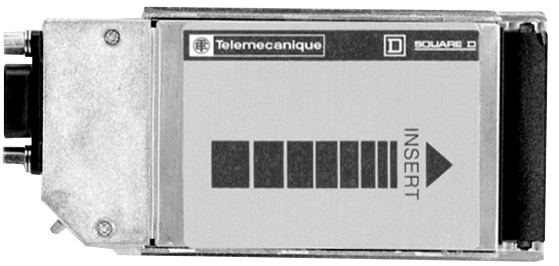
Instruction Bulletin
VD0C06S309
April 1997



ALTIVAR 66®
Modbus Plus® PCMCIA
Communication Card Kit

VW3A66305U

User's Manual

Telemecanique

SQUARE D

⚠ DANGER

HAZARDOUS VOLTAGE

- Before installing PCMCIA card or operating ALTIVAR 66 drive controller with PCMCIA card installed, read and understand completely this and all other bulletins delivered with the ALTIVAR 66 drive controller and associated options. Installation, adjustment, repair, and maintenance of these drive controllers must be performed by qualified personnel.
- Disconnect all power before servicing drive controller. WAIT ONE MINUTE until DC bus capacitors discharge, then measure DC bus capacitor voltage between PA and (–) terminals to verify DC voltage is less than 45 V. The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- DO NOT short across DC bus capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the drive controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Before servicing drive controller:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on drive controller disconnect.
- Lock disconnect in open position.

Failure to follow these instructions will result in death or serious injury.

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INTRODUCTION

The VW3A66305U Modbus Plus® PCMCIA Communication Card Kit allows you to connect an ALTIVAR® 66 drive controller (with firmware Version 3.2 or later) to Modbus Plus networks.

The Modbus Plus PCMCIA Kit includes:

- Type 3 PCMCIA (Personal Computer Memory Card International Association) card with SUB-D 9-pin female connector
- Plastic boot
- Ground clip

The user must supply the following items (available from Square D):

- Drop cable, 8 or 20 feet (see Table 1):

Table 1: Modbus Plus Drop Cables

Length of Cable on Reel	Catalog No.
8 ft (2.4 m)	990NAD211 10
20 ft (6 m)	990NAD211 30

- Modbus Plus tap 990NAD230 00
- Modbus Plus trunk cable (see Table 2 — length depends on your installation):

Table 2: Modbus Plus Trunk Cable Catalog Numbers

Length of Cable on Reel	Catalog No.
100 ft (30.5 m)	490NAA271 01
500 ft (152.5 m)	490NAA271 02
1,000 ft (305 m)	490NAA271 03
1,500 ft (457 m)	490NAA271 04
5,000 ft (1,525 m)	490NAA271 05

To use the Modbus Plus PCMCIA Card, your ALTIVAR 66 (ATV66) drive controller must be equipped with one of the following option modules:

- I/O Extension Module VW3A66201T or VW3A66202T, or
- Communication Carrier Module VW3A66205

NOTE: Ensure the date code on option modules listed above is "9630" or later.

As a node on a network, the ATV66 drive controller can receive and respond to data messages. This data exchange allows your network to access ATV66 functions, such as:

- Downloading of adjustment parameters
- Command and control
- Monitoring
- Diagnostics

SYSTEM SAFETY CONSIDERATIONS

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are Emergency Stop and Overtravel Stop. Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.

Failure to follow these instructions can result in death, serious injury, or equipment damage.[1]

1. For additional information, refer to NEMA ICS 1.1-1984 (R-1990), "Safety Guidelines for the application, Installation, and Maintenance of Solid State Control" and to NEMA ICS7.1-1995, "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems."

USING THIS MANUAL

This manual applies to ATV66 drive controllers equipped with firmware Version 3.2 or later. This manual has five sections:

- **Section 1:** Installation and Configuration (page 3)
- **Section 2:** Modbus Plus Overview (page 27)
- **Section 3:** Register Description (page 41)
- **Section 4:** Fault Management and Network Security (page 63)
- **Appendix A:** Register List / Index (page 67)

For more information about specific parameters, refer to the following ATV66 documentation:

- Level 1 & 2 Configuration Manual, VD0C06S305_
- I / O Extension Module & Level 3 Configuration Manual VD0C06T306_.

Other documentation available:

- Receiving, Installation & Start-Up Manual, VD0C06S304_
- Communication Carrier Module Manual, VD0C06N915_.
- Catalog, VD0C06S201_
- Modicon Modbus Plus Network Planning & Installation Guide, 890 USE 100 00
- Modicon Modbus Protocol Reference Guide, PI-MBUS-300

REVISION LEVEL

This is a new document. It is written for ALTIVAR 66 drive controllers equipped with firmware Version 3.2 or later.

SECTION 1 — INSTALLATION & CONFIGURATION

RECEIVING THE PCMCIA KIT

Remove the Modbus Plus PCMCIA Kit from its packaging and visually inspect it for shipping damage. If any damage is found, notify the carrier and your local Square D representative. Do not install a damaged card. To store the PCMCIA card, replace it in its original packing material and store at -40 to +185°F (-40 to +85 °C).

COMMUNICATION INTERFACE SPECIFICATIONS

Table 3: Modbus Plus PCMCIA Interface Specifications

Isolation (network to drive controller)	Galvanically isolated for 30 V RMS, 50 V peak
Isolation (cable jacket to ground)	150 V RMS
PCMCIA connector	9-pin, female D-shell
Electrical interface	RS-485
Storage temperature	-40 to 185 °F (-40 to +85 °C)
Operating temperature	Same as drive controller. See VD0C06S304_.
Humidity	95% relative humidity at +140 °F (+60 °C), non-condensing
Altitude	Up to 15,000 ft (4,500 m)
Shock (non-operating)	30 g for 11 ms (three shocks/axis)
Shock (operating)	Same as drive controller. See VD0C06S304_.

INSTALLING THE PCMCIA KIT

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

Read and understand this document, VD0C06S304_, VD0C06S305_, and manual for applicable option module before operating drive controller.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Before installing, removing, or replacing the Modbus Plus PCMCIA Kit, remove all power from the drive controller, including external control power that may be present on the option module, and perform the “Bus Voltage Measurement Procedure” on page 4.

Bus Voltage Measurement Procedure

⚠ DANGER

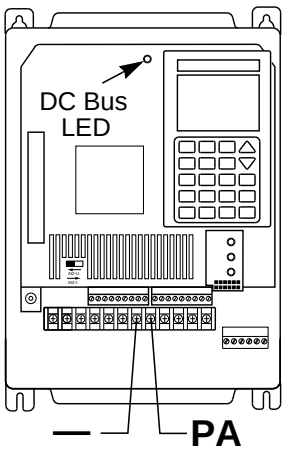
HAZARDOUS VOLTAGE

- Drive controller contains energy storage devices. Read and understand Bus Voltage Measurement Procedure before installing PCMCIA Communication Card Kit. Measurement of DC bus capacitor voltage must be performed by qualified personnel.
- DC bus LED is not an accurate indication of absence of DC bus voltage.
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

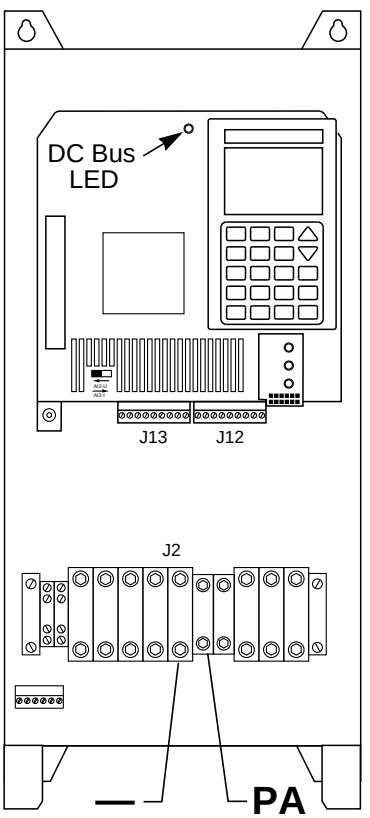
Failure to follow these instructions will cause shock or burn, resulting in death or serious injury.

The PA and – terminals are located inside the drive controller (see Figure 1). To measure bus capacitor voltage:

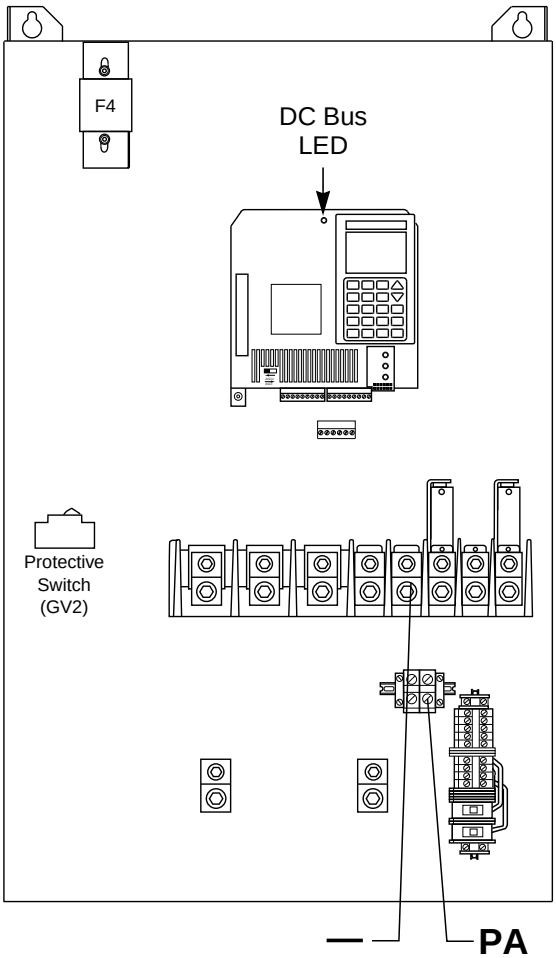
1. Disconnect all power from the drive controller.
2. Wait 1 minute to allow the DC bus to discharge.
3. Open the front cover of the drive controller.
4. Set the voltmeter to the 1000 VDC scale. Measure the bus capacitor voltage between the PA and – terminals to verify that the DC voltage is less than 45 V. **Do not short across capacitor terminals with voltage present!**
5. If the bus capacitors are not fully discharged, contact your local Square D representative. **Do do not operate the drive controller.**



ATV66U41N4 to D12N4 and
ATV66U41M2 to U90M2



ATV66D16N4 to D79N4 and
ATV66D12M2 to D46M2



ATV66C10N4 to C19N4

Figure 1: Location of PA and – Terminals: ATV66U41N4 to C19N4 and ATV66U41M2 to D46M2

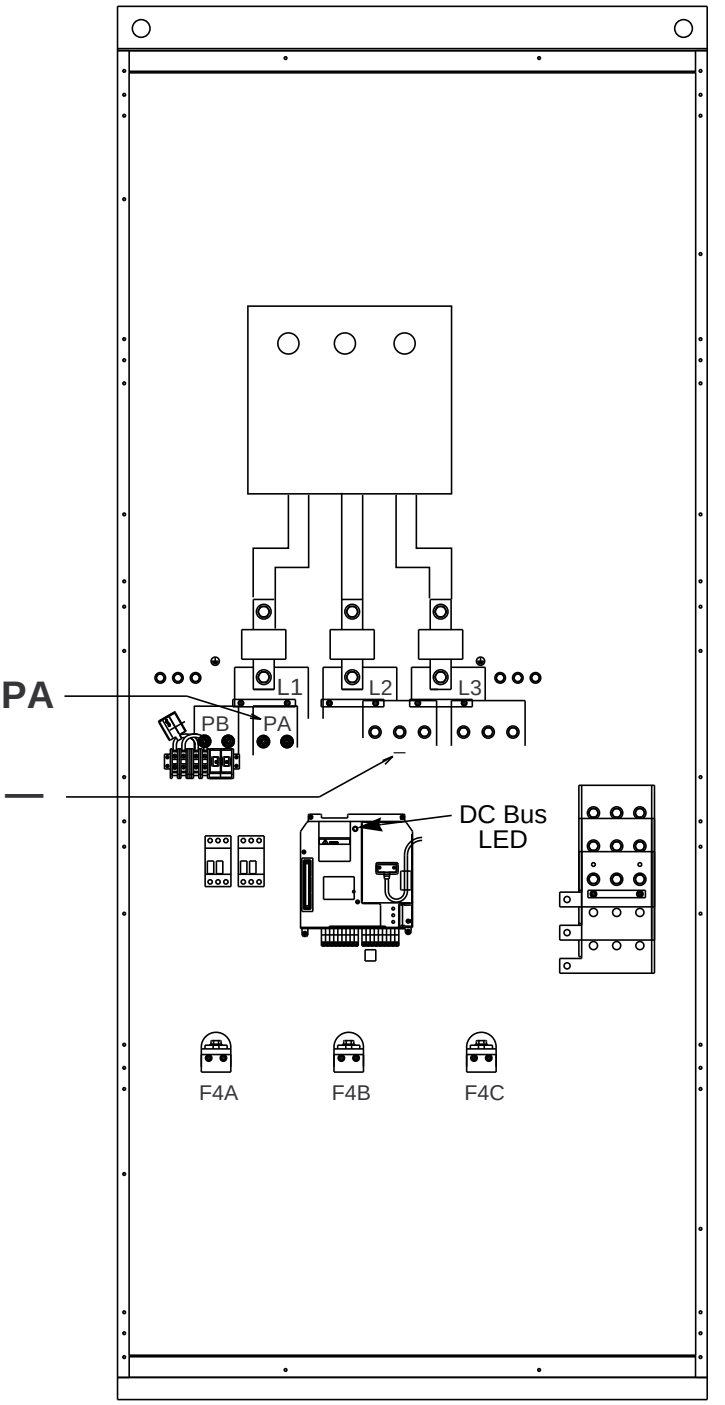


Figure 2: Location of PA and – Terminals: ATV66C23N41 to C31N41

Installing the Modbus Plus PCMCIA Kit

To install the Modbus Plus PCMCIA Kit into the drive controller:

1. Open the drive controller door.
2. On models ATV66U41N4 to D12N4 and ATV66U41M2 to U90M2, remove the plastic knockout from the top of drive controller cover.

   NOTE: The drive controller enclosure Type rating will change from Type 1 to Open when the knockout is removed.
3. Remove protective label from PCMCIA slot of option module
4. Install the plastic boot supplied with the Modbus Plus PCMCIA kit onto separately ordered cable (see Figure 3). Install cable onto 9-pin D-shell connector of the PCMCIA card.

   NOTE: Plastic boot must be installed to maintain ESD rating of drive controller.
5. Insert the PCMCIA card 68-pin connector into the PCMCIA slot on top of option card with the “Insert” arrows facing toward the front of drive controller (see Figure 3). Seat the plastic boot over the end of the PCMCIA card as shown.

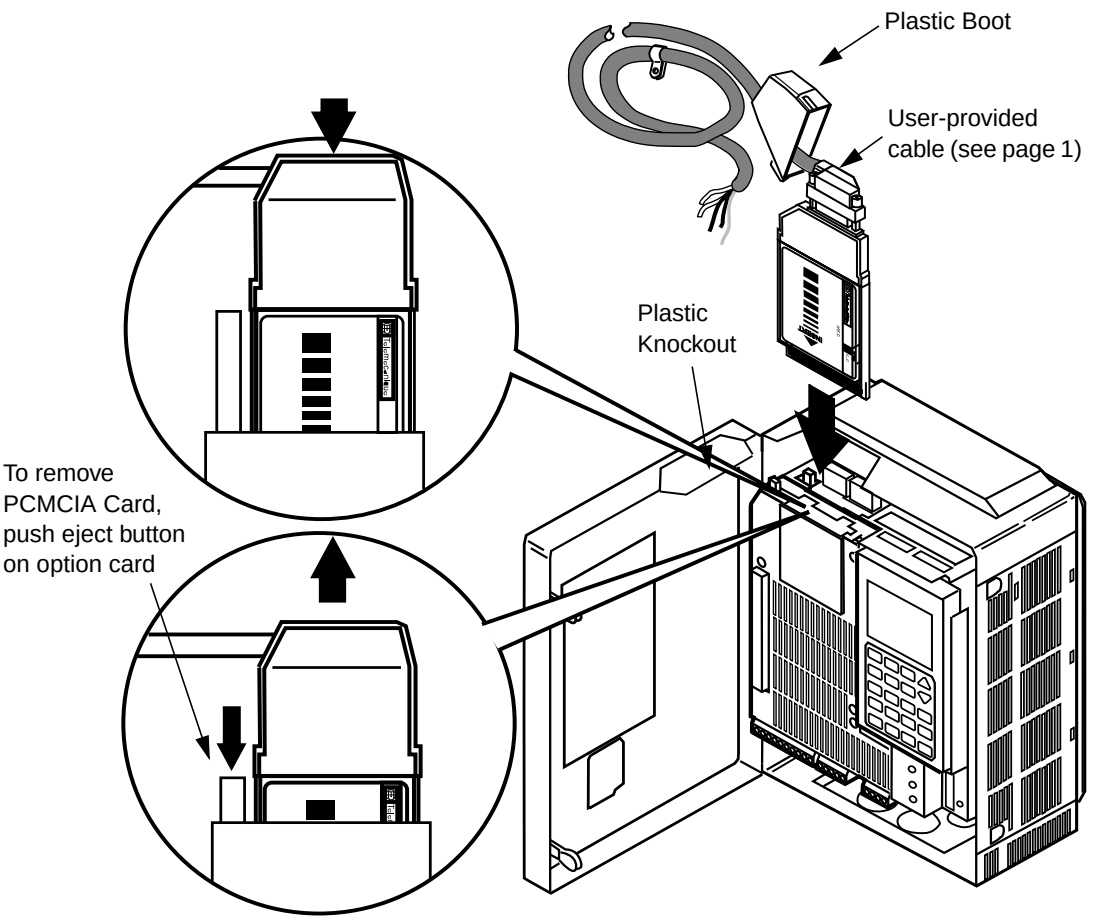


Figure 3: Mounting and Removing Modbus Plus PCMCIA Kit

6. Route the cable (ordered separately):
   a. For all drive controller models, route the cable with other control wiring. For more information, see “CABLE ROUTING PRACTICES” on page 12 and also refer to bulletin VD0C06S304_.
   b. For models ATV66U41N4 to D12N4 and ATV66U41M2 to U90M2, cable must be routed through the knockout and outside the drive controller enclosure.

      NOTE: Additional mechanical and environmental protection of the cable may be required.
   c. For models ATV66D16N4 to C19N4 and ATV66D12M2 to D46M2, provisions in the bottom plate allow the PCMCIA cable to exit through the bottom of the drive controller enclosure.

      For models ATV66C23N4 to C31N4, the PCMCIA cable may exit the drive controller enclosure either through the top conduit plate or through the bottom closing plate below the main fan intake.

      NOTE: When the PCMCIA cable exits the controller enclosure, additional mechanical and environmental protection of the cable may be required.
7. Ground the shield on the cable:
   a. For models ATV66U41N4 to D12N4 and ATV66U41M2 to U90M2, secure the tab on the grounding clip (supplied with the drop cable) to the metal mounting surface to which the drive controller is attached. Keep the connection close to the top left mounting foot of the drive controller.
   b. For models ATV66D16N4 to C31N4 and ATV66D12M2 to D46M2, hardware is supplied in the PCMCIA card kit for grounding.
      i. Thread the screw, washer, L-bracket, second washer, and nut through the tab on the grounding clip (supplied with the drop cable) as shown in Figure 4. Tighten to specified torque.
      ii. Completely unthread the bottom left screw on the control basket. Loosen, but do not completely unthread the other three screws on the control basket (see Figure 4).
      iii. Slide the L-bracket under the screw in the lower left corner, between the control basket and its mounting surface.
      iv. Thread the lower left screw through the hole in the L-bracket. Tighten all control basket screws to specified torque (see Figure 4).

NOTE: The cable and PCMCIA card have exposed metal parts. They must be routed and anchored so the exposed metal avoids contact with live conductors in the drive controller.

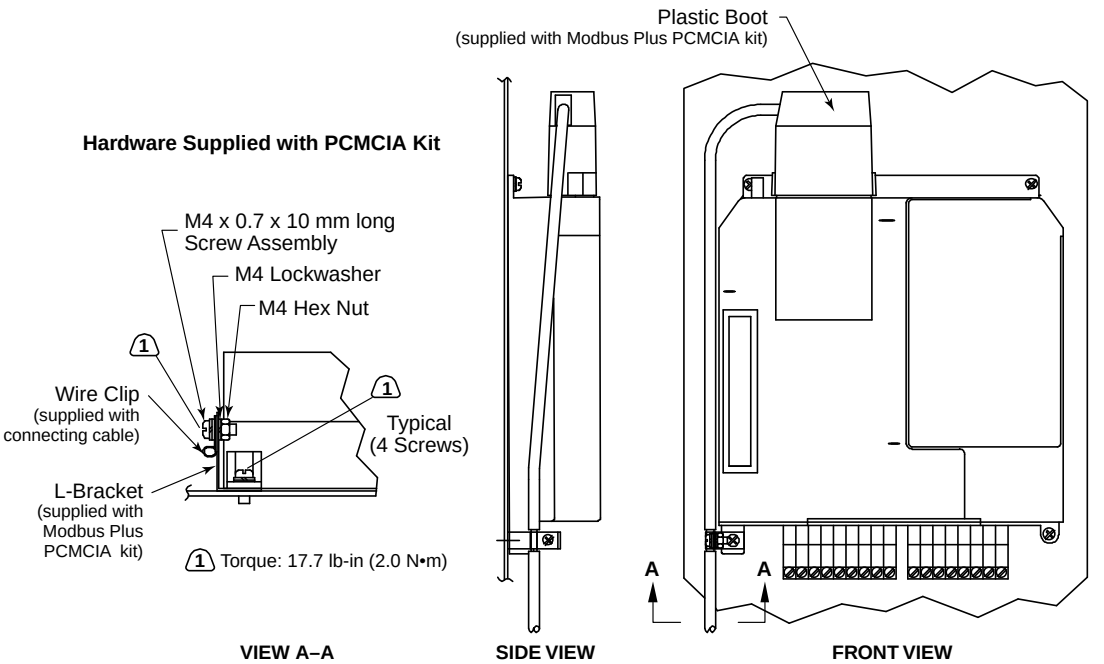


Figure 4: Cable Grounding (ATV66D16N4 to C31N4 & ATV66D12M2 to D46M2 models only)

NETWORK OVERVIEW

Modbus Plus is a Local Area Network system designed for industrial control applications. Up to 32 node devices can connect directly to the network bus cable over a length of up to 1,500 ft (450 m). Repeater devices are used to extend the cable distance to its maximum of 6,000 ft (1,800 m), and the node count to a maximum of 64.

Modbus Plus provides host level, peer-to-peer communication for networked PLCs. As a node on a Modbus Plus network, the Altivar 66 drive controller can receive and respond to data messages transmitted from a PLC, and place information into the network's global data base. Other nodes can access drive controllers on the local network, or on remote networks through bridge devices. The network also provides distributed input / output (DIO) communications in which PLCs communicate directly with input / output (I / O) subsystems.

The network must use a single-cable layout.

Modbus devices or networks of Modbus devices may join Modbus Plus networks through bridge multiplexers. A multiplexer provides four serial ports that are separately configurable to support Modbus or custom RS-232 / RS-485 devices. Modbus devices can communicate with Modbus Plus networked devices, as well as with devices at the other serial ports.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are Emergency Stop and Overtravel Stop. Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.

Failure to follow these instructions can result in death, serious injury, or equipment damage.[1]

1. For additional information, refer to NEMA ICS 1.1-1984 (R-1990), "Safety Guidelines for the application, Installation, and Maintenance of Solid State Control" and to NEMA ICS7.1-1995, "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems."

Figure 5 shows an example of two Modbus Plus networks. Networks A and B are host level networks joined by a Bridge Plus. For more information, consult *Modicon Modbus Plus Network Planning and Installation Guide.*

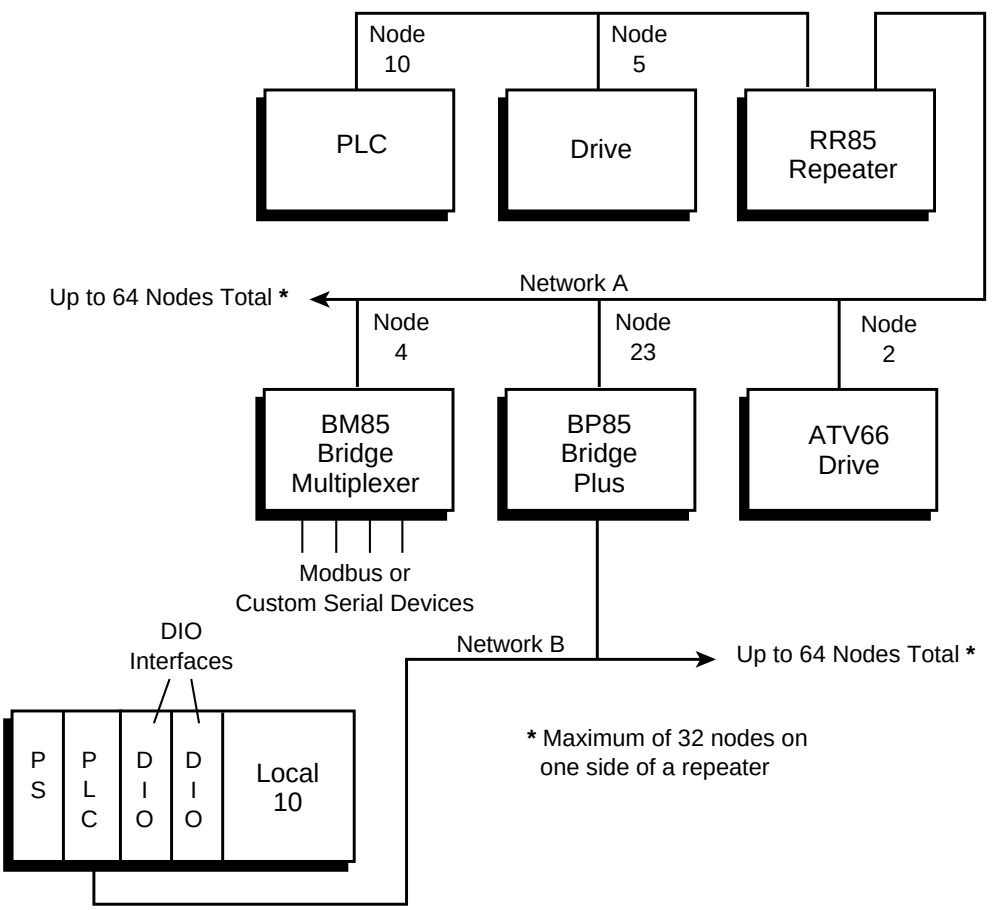


Figure 5: Network Overview

Logical Network

Network nodes are identified by user-assigned addresses. Each node's address is independent of its physical site location. Addresses must be within the range of 1 to 64 decimal, although they do not have to be sequential. Duplicate addresses are not allowed. A device with a duplicate address will not be allowed to join the network. If it attempts to join the network, it will display an LED pattern for duplicate address.

The token is a grouping of bits that is passed in rotating address sequence from one node to another. Network nodes function as peer members of a logical ring, gaining access to the network upon receipt of a token frame. Each network maintains its own token rotation sequence, independent of other networks. Where multiple networks are joined by bridges, the token is not passed through the bridge device.

While holding the token, a node initiates message transactions with other nodes. Each message contains routing fields defining its source and destination, including its routing path through bridges to the final destination on a remote network.

When passing the token, a node can write into a global database that is broadcast to all nodes on the network. Global data is transmitted as a field within the token frame. Other nodes monitor the token pass and can extract the global data if they have been programmed to do so. Use of the global database allows rapid updating of alarms, setpoints, and other data. Each network maintains its own unique global database, as the token is not passed through a bridge to another network. Figure 6 shows the token sequences in two networks joined by a Bridge Plus.

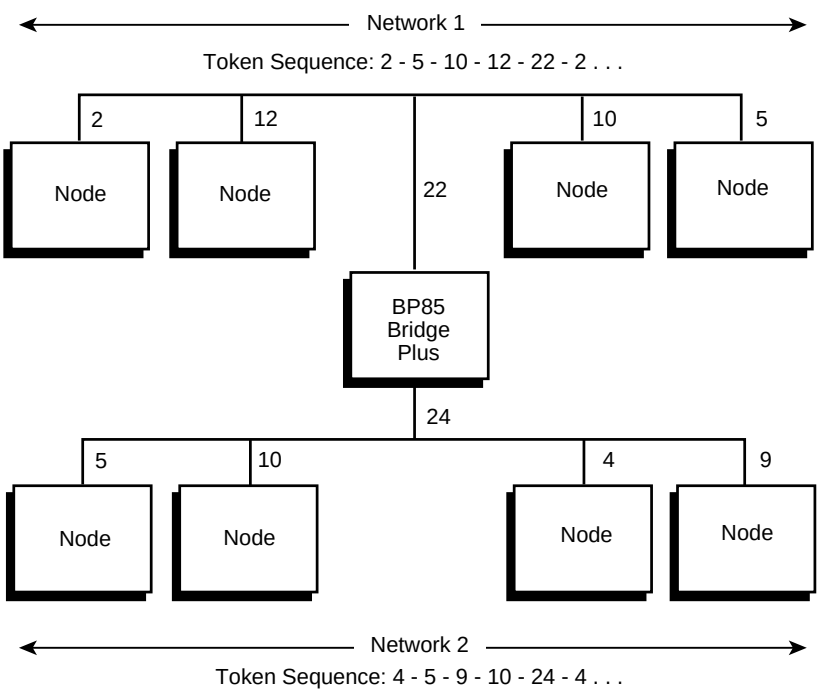


Figure 6: Token Sequences

Physical Network

The network bus consists of twisted-pair shielded cable that is run in a direct path between successive nodes. The two data lines in the cable are not sensitive to polarity; however, a standard wiring convention is followed in this bulletin to facilitate maintenance.

The physical network consists of one or more cable sections, with any section supporting up to 32 nodes at a maximum cable distance of 1,500 ft (450 m). Sections can be joined by repeater devices to extend the network's length and to support up to 64 nodes. The minimum cable length between any pair of nodes must be at least 10 ft (3 m). The maximum cable length between two nodes is the same as the maximum section length of 1,500 ft (450 m).

NOTE: The ATV66 drive controller does not support a dual or redundant cable layout.

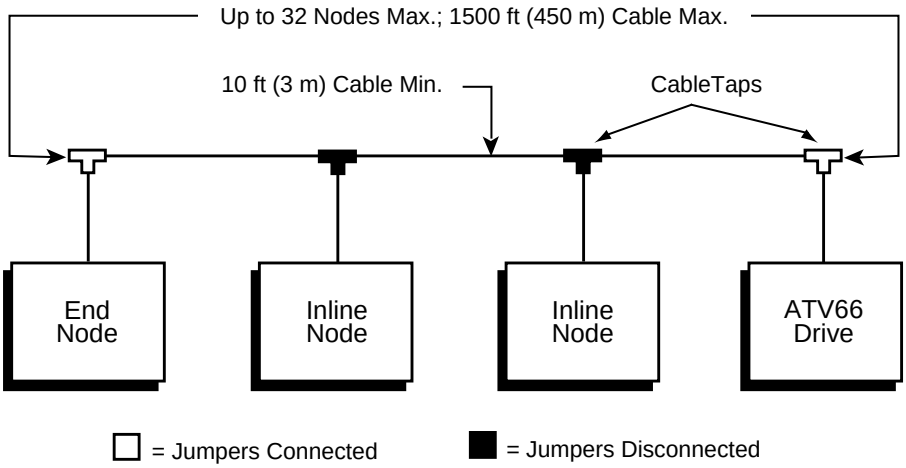


Figure 7: Single Cable Layout

NOTE: For information on jumpers, refer to Figure 8 on page 14.

CABLE ROUTING PRACTICES

Environmental Requirements

Avoid areas of high temperature, moisture, vibration, or other mechanical stress. Secure the cable where necessary to prevent its weight and the weight of other cables from pulling or twisting the cable. Use cable ducts, raceways, or other structures for protecting the cable. These structures should be used for signal wiring paths, and should not contain power wiring.

Avoid sources of electrical interference that can induce noise into the cable. Use the maximum practicable separation from such sources.

When planning cable routing within a building, follow these guidelines:

- Maintain a minimum separation of 3.3 ft (1 m) from the following equipment: air conditioners, elevators, escalators, large blowers, radios, televisions, intercom and security systems, fluorescent, incandescent and neon lighting fixtures.
- Maintain a minimum separation of 10 ft (3 m) from the following equipment: power wiring, transformers, generators, and alternators.

When wiring in electrical equipment rooms or large electrical equipment line-ups, observe the following guidelines for cable segregation and separation of circuits:

- Use metallic conduit for a drive controller wiring. Do not run control network and power wiring in the same conduit.
- Separate non-metallic conduits or cable trays used to carry power wiring from metallic conduit carrying low-level control network wiring by at least 12 in (305 mm).
- Separate metallic conduits carrying power wiring or low-level control network wiring by at least 3 in (80 mm).
- Cross the metallic conduits and non-metallic conduits at right angles whenever power and control network wiring cross.
- Attenuate conducted emissions to the line from the drive controller in some installations to prevent interference with telecommunication, radio, and sensitive electronic equipment. Such instances may require attenuating filters. Consult catalog for selection and application of these filters.

TRUNK AND DROP CABLING WITH TAPS

Nodes are connected to the cable by means of a tap device. This provides “through” connections for the network trunk cable and “drop” connections for the cable to the node device.

The tap also contains a resistive termination connected by two internal jumpers. The tap at each end of a cable section requires both jumpers to be connected to prevent signal reflections. All of the taps that are in-line on the cable section require their jumpers to be removed (open). See Figure 7 on page 12.

Figure 8 illustrates a tap at an in-line site. Two lengths of trunk cable are installed. The circled jumpers are not installed. If the tap is at the end site of a cable section, only one length of trunk cable is routed to the tap (it can enter either side) and the jumpers should be connected to the signal pins at the opposite side of the tap to provide the network termination.

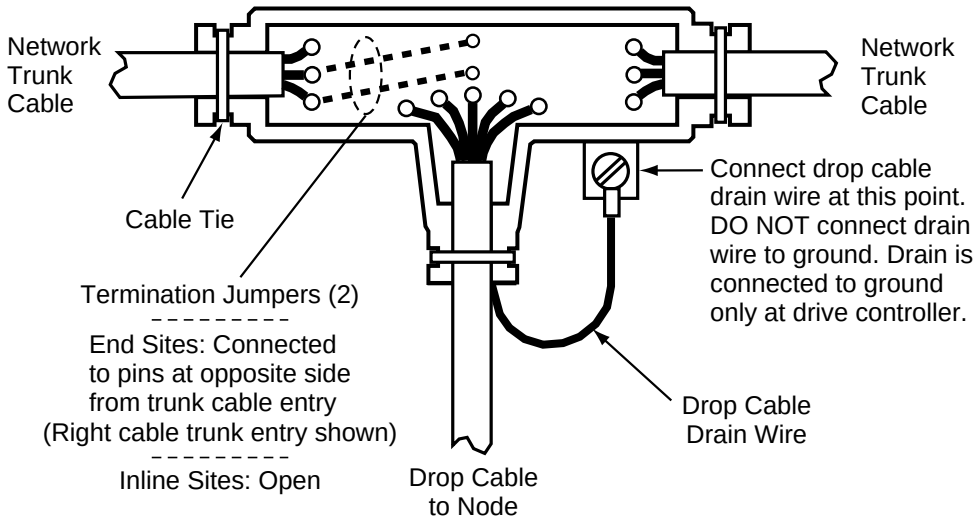


Figure 8: Cable Tap Layout (shown with cover open)

Routing Cables

Figure 9 shows typical cable routing of the network trunk cable between tap locations. The figure also shows cable drops to several node devices and service access points.

NOTE: The tap's internal termination jumpers are connected at the two end sites of a cable section, and disconnected and removed at each in-line site on the cable section.

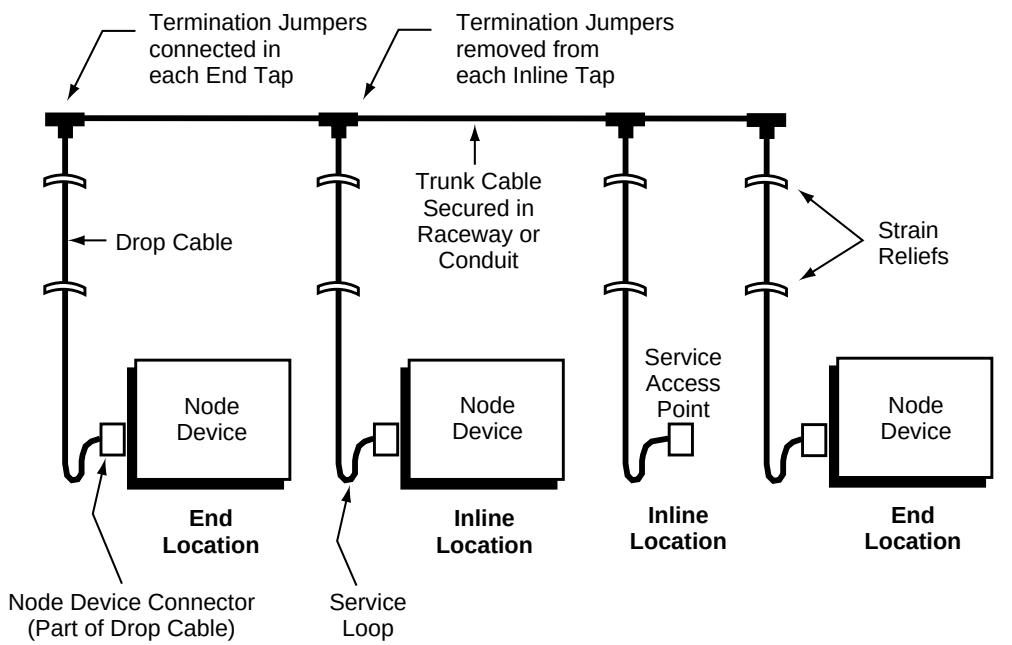


Figure 9: Typical Cable Routing

Referring to Figure 9, route the cable between the site locations of the node devices. Guidelines for cable routing are described below.

- Use a continuous length of trunk cable between locations. Do not use any splices.
- At each tap location, allow sufficient trunk cable length for a service loop to prevent pulling or twisting the cable.
- For each drop cable, provide a service loop to allow the connector to be connected and disconnected at the network node device without any strain on the cable. A service loop of 6 in (152 mm) minimum radius is adequate for most installations.
- Install cable ties or clamps on each trunk cable segment as required for strain reliefs, to prevent the cable from pulling on the tap.
- Install cable ties or clamps on each drop cable as required for strain reliefs, to prevent the cable from pulling on the tap or node device connector.
- Use additional ties or clamps as required to secure each cable from flexing or other damage in areas of mechanical motion devices and traffic.

Mounting the Tap

Mount each tap at a location near its node device. It is recommended that the tap be mounted outside the drive controller enclosure. The tap must be near enough to the node device to allow the drop cable to reach the node device with a service loop. See Figure 9 for drop cable routing.

The location must also be accessible for installing the trunk and drop cables, and for future maintenance. Figure 10 shows the tap's outer and mounting dimensions.

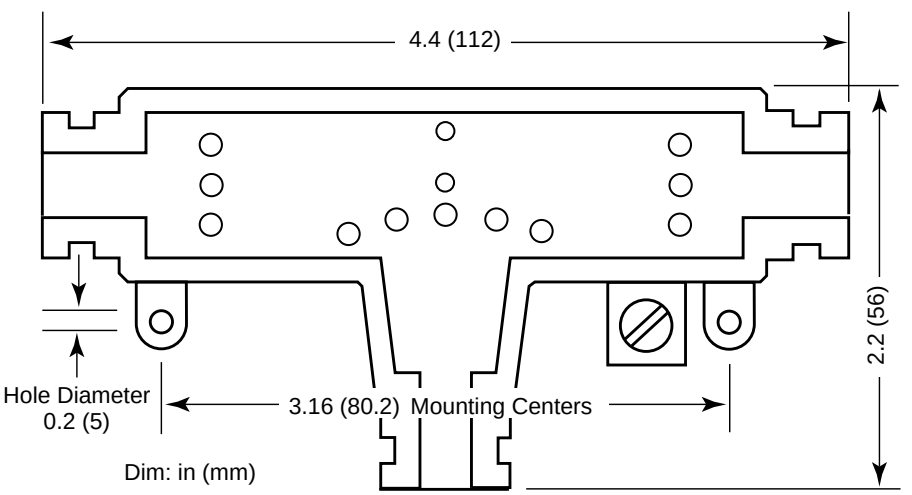


Figure 10: Tap Layout (Cover Open)

Connecting the Trunk Cables

Modbus Plus Trunk Cable

Cable specified for Modbus Plus trunk use is available from Square D. See Table 2 on page 1.

Your cable should run directly between the network device locations. Each cable segment must be a continuous run between the taps at two locations. **Do not** use splices, splitters, or any other configurations such as star or tree configurations. The only allowed media components are the network cable and taps.

Plan cable runs according to the horizontal distances between sites. Trunk cable is ordered in reels of fixed length. Order reels of sufficient length to allow continuous runs between the network devices.

Cable Entry and Jumpers (Taps at In-Line Sites)

At each in-line site, two lengths of trunk cable are installed. The cable to the right side of the previous tap must connect to the left side of this tap. The cable to the left side of the next tap must connect to the right side of this tap. The two internal jumpers must be removed. Figure 11 shows the connections for taps at in-line sites.

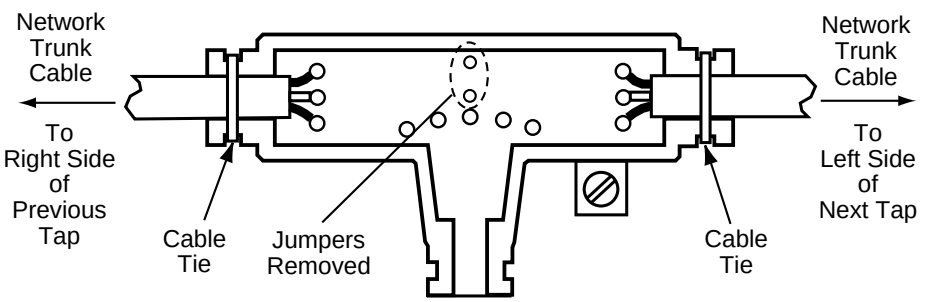


Figure 11: Taps at In-Line Sites

Cable Entry and Jumpers (Taps at End Sites)

At the two end sites on the cable section, one length of trunk cable is installed. It can be connected to either side of the tap. The two internal jumpers must be installed between the center posts and the lower two posts at the side of the tap opposite from the cable. Figure 12 on page 17 shows the connections for taps at end sites.

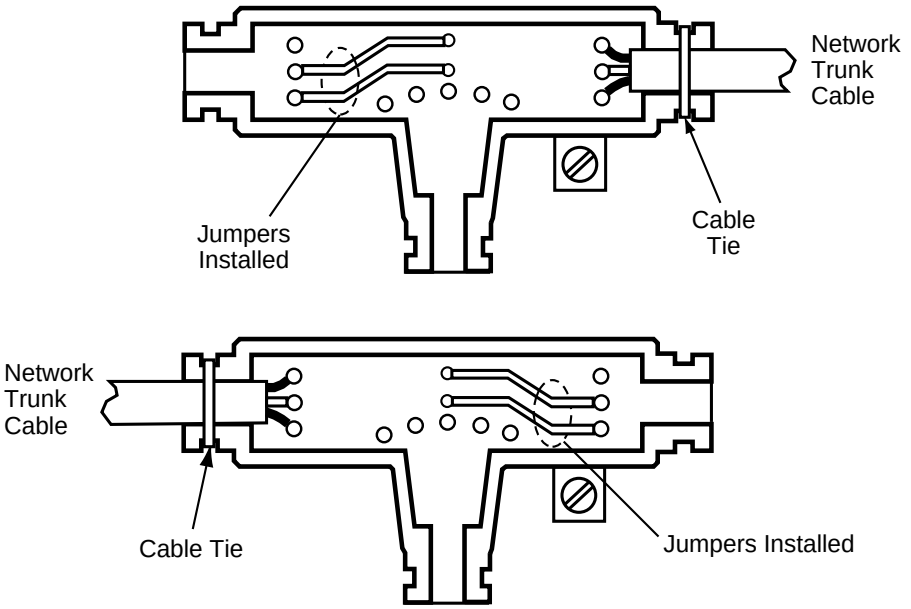


Figure 12: Taps at End Sites

Connecting the Wires

Detailed instructions for stripping the wires and making the connections are enclosed in each tap package. Below is a general description of the connections.

Trunk cable is connected as shown in Figure 13 on page 18. The terminals are marked as shown in Table 4.

Table 4: Trunk Cable Terminals

Terminal	Meaning	Location	Wire Color
GND	Network Bus, Ground	Top	Shield
W	Network Bus, White	Middle	White
BLK	Network Bus, Blue or Black	Bottom	Blue or Black

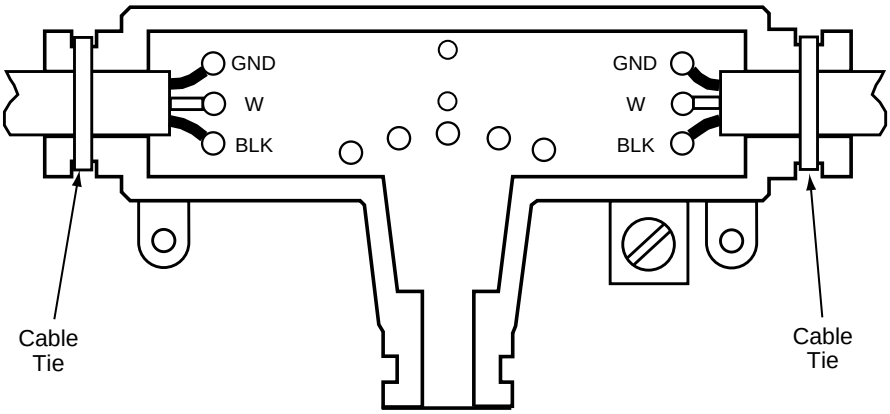


Figure 13: Trunk Cable Connections

To connect each wire:

1. Remove the plastic cap from the terminal.
2. Place the wire into the terminal slot.
3. Using a Phillips screwdriver, press the cap into the terminal to force the wire down into the slot.

Figure 14 shows the connection sequence. A special tool is available for making these connections (AMP part number 552714-3).

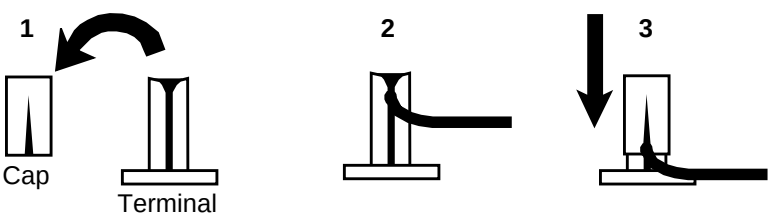


Figure 14: Wire Terminal Connection

Connecting the Drop Cable

Modbus Plus Drop Cable

A drop cable is used at each site to connect between the tap and a network node device. The cable is preassembled with a 9-pin D connector on one end for connection to the node device. The other end is open for connection to the taps. Cables are available in two lengths (see Table 1 on page 1).

Order a sufficient quantity of drop cables and taps to allow extra ones for service access and spares.

Connecting the Signal Wires

Detailed instructions for stripping the wires and making connections are enclosed in each tap package. Below is a general description of the connections.

The drop cable contains two sets of twisted-pair signal wires with separate shield wires. It also has an outer shield drain wire. This is a total of seven wires.

- One set of wires is color-coded WHITE and ORANGE, with a bare shield wire.
- The other set is WHITE and BLUE, with a bare shield wire.

Before connecting the wires, make sure you have identified the two sets of twisted-pair wires. The two white wires are not interchangeable. When you connect the wires, you must connect each wire to its proper terminal.

Insert the cable into the tap and secure it with a cable tie. Viewing the tap as shown in Figure 15, connect the wires. The terminals are marked as illustrated in Table 5.

Table 5: Drop Cable Terminals

Terminal	Location	Wire Color
O	Left	ORANGE
W	Left Center	WHITE
GND	Center	Shields (both sets of wires)
W	Right Center	WHITE
BLU	Right	BLUE

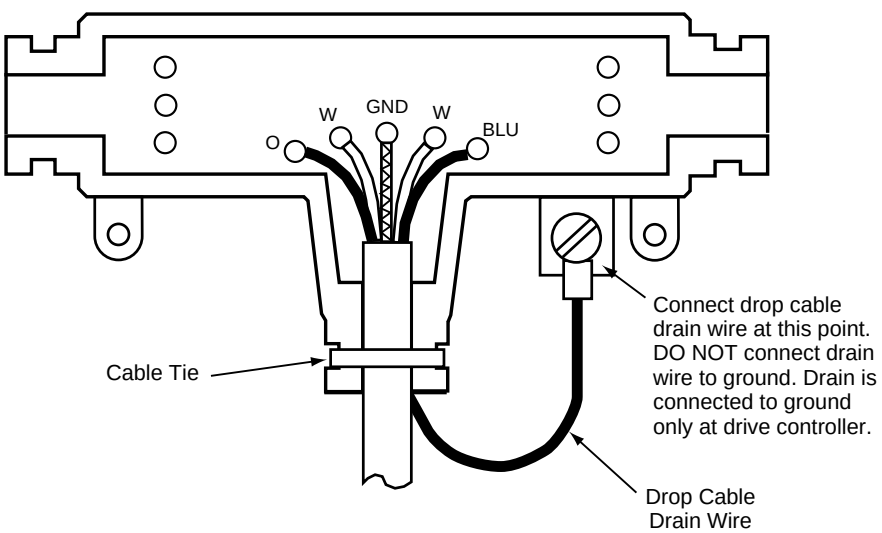


Figure 15: Drop Cable Connections

To connect each wire:

1. Remove the plastic cap from the terminal.
2. Place the wire into the terminal slot.
3. Using a Phillips screwdriver, press the cap into the terminal to force the wire down into the slot.

Figure 14 on page 18 shows the connection sequence. A special tool is available for making these connections (AMP part number 552714-3).

Connecting the Drop Cable Drain Wire

Install a lug on the drain wire. Tightly crimp or solder the lug to the wire. Connect the lug to the tap's screw as shown in Figure 15 on page 19.

Grounding

At drive controller end of the drop cable, terminate outer shield as described on page 8. You must maintain this connection even if there is no node device connected to the network at the site (i.e. temporary removal of drive controller for repair).

Labeling

After the cable is installed, label the cable segments for easy identification in future maintenance. Adhesive labels are available commercially for cable identification.

If a cable layout diagram exists for the installation, label each segment in accordance with the diagram. If a diagram does not exist, prepare one showing the cable segments and method of identifying them for future service. Then label the segments accordingly.

Affix the labels to the cables at each network node drop. Place them at a point that will be visible to maintenance personnel.

Complete the network installation labeling by properly labeling each site's cabinet or enclosure, device mounting panel, and device.

Checking the Cable Installation

Inspecting the Cable Installation

Visually inspect the cable for the following points:

- The cable runs should be consistent with the physical and electrical protection requirement described in "Environmental Requirements" on page 12.
- The cable runs should be consistent with the network cable routing illustrated in Figure 9 on page 14.

- The tap at each end drop site on each section of the network should have its two internal termination jumpers connected. They must be connected between the two center posts and the W and B posts at the side of the tap opposite from the trunk cable connection.
- The tap at each in-line drop site should have its two internal terminal jumpers disconnected and removed.
- Service loops should exist on the trunk cable at each tap, and on each drop cable at the node device end of the cable.
- Each tap should have the drop cable's drain wire connected to its terminating screw. The drop cable's outer shield should also be connected as described on page 8.
- Adequate strain reliefs should be installed on the cable at each drop.
- All identification labels should be in place and properly marked.

Checking Cable Continuity

Before checking continuity, disconnect all network cable connectors from the node devices. Leave the drop cable ground lugs connected to their site panel grounds. Verify the cable's end-to-end electrical continuity by checking the following points:

- At any node device connector, measure the resistance between pins 2 & 3 (the signal pins) — see Figure 16. This should range between 60 to 80Ω, including the cable wire resistance.
- At each node device connector, check for an open circuit between pin 2 (a signal pin) & pin 1 (the shield pin). Then check between pin 3 (a signal pin) & pin 1 — see Figure 16. An open circuit should exist for both checks.
- At each connector, check the continuity between pin 1 and the drive controller ground point on the local site panel or frame. Direct continuity should be present.
- Also check for proper termination and insulation of individual drop twisted pair shields.

If any check point fails, inspect the cable and all connections for damage or miswiring, and correct the condition.

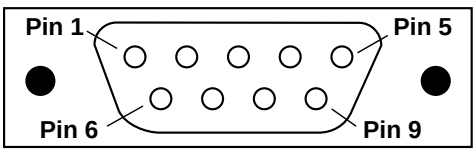


Figure 16: 9-Pin D-Shell Connector (drive controller end of drop cable)

COMMUNICATION CONFIGURATION

First Power Up

To understand access to the different menus, refer to the Level 1 & 2 Configuration manual, VD0C06S305_, and (if an I/O Extension Module is installed) the Level 3 Configuration manual, VD0C06T306_.

At first power up, a message appears on the keypad display, identifying the option module. The Modbus Plus PCMCIA card can be used with either the Communication Carrier module (VW3A66205) or the I/O Extension module (VW3A66201T or VW3A66202T). After OPT, the catalog number of the selected card is shown. Press ENT to reconfigure the drive controller to factory settings.

Figure 17: First Power Up (with VW3A66205 Option Module installed)

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Installing an option module will reset all drive controller parameters, including I/O assignments, to factory default settings.
- Before installing an option module, record all existing drive controller settings.
- After installing the option module, reset drive controller back to recorded values.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

In the Drive Identification menu, you can check the catalog number of the ATV66 option module by pressing the ▲ or ▼ key.

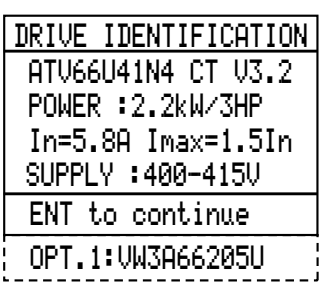


Figure 18: Drive Identification

The Modbus Plus PCMCIA Card cannot be used unless an option module (VW3A66201T, 202T, or 205) is installed in the drive controller. If the option module is removed after the drive controller is configured, a fault screen is displayed when the drive controller is powered up. Reinstall the module or reset the drive controller settings to their factory preset values.

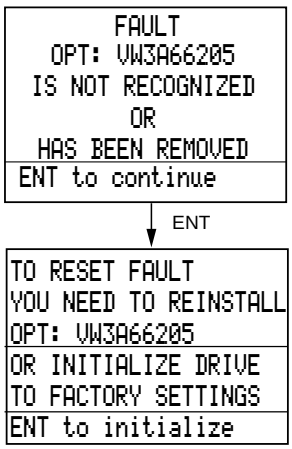


Figure 19: Fault Screen

Communication Configuration Menu

Select menu 11→Communication to access the configuration parameters of the Modbus Plus PCMCIA Kit. This menu allows you to configure the Protocol address and communication settings (see Figures 20 & 21, and Table 6). This PCMCIA card and manual support ONLY Modbus Plus. Selecting another protocol will result in a Serial Link Fault (SLF) upon the next power up of the drive controller. Using the keypad, enter MODBUS+ as the Protocol. Enter the drive controller address and then configure the other parameters. Menu 11 is not accessible if Serial Link mode is enabled (see “Taking Command over the Network” on page 37).

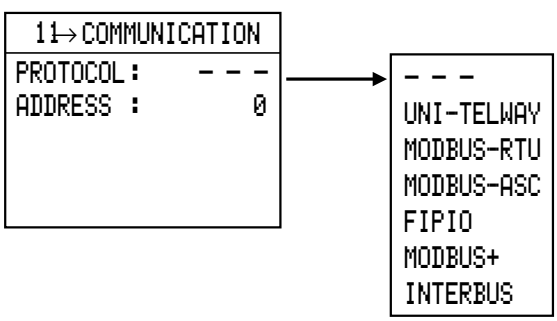


Figure 20: Setting the Protocol

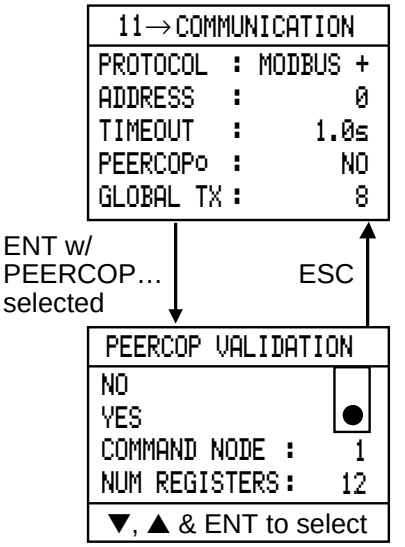


Figure 21: Communication Menu

Table 6: Modbus Plus Card Configuration Parameters

Parameter	Range	Default	Comments
PROTOCOL		— — —	Must be set to MODBUS+
ADDRESS	0 – 64	0	Modbus Plus node address, 0 = address not configured
TIMEOUT [1]	0.1 – 60 s	1.0	100 ms increments
PEERCOP NODE	NO/YES	NO	Press enter when selected to reach Peercop validation screen
GLOBAL TX [2] (Global Data Transmission)	0 – 32	8	0 = No Global Data Transmitted
COMMAND NODE [3]	1 – 64	1	Must not equal ADDRESS
NUM REGISTERS [3]	1 – 32	12	12 = All command registers

[1] Time period between last Peer Cop transmission from Command Node and moment when drive controller responds to data sent via messaging from other nodes (see “PEER COP” on page 30 for more information). Also, time period between loss of communication with node that placed drive controller in Serial Link Control mode and the resulting Serial Link Fault.

[2] For more information, see “Global Data Transmission” on page 33.

[3] For more information, see “PEER COP” on page 30.

Diagnostics

The status of the Modbus Plus communications link is indicated by the green LED (see Table 7). The LED is located next to the PCMCIA card's 9-pin connector. Network and PCMCIA card status is also displayed in menu 12→Communication State. For additional information on Troubleshooting, see "Section 4 — Fault Management & Network Security" on page 63.

Table 7: Network and PCMCIA Card Status

LED Pattern	ATV66 Display	Indication (Status)
Off	NOT CONFIGURED	PCMCIA card not configured (has no address).
	PCMCIA ERROR	PCMCIA card cannot communicate with drive controller, has lost communication, and does not respond to a reset.
	CONFIG. MISMATCH	PCMCIA card does not match the configuration of the drive controller option module.
1 flash per s	MONITOR LINK	Just after power-up or after exiting the 4 flashes mode, the card monitors the network and builds a table of active and token-holding nodes. After 5 s, the card attempts to go to its normal operating state (indicated by 6 flashes/second).
6 flashes per s	TOKEN GOOD	Token is circulating normally, and is received by PCMCIA card once per rotation.
2 flashes, then Off for 2 s	NEVER GETTING TOKEN	Token is being passed between other nodes, but PCMCIA card never receives it.
3 flashes, then Off for 1.7 s	SOLE STATION	Only node on the network, or connection has been lost.
4 flashes, then Off for 1.4 s	DUPLICATE STATION	Another node is using PCMCIA card address. PCMCIA card waits for reconfiguration or for the other node to log off the network.

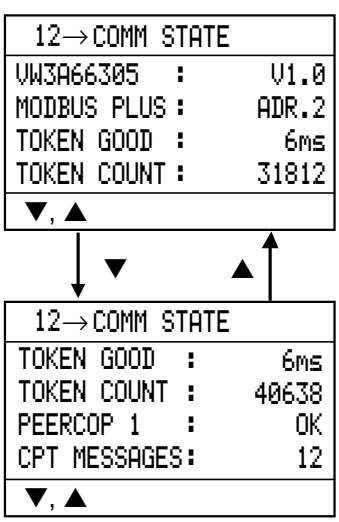


Figure 22: Drive Controller Comm State Screen

Table 8: Drive Controller Communication Parameters

Parameter	Range	Description
VW3A66305	—	PCMCIA card version.
MODBUS PLUS	0 – 64	Drive controller address configured in the 11→Communication Menu.
TOKEN GOOD	TOKEN GOOD with token rotation time MONITOR LINK NEVER GETTING TOKEN SOLE STATION DUPLICATE STATION	See Table 7 on page 25.
TOKEN COUNT	0 – 65535	When token pass counter reaches 65535, it begins again at 0.
PEERCOP n (n = 1 to 64)	OK DISABLED TIMEOUT	Parameter = Command Node address Range = Command Node state
CPT MESSAGES	0 – 65535	Number of messages received. When message counter reaches 65535, it begins again at 0.

Forced Local

A forced local logic input can be defined in the 7.2→Application Functions menu. This logic input returns control to the terminal strip or keypad if in Serial Link Command Mode (see page 39).

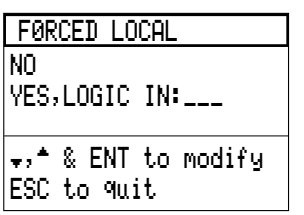


Figure 23: Forced Local Menu

Forced local can also be selected in the 5→Keypad Configuration menu and assigned to the F1 function key. The F1 function key can be used to toggle between Local (Keypad or Terminal Command, depending on the setting of T/K) and Remote (Serial Link Command).

SECTION 2 — MODBUS PLUS OVERVIEW

INTRODUCTION

The Modbus Plus PCMCIA card allows an ALTIVAR® 66 (ATV66) drive controller to function as a node on a Modbus Plus network. This section explains how information is exchanged between the drive controller registers and other nodes on the network. For a complete description of Modbus Plus networks and protocol, or to reference Modbus Plus terms and concepts, please refer to the following documents:

- *Modicon Modbus Plus Network Planning & Installation Guide*, 890 USE 100 00
- *Modicon Modbus Protocol Reference Guide*, PI-MBUS-300
- *Modicon Ladder Logic Block Library User Guide*, 840 USE 10 100

ALTIVAR 66 REGISTERS AND DATA EXCHANGE

When an ATV66 drive controller is a node on a Modbus Plus network, the data in its adjustment (Read & Write), command (Read & Write), and display (Read only) registers can be accessed by other devices on the network. There are three ways to access the drive controller registers with the Modbus Plus PCMCIA card:

– Messaging – Peer Cop – Global data

The following sections are an overview of Modbus Plus networks and communication methods. For details on the drive controller registers and their Modbus Plus addresses, refer to “Section 3 — Register Descriptions” on page 41.

Messaging

Messaging is a method of peer-to-peer communication between networked devices. It follows a query-response sequence. The initiating device sends a query to a specific node and receives a response. When messages are issued over a Modbus Plus network, the solicited node must send an immediate acknowledgment. When the solicited node holds the token, it may then send all requested data to the initiating node.

As a node on a Modbus Plus network, the ATV66 drive controller cannot initiate messages, but all of its Command (Read & Write), Adjustment (Read & Write), and Display (Read only) registers can be Read by other networked devices through messaging at any time, even when the drive controller is running.

Other networked devices can Write to:

- Command registers, as long as they are not peer-copped and the Command Semaphore is not reserved.
- Adjustment registers, as long as they are not peer-copped and the Adjustment Semaphore is not been reserved.

See “Command and Adjustment Semaphores” on page 34 for a discussion of how these semaphores limit messaging.

Registers that have received peer cop data from their command node within the time-out period designated in Menu 11→Communication cannot be written by other nodes through messaging. If a Write message is received for peer-copped registers, the message is refused and a negative acknowledgment is returned.

MSTR BLOCK

Overview of MSTR Block

PLCs that support a Modbus Plus communications capability have a special MSTR (master) instruction with which nodes of the network can initiate message transactions. The MSTR function allows you to initiate one of nine possible network communications operations over Modbus Plus. Each operation is designated by a code (see Table 9):

Table 9: MSTR Operation Codes

MSTR Operation	Code	MSTR Operation	Code
Write Data	1	Get Remote Statistics	7
Read Data	2	Clear Remote Statistics	8
Get Local Statistics	3	Peer Cop Health	9
Write Global Database	5		
Read Global Database	6		

This section discusses Read and Write MSTR instruction blocks. For additional information on Modbus instructions, refer to the *Modicon Ladder Logic Block Library User Guide*.

MSTR Block Structure

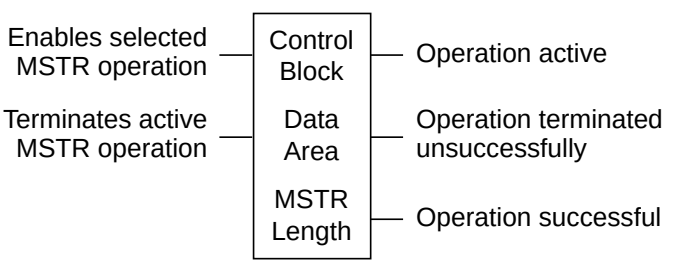


Figure 24: MSTR Block Structure

Inputs

MSTR has two control points (see Figure 24):

- Top node input — enables the instruction when it is ON.
- Middle node input — terminates the active operation when it is ON.

Outputs

MSTR can produce three possible outputs (see Figure 24):

- Top node output — echoes the state of the top input (goes ON while the instruction is active).
- Middle node output — echoes the state of the middle input and goes ON if the MSTR operation is terminated prior to completion.
- Bottom node output — goes ON when an MSTR operation is completed successfully.

Top Node Content

The 4x register entered in the top node is the first of nine contiguous holding registers that comprise the control block (see Table 10):

Table 10: Control Block Holding Registers — General Content

Register	Content
Displayed	Identifies one of the nine MSTR operations
1st implied	Displays error status
2nd implied	Displays length
3rd implied	Displays MSTR operation-dependent information
4th implied	Routing 1 register, used to designate the address of the destination node for a network message transaction.
5th implied	Routing 2 register
6th implied	Routing 3 register
7th implied	Routing 4 register
8th implied	Routing 4 register

NOTE: You must understand Modbus Plus routing path procedures before programming an MSTR instruction. For a complete overview, refer to the Modicon Modbus Plus Network Planning & Installation Guide.

Middle Node Content

The 4x register entered in the middle node is the first in a group of contiguous holding registers that comprise the data area. For operations that provide the communication processor with data — such as Write operation — the data area is the source of the data. For operations that acquire data from the communication processor — such as Read operation — the data area is the destination for the data.

Bottom Node Content

The integer value entered in the bottom node specifies the length — the maximum number of registers — in the data area. Although the typical Modbus Plus length may range from 1 to 100, the ATV66 drive controller range is 1 to 60.

Read and Write MSTR Operations

An MSTR Write operation transfers data from a controlling device to the drive controller. An MSTR Read operation transfers data from the drive controller to a controlling device on the network.

Control Block

The registers in the MSTR control block (the top node) contain the following information in a Read or Write operation (see Table 11):

Table 11: Control Block Registers — Read & Write Operations

Register	Function	Content
Displayed	Operation type	1 = Write; 2 = Read
1st implied	Error status	Displays a hex value indicating MSTR error, when relevant
2nd implied	Length	Write = # of registers to be sent to drive controller Read = # of registers to be read from drive controller
3rd implied	Drive controller data area	Specifies starting register in the drive controller to be read from or written to (1 = 40001, 49 = 40049)
4th … 8th implied	Routing 1 … 5	Designates 1st … 5th routing path addresses, respectively; last non-zero byte in routing path is the transaction device.

PEER COP

Peer Cop (also known as specific transfer) is a method of mapping a block of registers from one specific node to the drive controller's Command and Adjustment registers. The transmitting node sends the Peer Cop data once per token rotation with the token pass. Each command node can send up to 32 words of Peer Cop data per node to specific nodes on the network as long as the total does not exceed 500 words.

Peer Cop is a fast, efficient way to send data from the command node to the drive controller. It does not require ladder logic to be written.

NOTE: Peer Cop data cannot be passed through bridges. The drive controller cannot transmit peer cop data.

Peer Cop must be enabled through drive controller Menu 11→Communication (see page 24) and in Modsoft. The factory setting for peer cop communication is "No." To enable Peer Cop reception:

1. Select PEERCOP and press ENT. The PEERCOP VALIDATION menu is displayed.
2. Scroll down and select YES.
3. Specify the command node from which the peer cop data is to be received in the "COMMAND NODE" field.
4. Enter the number of registers to be received in the NUM REGISTERS field.

The received peer cop data is mapped either to the first "*n*" Command registers of the drive controller, or to all of the Command registers (12 total) plus the first *n* minus 12 Adjustment registers. If a Write message is received for peer-copped registers, the message is refused and a negative acknowledgment is returned. If no peer cop data is received from the command node within the specified time-out period, then the drive controller will allow other nodes to write to the peer-copped registers through messaging.

Tables 12 and 13 list the Command and Adjustment registers that can be mapped through peer cop transfers. They are listed in the order in which they are peer copped. For example,

- If 6 is entered in the NUM REGISTERS field of Menu 11→Communication (see Figure 21 on page 24) and in the LENGTH field of the Peer Cop screen in Modsoft, Command registers 2021 – 2026 receive the peer cop data.
- If 14 is entered is entered in the NUM REGISTERS field of the Communication menu and in the LENGTH field of the Peer Cop screen in Modsoft, Command registers 2021 – 2032 receive the first 12 words of peer cop data, and Adjustment registers 2001 – 2002 receive words 13 – 14.

Table 12: Command Registers Mapped with Peer Cop

Peer Cop Order	Drive Modbus Plus Address	Description	Default Settings [1]
1	2021	Command	0
2	2022	Reference frequency	0
3	2023	Write logic outputs	0
4	2024	AO1 value	0
5	2025	Current limit	1500
6	2026	Motoring torque limit	200
7	2027	Regenerating torque limit	200
8	2028	Reserved	0
9	2029	Voltage reduction	100
10	2030	AO2 value	0
11	2031	AO3 value	0
12	2032	Auxiliary Command register	0

[1] These values must be entered unless the application requires a customized setting. Entering a value of zero into registers 2025 – 2027 and 2029 may stall the motor.

Table 13: Adjustment Registers Mapped with Peer Cop [1, 2]

Peer Cop Order	Drive Modbus Plus Address	Description	Default Settings [3]
13	2001	High speed	600
14	2002	Low speed	0
15	2003	Accel 1	30
16	2004	Decel 1	30
17	2005	Accel 2	50
18	2006	Decel 2	50
19	2007	Slip compensation	30
20	2008	IR compensation	100
21	2009	Profile	20
22	2010	Voltage boost	20
23	2011	Damping	20
24	2012	Bandwidth	20
25	2013	Motor overload	43 [4]
26	2014	Reserved	[5]
27	2015	Reserved	[5]
28	2016	Reserved	[5]
29	2017	Reserved	[5]
30	2018	Reserved	[5]
31	2019	Reserved	[5]
32	2020	Reserved	[5]

[1] Adjustments Peer-Copped to these registers are only written to the drive controller's non-volatile memory when bit 2021,15 is set to 1. The factory setting is 0, and it is recommended that you leave it at 0. If you Peer-Cop a change to an Adjustment register and want to save the change, after Peer-Copping, cycle 2021,15 (set to 1, then back to 0). Adjustments Peer-Copped to these registers since the last time the bit was cycled are lost if all power to the controller is removed. Adjustments made through messaging are automatically stored in the controller's non-volatile memory.

[2] If multi-motor operation is selected, the values in these registers affect the motor currently active. For more information on 2021,11 & 12, see Tables 18 & 20 on pages 45 & 46.

[3] You must enter these values unless your application requires a customized setting.

[4] In an ATV66U41N4 drive controller, the setting of 43 is the default Motor Overload setting. For all other size controllers, the default setting is 0.9 times the Nominal Drive Controller Output Current (see bulletin VD0C06S304_).

[5] These registers are reserved for future use. DO NOT Peer Cop to these registers.

For more details on Adjustment and Command registers, see “Section 3 — Register Descriptions”.

Global Data Transmission

When a networked node holds the token, it may communicate with other nodes on the link and gather network statistics. When a node releases the token, it appends up to 32 sixteen-bit words of global data to the token frame. This data packet is seen by all nodes present on the network, and any appropriately programmed node can extract the data and record it in its global database. For a Modbus Plus network with the maximum 64 nodes, the global database can be up to 2048 sixteen-bit words (32 words per node). Global data cannot be shared between networks since the token cannot pass through a bridge.

If global data transmission is enabled for the ALTIVAR 66 drive controller, up to the first 32 display registers of the drive controller can be broadcast to the network as global data with each token rotation. To enable global data transmission, enter the number of display registers to be transmitted in the ”Global Tx” field of Menu 11→Communication (see Figure 21 on page 24). Entering “0” in this field disables global data transmission.

Table 14 lists the display registers transmitted as global data, their addresses in the drive controller, and the order in which the registers are transmitted in global data transfers. For example, if “8” is entered in the “Global Tx” field of Menu 11→Communication, the first eight display registers (words 2041 – 2048) will be broadcast as global data each time the drive controller passes the token.

Table 14: Display Parameters Mapping with Global Data

Order	Drive Modbus Plus Address	Register Description	Order	Drive Modbus Plus Address	Register Description
1	2041	State register	17	2057	Motor thermal state
2	2042	Output frequency	18	2058	Drive thermal state
3	2043	Output current	19	2059	Elapsed time (hours)
4	2044	I/O values	20	2060	Elapsed time (minutes)
5	2045	Value of AI1	21	2061	Motor RPM
6	2046	Motor torque	22	2062	Machine speed ref. (customer units)
7	2047	Reference frequency	23	2063	Machine speed (customer units)
8	2048	2nd state register	24	2064	Value of AI2
9	2049	3rd state register	25	2065	Value of AI3
10	2050	4th state register	26	2066	Value of AI4
11	2051	Fault-causing trip	27	2067	Value of AO1
12	2052	Display of present fault	28	2068	Value of AO2
13	2053	Output power	29	2069	Value of AO3
14	2054	Output voltage	30	2070	Speed April output
15	2055	Line voltage	31	2071	Reserved
16	2056	DC voltage	32	2072	Motor nominal voltage

Command and Adjustment Semaphores

Since the drive controller can be commanded from many different devices (for example, the keypad or devices connected through the serial link), it provides a Command Semaphore to ensure that only one device has command rights at any given time. A device may request reservation of the Command Semaphore and if the reservation is successful, that device will be granted exclusive rights to write to the drive controller's Command registers. Other devices may still read the Command registers, but any write attempts will be refused. The Command Semaphore can only be reserved through messaging.

Any node on the network can gain exclusive rights to the Adjustment registers by reserving the Adjustment Semaphore. The Adjustment Semaphore can only be reserved through messaging. Other devices may still Read the Adjustment registers, but all Write attempts are refused.

The Command and Adjustment Semaphores can be reserved by different nodes.

NOTE: If the Peer Cop Command node reserves the Command OR Adjustment Semaphore, this will disable its own Peer Cop capability.

Example of Modbus Plus Network Operation

Figure 25 illustrates typical Modbus Plus network operation with two ATV 66 drive controller nodes. Figure 26 shows how reserving the Command Semaphore affects the same network.

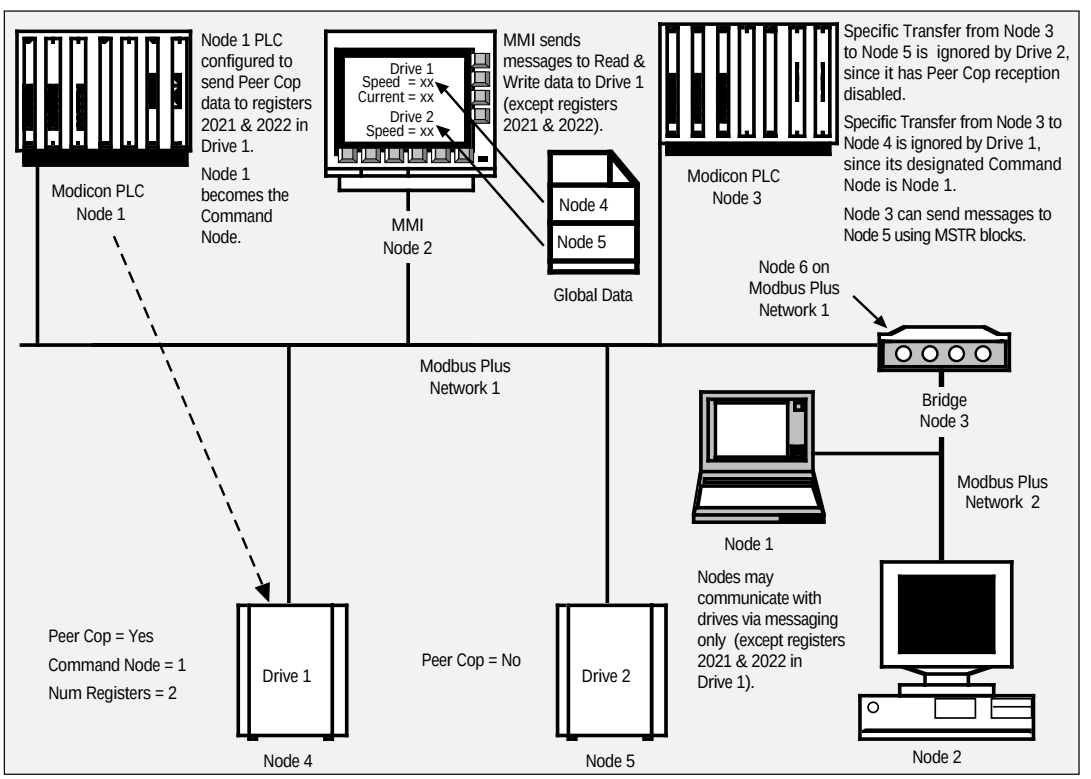


Figure 25: Typical Modbus Plus Network with ATV66 Drive Controller Nodes

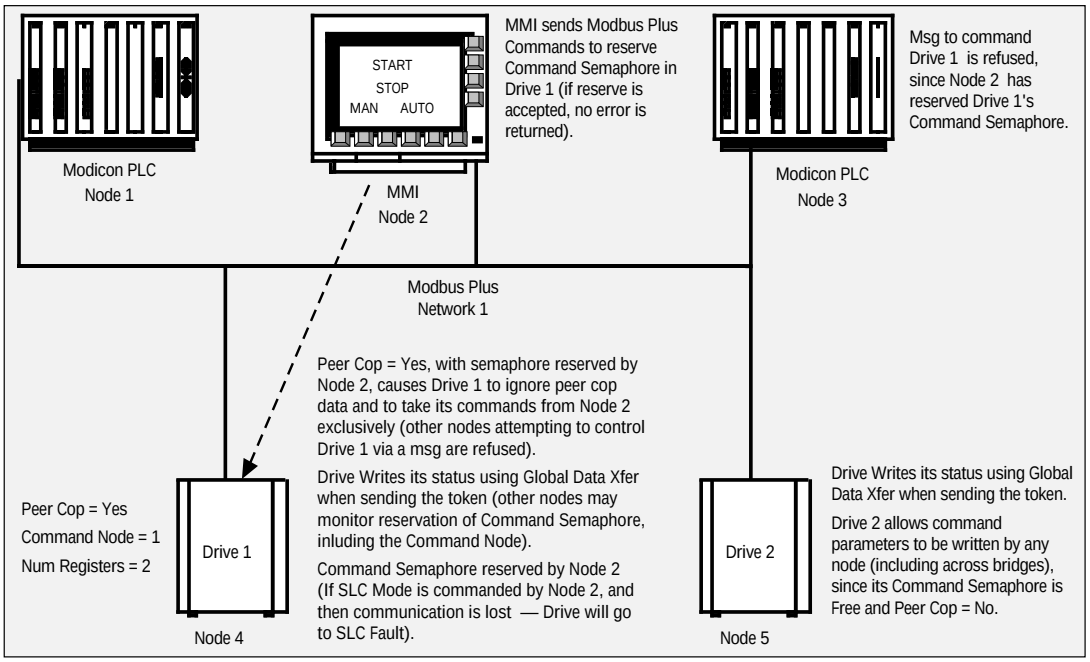


Figure 26: Using the Command Semaphore

OPTIMIZING NETWORK PERFORMANCE

Best network performance can be achieved by considering the following points during network design and implementation:

1. When structuring the information exchange requirements for a network, consider the speed of communications required to properly implement the application. Use the communication method that best matches the speed requirements of the information exchange requirements. Communicate information only when required by the application. Minimize network traffic by design.

   For instance, when controlling a simple process requiring only the command functions contained in the first several Command registers available via Peer Cop, set up Peer Cop to send only those registers. This minimizes network traffic and maintains best overall network speed.
2. For best network security, keep drive controllers and their associated controlling device on the same local network. Minimize and eliminate the need for drive controller commands to cross network bridges.
3. Always use the Command Semaphore when messaging Command registers. This ensures single-point command control on complex networks and prevents accidental messaging from incorrectly programmed devices.
4. Always use the Adjustment Semaphore when messaging Adjustment registers. This ensures single-point adjustment control on complex networks and prevents accidental messaging from incorrectly programmed devices.

5. The NTO (No Time-Out) function is for use during troubleshooting and commissioning. Do not use NTO during normal network operation.
6. Use distributed control where possible. The ATV66 drive controller has a large number of applications functions that can be used in conjunction with network communications. Where possible, use these functions to allow local control by the drive controller while using the network for communicating supervisory information. This minimizes the information exchange burden on the network and unburdens the controlling device.
7. Understand the failure possibilities of the network designed. Provide control redundancies and contingencies appropriate for the intended application.
8. Follow the wiring practices described in Section 1. Improperly installed network wiring can cause noisy or intermittent data transmission with resulting loss of network speed and security.

DRIVE CONTROLLER COMMUNICATION PRINCIPLES

Data Structures

ATV66 drive controllers are adjusted, controlled, and monitored through data stored in drive controller memory. The data consists of bits and words. Words consist of 16 bits and are designated Wx, where x indicates word number. Words are used for saving numerical values (for example, -32768 to +32767) or 16 independent logic states (bits).

For example, 2022 saves a numerical value for frequency reference and 2041 is a register consisting of 16 state bits. The notation 2041,2 designates bit 2 of register 2041.

Access to Data

The tables in Section 3 (pages 41 – 62), list drive controller parameters accessible by communication. Details of each parameter and how it affects drive controller operation are explained in bulletins VD0C06S305_ and VD0C06T306_.

Data such as fault and monitoring information can only be Read; the drive controller refuses attempts to Write to this data. You can Read from and Write to words corresponding to the drive controller adjustment, frequency reference, and command parameters.

Units

Words are always in signed (-32768 to +32767) or unsigned (0 to 65535) units. For example, 2003 (Acceleration 1 time) is in units of 0.1 s Therefore, a value of 60 corresponds to an acceleration time of 6 s.

Range

Each parameter has an allowable range. If a value outside of the range is written, the parameter is set to the range limit or to the factory default value.

Values at Power Up

At each power up, the ATV 66 drive controller is initialized with the configuration and adjustments saved in its non-volatile memory. This includes values saved to drive controller Modbus Plus Adjustment registers 2001 – 2013 via the keypad, messaging, or by Peer-Copping and cycling the Peer Cop Adjustment storage bit (2021,15). Drive controller Modbus Plus Command registers 2021 – 2032 are set to their factory default values (see Table 12 on page 31). Also at power up, the drive controller is placed in Local command (Terminal Strip or Keypad).

Taking Command over the Network

The minimum requirements to start drive from serial link are:

- Make selections in drive controller Menu 11→Communication.
- An active signal must be present on LI1 on the control basket. If you are using a 115V I/O Extension module (VW3A66202T), LI1 of that module must also be active.
- Ensure Forced Local is not active (see page 26).
- Ensure no other processor on the network has reserved the Command Semaphore (see page 34).
- Enable Serial Link Control — set word 2021,1 (DLI) & 2021,2 (FLI) to 1.

  NOTE: This manual does not support split DLI/FLI Control (see Table 18 on page 44).

  — Status display on keypad will read “SLC”.
- Send Run Command — set word 2021,5 (Stop / Run) to 1.
- Send Speed Reference — write a value between 3970 (60 Hz, forward) and -3970 (60 Hz, reverse) to word 2022.

Parameter Types

There are several different types of parameters:

- Command parameters — Enable and disable Serial Link Command mode, start and stop the drive controller, and command the general operation of the drive. Command parameters cannot be modified if:

  — Command Semaphore has been reserved by another device, or

  — In Forced Local Mode, or

  — Drive controller is being Peer Copped by another device.

  Command parameters (except 2121,1, 2 & 15) can be modified only if 2021,1 (DLI) & 2021,2 (FLI) are set, and can always be monitored by any device.
- Adjustment parameters — Used to change variables in the drive controller. These parameters can be written and read by any device while the controller is running or stopped. For exclusive control of the Adjustment registers, the device must reserve the Adjustment Semaphore.
- Display parameters (Read only)— Can be monitored by any device.

Protection of Command Access

The Command Semaphore ensures access protection in writing the Command registers. The device that sets 2236 to 1 reserves the semaphore and prohibits access to writing the Command registers by all other devices. The Command Semaphore is freed by setting 2236 to 0. It must be freed by the device that reserved it. The Command Semaphore is also freed if:

- There is a communication fault; or
- No message is sent for 60 seconds by the device which reserved it to the device controller.

The Command Semaphore is automatically reserved by Forced Local. In this case, the device that previously reserved the Command Semaphore loses it.

NOTE: It is possible to command the drive controller without reserving the semaphore. However, to improve network security, you should set (reserve) the semaphore when commanding the drive controller via messaging.

Protection of Adjustment Access

The Adjustment Semaphore ensures access protection when writing to the Adjustment registers. The device that sets Register 199 to 1 reserves the Adjustment Semaphore and prevents other devices from writing to the Adjustment registers. To free the Adjustment Semaphore, set Register 199 to 0 (it must be freed by the device that reserved it). The Adjustment Semaphore is also freed if:

- There is a communication fault, or
- No message is sent for 60 seconds by the device that reserved the semaphore.

Forced Local automatically reserves the Adjustment Semaphore and the device that reserved the Adjustment Semaphore loses it.

NOTE: You can adjust the drive controller without reserving the Adjustment semaphore. However, to improve network security, you should reserve (set) the Adjustment semaphore when commanding the drive controller via messaging.

Data Priority

When several types of parameters are written in the same request, they are treated in the following order:

1. Writing bits 2021,1 (DLI) & 2021,2 (FLI) to 1
2. Adjustment parameters
3. Command parameters (except 2021,1 & 2021,2)

Access Protection by Forced Local

Writing of Command registers is blocked during Forced Local. Forced Local automatically reserves the Command and Adjustment Semaphores even if they are already reserved.

Command Mode Transitions

Wire the drive controller as shown in the Receiving, Installation, & Start-Up manual (VD0C06S304_). When transitioning between Serial Link command, Terminal Strip command, and Keypad command, the drive controller operates as shown in Table 15. There are two ways to transition between states:

- By a change in state of Forced Local (by logic input or keypad Function key), or
- By a change in state of the DLI / FLI bits in 2021.

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- This manual does not support split control of the DLI and FLI bits (i.e., DLI = 1 and FLI = 0, or DLI = 0 and FLI = 1).
- If split control of DLI and FLI is required for your application, contact your Square D representative for assistance.
- DO NOT program the controller in split control of DLI and FLI mode using only the information in this manual!

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Table 15: Transition Between Command States

		DLI/FLI	0/0	0/0	0/0	0/0	1/1	1/1	1/1	1/1
		SLC Run	0	0	1	1	0	0	1	1
DLI/FLI	SLC Run	Forced Local	0	1	0	1	0	1	0	1
0/0	0	0		No Change	No Change	Not Possible	SLC (Stop)	Not Possible	SLC (Run)	Not Possible
0/0	0	1	No Change		Not Possible	No Change	Not Possible	No Change	Not Possible	No Change
0/0	1	0	No Change	Not Possible		No Change	SLC (Stop)	Not Possible	SLC (Run)	Not Possible
0/0	1	1	Not Possible	No Change	No Change		Not Possible	No Change	Not Possible	No Change
1/1	0	0	Local 2	Not Possible	Local 2	Not Possible		Local 2	SLC (Run)	Not Possible
1/1	0	1	Not Possible	No Change	Not Possible	No Change	SLC (Stop)		Not Possible	No Change
1/1	1	0	Local 1	Not Possible	Local 1	Not Possible	SLC (Stop)	Not Possible		Local 2
1/1	1	1	Not Possible	No Change	Not Possible	No Change	Not Possible	No Change	SLC (Run)[1]	

[1] Local Command mode speed and direction are copied to 2022 and 2041,9 respectively.

SLC: Serial Link Command

Local 1: When transferring to Keypad command mode, the drive controller stops. When transferring to Terminal command mode, the drive controller stops unless a terminal command is present (direction and speed coming from the terminal strip).

Local 2: When transferring to Keypad command mode, there is no change in drive controller state. When transferring to Terminal command mode, drive controller stops unless a terminal command is present (direction and speed coming from the terminal strip).

Compatibility of Application Functions

Table 16 shows the compatibility of ATV66 application functions with Serial Link Command Mode (both DLI & FLI are set). See footnotes for compatibility index. You must program these applications first with the keypad.

Table 16: Compatibility of Application Functions

Function	Compatibility Index	Function	Compatibility Index
+Speed / –Speed	6	Multi-Motor Selection	4
Alternate Ramps by LI	4	Multi-Parameters Selection	4
Alternate Ramps by Freq. Level	4	Orient	3
Auto Run	6	PI Regulator	6
Auto/Manual	6	Power Loss	1
Automatic Restart	1	Preset Speeds	6
Brake Sequence	2	Run Forward (2-wire control)	4
Bypass	2	Run Permissive (LI1, 2-wire control)	2
Catch on the Fly	7	Run Reverse (2-wire control)	4
Controlled Stop by Freq. Level	1	Setpoint Memory	6
Controlled Stop by LI.	6	Shutdown	1
Controlled Stop by Freq. Level & LI	6	Skip Frequencies	1
Default Current Limit	4	Speed Reference	4
Current Limit by AI	4	Tachometer Feedback	6
Current Limit by Freq. Level	4	Terminal / Keypad Selection	6
Current Limit by LI	4	Default Torque Limit	4
Customer Fault	4	Torque Limit by AI	4
Cycles	6	Torque Limit by Freq. Threshold	4
Factory Reset	6	Torque Limit by LI	4
Forced Local	5	Default Voltage Reduction	4
Fault Reset	4	Voltage Reduction by AI	4
Foldback	4	Voltage Reduction by Freq. Threshold	4
Jog	6	Voltage Reduction by LI	4
Loss of Follower Detection	6		

Compatibility Index:

1. Functionality is the same whether in SLC mode or in Local Command mode (terminal strip or keypad). Interaction with terminal strip or keypad is not necessary.
2. Functionality is the same whether in SLC mode or in Local Command mode (terminal strip or keypad). Responds to necessary terminal strip inputs and provides necessary terminal strip outputs.
3. Compatible with SLC mode, but must be activated by register or bit manipulation, not a Local Command mode input (terminal strip or keypad). Responds to necessary terminal strip inputs (except activation) and provides necessary terminal strip outputs.
4. Compatible with SLC mode, but must be activated and/or adjusted by register or bit manipulation, not a Local Command mode input. Does not interact with the terminal strip or keypad.
5. Has functionality only when SLC mode is enabled, but responds only to Local Command Mode input.
6. Not compatible while in SLC mode.
7. Compatible with SLC mode, but successful implementation requires continuous presence of run commands.

SLC = Serial Link Command

SECTION 3 — REGISTER DESCRIPTIONS

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- This manual does not support split control of the DLI and FLI bits (i.e., DLI = 1 and FLI = 0, or DLI = 0 and FLI = 1).
- If split control of DLI and FLI is required for your application, contact your Square D representative for assistance.
- DO NOT program the controller in split control of DLI and FLI mode using only the information in this manual!
- Writing to registers that are designated as reserved may cause unintended equipment operation.
- DO NOT write data to registers unless the function to be performed is completely understood. Consult the appropriate drive controller manual for additional details.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

INTRODUCTION

The Modbus Plus link identifies ALTIVAR® 66 (ATV66) drive controllers as a series of holding registers. The tables in this section describe ATV66 registers and their corresponding Modbus Plus addresses. Registers are shown as drive controller Modbus Plus addresses. These are the addresses you will use in the MSTR instructions. In this section, registers are grouped by function. For a list of registers in numerical order, see Appendix A on page 67.

NOTE: Bit 0 is the right-most (least-significant) bit. Bit 15 is the left-most (most-significant) bit.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are Emergency Stop and Overtravel Stop. Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.

Failure to observe these precautions can result in death, serious injury, or equipment damage.[1]

1. For additional information, refer to NEMA ICS 1.1-1984 (R-1990), “Safety Guidelines for the application, Installation, and Maintenance of Solid State Control” and to NEMA ICS7.1-1995, “Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems.”

ADJUSTMENT REGISTERS (Read & Write)

These parameters can be adjusted regardless of whether the drive controller is running or stopped and regardless of the DLI/FLI setting (see page 37).

NOTE: You can only use the keypad to choose Multi-Motor or Multi-Parameter operation. The Adjustment register values are linked with the Motor or Parameter set determined by 2021,11 and 2021,12 (see pages 45, – 46) in Serial Link Command Mode or by the keypad in Local Command Mode. For example, if you select 2 motor sets (Motor Select Switch menu) and registers 2021,11 = 1 and 2021,12 = 0, the values in these registers affect motor 2. If Multi-Motor or Multi-Parameter operation is selected, verify which motor or parameter set is being displayed in the Adjustment registers by reading bits 2048,10 and 2048,11 (see page 52) before changing the Adjustment registers.

NOTE: Adjustments Peer-Copped to these registers are only written to the drive controller's non-volatile memory when bit 2021,15 is set to 1. The factory setting is 0, and it is recommended that you leave it at 0. If you Peer-Cop a change to an Adjustment register and want to save the change, after Peer-Copping, cycle 2021,15 (set to 1, then back to 0). Adjustments Peer-Copped to these registers since the last time the bit was cycled are lost if all power to the controller is removed. Adjustments made through messaging are automatically stored in the controller's non-volatile memory, regardless of the setting of 2021,15.

Table 17: Adjustment Registers

Drive Modbus Plus Address	Range	Units	Description	Factory Setting
199	0 or 1 (0 = Free, 1 = Reserved)	—	Adjustment Semaphore (see page 34)	0
2001	Low Speed to Max. Freq. (set via keypad in Menu 7.12)	0.1 Hz	High speed	50 Hz for 50 Hz input power 60 Hz for 60 Hz input power
2002	0 to High Speed	0.1 Hz	Low speed	0 Hz
2003	1 to 9999	0.1 s	Accel 1	3 s
2004	1 to 9999	0.1 s	Decel 1	3 s
2005	1 to 9999	0.1 s	Accel 2 [1]	5 s
2006	1 to 9999	0.1 s	Decel 2 [1]	5 s
2007	1 to 100	0.1 Hz	Slip compensation [2]	3 Hz
2008	0 to 800 [3]	1%	IR compensation	100%
2009	0 to 100	1%	Profile	20%
2010	0 to 100	1%	Voltage boost	20%
2011	0 to 800 [3]	1%	Damping	20%
2012	0 to 100	0.1%	Bandwidth	20%
2013	45% In to 115% In	0.1 A	Motor overload	0.9 x In

[1] These registers are only effective if Alternate Ramps has been selected via the keypad.

[2] This register is only effective if Slip Compensation has been set to Manual via the keypad.

[3] Depends on torque type: High torque = 150; Special = 800; Other = 100.

COMMAND REGISTERS (READ & WRITE)

Command registers cannot be modified if another device on the Modbus Plus Network has reserved this drive's Command Semaphore, or is Peer Copping the desired Command register. Command registers can also not be modified if Forced Local is active on this drive. In addition, Command registers (except bits 2021,1 [DLI], 2021,2 [FLI], and 2021,15 [Peer Cop Adjustment storage]) can only be modified if DLI *and* FLI are set high (Serial Link Command is enabled).

NOTE: Bit 0 is the right-most (least-significant) bit. Bit 15 is the left-most (most-significant) bit.

Table 18: Command Registers

Drive Modbus Plus Address	Description	Possible Values
2021	Drive reset	2021,0 = 0 No reset 2021,0 = 1 Reset (must be in Serial Link Command [SLC] mode for reset to take effect)
	⚠ WARNING **UNINTENDED EQUIPMENT ACTION** • This manual does not support split control of the DLI and FLI bits (i.e., DLI = 1 and FLI = 0, or DLI = 0 and FLI = 1). • If split control of DLI and FLI is required for your application, contact your Square D representative for assistance. • DO NOT program the controller in split control of DLI and FLI mode using only the information in this manual! **Failure to follow these instructions can result in death, serious injury, or equipment damage.**	
	Assignment of logic commands over link (DLI) [1]	2021,1 = 0 No logic commands over link 2021,1 = 1 Logic commands over link
	Assignment of references over link (FLI) [1]	2021,2 = 0 No references over link 2021,2 = 1 References over link
	Alternate ramps (Ramp 2)	2021,3 = 0 Ramp 1 2021,3 = 1 Ramp 2
	⚠ WARNING **LOSS OF CONTROL** Setting 2021,4 (NTO) to 1 disables serial link fault protection. Provide alternate control paths when disabling the serial link fault protection. **Disabling the serial link fault protection can result in loss of control and can result in death, serious injury, or equipment damage.**	
	Suppression of communication control (NTO)	2021,4 = 0 Monitor communication fault 2021,4 = 1 Do not monitor communication fault (no time-out)

[1] Always write both bits to the same state. For operation in Serial Link Command (SLC) mode, DLI *and* FLI must be set to 1 and LI1 must be active.

Table 18: Command Registers (Cont'd)

Drive Modbus Plus Address	Description	Possible Values
2021 (cont'd)	Run/Stop command [2, 5]	2021,5 = 0 Stop 2021,5 = 1 Run
	Braking by DC injection (DCB)	2021,6 = 0 No command to inject DC 2021,6 = 1 Command to inject DC
	Orient Stop	2021,7 = 0 Orient Stop 2021,7 = 1 Normal Stop
	Freewheel stop Fast stop	2021,8 2021,9 — See Table 19 on page 46
	Command of Voltage Reduction	2021,10 — See Table 22 on page 47

⚠ WARNING

LOSS OF CONTROL

- When using Multi-Motor function, partial transfer of motor commands may occur if you attempt a command mode transfer with controller in running state (this includes motor operation with a zero speed reference).
- When using Multi-Motor function, always stop drive controller before switching between Terminal Command mode and Serial Link Command mode. Controller should be in Ready (RDY) state prior to changing command modes.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

	Multi-Motors or Multi-Parameters [3]	2021,11 2021,12 — See Table 20 on page 46
	Reserved	2021,13
	External fault command (EFL)	2021,14 = 0 No fault 2021,14 = 1 Fault [4]
	Peer Cop Adjustment Storage	2021,15 = 0 No storage 2121,15 = 1 Storage [6]

[2] Simultaneously writing 2021,1, 2021,2 and 2021,5 to zero while the drive controller is running in SLC mode transfers control to Local Command mode (Keypad or Terminal Strip). The drive controller responds as indicated in Table 15 on page 39. However, 2021,5 remains active.

[3] Always stop drive controller and be sure it is in the Ready (RDY) state before switching to another motor.

[4] Forces drive controller to fault when in SLC mode (DLI & FLI = 1) and when LIx is configured for customer fault.

[5] Keypad stop button stops drive controller, regardless of control mode (Serial, Keypad, or Terminal). To restart drive controller, you must cycle (→Off→On) the appropriate Run command.

[6] Data sent to Adjustment registers via Peer-Copping are only written to the drive controller's non-volatile memory when bit 2021,15 is set to 1. The factory setting is 0, and it is recommended that you leave it at 0. If you Peer-Cop a change to an Adjustment register and want to save the change, after Peer-Copping, cycle 2021,15 (set to 1, then back to 0). Adjustments Peer-Copped to these registers since the last time the bit was cycled are lost if all power to the controller is removed. Adjustments made through messaging are automatically stored in the controller's non-volatile memory, regardless of the setting of 2021,15.

Table 19: Freewheel & Fast Stop Selection

Freewheel Stop 2021,8	**Fast Stop** 2021,9	**Stop Type**
0	0	Normal stop
1	1	Freewheel stop
1	0	Freewheel stop
0	1	Fast stop

Table 20: Multi-Motor or Multi-Parameter Selection

Bit A 2021,11	**Bit B** 2021,12	**Selection**
0	0	Use Motor 1 or 1st parameter set [1]
1	0	Use Motor 2 or 2nd parameter set [1]
0	1	Use Motor 3 or 3rd parameter set [1]
1	1	Unchanged (uses existing drive parameters)

[1] Function of Motor Select Switch setting (Menu 7.2→Application Functions).

Table 21: Additional Command Registers

Drive Modbus Plus Address	**Range**	**Description**	**Possible Values**
2022	-32767 to 32767	Reference Frequency	26478 = 400 Hz; -26478 = - 400 Hz (reverse) Factory default = 0 (0 Hz)
2032,1	0 or 1	Run Direction	0 = Forward 1 = Reverse Factory default = 0
2032,8	0 or 1	Elapsed Timer Reset	0 = No Reset 1 = Reset Elapsed Timer Factory default = 0
2032, bits 2, 4 – 7, 9 – 15		Reserved	
2236	0 or 1	Command Semaphore (see page 34)	0 = Free 1 = Reserved Factory default = 0

Table 22: Limit Command Registers

Drive Modbus Plus Address	Range	Description	Possible Values
2032,0	0 or 1	Command of Current Limit – *valid only if Current Limit by LI is enabled via keypad*	0 = Factory default value of register 2025 1 = Value in register 2025 Factory default = 0
2025	400 to 1500	Current Limit Level, % of motor nominal current (0.1% steps) **[1]**	400 = 40%; 1500 = 150% Factory default **[2]** = 150% (CT @ 60 Hz) or 135% (CT @ 50 Hz) 110% (VT)
2032,3	0 or 1	Command of Torque Limit (motoring & regenerating) – *valid only if Torque Limit by LI is enabled via keypad*	0 = Factory default value of registers 2026 & 2027 1 = Value in registers 2026 & 2027 Factory default = 0
2026	0 to 200	Motoring Torque Limit Level, % of motor nominal torque (1% steps) **[1]**	0 = 0%; 200 = 200%. Available only in CT High Torque Mode Factory default = 200% **[2]**
2027	0 to 200	Regenerating torque limit level, % of motor nominal torque (1% steps) **[1]**	0 = 0%; 200 = 200% Available only in CT High Torque Mode Factory default = 200% **[2]**
2021,10	0 or 1	Command of Voltage Reduction – *valid only if Voltage Reduction by LI is enabled*	0 = Factory default value of register 2029 1 = Value in register 2029 Factory default = 0
2029	20 to 100	Voltage Reduction Level, % of motor nominal voltage (1% steps) **[1]**	20 = 20%, 100 = 100% Factory default = 100% **[2]**

[1] Drive controller must be in Serial Link Command (SLC) mode for this register to be active. If this function is programmed via keypad as “Default Limit” or “By Analog Input”, this value is always active. If programmed as “By Frequency Level”, this value is active above the programmed frequency. If programmed as “By Logic Input”, you must set the function command bit (2021,10, 2032,0 or 2032,3) high for this value to take control.

[2] Loss of all power to drive controller (Control logic inactive, green LED on front of controller Off) resets this bit to factory default.

Table 23: Logic/Relay/Analog Output Command Registers

Drive Modbus Plus Address	Range	Description	Possible Values
2023,1	0 or 1	Command of LO1 [1]	0 = Off, 1 = On, Factory default = 0 [2]
2023,2	0 or 1	Command of LO2 [1]	0 = Off, 1 = On, Factory default = 0 [2]
2023,6	0 or 1	Command of R2 [1]	0 = Off, 1 = On, Factory default = 0 [2]
2023,7	0 or 1	Command of R3 [1]	0 = Off, 1 = On, Factory default = 0 [2]
2023,8	0 or 1	Command of R4 [1]	0 = Off, 1 = On, Factory default = 0 [2]
2023, bits 0, 3 – 5, 9 –15		Reserved	
2024	0 to 4095	Command of AO1 Level	0 = 0 or 4 mA [3]; 4095 = 20 mA Factory default = 0 [2]
2030	0 to 4095	Command of AO2 Level	0 = 0 or 4 mA [3]; 4095 = 20 mA Factory default = 0 [2]
2031	0 to 4095	Command of AO3 Level	0 = 0 or 4 mA [3]; 4095 = 20 mA Factory default = 0 [2]

[1] Logic and relay outputs must be unassigned via the keypad or their controlling bits are ignored.

[2] Loss of all power to drive controller (Control logic inactive, green LED on front of controller Off) resets this bit to factory default.

[3] Use the keypad to select 0 – 20 mA or 4 – 20 mA. 1) Assign an analog output to a function. 2) Select the desired range. 3) Unassign the analog output. *Note: If the analog output is assigned, this register is ignored.*

DISPLAY REGISTERS (Read Only)

Table 24: Analog Input Registers

Drive Modbus Plus Address	Range	Units	Description	Possible Values
2045	0 to 100	1%	Value of Analog Input AI1	0% for 0 V and 100% for 10 V
2064	0 to 100	1%	Value of Analog Input AI2	0% for 0 mA and 100% for 20 mA
2065	-100 to 100	1%	Value of Analog Input AI3	-100% for -10 V and 100% for 10 V
2066	0 to 100	1%	Value of Analog Input AI4	0% for 0 mA and 100% for 20 mA
2101 2102			Assignment of AI1 Assignment of AI2	0 = Not assigned 1 = Current Limit 2 = Voltage Reduction 3 = Speed Ref. 1 (AI1 factory setting) 4 = Speed Ref. 2 (AI2 factory setting) 5 = Speed Ref. 3 8 = Setpoint Input (PI) 9 = Feedback Input (PI) 10 = Setpoint Manual Input (PI) 11 = Torque Limit
2103			Assignment of AI3	0 = Not assigned 1 = Current Limit 2 = Voltage Reduction 3 = Speed Ref. 1 4 = Speed Ref. 2 5 = Speed Ref. 3 (factory setting) 6 = Tach Feedback 8 = Setpoint Input (PI) 9 = Feedback Input (PI) 10 = Setpoint Manual Input (PI) 11 = Torque Limit
2104			Assignment of AI4	0 = Not assigned (factory setting) 1 = Current Limit 2 = Voltage Reduction 3 = Speed Ref. 1 4 = Speed Ref. 2 5 = Speed Ref. 3 8 = Setpoint Input (PI) 9 = Feedback Input (PI) 10 = Setpoint Manual Input (PI) 11 = Torque Limit

Table 25: Power, Voltage, & Thermal State Registers

Drive Modbus Plus Address	Range	Units	Description	Possible Values
2053		0.1 kW	Output Power	Function of hp
2054	0 to Nominal Motor Voltage	1 V	Output Voltage	Function of drive voltage range
2055	0 to Max. [1]	1 V	Line Voltage	Function of drive voltage range
2056	0 to Max. [2]	1 V	Bus Voltage	Function of drive voltage range
2072	0 to 2		Nominal Motor Voltage range	0 = 208 – 240 V 1 = 380 – 415 V 2 = 440 – 460 V
2203	0 to 2		Drive Controller Voltage range	0 = Not used 1 = 208 – 240 V 2 = 380 – 460 V
2057	0 to 199	1%	Motor Thermal State value	
2058	0 to 125	1%	Drive controller Thermal State value	for D16 to C31N4 & D12 to D46M2 drives

[1] Maximum depends on line: 264 V for ATV66•••M2; 460 V for 50 Hz line (ATV66•••N4); 529 V for 60 Hz line (ATV66•••N4).

[2] Maximum depends on line: 374 V for ATV66•••M2; 651 V for 50 Hz line (ATV66•••N4); 748 V for 60 Hz line (ATV66•••N4).

Table 26: Frequency, Current, Torque, & Speed Registers

Drive Modbus Plus Address	Range	Unit	Description	Possible Values
2204			Line Frequency Recognized	0 = Unknown 1 = 50 Hz 2 = 60 Hz
2205	90, 200, or 400	Hz	Drive Controller Max. Rated Frequency	U41 – D79 (CT) = 400 Hz C10 – C31 (CT) = 200 Hz VT = 90 Hz
2206		0.1 A	Drive Controller Nominal Current	Function of hp, line voltage, and torque type
2207		0.1 A	Drive Controller Maximum Current	Function of hp, line voltage, and torque type
2042	-26478 to 26478		Output Frequency	26478 = 400 Hz
2043		0.1 A	Output Current	Function of hp and line voltage
2046	0 to 200	1%	Motor Torque	Measured % of nominal motor torque
2047	-32767 to 32767		Speed Reference	26478 = 400 Hz -26478 = -400 Hz (reverse)
2070	-400 to 400	Hz	Speed Ramp Output	Speed command to gating control

NOTE: Bit 0 is the right-most (least-significant) bit. Bit 15 is the left-most (most-significant) bit.

Table 27: Fault Registers & SLC/Local

Drive Modbus Plus Address	Description	Possible Values
2041	Mode in which all commands are assigned	2041,0 = 0 Commands assigned by link (SLC mode) 2041,0 = 1 Commands assigned by terminal or keypad (local mode)
	Drive controller ready (RDY or SLC)	2041,1 = 0 Drive controller not ready 2041,1 = 1 Drive controller ready
	Fault (FLT)	2041,2 = 0 No fault 2041,2 = 1 Drive controller faulted
	Reset authorized	2041,3 = 0 Reset not authorized 2041,3 = 1 Reset authorized
	Brake engage relay state	2041,4 = 0 Brake set (relay deenergized) 2041,4 = 1 Brake released (relay energized)
	Forced local	2041,5 = 0 Drive controller not forced to local 2041,5 = 1 Drive controller forced to local
	NTO	2041,6 = 0 Time-out fault 2041,6 = 1 No time-out fault
	Resettable fault	2041,7 = 0 Non-resettable fault 2041,7 = 1 Resettable fault
	Motor running	2041,8 = 0 Motor stopped 2041,8 = 1 Motor running
	Actual rotation direction	2041,9 = 0 Forward 2041,9 = 1 Reverse
	DC injection braking	2041,10 = 0 No current injected 2041,10 = 1 DC being injected
	Steady state	2041,11 = 0 Drive controller not in steady state 2041,11 = 1 Drive controller in steady state
	Motor thermal overload alarm	2041,12 = 0 Drive controller not in motor overload 2041,12 = 1 Drive controller in motor overload
	Reserved	2041,13
	Current limit	2041,14 = 0 Drive controller not in current limit 2041,14 = 1 Drive controller in current limit
	No line power (NLP)	2041,15 = 0 Drive controller not faulted on line phase loss 2041,15 = 1 Drive controller faulted on line phase loss

Table 28: Drive Controller Status Registers

Drive Modbus Plus Address	Description	Possible Values
2048	Local command mode T/K	2048,0 = 0 Terminal command 2048,0 = 1 Keypad command
	Logic commands over link (DLI)	2048,1 = 0 Not activated 2048,1 = 1 Activated
	Reference commands over link (FLI)	2048,2 = 0 Not activated 2048,2 = 1 Activated
	Dynamic braking	2048,3 = 0 Dynamic braking not active 2048,3 = 1 Dynamic braking in progress
	Fast stop	2048,4 = 0 Fast stop not active 2048,4 = 1 Fast stop in progress
	Power loss, ramp stop	2048,5 = 0 Not active 2048,5 = 1 Ramp stop in progress
	Gating state	2048,6 = 0 Drive controller gating 2048,6 = 1 Drive controller not gating
	Orient complete	2048,7 = 0 Orient stop not active 2048,7 = 1 Orient stop complete (200 ms pulse)
	Deceleration (DEC)	2048,8 = 0 Drive controller not in deceleration 2048,8 = 1 Drive controller in deceleration
	Acceleration (ACC)	2048,9 = 0 Drive controller not in acceleration 2048,9 = 1 Drive controller in acceleration
	Multi-Motor or Multi-Parameter	2048,10 2048,11 — See Table 29 below
	Reserved	2048,12
	Drive controller thermal fault	2048,13 = 0 Drive controller not in thermal overload fault 2048,13 = 1 Drive controller in thermal overload fault
	Torque limit	2048,14 = 0 Drive controller not in torque limit 2048,14 = 1 Drive controller in torque limit
	Stopping by the keypad	2048,15 = 0 Not active 2048,15 = 1 Drive controller stopped by keypad [1]

[1] Keypad Stop button stops drive controller, regardless of control mode (Serial, Keypad, Terminal). To restart the controller, you must cycle (→Off →On) the appropriate Run command. You can monitor bit 2048,15 to lock out the controller when the keypad Stop button is pressed.

Table 29: Multi-Motor or Multi-Parameter Set Selected

Bit A 2048,10	Bit B 2048,11	Selection
0	0	Motor 1 or 1st parameter set selected [1]
1	0	Motor 2 or 2nd parameter set selected [1]
0	1	Motor 3 or 3rd parameter set selected [1]
1	1	Unchanged

[1] Function of Motor Select Switch setting (Menu 7.2→Application Functions).

Table 30: Additional Drive Controller Status Registers

Drive Modbus Plus Address	Description	Possible Values
2049	Jog	2049,0 = 0 Jog not in progress 2049,0 = 1 Jog in progress
	Shutdown complete	2049,1 = 0 Shutdown not complete 2049,1 = 1 Shutdown complete
	Cycle complete	2049,2 = 0 Cycle not complete 2049,2 = 1 Cycle complete (200 ms pulse)
	Alternate ramp	2049,3 = 0 Ramp 1 2049,3 = 1 Ramp 2
	Auto/Manual	2049,4 = 0 Manual activated 2049,4 = 1 Auto activated
	Frequency level 1 attained	2049,5 = 0 Freq. level 1 not attained 2049,5 = 1 Freq. level 1 attained
	Frequency level 2 attained	2049,6 = 0 Freq. level 2 not attained 2049,6 = 1 Freq. level 2 attained
	Current level 1 attained	2049,7 = 0 Current level 1 not attained 2049,7 = 1 Current level 1 attained
	Current level 2 attained	2049,8 = 0 Current level 2 not attained 2049,8 = 1 Current level 2 attained
	Thermal level 1 attained	2049,9 = 0 Thermal level 1 not attained 2049,9 = 1 Thermal level 1 attained
	Thermal level 2 attained	2049,10 = 0 Thermal level 2 not attained 2049,10 = 1 Thermal level 2 attained
	No ramp follow	2049,11 = 0 Not active 2049,11 = 1 Active
	Run output command (bypass)	2049,12 = 0 Not active 2049,12 = 1 Active
	Rotation direction	2049,13 = 0 Running in forward 2049,13 = 1 Running in reverse
	Reserved	2049,14 2049,15
2050,0	Drive Faulted, stopped	2050,0 = 0 Drive not faulted 2050,0 = 1 Drive faulted
2050,4	State of Adjustment Semaphore	2050,4 = 0 Adjustment Semaphore free 2050,4 = 1 Adjustment Semaphore reserved
2050,5	State of Command Semaphore	2050,5 = 0 Command Semaphore free 2050,5 = 1 Command Semaphore reserved
2050, bits 1 – 3, 6 – 15	Reserved	

Table 31: Motor/Parameter Set, Cycle, Preset Speed

Drive Modbus Plus Address	Range	Description
2075	0 to 2	Number of motor or parameter set selected: 0 = Motor/Parameter set #1 1 = Motor/Parameter set #2 2 = Motor/Parameter set #3
2076	1 to 8	Cycles step number in progress
2077	0 to 7	Preset speed number in progress

Table 32: Drive Controller Horsepower

Drive Modbus Plus Address	Range	Description	Remarks
2201	0 to 22	Drive controller horsepower (hardware rating)	0 = Not used 1 = Reserved 2 = Reserved 3 = 2.2 kW, 3 hp 4 = 3 kW 5 = 4 kW, 5 hp 6 = 5.5 kW, 7.5 hp 7 = 7.5 kW, 10 hp 8 = 11 kW, 15 hp 9 = 15 kW, 20 hp 10 = Reserved 11 = 22 kW, 30 hp 12 = 30 kW, 40 hp 13 = 37 kW, 50 hp 14 = 45 kW, 60 hp 15 = 55 kW, 75 hp 16 = 75 kW, 100hp 17 = 90 kW, 125 hp 18 = 110 kW, 150 hp 19 = 132 kW, 200 hp 20 = 160 kW, 250 hp 21 = 200 kW, 300 hp 22 = 220 kW, 350 hp
2202	0 to 23	Drive controller horsepower (configured rating)	Same as above with: 1 = 0.75 kW, 1 hp 2 = 1.5 kW, 2 hp 10 = 18.5 kW, 25 hp 23 = 250 kW, 400 hp

Table 33: Status of Options (cards, modules, keypad)

Drive Modbus Plus Address	Range	Description	Possible Values
2212	0 to 1	Memory card option	0 = Memory card not installed 1 = Memory card installed
2213	0 to 1	Communication carrier option	0 = Communication carrier module not installed 1 = Communication carrier module installed
2214	0 to 1	Presence of keypad	0 = Keypad not present 1 = Keypad installed
2215	0 to 2	I/O Extension option module	0 = I/O Extension module not installed 1 = 24 V I/O Extension installed 2 = 115 V I/O Extension installed
2217	0, 1, 4	PCMCIA communication card	0 = No PCMCIA card installed 1 = Uni-Telway/Modbus/Jbus PCMCIA card installed 4 = Modbus Plus PCMCIA card installed

Table 34: Command Node Status

Drive Modbus Plus Address	Description	Possible Values
2222	State of command node	0 = Disabled 1 = OK 2 = Time-out

Table 35: Token & Message Status

Drive Modbus Plus Address	Range	Units	Description
2223	0 to 65535	ms	Token rotation time
2224	0 to 65535		Token count
2225	0 to 65535		Messages received

Table 36: Elapsed Time, Output Speed, & Machine Frequency

Drive Modbus Plus Address	Units	Description	Possible Values
2059	H	Elapsed time (hours)	Total time 2059 + 2060
2060	min	Elapsed time (minutes)	
2061	RPM	Output speed	Scale factor determined by nominal motor RPM
2062	User defined	Machine frequency reference (customer units)	Frequency times scaling factor
2063	User defined	Machine frequency (customer units)	Frequency times scaling factor

Table 37: Analog Output Assignment and Value

Drive Modbus Plus Address	Range	Description	Possible Values
2067	0 to 100%	Value of AO1	
2068	0 to 100%	Value of AO2	
2069	0 to 100%	Value of AO3	
2105	0 to 11	Assignment of analog output AO1	0 = Not assigned 1 = Output Current 2 = Output Frequency (factory setting) 3 = Output Power 4 = Motor Torque 5 = Output Voltage 6 = Motor Thermal State 7 = Ramp Output 8 = PI reference Output 9 = PI feedback Output 10 = PI error Output 11 = PI Integrator
2106	0 to 11	Assignment of analog output AO2	0 = Not assigned 1 = Motor Current (factory setting) 2 = Motor Frequency 3 = Output Power 4 = Motor Torque 5 = Output Voltage 6 = Motor Thermal State 7 = Ramp Output 8 = PI Reference Output 9 = PI Feedback Output 10 = PI Error Output 11 = PI Integrator
2107	0 to 11	Assignment of analog output AO3	0 = Not assigned 1 = Motor Current 2 = Motor Frequency 3 = Output Power (factory setting) 4 = Motor Torque 5 = Output Voltage 6 = Motor Thermal State 7 = Ramp Output 8 = PI Reference Output 9 = PI Feedback Output 10 = PI Error Output 11 = PI Integrator

Table 38: LIx/LOx/ROx State

Drive Modbus Plus Address	Description	Possible Values
2044	Display of LI1 activation	2044,1 = 0 Input not active 2044,1 = 1 Input active
	Display of LI2 activation	2044,2 = 0 Input not active 2044,2 = 1 Input active
	Display of LI3 activation	2044,3 = 0 Input not active 2044,3 = 1 Input active
	Display of LI4 activation	2044,4 = 0 Input not active 2044,4 = 1 Input active
	Display of LI5 activation	2044,5 = 0 Input not active 2044,5 = 1 Input active
	Display of LI6 activation	2044,6 = 0 Input not active 2044,6 = 1 Input active
	Display of LI7 activation	2044,7 = 0 Input not active 2044,7 = 1 Input active
	Display of LI8 activation	2044,8 = 0 Input not active 2044,8 = 1 Input active
	Display of LO1 activation	2044,9 = 0 Output not active 2044,9 = 1 Output active
	Display of LO2 activation	2044,10 = 0 Output not active 2044,10 = 1 Output active
	Display of R1 activation	2044,11 = 0 Output not active 2044,11 = 1 Output active
	Display of R2 activation	2044,12 = 0 Output not active 2044,12 = 1 Output active
	Display of R3 activation	2044,13 = 0 Output not active 2044,13 = 1 Output active
	Display of R4 activation	2044,14 = 0 Output not active 2044,14 = 1 Output active
	Reserved	2044,0 2044,15

Table 39: LOx/ROx Assignment

Drive Modbus Plus Address	Description	Possible Values
2108	Assignment of LO1; (factory setting: At Speed)	0 = No assignment 1 = Ready State 2 = Running State 3 = At Speed 4 = Forward Direction 5 = Reverse Direction 6 = Terminal/Keypad 7 = Auto/Manual 8 = Current Limit 9 = Torque Limit 10 = Fault State 11 = Drive Controller Thermal Alarm 12 = Loss of Follower 13 = No Ramp Follow 14 = Feedback Loss 15 = Overspeed 16 = Frequency Level 1 17 = Frequency Level 2 18 = Current Level 1 19 = Current Level 2 20 = Thermal Level 1 21 = Thermal Level 2 22 = Reserved 23 = Brake Release 24 = Shutdown Complete 25 = Orient Complete 26 = Cycle Complete 27 = Cycle Fault 28 = Run Output Command (Bypass) 29 = Jog enabled 32 = Feedback Limit (PI) 33 = Feedback High Alarm (PI) 34 = Feedback low alarm (PI)
2109	Assignment of LO2 (factory setting: Current Limit)	
2112	Assignment of R1 (factory setting: Fault)	
2113	Assignment of R2 (factory setting: Running State)	
2114	Assignment of R3 (factory setting: Thermal Level 1)	
2115	Assignment of R4 (factory setting: Ready State)	

Table 40: Logic Input Assignments

Drive Modbus Plus Address	Description	Possible Values
2116	Assignment of LI1: Stop (3-wire control) or Run Enable (2-wire control) (not reconfigurable)	0 = Not assigned 1 = Stop (3-wire control) 2 = Run Enable (2-wire control) 3 = Forward 4 = Reverse 5 = Current Limit 6 = Voltage Reduction 7 = Alternate Ramps 8 = Jog 9 = +Speed 10 = -Speed 11 = Controlled stop 12 = Start Cycle (Cycles) 13 = Reset Cycle (Cycles) 14 = Step Locking (Cycles) 15 = Next step (Cycles) 16 = Setpoint Memory 17 = Preset Speed a (PS A) 18 = Preset Speed b (PS B) 19 = Preset Speed c (PS C) 20 = Orient Command 21 = Orient Pulses 22 = Forced Local 23 = Auto/Manual 24 = Terminal/Keypad 25 = Process Input (Bypass) 26 = Sequence Input (Bypass) 27 = Motor Select a 28 = Motor Select b 29 = Customer Fault 30 = Reset Fault 31 = Auto Run 33 = Auto/Manual (PI) 34 = Reverse Speed (PI)
2117	Assignment of LI2: Forward (not reconfigurable)	
2118	Assignment of LI3 (factory setting: Reverse)	
2119	Assignment of LI4 (factory setting: Jog)	
2120	Assignment of LI5 (factory setting: PS A)	
2121	Assignment of LI6 (factory setting: PS B)	
2122	Assignment of LI7 (factory setting: PS C)	
2123	Assignment of LI8 (factory setting: Reset Fault)	

Table 41: Fault Register (Fault that Caused Drive Controller to Trip)

Drive Modbus Plus Address	Possible Values
2051	0 = No fault 1 = AC line overvoltage 2 = DC bus overvoltage 3 = DC bus undervoltage 4 = Ground fault 5 = Short circuit between phases (Desat) 6 = ±15 V control basket power supply (internal fault) 7 = Horsepower not recognized (internal fault) 8 = Input phase loss 9 = Motor overload 10 = Customer fault 11 = Drive Overtemperature 12 = Overspeed (with tachometer) 13 = Feedback loss 14 = Serial link fault 15 = Loss of follower 16 = Memory failure 17 = Precharge failure 18 = Sequence time-out fault (Bypass) 19 = Process time-out fault (Bypass) 20 = Dynamic brake fault 21 = DB resistor thermal fault 22 = Transistor short circuit 23 = Open transistor 24 = Output phase loss 25 = Control supply 26 = Short circuit on motor (LIC exceeded) 27 = Reserved 28 = Reserved 29 = Overspeed (without tachometer)

Table 42: Present Faults Register (Fault Present if bit = 1)

Drive Modbus Plus Address	Possible Values	
2052 [1]	2052,0	Internal fault or other ATV66 drive controller fault not listed
	2052,1	Serial link fault
	2052,2	Reserved
	2052,3	Reserved
	2052,4	DC bus undervoltage
	2052,5	AC line overvoltage
	2052,6	Input phase loss
	2052,7	Drive Overtemperature
	2052,8	No feedback, overspeed
	2052,9	Short circuit between phases or to ground
	2052,10	DC bus overvoltage
	2052,11	Reserved
	2052,12	Motor overload
	2052,13	Output phase loss
	2052,14	Reserved
	2052,15	Precharge failure

[1] While one fault takes priority and causes the drive controller to trip (register 2051), register 2052 can list other conditions detected at the most recent controller fault.

Table 43: Fault History

Drive Modbus Plus Address	Description	Possible Values
2141	Indicates the position of marker on 1 of 8 past faults	1 = 1st fault marked 8 = Last fault marked
2142	Past fault 1: drive controller state	0 = — — — 1 = Accelerating 2 = Decelerating 3 = Drive running (at speed) 4 = Braking (dynamic or regenerative) 5 = Drive stopped & ready 6 = DC injection braking 7 = Current limit active 8 = Auto test 9 = Reserved 10 = No run permissive 11 = Faulted 12 = No line power (control power supplied separately)
2144	Past fault 2: drive controller state	
2146	Past fault 3: drive controller state	
2148	Past fault 4: drive controller state	
2150	Past fault 5: drive controller state	
2152	Past fault 6: drive controller state	
2154	Past fault 7: drive controller state	
2156	Past fault 8: drive controller state	
2143	Past fault 1: name of fault	= 0 No fault = 1 AC line overvoltage = 2 DC bus overvoltage = 3 DC bus undervoltage = 4 Ground fault = 5 Short circuit between phases (Desat) = 6 ±15 V control basket power supply (internal fault) = 7 Horsepower not recognized (internal fault) = 8 Input phase loss = 9 Motor overload = 10 Customer fault = 11 Drive Overtemperature = 12 Overspeed (with tachometer) = 13 Feedback loss = 14 Serial link fault = 15 Loss of follower = 16 Memory failure = 17 Precharge failure = 18 Sequence time-out fault (Bypass) = 19 Process time-out fault (Bypass) = 20 Dynamic brake fault = 21 DB resistor thermal fault = 22 Transistor short circuit = 23 Open transistor = 24 Output phase loss = 25 Control supply = 26 Short circuit on motor (LIC exceeded) = 27 Reserved = 28 Reserved = 29 Overspeed (without tachometer)
2145	Past fault 2: name of fault	
2147	Past fault 3: name of fault	
2149	Past fault 4: name of fault	
2151	Past fault 5: name of fault	
2153	Past fault 6: name of fault	
2155	Past fault 7: name of fault	
2157	Past fault 8: name of fault	

SECTION 4 — FAULT MANAGEMENT & NETWORK SECURITY

A serial link fault (SLF) may occur under certain conditions. Tables 44 & 45 on page 64 list some typical conditions and the drive controller's response. The controller's response is based on:

- Which node put the drive controller in SLC mode (serial link command mode; DLI & FLI set to 1).
- Whether drive controller is in SLC mode.
- State of bit 4 of register 2021 (NTO). If 2021,4 is set to 1, the Modbus Plus PCMCIA card does not monitor the frequency of messaging on the serial link. It is useful to set 2021,4 to 1 during certain diagnostic and commissioning procedures. Set it to 0 for normal SLC mode operation.

⚠ WARNING

LOSS OF CONTROL

Setting 2021,4 (NTO) to 1 disables serial link fault protection. Provide alternate control paths when disabling the serial link fault protection.

Disabling the serial link fault protection can result in loss of control and can result in death, serious injury, or equipment damage.

Table 44: Drive Controller Response to Loss of Node

Network Condition	Did this node put drive in SLC mode?	State of 2021,4 (NTO)	Fault	Drive Controller Response
Loss of Peer Cop Command Node or Local Node [1] that initiated message or bridge connection to other network	No	0	No	—
	Yes	0	Yes	SLF after Time Out (set in Menu 11) expires
	No	1	No	—
	Yes	1	No	—
Same as above but node or bridge connection has reserved Command Semaphore	No	0	Yes	SLF after 60 s
	Yes	0	Yes	SLF after Time Out (set in Menu 11) expires
	No	1	No	Command Semaphore freed after 60 s
	Yes	1	No	Command Semaphore freed after 60 s
Loss of Remote Node [1], Command Semaphore NOT reserved	No	0	No	—
	Yes	0	No	—
	No	1	No	—
	Yes	1	No	—
Loss of Remote Node [1] that reserved Command Semaphore	No	0	Yes	SLF after 60 s if no other node on same remote network sends message to drive controller
	Yes	0	Yes	SLF after 60 s if no other node on same remote network sends message to drive controller
	No	1	No	Command Semaphore freed after 60 s if no other node on same remote network sends message to drive controller
	Yes	1	No	Command Semaphore freed after 60 s if no other node on same remote network sends message to drive controller

[1] A local node is on the same network as the drive controller. A remote nodes is on a different network and is connected to the drive controller's network via a bridge. See Figure 28 on page 66.

Table 45: Other Typical Fault Conditions

Network Condition	Drive in SLC mode?	State of 2021,4 (NTO)	Fault	Drive Controller Response
Loss of token	No	0	No	—
	Yes	0	Yes	SLF after Time Out (set in Menu 11) expires
	No	1	No	—
	Yes	1	No	—
Loss of communication between PCMCIA card and drive controller	No	0	Yes	SLF as soon as detected
	Yes	0	Yes	SLF as soon as detected
	No	1	Yes	SLF as soon as detected
	Yes	1	Yes	SLF as soon as detected

SLC = Serial Link Communication, NTO = No Time Out, SLF = Serial Link Fault

Figure 27 illustrates the basic network security features of a local network with two PLCs (Programmable Logic Controllers), one MMI (Man-Machine Interface) and two drive controllers in SLC (Serial Link Command) mode.

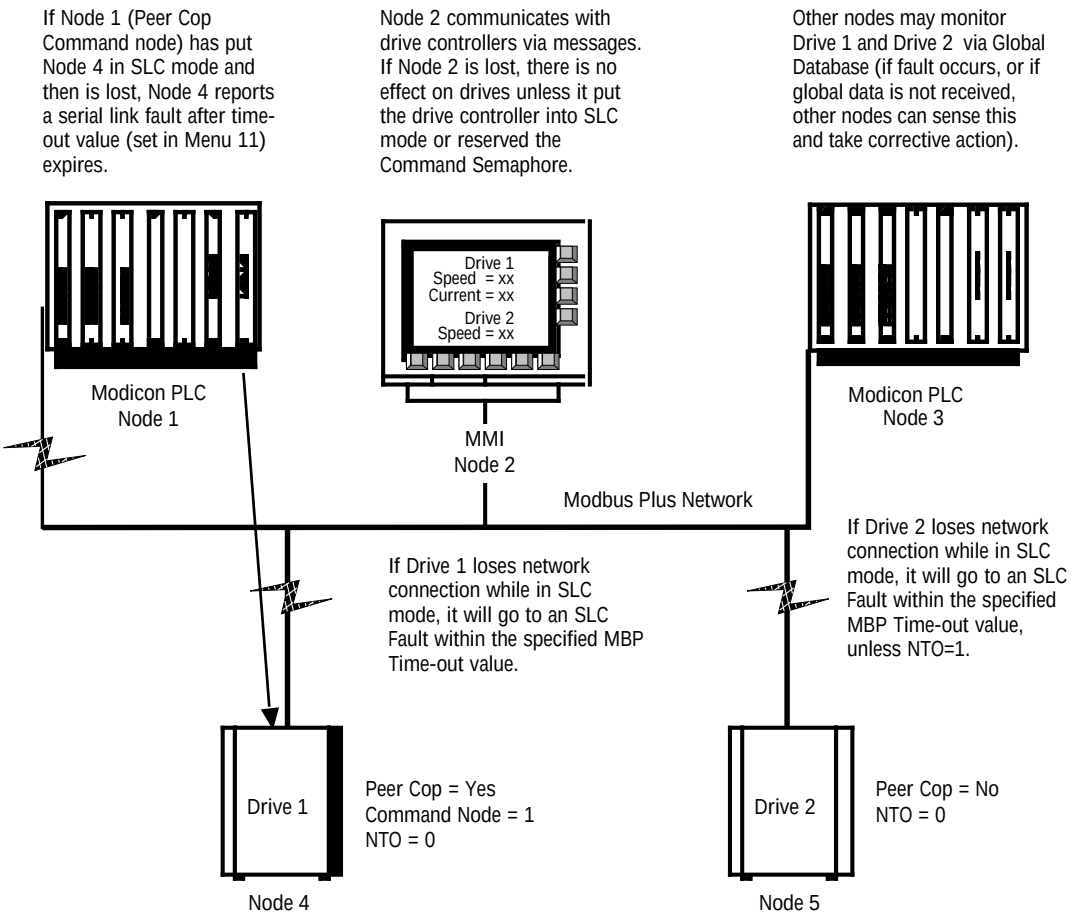


Figure 27: Typical Communication Fault, Example 1

Figure 28 shows a local network with one PLC, one MMI, two drive controllers, and a remote network (Network 2) with a PLC and an MMI. A bridge separates the two networks.

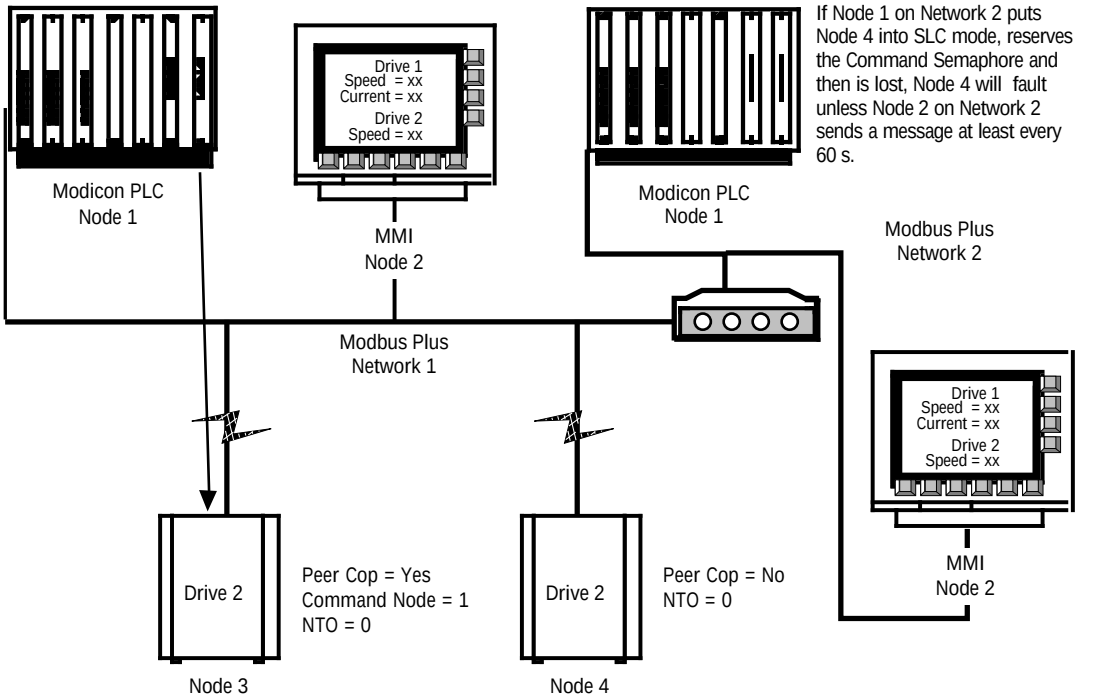


Figure 28: Communication Loss, Example 2 (no SLC Fault)

The loss of a single node on the Modbus Plus network does not cause a fault, because the token can still rotate among the remaining nodes on the network. However, if a node commands the drive controller to enter serial link command mode and then loses communication with the controller, a serial link fault is issued.

To prevent loss of a commanding node without issuing a drive controller fault, command the controller from a local node. When controlling the drive controller via messaging, you should reserve the Command Semaphore. If a local node reserves the Command Semaphore and puts the controller into serial link mode (DLI & FLI = 1), it must send a message before the controller's Time-Out period (set in menu 11) expires or the controller will stop and issue a serial link fault. If a node reserves the Command Semaphore of a controller already in serial link mode and a message is not sent to the controller within 60 seconds, the drive controller will stop and issue a serial link fault.

To ensure exclusive access rights, you should also reserve the Adjustment Semaphore when adjusting the drive controller via messaging. The node that reserves the Adjustment Semaphore has exclusive control of the Adjustment registers. The node that reserves the Adjustment semaphore must send a message to the controller within 60 seconds or the Adjustment Semaphore is freed.

APPENDIX A — ADDRESS DESCRIPTIONS & INDEX

Address	Bit	Description	Page
199	—	Adjustment Semaphore	43
2001	—	High speed	32, 43
2002	—	Low speed	
2003	—	Accel 1	
2004	—	Decel 1	
2005	—	Accel 2	
2006	—	Decel 2	
2007	—	Slip compensation	
2008	—	IR compensation	
2009	—	Profile	
2010	—	Voltage boost	
2011	—	Damping	
2012	—	Bandwidth	
2013	—	Motor overload	
2021	0 1 2 3 4 5	Drive reset Assignment of logic commands over link (DLI) Assignment of references over link (FLI) Alternate ramps (Ramp 2) Suppression of communication control (NTO) Run/Stop command	31, 44 – 45
	6 7 8 9	Braking by DC injection (DCB) Orient Stop Freewheel stop Fast stop	31, 45 – 46
	10	Command of voltage reduction	31, 47
	11 12	Multi-motors or Multi-parameters	31, 45 – 46
	14	External fault command (EFL)	31, 45
	15	Peer Cop Adjustment storage	
2022	—	Reference frequency	31, 46
2023	1 – 3, 6 – 8	Command of LOx / ROx state	31, 48
2024	—	Command of AO1 level	31, 48
2025		Current limit level	31, 47
2026		Motoring torque limit level	31, 47
2027		Regenerating torque limit level	31, 47
2029		Voltage reduction level	31, 47
2030	—	Command of AO2 level	31, 48
2031	—	Command of AO3 level	

Address	Bit	Description	Page
2032	0	Command of current limit	31, 47
	1	Run direction	31, 46
	3	Command of torque limit	31, 47
	8	Elapsed timer reset	31, 46
2041	0	Mode in which all commands are assigned	33, 51
	1	Drive controller ready (RDY or SLC)	
	2	Fault (FLT)	
	3	Reset authorized	
	4	Brake engage relay state	
	5	Forced local	
	6	NTO	
	7	Resettable fault	
	8	Motor running	
	9	Actual rotation direction	
	10	DC injection braking	
	11	Steady state	
	12	Motor thermal overload alarm	
	14	Current limit	
	15	No line power (NLP)	
2042	—	Output frequency	33, 50
2043	—	Output current	
2044	1 – 8	Display of logic input activation (LI1 – LI8)	33, 57
	9 – 10	Display of logic output activation (LO1 – LO2)	
	11 – 14	Display of relay activation (R1 – R4)	
2045	—	Value of analog input (AI1)	33, 49
2046	—	Motor torque	33, 50
2047	—	Speed reference	
2048	0	Local command mode T/K	33, 52
	1	Logic commands over link (DLI)	
	2	Reference commands over link (FLI)	
	3	Dynamic braking	
	4	Fast stop	
	5	Power loss, ramp stop	
	6	Gating state	
	7	Orient complete	
	8	Deceleration (DEC)	
	9	Acceleration (ACC)	
	10	Multi-motor or	
	11	Multi-parameter selected	
	13	Drive controller thermal fault	
	14	Torque limit	
	15	Stopping by the keypad	

Address	Bit	Description	Page
2049	0	Jog	33, 53
	1	Shutdown complete	
	2	Cycle complete	
	3	Alternate ramp	
	4	Auto/Manual	
	5	Frequency level 1 attained	
	6	Frequency level 2 attained	
	7	Current level 1attained	
	8	Current level 2 attained	
	9	Thermal level 1attained	
	10	Thermal level 2 attained	
	11	No ramp follow	
	12	Run output command (bypass)	
	13	Rotation direction	
2050	0	Drive faulted, stopped	33, 53
	4	State of Adjustment Semaphore	
	5	State of Command Semaphore	
2051	—	Display of fault causing trip	33, 60
2052	—	Display of present faults	33, 61
2053	—	Output power	33, 50
2054	—	Output voltage	
2055	—	Line voltage	
2056	—	Bus voltage	
2057	—	Motor thermal state value	
2058	—	Drive controller thermal state value	
2059	—	Elapsed time (hours)	33, 55
2060	—	Elapsed time (minutes)	
2061	—	Output speed (rpm)	
2062	—	Machine frequency reference (customer units)	
2063	—	Machine frequency (customer units)	
2064	—	Value of analog input AI2	33, 49
2065	—	Value of analog input AI3	
2066	—	Value of analog input AI4	
2067	—	Value of AO1	33, 56
2068	—	Value of AO2	
2069	—	Value of AO3	
2070	—	Speed ramp output	33, 50
2072	—	Nominal motor voltage range	
2075	—	Number of motor or parameter set selected	54
2076	—	Cycles step number in progress	
2077	—	Preset speed number in progress	

Address	Bit	Description	Page
2101	—	Assignment of AI1	49
2102	—	Assignment of AI2	
2103	—	Assignment of AI3	
2104	—	Assignment of AI4	
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