS-232 communications based ports only. Ports 3 and 4 can be configured for RS-232, RS-422, or RS-485 communications. System diagnostics continuously monitor each SIO module for proper operation.

SIO Module LED descriptions:

RUN LED—The green LED turns on to indicate that the SIO module is functioning and there are no faults present.

FAULT LED—The red LED turns on to indicate a module fault has occurred and is annunciated.

WARNING

Hot Swapping the SIO module can cause a dip in the 5 Vdc supply. Depending on the severity of the dip, other modules or the CPU can be forced into a reset state.

With this control, the removal of any single kernel will not cause the control to shut down. However, if other faults are present within other kernels, those faults, combined with any faults caused by shutting down the kernel power supply, may cause a system shutdown.

To Replace an SIO module:

1. Read all warnings on pages v and vi of this volume before replacing any module.

2. If the control is running and on-line, use the system engineering workstation to verify that the other CPUs and kernels are running without faults.

3. Switch the respective kernel's CPU Reset Switch to its reset position (push top of switch in).

4. Disconnect any communication cables from the SIO Module.

5. Unscrew the SIO modules captive-screw fasteners and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down.

6. Remove the module by pulling straight out and place it into a conductive plastic bag (Woodward P/N 4951-041)

7. Install the replacement SIO module by aligning the circuit board edge in the card guides and pushing the module into the slots until the connectors on the module and the connectors on the motherboard make contact.

8. With even pressure exerted at the top and bottom of the module's front panel, firmly push the module into place.

9. Tighten the two screws that secure the module in place (one at the top and one at the bottom).

10. Reconnect the communication cables to the SIO module.

11. Switch the CPU's Reset switch to its normal position (push bottom of the switch in).

2 Channel Actuator Module

Analog and Discrete Module and FTM troubleshooting instructions apply to the 2 Channel Actuator Module and FTM with the exception of the fuses. The Actuator FTM does not contain any fuses, however the Actuator Chassis Module does have a fuse accessible at the rear bottom edge of the module. In case of module non-operation, this fuse may be checked before replacing the module. If it is faulty replace with a .2 A / 250 V fuse.

Termination Modules

The replacement of termination modules can be performed on-line (while the unit is operational) or off-line (while the unit is shut down).

Caution must be taken whenever replacing a termination module on-line, or a unit trip could result. The procedure used in the replacement of termination modules on-line varies based on the control's configuration and system wiring configuration. Contact a Woodward representative to establish the correct termination procedure to use based on your configuration.

To replace an Analog or Discrete Termination Module while the unit is off-line:

1. Read all warnings on pages v and vi of this Volume before replacing any module.
2. Shut down the control.
3. Remove all power from the system. Do not attempt to replace a termination module with the system powered.
4. Disconnect all ATM/DTM and field wiring.
5. Disconnect all ATM/DTM cables. The I/O cables use a slide latch (to disengage, slide the latch toward the cable end).
6. Remove the termination module from its panel and install its replacement.
7. Re-connect all cables. The I/O cables use a slide latch; to secure cable, slide the latch away from the cable end.
8. Re-connect all field wiring.
9. Re-apply all power to the system.
10. Reset all CPUs.

To replace ATM Fuses:

1. Read all warnings on pages v and vi of this Volume before replacing any fuse. If the control is running and on-line, take care not to come in contact with any ATM circuitry.
2. Remove ATM cover.
3. Verify that the circuit problem has been corrected.
4. Locate and replace fuse (See Figure 5-1) with one of the same size and rating (24 Vdc/0.1 A).
5. Replace ATM Cover.

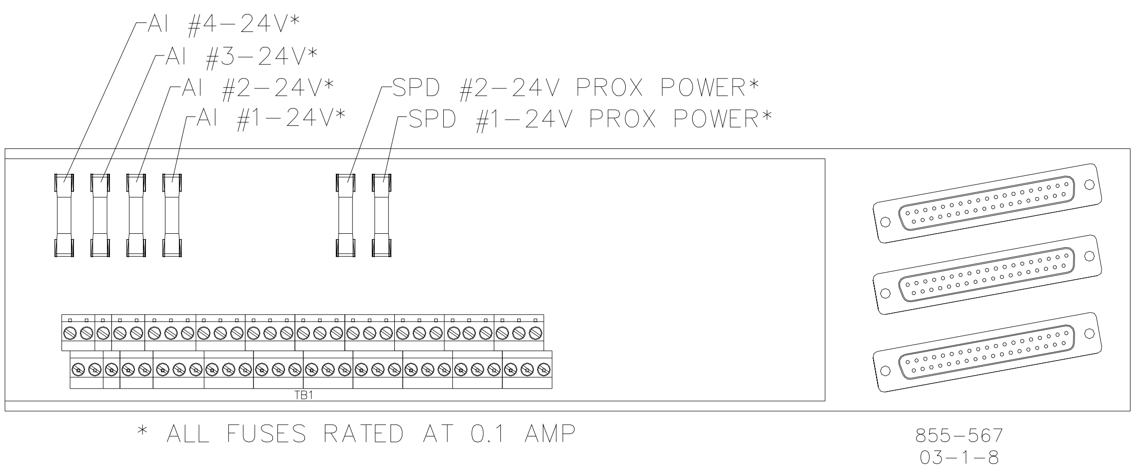


Figure 5-1. ATM Fuse Locations

To replace DTM Relays:

WARNING

HIGH VOLTAGE—Relay circuit power is also present on a DTM's relay and cable connectors. When using high voltage relay circuit power, it is recommended that care be taken not to touch exposed connectors when replacing relays or cables. If possible remove relay circuit power from all DTM relays before replacing any DTM relay or cable.

1. Read all warnings on pages v and vi of this Volume before replacing any Relay.
2. Locate and replace faulty relay (See Figure 4-16). See Chapter 6 of the manual for recommended replacement relays.
3. Perform a system Reset to clear Alarm.

Diagnostics

Each CPU performs both off-Line and on-line diagnostics. Off-Line diagnostics are performed at power-up or when the CPU's Reset switch is toggled. On-Line diagnostics are performed when the CPU is in its normal operational mode, under application-program control.

Off-Line Diagnostics

The following list shows the tests run by Off-Line diagnostics, and the order in which they are run. Off-Line diagnostics are started immediately after a CPU Reset switch is toggled. If during a diagnostics routine, a particular test fails, testing is stopped and the failure annunciated, through the Fault LED and engineering workstation. If an engineering workstation is not connected to the control at that time the failure is stored for later reading. When a fault is detected by a diagnostics routine, the CPU module's Fault LED will periodically repeat bursts of flashes; the number of flashes in each burst indicates the test that failed. If the CPU module's Fault LED flashes replace the module.

Table 5-1. Off-Line Diagnostic Messages

Flashes In Burst	Error Detected
1	Start Up test failed
2	Control Status Register test failed
3	DUART test failed
4	Local RAM test failed
5	Local RAM Misaligned test failed
6	Flash Memory test failed
7	Clock Interrupt test failed
8	VME Bus Timeout test failed
9	EEPROM test failed
10	Floating Point Math Co-processor test failed
11	Real-Time Clock failed

On-Line Diagnostics

As soon as the application program starts running, the system will use a small portion of run time to continuously run on-line diagnostic tests. A failure of any one of the on-line tests results in the I/O lock being asserted and display of a message in the PCI's OpSys Fault mode, as shown in Table 5-2. If the CPU module's I/O Lock LED stays on during normal operation replace the module.

Table 5-2. On-Line Test Failure Messages

Local Ram Failed	Checksum Error
Application Ram Failed	System Error (#)
FPU Co-Processor Failed	EEPROM Fault
Task Overrun	Math Exception
Rate Group Slip (#)	EEPROM Initialization Fault
Exception Error Vector #	

System Troubleshooting Guide

The following is a troubleshooting guide for areas to check which may present potential difficulties. By making these checks prior to contacting Woodward for technical assistance your system problems can be more quickly and accurately assessed.

MECHANICAL SYSTEM

ACTUATORS
- Is the oil clean?
- Does the actuator have the correct hydraulic pressure (if required)?
- Does the actuator have the correct pneumatic pressure (if required)?
- Does the drive shaft rotate (if required)?
- Is the actuator wiring correct?
- Is the direction of the stroke correct?
- Has the compensation (if so equipped) been adjusted correctly?
- Is the hydraulic return line free and not clogged?
- Is there backpressure on the hydraulic return line?
- Is the feedback (if any) adjusted correctly and sending the correct signal?

LINKAGE
- Is there slop or lost motion?
- Is there misalignment, binding, or side loading?
- Is there visible wear or scarring?
- Does the linkage move smoothly?

VALVES
- Does the valve move through it's proper stroke smoothly?
- Does the valve travel it's full stroke?
- Can mid-stroke be obtained and held?
- Does the valve fully seat (close) before the governor reaches full minimum stroke?
- Does the valve fully open before the governor reaches maximum stroke?
- Is the bypass valve(s) (if any) in the proper position?
- Are there nicks or contamination which allow steam to pass when the valve is closed?

OIL/HYDRAULIC SYSTEM
- Is the oil at the proper operating pressure?
- Is the oil temperature too high for the type of oil being used?
- Is the oil contaminated?
- Does the actuator have sufficient flow of oil?
- Are the accumulators (if any) charged to the correct pressure?
- Are the filters plugged?
- Is the oil pump operating properly?

STEAM CONDITIONS
- Is the turbine inlet pressure at design specification?
- Is the steam pressure in the proper operating range?
- Are pressure transducers (if any) located close to the turbine?
- Are there any pressure regulating devices or valves which may interfere with governor operation or proper steam flow?

CONTROL, ALARM, AND FAULT INDICATIONS
- Does the governor indicate it is in the correct control mode?
- Is the governor issuing any alarms?
- Are any of the components of the governor indicating hardware faults?
- Does the actuator demand agree with the actual valve position?
- Are any shut\ down conditions present?
- Have the control dynamics been tuned to match the system response?

INPUT SIGNALS
- Are all input signals properly scaled?
- Are the inputs free of electrical noise and properly shielded?
- Is the wiring correct?
- Have all field input signals to the control been verified?
- Is the polarity of the signals correct?

OUTPUT SIGNALS
- Are the outputs calibrated?
- Have the actuator drivers been calibrated to the stroke of the turbine valves?
- Are the output signals free of noise and properly shielded?
- Is the wiring correct?

TRANSDUCERS
- Is the transducer calibrated for the proper range?
- Has it been tested by simulating it's input and measuring it's output signal?
- Does the transducer have power?
- Are the sensing lines feeding the transducer clear of obstructions?

MAGNETIC PICKUPS AND OTHER SPEED SENSING DEVICES
- Is the wiring between the speed sensing pickup and the control correct?
- Are there any grounding problems or worn shields?
- Is the signal sufficient (at least 1.5 Vrms)?
- Is the signal a clean sine wave or square wave with no spikes or distortions?
- Is the MPU head clean and free of oil or metallic particles?
- Is the MPU head free of any nicks or chips?
- Is the MPU or proximity probe correctly aligned with the gear?
- Is the speed sensing probe adjusted to the correct gap?
- Is the speed sensing probe head the correct size for the toothed wheel it is being used with?

INPUT VOLTAGE/POWER SUPPLIES
- Is the input power within the range of the control's power supply input?
- Is the input power free of switching noise or transient spikes?
- Is the power circuit dedicated to the governor only?
- Are the control's supplies indicating that they are OK?
- Are the control's supplies outputting the correct voltage?

ELECTRICAL CONNECTIONS
- Are all electrical connections tight and clean?
- Are all signal wires shielded?
- Are shields continuous from the device to the control?
- Are the shields terminated according to Woodward specifications?
- Are there low voltage signal wires running in the same wiring trays as high voltage wiring?
- Are the governor's signal common or grounds not tied to any other devices?
- Have the signals been checked for electrical noise?

VOLTAGE REGULATOR

- Is the voltage regulator working properly?

EXTERNAL DEVICES

- Are there external devices the control is dependent on for input signals?
- Are these devices providing the correct signal to the control?
- Is the external device configured or programmed to be compatible with the control?

The following tables (5-3 thru 5-6) can be used to troubleshoot electrical signals coming into and out of the 5009C control. A listing from each I/O module's Sub D connector on the front panel to the respective terminal block on the FTM is given. If a signal is shorted or missing, the tables can be used to troubleshoot the problems to the FTM, cables, or the respective I/O module.

Table 5-3. Discrete In Cable Connections

Function	Module to DTM Cable	Interconnection Cable		Input / Output
+24Vdc-DI Wetting Voltage	DTM 1 - J1/J2/J3 - pin 6			Diode Sel to DTM 1 -TB27-32
24Vdc Com-DI Wetting V.	DTM 1 - J1/J2/J3 - pin 49			Diode Sel to DTM 1 - TB33
DI - Chan 1 (+)	DTM 1 - J1/J2/J3 - pin 47			DTM 1 - TB21
DI - Chan 2 (+)	DTM 1 - J1/J2/J3 - pin 27			DTM 1 - TB22
DI - Chan 3 (+)	DTM 1 - J1/J2/J3 - pin 5			DTM 1 - TB23
DI - Chan 1,2,3 (-)	DTM 1 - J1/J2/J3 - pin 26			Diode Sel to DTM 1 - TB34
DI - Chan 4 (+)	DTM 1 - J1/J2/J3 - pin 46			DTM 1 - TB24
DI - Chan 5 (+)	DTM 1 - J1/J2/J3 - pin 25			DTM 1 - TB25
DI - Chan 6 (+)	DTM 1 - J1/J2/J3 - pin 4			DTM 1 - TB26
DI - Chan 4,5,6 (-)	DTM 1 - J1/J2/J3 - pin 3			Diode Sel to DTM 1 - TB35
+24Vdc-DI Wetting Voltage	DTM 1 - J1/J2/J3 - pin 7	DTM 1 - J7/J8/J9 - pin 8	DTM 2 - J4/J5/J6 - pin 27	Diode Sel to DTM 2 -TB27-32
24Vdc Com-DI Wetting V.	DTM 1 - J1/J2/J3 - pin 48	DTM 1 - J7/J8/J9 - pin 6	DTM 2 - J4/J5/J6 - pin 29	Diode Sel to DTM 2 - TB33
DI - Chan 7 (+)	DTM 1 - J1/J2/J3 - pin 45	DTM 1 - J7/J8/J9 - pin 16	DTM 2 - J4/J5/J6 - pin 19	DTM 2 - TB21
DI - Chan 8 (+)	DTM 1 - J1/J2/J3 - pin 24	DTM 1 - J7/J8/J9 - pin 15	DTM 2 - J4/J5/J6 - pin 20	DTM 2 - TB22
DI - Chan 9 (+)	DTM 1 - J1/J2/J3 - pin 2	DTM 1 - J7/J8/J9 - pin 14	DTM 2 - J4/J5/J6 - pin 21	DTM 2 - TB23
DI - Chan 7,8,9 (-)	DTM 1 - J1/J2/J3 - pin 44	DTM 1 - J7/J8/J9 - pin 13	DTM 2 - J4/J5/J6 - pin 22	Diode Sel to DTM 2 - TB34
DI - Chan 10 (+)	DTM 1 - J1/J2/J3 - pin 43	DTM 1 - J7/J8/J9 - pin 12	DTM 2 - J4/J5/J6 - pin 23	DTM 2 - TB24
DI - Chan 11 (+)	DTM 1 - J1/J2/J3 - pin 23	DTM 1 - J7/J8/J9 - pin 11	DTM 2 - J4/J5/J6 - pin 24	DTM 2 - TB25
DI - Chan 12 (+)	DTM 1 - J1/J2/J3 - pin 1	DTM 1 - J7/J8/J9 - pin 10	DTM 2 - J4/J5/J6 - pin 25	DTM 2 - TB26
DI - Chan 10,11,12 (-)	DTM 1 - J1/J2/J3 - pin 22	DTM 1 - J7/J8/J9 - pin 9	DTM 2 - J4/J5/J6 - pin 26	Diode Sel to DTM 2 - TB35
+24Vdc-DI Wetting Voltage	DTM 3 - J1/J2/J3 - pin 6			Diode Sel to DTM 3 -TB27-32
24Vdc Com-DI Wetting V.	DTM 3 - J1/J2/J3 - pin 49			Diode Sel to DTM 3 - TB33
DI - Chan 13 (+)	DTM 3 - J1/J2/J3 - pin 47			DTM 3 - TB21
DI - Chan 14 (+)	DTM 3 - J1/J2/J3 - pin 27			DTM 3 - TB22
DI - Chan 15 (+)	DTM 3 - J1/J2/J3 - pin 5			DTM 3 - TB23
DI - Chan 13,14,15 (-)	DTM 3 - J1/J2/J3 - pin 26			Diode Sel to DTM 3 - TB34
DI - Chan 16 (+)	DTM 3 - J1/J2/J3 - pin 46			DTM 3 - TB24
DI - Chan 17 (+)	DTM 3 - J1/J2/J3 - pin 25			DTM 3 - TB25
DI - Chan 18 (+)	DTM 3 - J1/J2/J3 - pin 4			DTM 3 - TB26
DI - Chan 16,17,18 (-)	DTM 3 - J1/J2/J3 - pin 3			Diode Sel to DTM 3 - TB35
+24Vdc-DI Wetting Voltage	DTM 3 - J1/J2/J3 - pin 7	DTM 3 - J7/J8/J9 - pin 8	DTM 4 - J4/J5/J6 - pin 27	Diode Sel to DTM 4 -TB27-32
24Vdc Com - DI Wetting V	DTM 3 - J1/J2/J3 - pin 48	DTM 3 - J7/J8/J9 - pin 6	DTM 4 - J4/J5/J6 - pin 29	Diode Sel to DTM 4 - TB33
DI - Chan 19 (+)	DTM 3 - J1/J2/J3 - pin 45	DTM 3 - J7/J8/J9 - pin 16	DTM 4 - J4/J5/J6 - pin 19	DTM 4 - TB21
DI - Chan 20 (+)	DTM 3 - J1/J2/J3 - pin 24	DTM 3 - J7/J8/J9 - pin 15	DTM 4 - J4/J5/J6 - pin 20	DTM 4 - TB22
DI - Chan 21 (+)	DTM 3 - J1/J2/J3 - pin 2	DTM 3 - J7/J8/J9 - pin 14	DTM 4 - J4/J5/J6 - pin 21	DTM 4 - TB23
DI - Chan 19,20,21 (-)	DTM 3 - J1/J2/J3 - pin 44	DTM 3 - J7/J8/J9 - pin 13	DTM 4 - J4/J5/J6 - pin 22	Diode Sel to DTM 4 - TB34
DI - Chan 22 (+)	DTM 3 - J1/J2/J3 - pin 43	DTM 3 - J7/J8/J9 - pin 12	DTM 4 - J4/J5/J6 - pin 23	DTM 4 - TB24
DI - Chan 23 (+)	DTM 3 - J1/J2/J3 - pin 23	DTM 3 - J7/J8/J9 - pin 11	DTM 4 - J4/J5/J6 - pin 24	DTM 4 - TB25
DI - Chan 24 (+)	DTM 3 - J1/J2/J3 - pin 1	DTM 3 - J7/J8/J9 - pin 10	DTM 4 - J4/J5/J6 - pin 25	DTM 4 - TB26
DI - Chan 22,23,24 (-)	DTM 3 - J1/J2/J3 - pin 22	DTM 3 - J7/J8/J9 - pin 9	DTM 4 - J4/J5/J6 - pin 26	Diode Sel to DTM 4 - TB35

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Table 5-4. Relay Cable Connections

Function	Module to DTM Cable	Interconnection Cable		Input / Output
+24Vdc - Relay Coil Power	DTM 1 - J1/J2/J3 - pin 9			DTM 1 - Relay Coil Pwr A,B,C
Common - Relay Coil Pwr	DTM 1 - J1/J2/J3 - pin 50			DTM 1 - RC Com TB4,5,6
Output Drvr - Relay 1(a)	DTM 1 - J1/J2/J3 - pin 54			DTM 1 - Relay 1 - A1/B1/C1
Output Drvr - Relay 1(b)	DTM 1 - J1/J2/J3 - pin 34			DTM 1 - Relay 1 - A2/B2/C2
DI - LFD - Rly 1(+)	DTM 1 - J1/J2/J3 - pin 62			DTM 1 - Relay 1 - TB8
DI - LFD - Rly 1(-)	DTM 1 - J1/J2/J3 - pin 61			DTM 1 - Relay 1
DI - LFD - Rly 1(+)	DTM 1 - J1/J2/J3 - pin 42			DTM 1 - Relay 1
DI - LFD - Rly 1(-)	DTM 1 - J1/J2/J3 - pin 41			DTM 1 - Relay 1
Output Drvr - Relay 2 (a)	DTM 1 - J1/J2/J3 - pin 13			DTM 1 - Relay 2 - A1/B1/C1
Output Drvr - Relay 2 (b)	DTM 1 - J1/J2/J3 - pin 53			DTM 1 - Relay 2 - A2/B2/C2
DI - LFD - Rly 2 (+)	DTM 1 - J1/J2/J3 - pin 21			DTM 1 - Relay 2 - TB12
DI - LFD - Rly 2 (-)	DTM 1 - J1/J2/J3 - pin 20			DTM 1 - Relay 25
DI - LFD - Rly 2 (+)	DTM 1 - J1/J2/J3 - pin 60			DTM 1 - Relay 2
DI - LFD - Rly 2 (-)	DTM 1 - J1/J2/J3 - pin 59			DTM 1 - Relay 2
Output Drvr - Relay 3 (a)	DTM 1 - J1/J2/J3 - pin 33			DTM 1 - Relay 3 - A1/B1/C1
Output Drvr - Relay 3 (b)	DTM 1 - J1/J2/J3 - pin 12			DTM 1 - Relay 3 - A2/B2/C2
DI - LFD - Rly 3 (+)	DTM 1 - J1/J2/J3 - pin 40			DTM 1 - Relay 3 - TB16
DI - LFD - Rly 3 (-)	DTM 1 - J1/J2/J3 - pin 39			DTM 1 - Relay 3
DI - LFD - Rly 3 (+)	DTM 1 - J1/J2/J3 - pin 19			DTM 1 - Relay 3
DI - LFD - Rly 3 (-)	DTM 1 - J1/J2/J3 - pin 18			DTM 1 - Relay 3
+24Vdc - Relay Coil Power	DTM 1 - J1/J2/J3 - pin 8	DTM 1 - J7/J8/J9 - pin 5	DTM 2 - J4/J5/J6 -pin 30	DTM 2 - Relay Coil Pwr A,B,C
Common - Relay Coil Pwr	DTM 1 - J1/J2/J3 - pin 29	DTM 1 - J7/J8/J9 - pin 3	DTM 2 - J4/J5/J6 -pin 32	DTM 2 - RC Com TB4,5,6
Output Drvr - Relay 4 (a)	DTM 1 - J1/J2/J3 - pin 52	DTM 1 - J7/J8/J9 - pin 34	DTM 2 - J4/J5/J6 -pin 1	DTM 2 - Relay 1 - A1/B1/C1
Output Drvr - Relay 4 (b)	DTM 1 - J1/J2/J3 - pin 32	DTM 1 - J7/J8/J9 - pin 33	DTM 2 - J4/J5/J6 -pin 2	DTM 2 - Relay 1 - A2/B2/C2
DI - LFD - Rly 4 (+)	DTM 1 - J1/J2/J3 - pin 58	DTM 1 - J7/J8/J9 - pin 28	DTM 2 - J4/J5/J6 - pin 7	DTM 2 - Relay 1 - TB8
DI - LFD - Rly 4 (-)	DTM 1 - J1/J2/J3 - pin 57	DTM 1 - J7/J8/J9 - pin 27	DTM 2 - J4/J5/J6 - pin 8	DTM 2 - Relay 1
DI - LFD - Rly 4 (+)	DTM 1 - J1/J2/J3 - pin 38	DTM 1 - J7/J8/J9 - pin 26	DTM 2 - J4/J5/J6 - pin 9	DTM 2 - Relay 1
DI - LFD - Rly 4 (-)	DTM 1 - J1/J2/J3 - pin 37	DTM 1 - J7/J8/J9 - pin 25	DTM 2 - J4/J5/J6 - pin 10	DTM 2 - Relay 1
Output Drvr - Relay 5 (a)	DTM 1 - J1/J2/J3 - pin 11	DTM 1 - J7/J8/J9 - pin 32	DTM 2 - J4/J5/J6 - pin 3	DTM 2 - Relay 2 - A1/B1/C1
Output Drvr - Relay 5 (b)	DTM 1 - J1/J2/J3 - pin 51	DTM 1 - J7/J8/J9 - pin 31	DTM 2 - J4/J5/J6 - pin 4	DTM 2 - Relay 2 - A2/B2/C2
DI - LFD - Rly 5 (+)	DTM 1 - J1/J2/J3 - pin 17	DTM 1 - J7/J8/J9 - pin 24	DTM 2 - J4/J5/J6 - pin 11	DTM 2 - Relay 2 - TB12
DI - LFD - Rly 5 (-)	DTM 1 - J1/J2/J3 - pin 16	DTM 1 - J7/J8/J9 - pin 23	DTM 2 - J4/J5/J6 - pin 12	DTM 2 - Relay 2
DI - LFD - Rly 5 (+)	DTM 1 - J1/J2/J3 - pin 56	DTM 1 - J7/J8/J9 - pin 22	DTM 2 - J4/J5/J6 - pin 13	DTM 2 - Relay 2
DI - LFD - Rly 5 (-)	DTM 1 - J1/J2/J3 - pin 55	DTM 1 - J7/J8/J9 - pin 21	DTM 2 - J4/J5/J6 - pin 14	DTM 2 - Relay 2
Output Drvr - Relay 6 (a)	DTM 1 - J1/J2/J3 - pin 31	DTM 1 - J7/J8/J9 - pin 30	DTM 2 - J4/J5/J6 - pin 5	DTM 2 - Relay 3 - A1/B1/C1
Output Drvr - Relay 6 (b)	DTM 1 - J1/J2/J3 - pin 10	DTM 1 - J7/J8/J9 - pin 29	DTM 2 - J4/J5/J6 - pin 6	DTM 2 - Relay 3 - A2/B2/C2
DI - LFD - Rly 6 (+)	DTM 1 - J1/J2/J3 - pin 36	DTM 1 - J7/J8/J9 - pin 20	DTM 2 - J4/J5/J6 - pin 15	DTM 2 - Relay 3 - TB16
DI - LFD - Rly 6 (-)	DTM 1 - J1/J2/J3 - pin 35	DTM 1 - J7/J8/J9 - pin 19	DTM 2 - J4/J5/J6 - pin 16	DTM 2 - Relay 3
DI - LFD - Rly 6 (+)	DTM 1 - J1/J2/J3 - pin 15	DTM 1 - J7/J8/J9 - pin 18	DTM 2 - J4/J5/J6 - pin 17	DTM 2 - Relay 3
DI - LFD - Rly 6 (-)	DTM 1 - J1/J2/J3 - pin 14	DTM 1 - J7/J8/J9 - pin 17	DTM 2 - J4/J5/J6 - pin 18	DTM 2 - Relay 3
+24Vdc - Relay Coil Power	DTM 3 - J1/J2/J3 - pin 9			DTM 3 - Relay Coil Pwr A,B,C
Common - Relay Coil Pwr	DTM 3 - J1/J2/J3 - pin 50			DTM 3 - RC Com TB4,5,6
Output Drvr - Relay 7 (a)	DTM 3 - J1/J2/J3 - pin 54			DTM 3 - Relay 1 - A1/B1/C1
Output Drvr - Relay 7 (b)	DTM 3 - J1/J2/J3 - pin 34			DTM 3 - Relay 1 - A2/B2/C2
DI - LFD - Rly 7 (+)	DTM 3 - J1/J2/J3 - pin 62			DTM 3 - Relay 1 - TB8
DI - LFD - Rly 7 (-)	DTM 3 - J1/J2/J3 - pin 61			DTM 3 - Relay 1
DI - LFD - Rly 7 (+)	DTM 3 - J1/J2/J3 - pin 42			DTM 3 - Relay 1
DI - LFD - Rly 7 (-)	DTM 3 - J1/J2/J3 - pin 41			DTM 3 - Relay 1

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Table 5-4. Relay Cable Connections (cont.)

Function	Module to DTM Cable	Interconnection Cable		Input / Output
Output Drvr - Relay 8 (a)	DTM 3 - J1/J2/J3 - pin 13			DTM 3 - Relay 2 - A1/B1/C1
Output Drvr - Relay 8 (b)	DTM 3 - J1/J2/J3 - pin 53			DTM 3 - Relay 2 - A2/B2/C2
DI - LFD - Rly 8 (+)	DTM 3 - J1/J2/J3 - pin 21			DTM 3 - Relay 2 - TB12
DI - LFD - Rly 8 (-)	DTM 3 - J1/J2/J3 - pin 20			DTM 3 - Relay 25
DI - LFD - Rly 8 (+)	DTM 3 - J1/J2/J3 - pin 60			DTM 3 - Relay 2
DI - LFD - Rly 8 (-)	DTM 3 - J1/J2/J3 - pin 59			DTM 3 - Relay 2
Output Drvr - Relay 9 (a)	DTM 3 - J1/J2/J3 - pin 33			DTM 3 - Relay 3 - A1/B1/C1
Output Drvr - Relay 9 (b)	DTM 3 - J1/J2/J3 - pin 12			DTM 3 - Relay 3 - A2/B2/C2
DI - LFD - Rly 9 (+)	DTM 3 - J1/J2/J3 - pin 40			DTM 3 - Relay 3 - TB16
DI - LFD - Rly 9 (-)	DTM 3 - J1/J2/J3 - pin 39			DTM 3 - Relay 3
DI - LFD - Rly 9 (+)	DTM 3 - J1/J2/J3 - pin 19			DTM 3 - Relay 3
DI - LFD - Rly 9 (-)	DTM 3 - J1/J2/J3 - pin 18			DTM 3 - Relay 3
+24Vdc - Relay Coil Power	DTM 3 - J1/J2/J3 - pin 8	DTM 3 - J7/J8/J9 - pin 5	DTM 4 - J4/J5/J6 - pin 30	DTM 4 - Relay Coil Pwr 1,2,3
Common - Relay Coil Pwr	DTM 3 - J1/J2/J3 - pin 29	DTM 3 - J7/J8/J9 - pin 3	DTM 4 - J4/J5/J6 - pin 32	DTM 4 - Relay Coil Com 1,2,3
Output Drvr - Relay 10 (a)	DTM 3 - J1/J2/J3 - pin 52	DTM 3 - J7/J8/J9 - pin 34	DTM 4 - J4/J5/J6 - pin 1	DTM 4 - Relay 1 - A1/B1/C1
Output Drvr - Relay 10 (b)	DTM 3 - J1/J2/J3 - pin 32	DTM 3 - J7/J8/J9 - pin 33	DTM 4 - J4/J5/J6 - pin 2	DTM 4 - Relay 1 - A2/B2/C2
DI - LFD - Rly 10 (+)	DTM 3 - J1/J2/J3 - pin 58	DTM 3 - J7/J8/J9 - pin 28	DTM 4 - J4/J5/J6 - pin 7	DTM 4 - Relay 1 - TB8
DI - LFD - Rly 10 (-)	DTM 3 - J1/J2/J3 - pin 57	DTM 3 - J7/J8/J9 - pin 27	DTM 4 - J4/J5/J6 - pin 8	DTM 4 - Relay 1
DI - LFD - Rly 10 (+)	DTM 3 - J1/J2/J3 - pin 38	DTM 3 - J7/J8/J9 - pin 26	DTM 4 - J4/J5/J6 - pin 9	DTM 4 - Relay 1
DI - LFD - Rly 10 (-)	DTM 3 - J1/J2/J3 - pin 37	DTM 3 - J7/J8/J9 - pin 25	DTM 4 - J4/J5/J6 - pin 10	DTM 4 - Relay 1
Output Drvr - Relay 11 (a)	DTM 3 - J1/J2/J3 - pin 11	DTM 3 - J7/J8/J9 - pin 32	DTM 4 - J4/J5/J6 - pin 3	DTM 4 - Relay 2 - A1/B1/C1
Output Drvr - Relay 11 (b)	DTM 3 - J1/J2/J3 - pin 51	DTM 3 - J7/J8/J9 - pin 31	DTM 4 - J4/J5/J6 - pin 4	DTM 4 - Relay 2 - A2/B2/C2
DI - LFD - Rly 11 (+)	DTM 3 - J1/J2/J3 - pin 17	DTM 3 - J7/J8/J9 - pin 24	DTM 4 - J4/J5/J6 - pin 11	DTM 4 - Relay 2 - TB12
DI - LFD - Rly 11 (-)	DTM 3 - J1/J2/J3 - pin 16	DTM 3 - J7/J8/J9 - pin 23	DTM 4 - J4/J5/J6 - pin 12	DTM 4 - Relay 2
DI - LFD - Rly 11 (+)	DTM 3 - J1/J2/J3 - pin 56	DTM 3 - J7/J8/J9 - pin 22	DTM 4 - J4/J5/J6 - pin 13	DTM 4 - Relay 2
DI - LFD - Rly 11 (-)	DTM 3 - J1/J2/J3 - pin 55	DTM 3 - J7/J8/J9 - pin 21	DTM 4 - J4/J5/J6 - pin 14	DTM 4 - Relay 2
Output Drvr - Relay 12 (a)	DTM 3 - J1/J2/J3 - pin 31	DTM 3 - J7/J8/J9 - pin 30	DTM 4 - J4/J5/J6 - pin 5	DTM 4 - Relay 3 - A1/B1/C1
Output Drvr - Relay 12 (b)	DTM 3 - J1/J2/J3 - pin 10	DTM 3 - J7/J8/J9 - pin 29	DTM 4 - J4/J5/J6 - pin 6	DTM 4 - Relay 3 - A2/B2/C2
DI - LFD - Rly 12 (+)	DTM 3 - J1/J2/J3 - pin 36	DTM 3 - J7/J8/J9 - pin 20	DTM 4 - J4/J5/J6 - pin 15	DTM 4 - Relay 3 - TB16
DI - LFD - Rly 12 (-)	DTM 3 - J1/J2/J3 - pin 35	DTM 3 - J7/J8/J9 - pin 19	DTM 4 - J4/J5/J6 - pin 16	DTM 4 - Relay 3
DI - LFD - Rly 12 (+)	DTM 3 - J1/J2/J3 - pin 15	DTM 3 - J7/J8/J9 - pin 18	DTM 4 - J4/J5/J6 - pin 17	DTM 4 - Relay 3
DI - LFD - Rly 12 (-)	DTM 3 - J1/J2/J3 - pin 14	DTM 3 - J7/J8/J9 - pin 17	DTM 4 - J4/J5/J6 - pin 18	DTM 4 - Relay 3

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Table 5-5. Analog Combo Module

Module Connector J1 or J2
TMR FTM Connector J1, J2, or J3

PIN #	Function	FTM TB#
1	Analog Input 4,8 Shield	50
2	Analog Input 4,8 (-)	25
3		
4	Analog Input 3,7 Shield	22
5	Analog Input 3,7 (-)	48
6	Analog Input 2,6 Shield	45
7	Analog Input 2,6 (-)	20
8	Analog Input 1,5 Shield	17
9	Analog Input 1,5 (-)	43
10	Actuator Driver 1,2 Shield	13,41
11	+24Vdc - Prox Power	4,34
12	Analog Output 2,4 Shield	37
13	24Vdc Common - Prox Power	5,35
14	Analog Output 1,3 Shield	10
15	+24Vdc - Prox Power	4,34
16	Speed Sensor 2,4 - Shield	33
17	Speed Sensor 2,4 - Prox Rtn	8
18	Speed Sensor 1,3 - Shield	3
19	Speed Sensor 1,3 - Prox Rtn	29
20		
21	Analog Input 4,8 (+)	51
22		
23	Analog Input 3,7 (+)	23
24		
25	Analog Input 2,6 (+)	46
26		
27	Analog Input 1,5 (+)	18
28	Actuator Driver 1,2 (-)	14 &/or 15
29	Actuator Driver 1,2 (+)	39 &/or 40
30	Analog Output 2,4 (-)	38
31	Analog Output 2,4 (+)	12
32	Analog Output 1,3 (-)	11
33	Analog Output 1,3 (+)	36
34	Speed Sensor 2,4 - MPU (-)	6 &/or 7
35	Speed Sensor 2,4 - MPU (+)	31 &/or 32
36	Speed Sensor 1,3 - MPU (-)	27 &/or 28
37	Speed Sensor 1,3 - MPU (+)	1 &/or 2

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Table 5-6. DTM Interconnect Cables W14, W15, W16

Function	DTM-1	DTM-2
	J7,8,9	J4,5,6
Output Drvr - Relay 4 (a)	34	1
Output Drvr - Relay 4 (b)	33	2
Output Drvr - Relay 5 (a)	32	3
Output Drvr - Relay 5 (b)	31	4
Output Drvr - Relay 6 (a)	30	5
Output Drvr - Relay 6 (b)	29	6
DI - LFD - Rly 4 (+)	28	7
DI - LFD - Rly 4 (-)	27	8
DI - LFD - Rly 4 (+)	26	9
DI - LFD - Rly 4 (-)	25	10
DI - LFD - Rly 5 (+)	24	11
DI - LFD - Rly 5 (-)	23	12
DI - LFD - Rly 5 (+)	22	13
DI - LFD - Rly 5 (-)	21	14
DI - LFD - Rly 6 (+)	20	15
DI - LFD - Rly 6 (-)	19	16
DI - LFD - Rly 6 (+)	18	17
DI - LFD - Rly 6 (-)	17	18
DI - Chan 7 (+)	16	19
DI - Chan 8 (+)	15	20
DI - Chan 9 (+)	14	21
DI - Chan 7,8,9 (-)	13	22
DI - Chan 10 (+)	12	23
DI - Chan 11 (+)	11	24
DI - Chan 12 (+)	10	25
DI - Chan 10,11,12 (-)	9	26
+24Vdc - DI Wetting Voltage	8	27
	7	28
Common - 24Vdc DI Wetting V.	6	29
+24Vdc - Relay Coil Power	5	30
	4	31
Common - 24Vdc Relay Coil Pwr	3	32
	2	33
	1	34

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Chapter 6.
Hardware Specifications

5009C Control Package—Not Including Optional Hardware (except as noted)

Safety and EMC Standards Compliance

- Conforms to EMC Directive 89/336/EEC. Conformity established by test to EN 61000-6-2 and EN 61000-6-4.
- Conforms to Low Voltage Directive 73/23/EEC when used in accordance with instructions. Conformity established by testing to EN50178 1997.
- Listed UL and cUL Industrial Control Equipment for Class I, Division 2, Groups A, B, C, and D hazardous locations (MicroNet™ TMR-5009C Main Chassis and Power Supply Chassis with modules. Includes FTMs except FT Relay module). FT Relay module is Listed UL and cUL Industrial Control Equipment for ordinary (non-hazardous) locations.
- Certified by Lloyd's for ENV1 and ENV2.

Environmental

Humidity
Lloyd's type ENV2 Humidity test #1: Two temperature cycles between 20 to 55 °C at 95% Relative humidity within 48 hours

Shock
US MIL-STD-810C, Method 516.2-1 procedure 1b (15g 11ms Half Sine pulse)

Vibration
Lloyd's type ENV2 Vibration test #1
13–150 Hz @ 1.0 G Ten sweeps at one octave per minute
Unless otherwise reduced by options as shown in the Environmental Classifications for Options Table below, the following classifications apply.

EN 50178 Temp. Class for Cabinet	EN 50178 Humidity Class	EN 50178 Air Pressure Class
3K3 5 to 40 °C	3K3 5% to 85%	3K3 86 to 106 kPa

Tested operating temperature range is 0 to 55 °C.

Environmental Classifications for Options For systems with the optional Cabinet, the presence of any of the following options reduces the Environmental Class of the cabinet assembly to the lowest classification of the options present.				
Woodward Part No.	**Description**	**Mfg./Part No.**	**Mfg. Temp. Rating (°C)**	**Cabinet Max. Ambient (°C)**
1790-3000	OpView 90–250 Vac (color)	PS-10-2T2-DD1-BD5	0–50	0–40
1790-3001	OpView 90–250 Vac (monochrome)	PS-10-2M2-DD1-BD5	0–50	0–40
N/A	No OpView	N/A	N/A	45

Air Quality
Pollution Degree #2

Operating Temperature
0 to +55 °C (+32 to +131 °F), still air, no external heat loads

Storage Temperature
–20 to +70 °C (-4 to +158 °F)
Component life is adversely affected by high temperature, high humidity environments. Room temperature storage is recommended for long life.

Sound Level
Less than 70 dBA

MicroNet TMR/5009C I/O Chassis Weight:
22 kg (48 lb)

MicroNet TMR/5009C Main Power Supply Weight:
8 kg (17 lb)

Power Supply Specifications

Input Power Ratings
Low Voltage DC (18–36 Vdc)
- Nominal Voltage Rating (20–32 Vdc), (as on Power Supply Label)
- Rated Maximum Current = 32 A
- Maximum Power = 576 W
- Input Power Fuse/Breaker Rating = 40 A slow blow
- Wire Size = 10 mm² (8 AWG) or larger
- Holdup Time = 5 ms @ 24 Vdc

DC (100–150 Vdc)
- Nominal Voltage Rating (111–136 Vdc), (as on Power Supply Label)
- Rated Maximum Current = 5.8 A
- Maximum Power = 576 W
- Input Power Fuse/Breaker Rating = 10 A slow blow
- Wire Size = 2.5 mm² (14 AWG) or larger
- Holdup Time = 7 ms @ 120 Vdc

AC (88–132 Vac, 47–63 Hz)
- Nominal Voltage Rating (98–120 Vac), (as on Power Supply Label)
- Rated Maximum Current = 13 A
- Maximum Power = 1150 VA
- Input Power Fuse/Breaker Rating = 20 A slow blow
- Wire Size = 4.0 mm² (12 AWG) or larger
- Holdup Time = 1 cycle @ 120 Vac

High Voltage AC (180–264 Vac, 47–63 Hz)
- Nominal Voltage Rating (200–240 Vac), (as on Power Supply Label)
- Rated Maximum Current = 6.5 A
- Maximum Power = 1150 VA
- Input Power Fuse/Breaker Rating = 10 A slow blow
- Wire Size = 2.5 mm² (14 AWG) or larger
- Holdup Time = 1 cycle @ 220 Vac

High Voltage DC (200–300 Vdc)
- Nominal Voltage Rating (223–272 Vdc), (as on Power Supply Label)
- Rated Maximum Current = 2.9 A
- Maximum Power = 600 VA
- Input Power Fuse/Breaker Rating = 10 A slow blow
- Wire Size = 2.5 mm² (14 AWG) or larger
- Holdup Time = 7 ms @ 200 Vdc

Installation Overvoltage Rating
Category II

Dielectric Withstand
24 V power supply: 707 Vdc from power input to chassis
AC/DC and HVAC version: 2200 Vdc from power input to chassis

Power Output Ratings
- 24 Vdc Analog power (prox and analog input power)
  Acceptable Output Range 20.4—25.2 Vdc (at ATM terminals)
  Fused to 100mA on each terminal output
- 24 Vdc Discrete Input power (Contact Wetting Voltage)
  Acceptable Output Range 20.4—25.2 Vdc (at DTM terminals)
  Current Limited to 400 mA on each DTM output

CPU Batteries for Real Time Clock Back-Up
NiCd, Not User Replaceable; Charge Time: 16 hours @ 25 °C.
CPU Storage Temperature with battery operating specifications: –20 to +45 °C.

⚠WARNING	**ELECTROCUTION HAZARD—Ground leakage exceeds 3.5 mA. Protective earth grounding is required.**

General I/O Specifications

VME Module Fuse Ratings (for all on-module fuses)
24Vdc, .1 A

Digital Speed Sensor Inputs
Number of channels: 4
Speed Inputs: MPU or Proximity probe selectable

MPU Input Ratings

Input frequency:	100–25 000 Hz
Input amplitude:	1–25 Vrms
Input impedance:	2000 Ω
Isolation:	
Channel to Channel	500 Vdc
To Chassis	200 Vdc continuous, 600 Vdc DWV
Resolution:	dependent on frequency
Accuracy:	software calibrated to 0.03%, minimum
Time Stamping	High & Low Alarms to 5 ms resolution

Proximity Probe Input Ratings

Input frequency:	0.5–25 000 Hz
Input amplitude:	3.5–32 Vdc input to the module
Available power:	12 V or 24 V, 50 mA maximum
Isolation:	
Channel to Channel	0 Vrms
To Chassis	200 Vdc continuous, 600 Vdc DWV
Resolution:	dependent on frequency
Accuracy:	software calibrated to 0.03%, minimum
24 V Protection:	24 V proximity probe power is fuse protected on the ATM (100 mA fuse)
12 V Protection:	12V proximity probe power is limited to 100mA via a regulator on the ATM

Analog Inputs (4–20 mA)

Number of channels:	8
Isolation:	
Channel to Channel/ Channel to Common	–60 dB MMR, 200 Vdc common mode rejection voltage
To Chassis	200 Vdc continuous, 600 Vdc DWV; Combo 500 Vdc continuous, 600 Vdc DWV; HD
Input impedance:	200 Ω
Anti-aliasing filter:	2 poles at 10 ms
Resolution:	16 bits
Accuracy:	software calibrated to 0.1%, minimum
Temp Drift:	275 ppm/°C, maximum
Fuse:	100 mA fuse per channel (See Figure 5-1)

Analog Outputs (4–20 mA)

Number of channels:	4
Driver:	Pulse Width Modulated (PWM)
PWM frequency:	6.14 kHz
Filtering:	three 500 ms poles
Current output:	4–20 mA
Isolation:	
Channel to Channel	0 Vrms
To Chassis	200 Vdc continuous, 600 Vdc DWV; Combo 500 Vdc continuous, 600 Vdc DWV; HD
Max load resistance:	600 Ω
Current Readback:	10 bits
Resolution:	10 bits
Accuracy:	software calibrated to 0.2%
Temperature Drift:	125 ppm/°C, maximum
Readback accuracy:	0.1%
Readback temp drift:	400 ppm/°C, worst case

Actuator Combo Driver Outputs

Number of channels:	2
Driver:	Pulse Width Modulated (proportional only), Single or Dual Coil
PWM frequency:	4.88 kHz
Filtering:	three 500 ms poles
Default output Ranges:	4–20 mA or 20-160 mA, software selectable
Maximum Current Range:	2–24 mA or 10–196 mA
Isolation:	
Channel to Channel	0 Vrms
To Chassis	200 Vdc continuous, 600 Vdc DWV
Max. act resistance:	45 Ω on the 20–160 mA output, 360 Ω on the 4–20 mA output
Readback:	Actuator source and return currents
Dither current:	25 Hz, fixed duty cycle, software variable amplitude
Resolution:	10 bits
Accuracy:	software calibrated to 0.2%
Temperature Drift:	125 ppm/°C, maximum
Readback accuracy:	0.1%
Readback temp drift:	150 ppm/°C, worst case

Actuator Cards Driver Outputs

General:	
Number of Channels	2 per FTM
Actuator Type	Proportional or integrating , hydro-mechanical or pneumatic actuators
Power requirements	+5V @ 0.5 A, +24 V @ 1 A
Driver:	
Current range	(range is determined by part number) ±245 mA max
Dither Current	25 Hz, 25% duty cycle, tunable amplitude
Max Load Resistance	10/(maximum current required, in amps)
Position Feedback:	
Feedback devices	1 or 2 per channel
Device types	LVDT, RVDT
Excitation	3 kHz sine wave, amplitude programmable from 2 to 8 Vrms, 120 mA maximum, 1% THD maximum.
Input impedance of feedback circuit	200 kΩ
Fault Detection:	
Driver	Alarm if current error > 10% Alarm if open Alarm if shorted
Excitation	Alarm if voltage error > 10% or if in current limit
Feedback	Alarms for: open-wire, voltage-out-of-range, computed position out-of-range; ranges are programmable
Position Error	Programmable threshold and delay
Microcontroller	Software watchdog is monitored by the CPU module. Hardware watchdog monitors logic power, microcontroller activity.
System	Outputs turn off if communications with the CPU module are lost

Performance:

Position Accuracy	0.25% of full-scale @ 25 °C, does not include transducer error
Position Drift	150 ppm/°C, does not include transducer drift
Output Current Tolerance	±1% of full scale
Current Readback Tolerance	±5% of full scale

Discrete Inputs

IMPORTANT **The F/T Relay Discrete In Panel is suitable for use in non-hazardous locations only.**

Number of channels:	24
Input type:	Optically isolated discrete input
Input Thresholds:	< 8 Vdc = "OFF", > 16 Vdc = "ON"
Input Current:	13 mA @ 24 Vdc
External Input Voltages:	18–32 Vdc (meets CE & UL) or 100–150 Vdc (meets UL only)
Isolation:	
Channel to Channel	1100 Vdc
To Control Common	1100 Vdc
To Chassis	500 Vdc continuous

Isolated 24 Vdc supply may be used to power contacts, 400 mA maximum

Relay Outputs

IMPORTANT **The F/T Relay Discrete In Panel is suitable for use in non-hazardous locations only.**

Number of channels:	12
Relay Type:	Dust-tight with magnetic blow-out
Coil Rating:	52 mA @ 24 Vdc
Operating Time:	20 ms max.
Release Time:	10 ms max.
Shock:	5G for 11 ms
Temperature:	–45 to +70 °C
Dielectric Strength:	500 Vrms across open contacts 2500 Vrms between all other conductive elements
Expected Life:	100 000 operations @ rated load
Replaceability:	Relays are socket mounted and retained by a hold-down spring

Maximum Relay Output Circuit Ratings:

NOTE—Dry contacts "wetted" by customer-supplied circuits.

Relay Output Voltage	North America (UL)	International (CE Marking)
28 Vdc	10 A Resistive	10 A Resistive
120 Vac	15 A Resistive 1/3 hp	
150 Vdc	3 A Resistive	
240 Vac	15 A Resistive 1/2 hp	

Cabinet (optional)

Dimensions:	2251 mm in (88.61) high x 599 mm (23.573 in) wide x 834 mm (32.838 in) deep
Material:	Frame—All sheet steel construction, 9-fold profile Door—2.0 mm / 14 gauge steel Sides—1.5 mm / 16 gauge steel Panels—3.0 mm / 11 gauge steel
Finish:	Frame—Dip-bath primed Pebble Gray, RAL 7032 Door, sides—Dip-bath primed and powder coated Pebble Gray, RAL 7032 Panels—Powder coated Gray, ANSI 61
Ratings:	NEMA 12 IP55
Temperature Rise:	9 °C (16 °F) - (in cabinet, worse case)
Weight:	Approximately 272 kg (600 lb) (including control)
Fan:	Power Requirements—115/230 Vac 50/60 Hz 0.1/0.2 A Fan Life—Rated for 20,000 Hours Fan Air Filter—Replacement recommended every 60 days to 18 months based on environment.

OpView (future option)

Power Requirements (for Color or Monochrome units)
- 90–250 Vac, 50/60 Hz, (110 W max.)

For all OpView specifications, refer to documentation included with the CTC Power Station.

Chapter 7.
System Maintenance

Cables and Connections

Periodically, check the cables to make sure they are still in good condition, and check the connectors to make sure they are plugged in all the way.

Fans

Only qualified personnel should replace system fans. As a preventive maintenance it is recommended that the main chassis and power chassis cooling fans be replaced every 50 000 hours, and the cabinet front door fan every 60 000 hours. For replacement, use fans of like design and specification, or purchase replacement fans from Woodward. See Chapter 6 of this Volume for fan voltage and power specifications.

Air Filter Maintenance

If your system comes with a cabinet, the cabinet includes a front door fan assembly (with air filter) for cabinet cooling. Periodic cleaning of this air filter is required to ensure proper cabinet air flow and cooling. This filter should be cleaned when it gets dirty; the period between cleanings will depend on the type of environment the cabinet is located.

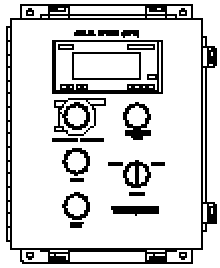
To clean the filter, remove the filter element from the assembly, wash in soapy water, and allow to dry before re-installing.

Battery Check

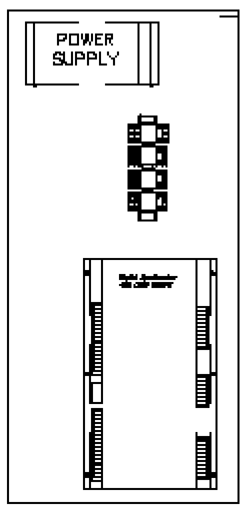
Periodically inspect the CPU battery(ies) for signs of leakage, swelling, or damage. If the battery is leaky, has apparent damage, or won’t hold a charge, return the CPU module to Woodward.

Chapter 8. MicroNet™ TMR Compatible Products

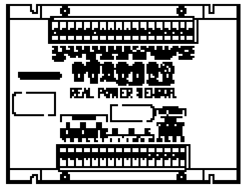
The following is a list of compatible Woodward products that may be used with the MicroNet™ TMR 5009C System:



Operator Control Panel



DSLC Panel



Real Power Sensor

Figure 8-1. MicroNet Compatible Products

Operator Control Panel (OCP)

(8236-341, 8236-361)

The Operator Control Panel includes functions typically used to start and stop a turbine, and perform overspeed tests. The OCP includes a front access NEMA 4 enclosure and is provided with the switches and meter mounted within the station's front door. The Operator Control Station is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only. Refer to Chapter 1 of this volume for related installation and wiring warnings.

To complete the interface to the control, the OCP switches and meter must be hardwired to the 5009C control and the control program configured to accept the interface logic (Analog Output and Contact Inputs programmed).

Depending on the station's purpose, not all the OCP switches may need to be connected to the control (overspeed, etc.).

Wiring Notes:
Refer to Figure 8-3 for OCP wiring.

- Wiring must be in accordance with Class I, Division 2 wiring methods and/or in accordance with the authority having jurisdiction.
- It is recommended that 0.75 mm² (20 AWG) or larger wire be used between each device and termination module.
- Shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block. The exposed wire length, beyond the shield, should be limited to 25 mm (1 inch).
- Do not place shielded wires in the same cable conduit with high-voltage or large-current-carrying cables.

Installation of the Operator Control Panel

Mount the control within 300 m (1000 ft) from the 5009C control, leaving an adequate service loop.

1. Mark the panel location and mounting holes (see Figure 8-2).
2. Drill and tap the mounting holes using the appropriate size hardware.
3. Place the panel in position, insert the mounting screws into the tapped holes, and tighten the hardware securely.

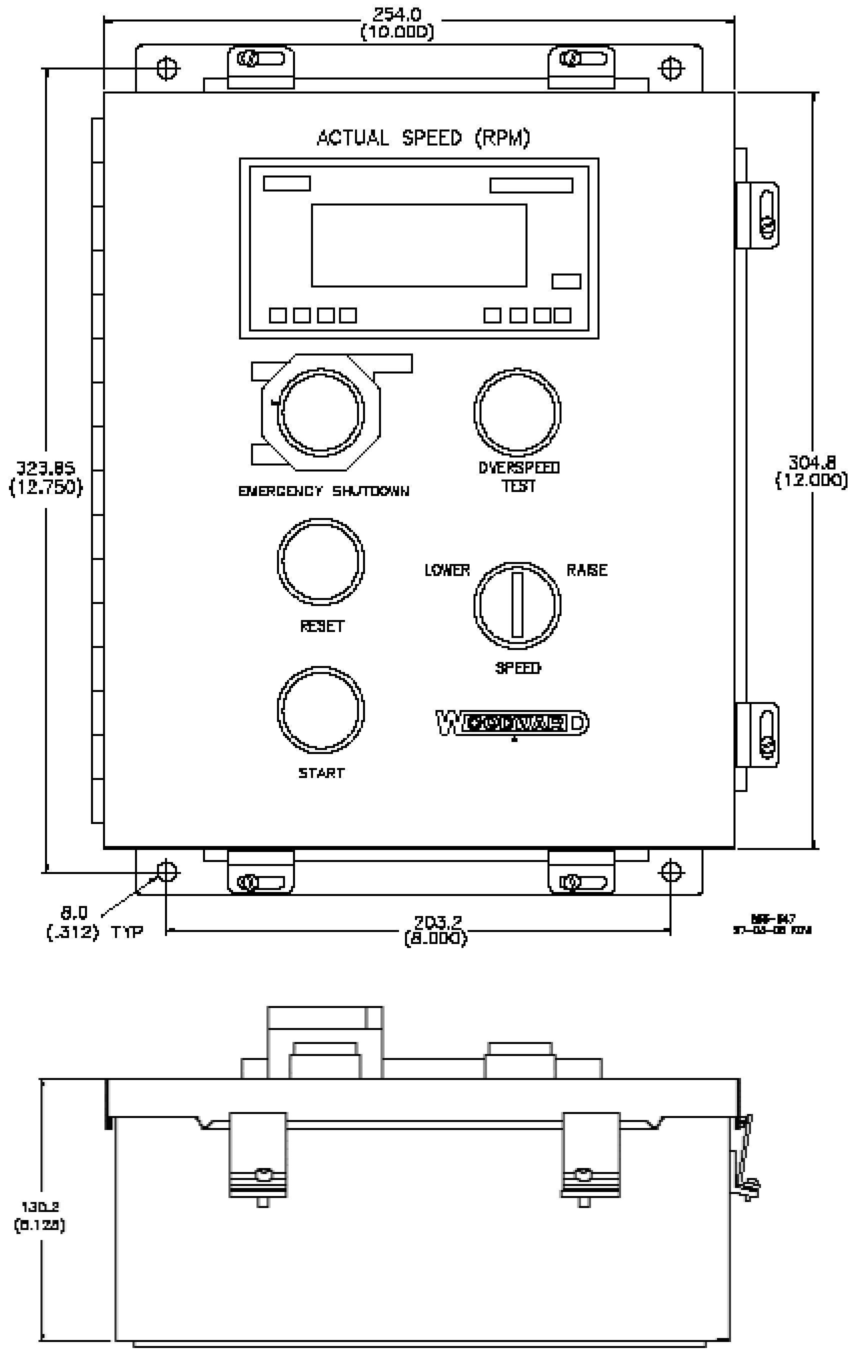


Figure 8-2. Operator Control Panel

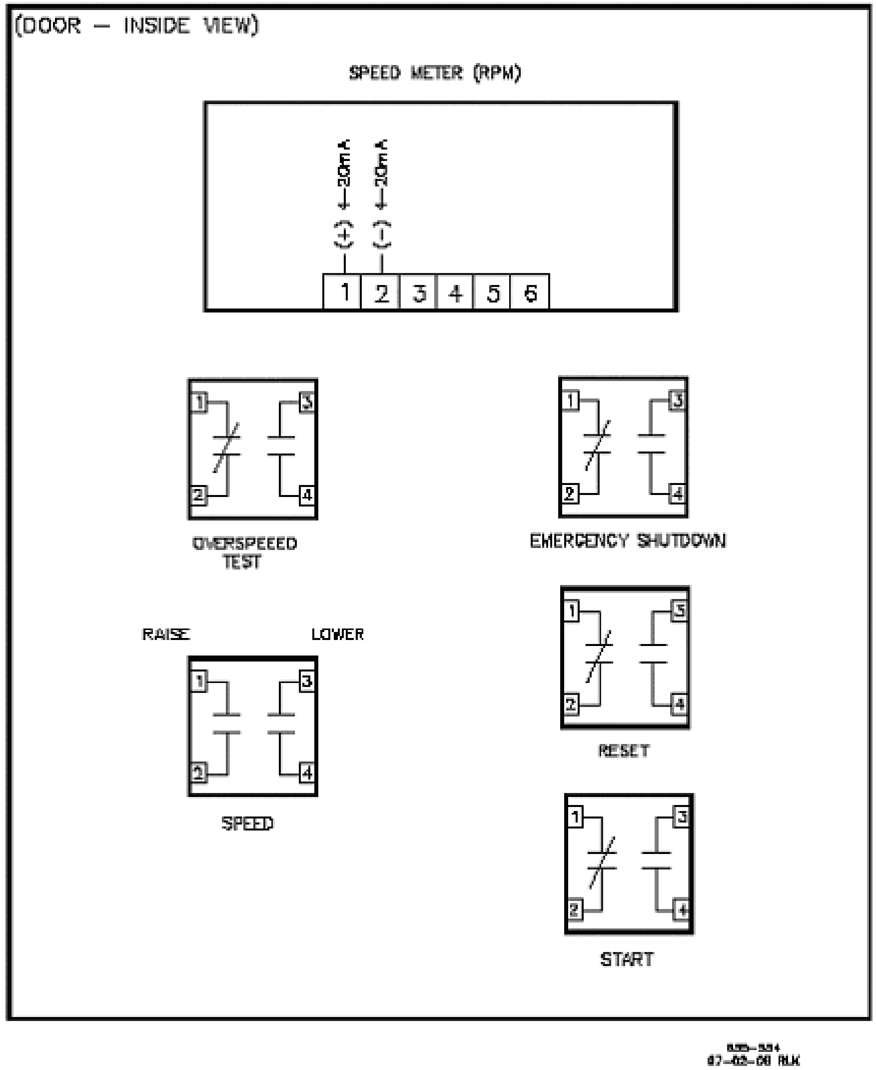


Figure 8-3. Inside View of Door

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Please reference publication 26320V2B.

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