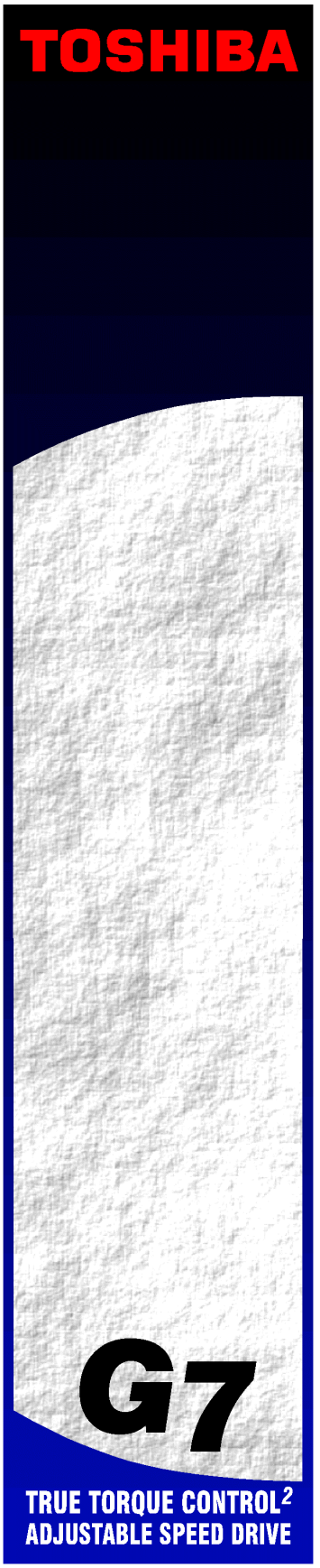
G7 Adjustable Speed Drive Multi-Protocol Communication And PG Feedback Option Manual



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About This Manual

This manual was written by the TOSHIBA Technical Publications Group. This group is tasked with providing technical documentation for the **G7 Adjustable Speed Drive**. Every effort has been made to provide accurate and concise information to you, our customer.

Contacting TOSHIBA's Customer Support Center

TOSHIBA's Customer Support Center can be contacted to obtain help in resolving any **G7 Adjustable Speed Drive** system problem that you may experience or to provide application information. The center is open from 8 a.m. to 5 p.m. (CST), Monday through Friday. The Support Center's toll free number is US (800) 231-1412/Fax (713) 466-8773 — Canada (800) 527-1204.

You may also contact TOSHIBA by writing to:

TOSHIBA International Corporation
13131 West Little York Road
Houston, Texas 77041-9990
Attn: ASD Product Manager.

For further information on TOSHIBA's products and services, please visit our website at **TIC.TOSHIBA.COM**.

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TOSHIBA INTERNATIONAL CORPORATION

G7 Adjustable Speed Drive Multi-Protocol and PG Feedback Option

Please complete the Warranty Card supplied with the option and return it to Toshiba by prepaid mail. This will activate the 12-month warranty from the date of installation; but shall not exceed 18 months from the date of purchase.

Complete the following information about the option and retain it for your records.

Model Number: ASD-MULTICOM-A or ASD-MULTICOM-B

Serial Number: _____

Date of Installation: _____

Inspected By: _____

Name of Application: _____

Important Notice

This user manual may not cover all of the variations of option applications, nor may it provide information on every possible contingency concerning installation, programming, operation, or maintenance.

The contents of this user manual shall not become a part of or modify any prior agreement, commitment, or relationship between the customer and TOSHIBA International Corporation. The sales contract contains the entire obligation of TOSHIBA International Corporation. The warranty contained in the contract between the parties is the sole warranty of TOSHIBA International Corporation's ASD Division and any statements contained herein do not create new warranties or modify the existing warranty.

Any electrical or mechanical modifications to this equipment without prior written consent of TOSHIBA International Corporation will void all warranties and may void any UL/CUL listing or other safety certifications. Unauthorized modifications may also result in equipment damage or personal injury.

This Manual's Purpose and Scope

Currently, this manual covers the following G7 Adjustable Speed Drive options:

- ASD-MULTICOM-A (multi-protocol communications + PG feedback)
- ASD-MULTICOM-B (PG feedback only)

Not all sections of this manual will apply to the ASD-MULTICOM-B option. These sections will be indicated in their respective introduction paragraphs.

This manual provides information that will assist the qualified user in the safe installation, setup, operation, and disposal of the **G7 Adjustable Speed Drive Multi-Protocol Communication Option** and **PG Feedback Option**. The information provided in this manual is applicable to the **G7 Adjustable Speed Drive Multi-Protocol Communication Option** and **PG Feedback Option** only.

This operation manual provides information on the various features and functions of these powerful cost-saving devices, including

- Installation,
- System operation, and
- Mechanical and electrical specifications.

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1. Introduction

Congratulations on the purchase of the new **G7 Adjustable Speed Drive (ASD) Multi-Protocol Communication (ASD-MULTICOM-A)** or **PG Feedback (ASD-MULTICOM-B) Option**.

ASD-MULTICOM-A / ASD-MULTICOM-B

These option cards provide the ability to connect various different pulse generator/feedback sources, such as encoders, to the G7 ASD. These PG input signals can then provide enhanced performance for vector control, pulsed speed command, and process (PID) control applications.

Two different types of pulse input circuitry are provided, which allows very flexible application and connectivity to a wide array of PG devices available on the market today.

ASD-MULTICOM-A

In addition to the PG feedback circuitry, this option card also provides connectivity to the most popular fieldbus networks in use today. These networks include Profibus, DeviceNet, and RS-485 based networks. Different option board firmware versions may provide varying levels of support for these different networks, so when using this manual, always keep in mind that the firmware version operating on your option board must match this manual's respective revision for all documented aspects to apply. The option board firmware version covered by each revision of the manual is indicated in the last section of the "Document Number" on the manual's front cover. For example, if the Document Number on the front cover ends in "-V3.00", then this manual is only applicable for version 3.00 option board firmware.

The method of determining your board's firmware version varies depending on the network being used. Please refer to the specific network interface sections of this manual to determine the method required for your installation.

This manual will primarily be concerned with the option's hardware specifications, input characteristics, configuration, and installation and wiring precautions. For more advanced application-level information, please contact Toshiba's ASD Marketing Department for copies of available application notes.

To maximize the abilities of your new ASD option, a working familiarity with this manual will be required. This manual has been prepared for the option installer, user, and maintenance personnel. With this in mind, use this manual to develop a system familiarity before attempting to install or operate the device.

2. Safety Precautions

DANGER!

Rotating shafts and electrical equipment can be hazardous. Installation, operation, and maintenance of the ASD and option shall be performed by **Qualified Personnel** only.

Qualified Personnel shall be:

- Familiar with the construction and function of the ASD and option, the equipment being driven, and the hazards involved.
- Trained and authorized to safely clear faults, ground and tag circuits, energize and de-energize circuits in accordance with established safety practices.
- Trained in the proper care and use of protective equipment in accordance with established safety practices.

Installation of ASD systems and associated options should conform to the **1999 National Electrical Code Article 110** (NEC) *(Requirements For Electrical Installation*s), all regulations of the **Occupational Safety and Health Administratio**n, and any other applicable national, regional, or industry codes and standards.

DO NOT install, operate, perform maintenance, or dispose of this equipment until you have read and understood all of the following product warnings and user directions. Failure to do so may result in equipment damage, operator injury, or death.

2.1 Installation Precautions

DANGER!

- Use lockout/tagout procedures on the branch circuit disconnect before installing the option into the ASD.
- Avoid installation in areas where vibration, heat, humidity, dust, metal particles, or high levels of electrical noise (EMI) are present.
- Do not install the ASD or option where it may be exposed to flammable chemicals or gasses, water, solvents, or other fluids.
- Where applicable, always ground the option appropriately to prevent electrical shock to personnel and to help reduce electrical noise. The ASD's input, output, and control power cables are to be run separately from the option's associated cables.

  Note: *Conduit is not an acceptable ground.*
- Turn the power on only after attaching the front cover.
- Follow all warnings and precautions and do not exceed equipment ratings.
- The ASD maintains a residual charge for a while after turning the ASD off. Wait at least ten minutes before servicing the ASD after turning the ASD power off. Ensure that the **Charge LED** is off prior to beginning installation.
- For further drive-specific precaution, safety and installation information, please refer to the *G7 Adjustable Speed Drive Operation Manual* supplied with your drive.

2.2 Maintenance Precautions

DANGER!

- Use lockout/tagout procedures on the branch circuit disconnect before servicing the ASD or installed option.
- The ASD maintains a residual charge for a while after turning the ASD off. Wait at least ten minutes before servicing the ASD after turning the ASD power off. Ensure that the **Charge LED** is off.
- **Do Not** attempt to disassemble, modify, or repair the option card. Call your Toshiba sales representative for repair or service information.
- Turn the power on only after attaching the front cover and **Do Not** remove the front cover of the ASD when the power is on.
- If the ASD should emit smoke or an unusual odor or sound, turn the power off immediately.
- The heat sink and the discharge resistors may become extremely hot to the touch. Allow the unit to cool before coming in contact or performing service on the ASD or option card.
- The system should be inspected periodically for damaged or improperly functioning parts, cleanliness, and to determine that the connectors are tightened securely.

2.3 Inspection

Upon receipt, perform the following checks:

- Inspect the unit for shipping damage.
- Check for loose, broken, damaged or missing parts.

Report any discrepancies to your Toshiba sales representative.

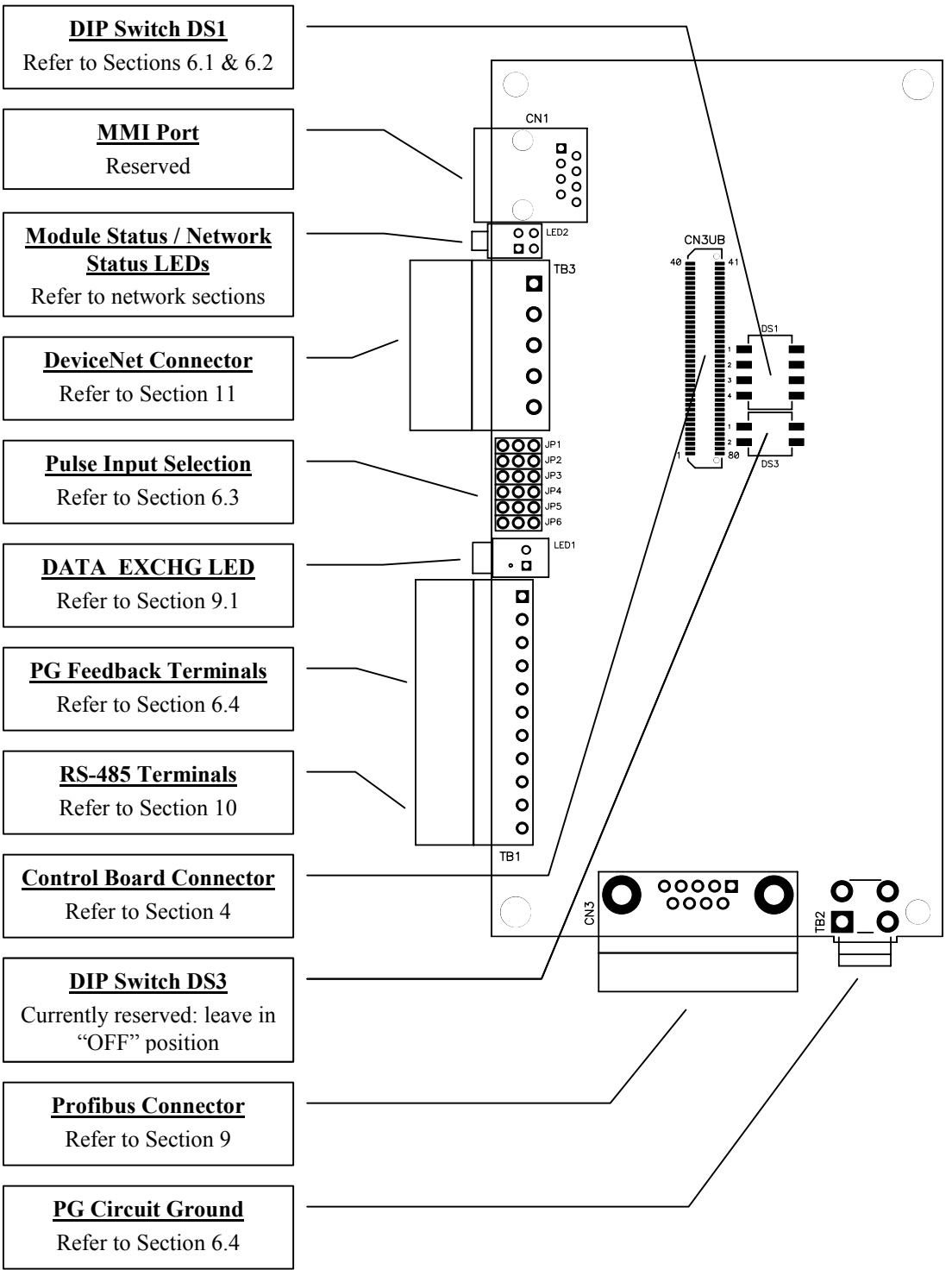
2.4 Storage

- Store the device in a well ventilated location (in its shipping carton, if possible).
- Avoid storage locations of extreme temperatures, high humidity, dust, or metal particles.

2.5 Disposal

- Contact the local or state environmental agency in your area for details on the disposal of electrical components and packaging.
- Do not dispose of the unit via incineration.

3. Board Overview



NOTE: Not all indicated items are available on ASD-MULTICOM-B.

4. Installation

4.1 Installation Procedure

The interface cards for the G7 ASD have been designed for quick and simple installation. The card is connected to the drive's control board via an 80-pin connector, and is mechanically supported with nylon standoffs attached through the control PCB to the chassis. The only tools required for installation are a flat screwdriver, a #2 Phillips screwdriver and, for most installations, a utility knife to aid in the removal of the front cover's side access window. Each interface card kit includes one #51326A connector PCB and four #47220 nylon hex standoffs.

Before opening the drive, please observe all safety precautions as outlined on the unit's front cover and in the operation manual. After securing the unit against hazardous voltages, loosen the two lower fasteners and remove the cover, taking care not to damage the keypad-to-drive cable connection. Remove the four pan head screws that secure the control PCB to the drive (refer to Figure 1) and replace with the #47220 1/2" hex standoffs provided. Make these substitutions one or two fasteners at a time to prevent any shifting of the control board.

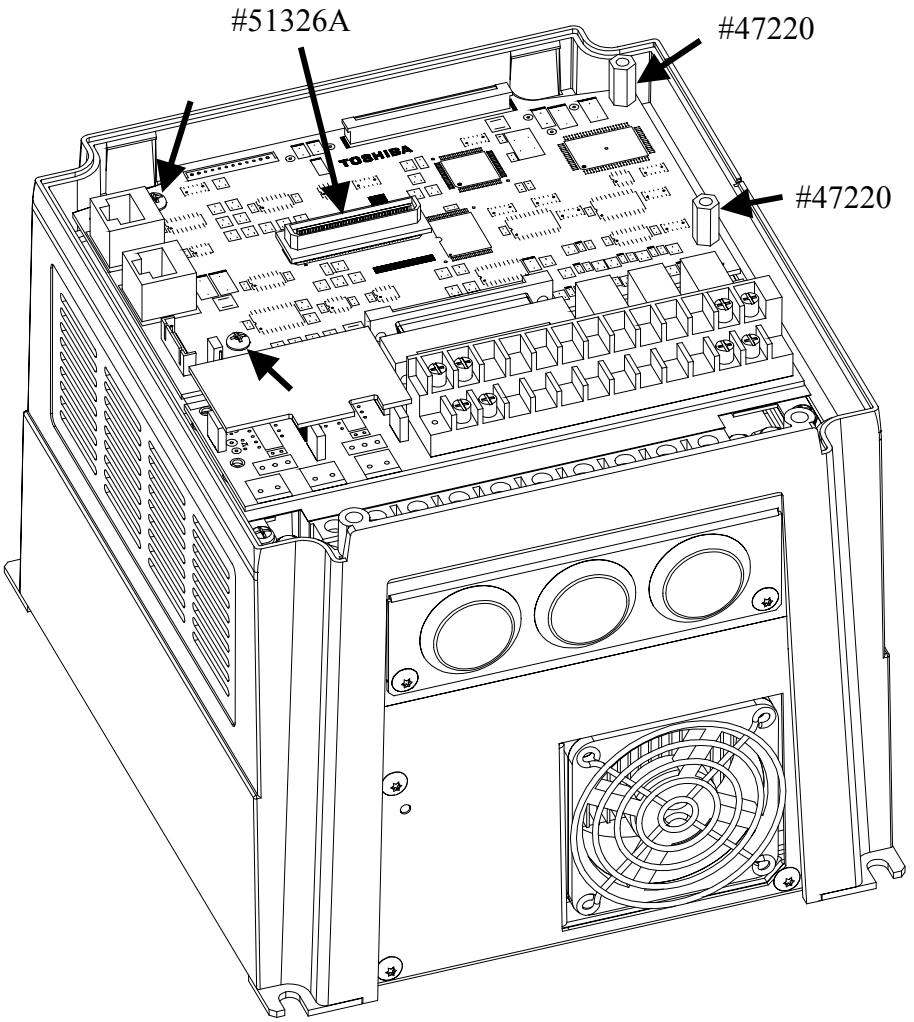
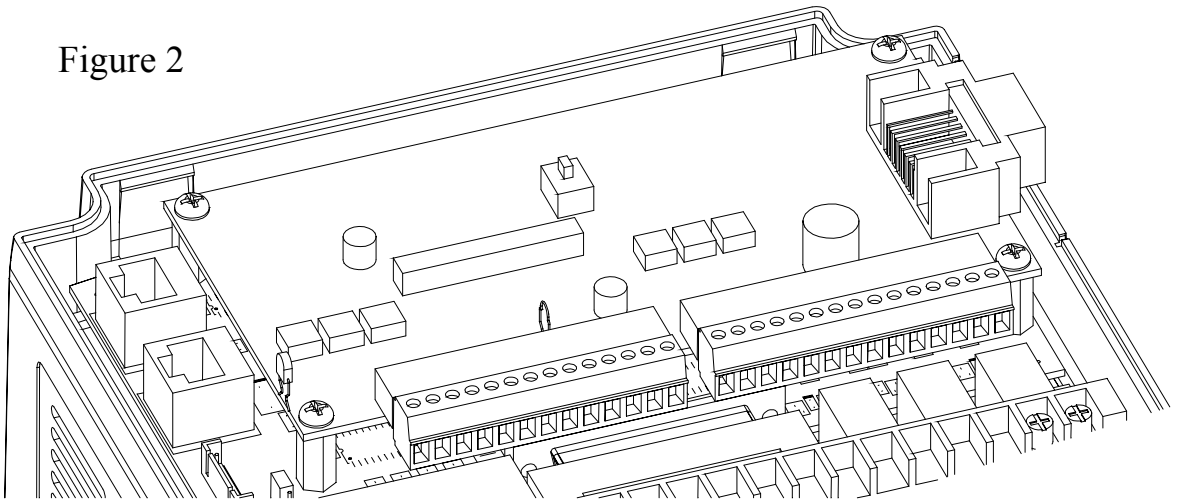


Figure 1: Screw Removal, Standoff and Connector PCB Installation

Install the #51326A connector PCB in the control board's 80-pin connector, making sure that the connector is fully seated. Next, position the option card and snap the connectors together. Finally, secure the card to the standoffs with the remaining pan head screws (see Figure 2).

Figure 2



If your option card is equipped with a data connector along its right side edge, you will need to remove the side access window of your drive's cover before reinstalling it. Place the cover upside down on a level surface (see Figure 3), and with downward pressure on your utility knife, cut along the two vertical grooves. Next, bend the resulting flap back and forth several times until it snaps apart. Clean up the opening as necessary and reattach the front cover to the drive.

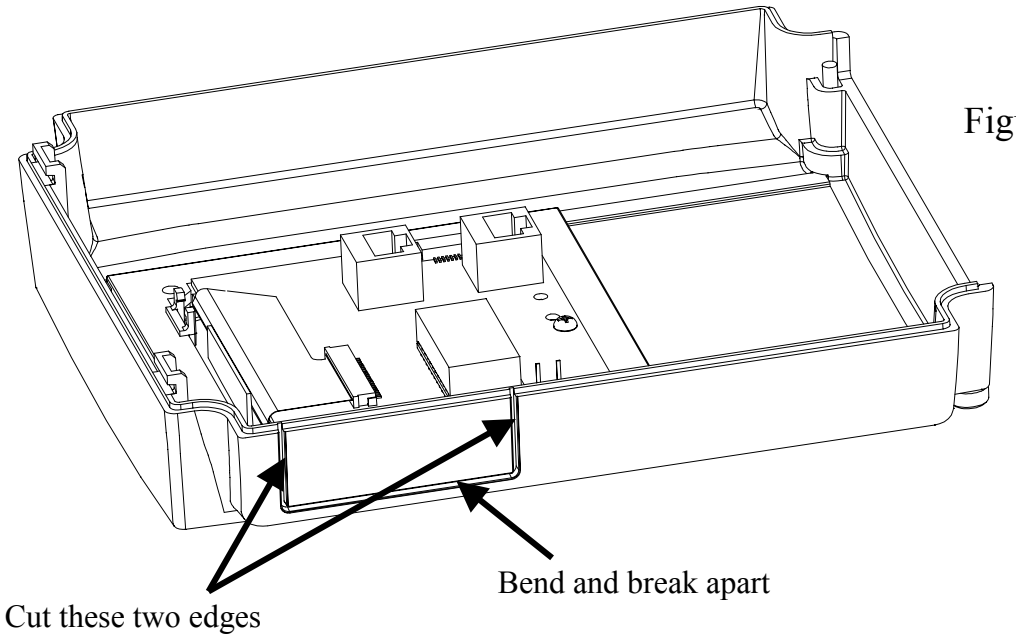


Figure 3

4.2 Wiring

- **Use shielded wire for control signals and ground the unit with shielded wire**.
- Applicable wire size for terminal block TB1 is 0.2 to 2.5mm^2.
- Strip off the end of the wire by about 5mm.
- For connecting wires, use a screwdriver that has a blade tip of 0.4mm thickness and 2.5mm width.
- Tightening torque of the terminal block screws should be 0.22 to 0.25Nm.
- **Never route the signal or communication network lines and main circuit power wires together**. Separate the signal and communication network lines and the main circuit power wires by more than 200mm.
- Use 0.75mm^2 wire for connecting the option's PGCC terminal to the drive's CC terminal.
- Use 0.75mm^2 wire for connecting the option's ground lug (TB2) to the drive's G/E terminal.

5. Environmental Specifications

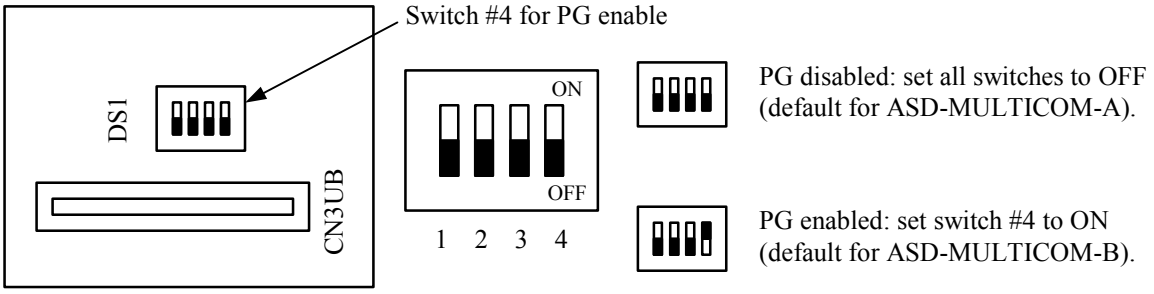
Item	Specification
Operating Environment	Indoors, less than 1000m above sea level, do not expose to direct sunlight or corrosive / explosive gasses
Operating Temperature	-10 ~ +50°C (+14 ~ +122°F)
Storage Temperature	-40 ~ +85°C (-40 ~ +185°F)
Relative Humidity	20% ~ 90% (without condensation)
Vibration	5.9m/s^2 {0.6G} or less (10 ~ 55Hz)
Cooling Method	Self-cooled

6. PG Feedback Operation

This section applies to both ASD-MULTICOM-A and ASD-MULTICOM-B option boards.

6.1 PG Feedback Enable Setting

To enable PG feedback with the option, set the position of switch #4 on DS1 to the ON position as shown in the figure below.



6.2 PG Power Supply Voltage Selection

The PG feedback option is capable of providing a PG power supply of 5V, 6V, 12V or 15V. To select the desired PG power supply voltage, properly set the position of switch #1, switch #2, and switch #3 on DS1 as shown in the figure below. Table 1 provides the proper switch settings.

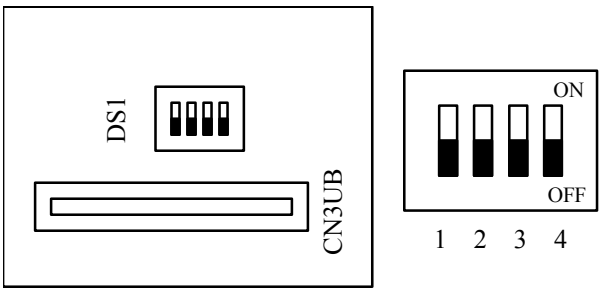


Table 1: PG Power Supply selection

Power Supply	Switch 1	Switch 2	Switch 3
5V	OFF	OFF	OFF
6V	ON	OFF	OFF
12V	ON	ON	OFF
15V	ON	ON	ON

6.3 Pulse Input Selection

Two different types of pulse input circuitry are provided. To select the desired pulse input circuitry, properly set the position of jumpers JP1~JP6 as shown in the figure below. Table 2 provides the proper jumper settings.

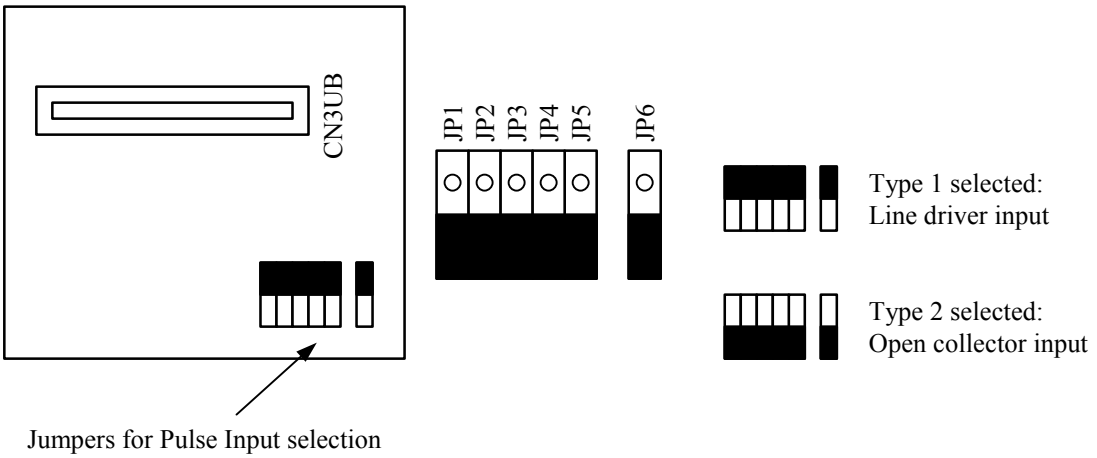
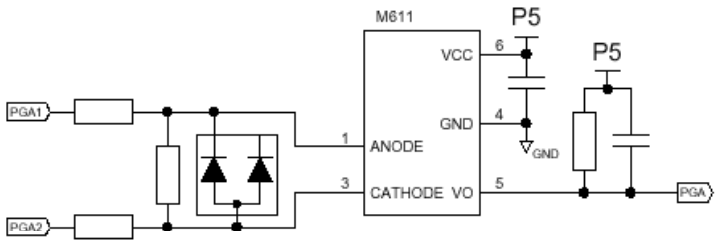
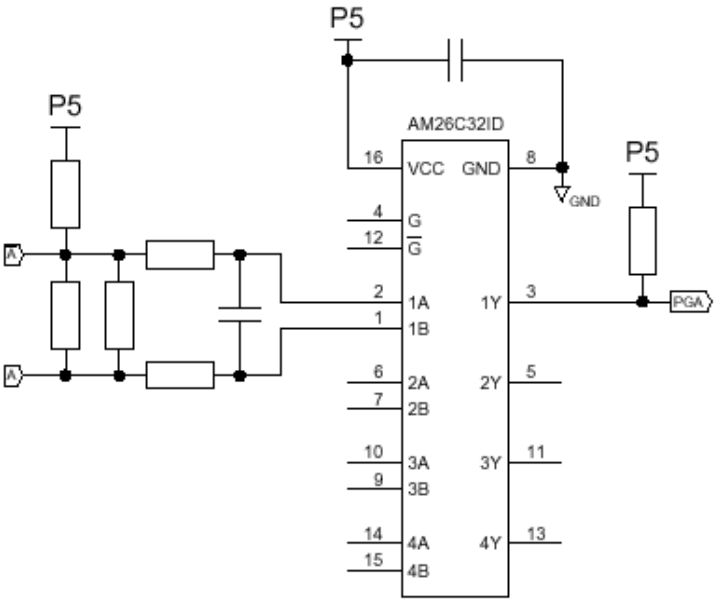


Table 2: Jumper Settings

Pulse Input Type	Characteristics
Type 1 Line Driver	▪ Rated voltage output with emitter/follower combination. ▪ Higher noise-immunity characteristics. ▪ High-speed response. Long-distance transmission capability. ▪ Need to pay attention to waveform irregularity. ▪ Input voltage ($V_{PGA1-PGA2}$) range: 8.3V-16.6V ▪ Input circuit diagram: 

Pulse Input Type	Characteristics
Type 2 Open Collector	▪ Lower noise-immunity characteristics. ▪ Need to pay attention to waveform irregularity and distortion. ▪ Input circuit diagram: 

6.4 PG Feedback Connection

The pulse input signals are connected to terminal block TB1. Table 3 provides terminal descriptions for terminal block TB1. PGA1 and PGA2 are connected for Phase A, PGB1 and PGB2 are connected for Phase B, and PGZ1 and PGZ2 are connected for Phase Z. The wiring for Phase Z is done only when using a Z-marker is necessary. The polarity of the pulse input signals should be as follows:

+ Side: PGA1, PGB1, PGZ1

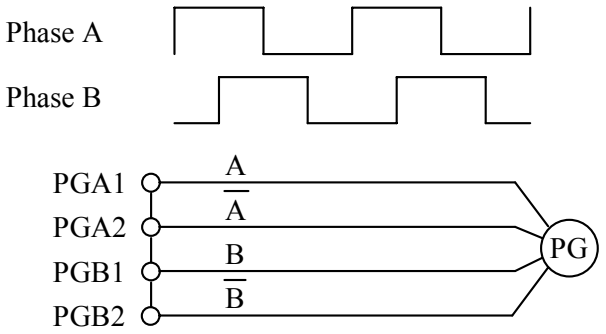
- Side: PGA2, PGB2, PGZ2

Table 3: Terminal description for TB1

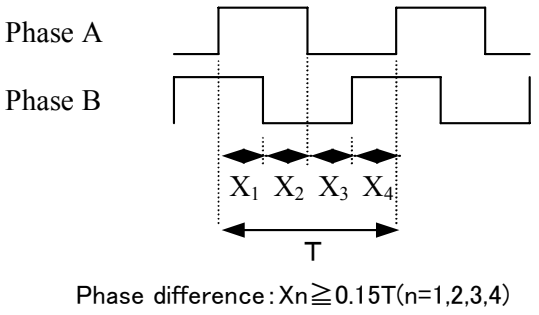
Terminal Number	Terminal Name	Function	Specification
1	PGA1	PG feedback input, Pulse train speed command input (Phase A input)	Selectable: line driver / open collector Maximum input frequency: 60kpps (2 phases) 120kpps (single phase) Pulse duty cycle: 50 ± 10% Minimum input current requirement: 2.5mA
2	PGA2		
3	PGB1	PG feedback input Pulse train speed command input (Phase B input)	
4	PGB2		
5	PGZ1	PG feedback input Pulse train speed command input (Phase Z input)	
6	PGZ2		
7	PGVC	PG power supply terminal	Selectable: 5VDC, 6VDC, 12VDC, 15VDC
8	PGCC		

The pulse input signals should have the waveform of the figure below in terms of motor rotation direction. The encoder installation direction and signal wiring should be done accordingly.
Forward rotation or reverse rotation is determined from the quadrature orientation of the Phase A and Phase B feedback pulses. **Therefore, it should be noted that when connections are wrong, there is a possibility for abnormal rotation of the motor.**

Forward rotation



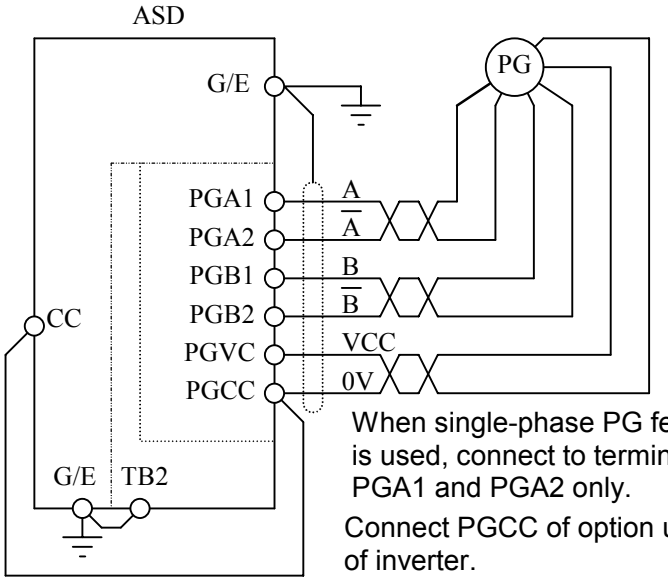
Reverse rotation



Phase difference : Xn≧0.15T(n=1,2,3,4)

When single-phase PG feedback is used, connect to terminals PGA1 and PGA2 only. The determination of forward rotation and reverse rotation is impossible: only speed control is applicable.

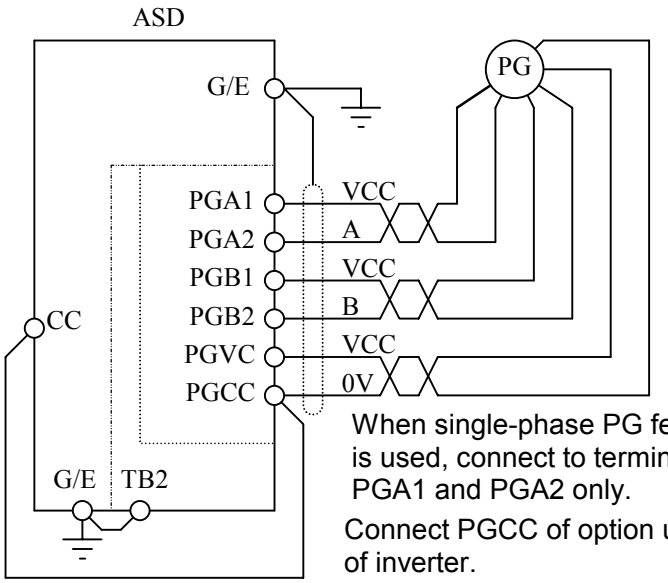
Example of line driver (pulse input type 1) encoder connection:



When single-phase PG feedback is used, connect to terminals PGA1 and PGA2 only.

Connect PGCC of option unit to CC of inverter.

Example of open collector (pulse input type 2) encoder connection:



When single-phase PG feedback is used, connect to terminals PGA1 and PGA2 only.

Connect PGCC of option unit to CC of inverter.

6.5 Maximum Input Frequency Using an Open Collector Encoder

When using an open collector (pulse input type 2) encoder, the rise time of the voltage when the encoder's internal transistor turns OFF tends to be longer than the fall time when the transistor turns ON. Therefore, if the input frequency becomes high enough, the pulse duty cycle cannot maintain the 50±10% specification. For the pulse duty cycle to be within the specified range, the generated frequency from the open collector encoder needs to be below a maximum input frequency. To calculate the maximum input frequency for an open collector (pulse input type 2) encoder, use the following equations:

(eq.1) $$\frac{0.8}{\text{Maximum input frequency (Pulses/s)} \times A} - \text{Voltage rise time(s)} = 3 \times 10^{-6}\,(\text{s})$$

Single phase input: A=2
Two phase input: A=4

(eq.2) $$\text{Voltage rise time} = \text{Encoder exclusive pulse rise time} + (R \times C)$$

Encoder exclusive pulse rise time (s) ..... Refer to encoder specifications.

R (Ω) (Input resistance)..... internal resistance 1000 (Ω) + external resistance value (if there is external resistance).

C (F) (Cable static capacitance) ..... Refer to cable specifications.

Example

Encoder .....LBJ-005-500 (SUMTAK), 2-phase output, pulse rise time= 0.35 x 10^{-6} (s)

Cable .....Any Brand
Static capacitance=120 x 10^{-12} (F/m) x 10 (m)

Using equation (eq.2)

Voltage rise time = Encoder exclusive pulse rise time + (R x C)
= [0.35 x 10^{-6} (s)] + [1000 (Ω) x 120 x 10^{-12} (F/m) x 10 (m)]
= 1.55 x 10^{-6} (s)

Using equation (eq.1)

$$\frac{0.8}{\text{Maximum input frequency (Pulses/s)} \times A} - \text{Voltage rise time(s)} = 3 \times 10^{-6}\,(\text{s})$$

Maximum input frequency = 87912 (Pulse/s) for single phase input
= 43956 (Pulse/s) for two phase input

7. LED Indicators

This section applies to ASD-MULTICOM-A option boards only.

The interface board contains two bi-color red/green status LEDs. The lower LED indicates the Module Status (MS), and the upper LED indicates the Network Status (NS). Refer to Figure 2. The use and context of these LEDs is network-specific: refer to each network's section in this manual for further information.

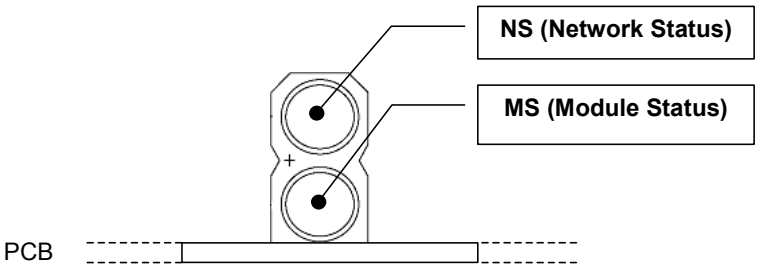


Figure 2: LED Indicators

8. Network Configuration Parameters

This section applies to ASD-MULTICOM-A option boards only.

Because the Multicom interface supports several different fieldbus physical layers and protocols, some configuration must be performed prior to inclusion on the network to inform the Multicom interface which network it is being asked to communication via, and what the characteristics of that network are. This configuration is performed by setting ASD parameters F890 ~ F894, which are collectively known as the "Network Configuration Parameters".

Note that the values of these 5 Network Configuration Parameters are only read by the Multicom interface upon initialization after a drive reset or power-up condition. Therefore, if any of these parameters are changed, be sure to reset the drive to enable the changes (as will be explained later, this may actually involve resetting the drive twice: once when changing the "Network Selection" parameter to validate the chosen network, and then once more when changing any of the configuration items associated with the chosen network). Also note that although parameters F890 ~ F894 are always available, whether or not all of these configuration parameters are actually used by the Multicom interface will depend on the Multicom interface's firmware version and the selected network.

The primary network selection is chosen by parameter F890 (refer to Table 4).

Table 4: Network Selection

Parameter	Function	Settings	Default Value
F890	Network Selection	0: Profibus DP 1: Modbus RTU 2: DeviceNet	0

The function and adjustment ranges assigned to parameter F890 are fixed; that is to say that parameter F890 is always the "Network Selection" parameter. The functions and adjustment ranges of the remaining network configuration parameters (F891 ~ F894), however, will vary based on the setting of parameter F890. For example, when parameter F890 is configured for Profibus DP communications, then parameter F891 is unused, and its upper and lower adjustment limits will both be "0". When parameter F890 is configured for Modbus RTU communications, however, then parameter F891 is used to select the Modbus network baud rate, and its adjustment range then becomes 0 ~ 7.

As previously mentioned, the values of the Network Configuration Parameters are validated by the Multicom interface only during a drive initialization procedure. Therefore, when the drive and the Multicom interface are initializing, the settings of the Network Configuration Parameters are read and internally saved by the Multicom interface. These internally-saved values *will not change* until the next initialization procedure. For this reason, two drive resets may be required when modifying the Network Configuration Parameters: one to change and validate the network selection (parameter F890), and another one to change and validate the remaining Network Configuration Parameters (parameters F891 ~ F894) if necessary.

This behavior may best be explained through the use of an example. Say, for instance, that the Multicom interface is currently configured for Profibus DP communications (parameter F890 = 0). Let's also say that we would like to reconfigure the Multicom interface to communicate via Modbus RTU at 38.4kbaud with even parity, and that all configuration parameters are currently at their factory-default values:

1. Apply power to the drive. The drive and Multicom interface initialize. Parameter F890 is set to 0, so the Multicom interface internally configures itself for Profibus DP communications.

2. Change parameter F890 from its current setting of "0" to "1" to select Modbus RTU communications. Press the "ENTER" key on the drive's panel to write the change. At this point, the Multicom interface is *still configured for Profibus DP communications*, so parameters F891 ~ F894 will not be adjustable beyond "0".
3. Reset the drive (fault the drive and reset it, or momentarily power it off). Now, parameter F890 is set to 1 during initialization, so the Multicom interface internally configures itself for Modbus RTU communications.
4. Now when we inspect parameter F891 (now "Modbus baud rate"), the value will be 5. Therefore, we need to change parameter F891 from its current setting of "5" (9600 baud) to "7" (38.4kbaud). Press the "ENTER" key on the drive's panel to write the change. At this point, the internal Modbus baud rate is *still configured for 9600 baud* (until the next initialization sequence takes place).
5. Similarly, change parameter F892 (now "Modbus parity & stop bits") from its factory-default value of "1" (no parity/2 stop bits) to "2" (even parity).
6. Reset the drive once more. Now, when the drive and Multicom interface initialize, the Multicom interface will initialize with Modbus RTU communications at 38.4kbaud and even parity. The network configuration is now completed.

Once the network configuration parameters are configured for a specific network, their settings for that network will be retained even if a different network is chosen and the second network's configuration parameters changed. Continuing with the above example for demonstration, even if a different network is chosen, and parameters F891 ~ F894 associated with that network are changed, and then Modbus RTU communications are once again selected by changing parameter F890 to "1", the Modbus baud rate will still be set to 38.4kbaud, and the parity will still be set to "even" when drive/Multicom initialization has completed.

8.1 Profibus DP Configuration

When parameter F890 is selected for Profibus DP communications, no additional network configuration is required. The additional Network Configuration Parameters, therefore, are unused (refer to Table 5).

Table 5: Profibus DP Network Configuration Parameters

Parameter	Function	Settings	Default Value
F891	Unused	N/A (Always 0)	0
F892	Unused	N/A (Always 0)	0
F893	Unused	N/A (Always 0)	0
F894	Unused	N/A (Always 0)	0

8.2 Modbus RTU Configuration

When parameter F890 is selected for Modbus RTU communications, then the additional Network Configuration Parameters are assigned the functions as indicated in Table 6.

Table 6: Modbus RTU Network Configuration Parameters

Parameter	Function	Settings	Default Value
F891	Baud Rate	0: 300 baud 1: 600 baud 2: 1200 baud 3: 2400 baud 4: 4800 baud 5: 9600 baud 6: 19.2 kbaud 7: 38.4 kbaud	5
F892	Parity & Stop Bits	0: no parity (1 stop bit) 1: no parity (2 stop bits) 2: even parity 3: odd parity	1
F893	Response Delay	0 ~ 200 (0.00s ~ 2.00s)	0
F894	Unused	N/A (Always 0)	0

8.3 DeviceNet Configuration

When parameter F890 is selected for DeviceNet communications, then the additional Network Configuration Parameters are assigned the functions as indicated in Table 7.

Table 7: DeviceNet Network Configuration Parameters

Parameter	Function	Settings	Default Value
F891	Baud Rate	0: 125kbaud 1: 250kbaud 2: 500kbaud	0
F892	Network Communication Loss Action	0 = Set all consumed data to 0 1 = Retain last data values 2 = Issue STOP command to drive 3 = Issue EMERGENCY OFF command to drive 4 = Run preset speed #1 5 = Run preset speed #2 6 = Run preset speed #3 7 = Run preset speed #4 8 = Run preset speed #5 9 = Run preset speed #6 10 = Run preset speed #7 11 = Run preset speed #8 12 = Run preset speed #9 13 = Run preset speed #10 14 = Run preset speed #11 15 = Run preset speed #12 16 = Run preset speed #13 17 = Run preset speed #14 18 = Run preset speed #15	0
F893	Selected I/O Assembly Instance Set	0: Toshiba-specific 1: Basic speed control 2: Extended speed control	0
F894	Unused	N/A (Always 0)	0

9. Profibus Interface

This section applies to ASD-MULTICOM-A option boards only.

9.1 Feature Summary

The Multicom interface provides a wide array of network data access and drive control features. Combined with the flexible configuration and high-speed data transfer capabilities of the Profibus network, this allows powerful networked control and monitoring systems to be designed. Some of the main features provided by the Multicom interface which allow for this control and configurability are briefly described here:

Protocol

Profibus DP (Decentralized Periphery) as specified in European standard EN 50170. The Multicom interface can also co-exist simultaneously on networks using Profibus-FMS.

Network Baud Rates

Supports all Profibus baud rates from 9.6kbaud to 12Mbaud. The network baud rate is automatically detected and continuously monitored during operation; no parameter settings are necessary.

Power Supply

Self-contained. Powered directly from the connected drive. No external power supply devices or connections are required.

Isolation

The drive is fully optically isolated from the Profibus network. By using optically isolated connections, grounding differential problems are eliminated and noise immunity characteristics are greatly improved.

Global Control Functions

- *Freeze mode:* Input (monitor) data values are held constant within the Multicom interface until the next “freeze” command or an “unfreeze” command is received. Used primarily for synchronized monitoring of multiple Profibus nodes.
- *Sync mode:* Output (control) data values are held constant within the Multicom interface until the next “sync” command or an “unsync” command is received. Used primarily for synchronized control of multiple Profibus nodes.
- *Clear_Data:* All output (control) data values are cleared to “0”.

Network Watchdog

A network watchdog function is always operating within the Multicom interface (if selected at time of unit commissioning). In the event of a disconnection from the Profibus network or loss of the network master, the Multicom interface will automatically set its control data to 0.

Indicator

A green LED (LED1) is provided to indicate when the Multicom interface has achieved the DATA_EXCHANGE state with the Profibus network master. This serves as a convenient indicator that the Profibus master and Multicom interface are configured properly and are exchanging data.

Profibus Network Connector

The network interface is a standard DB-9 female connector. The metallic housing of the DB-9 connector is typically connected to the network shield in the attached Profibus connector. The DB-9 housing can, in turn, then be connected to earth ground if desired.

Input/Output Data

The Multicom interface's cyclic output (control) and input (status) data sizes are selectable (modular) in 16 different configurations representing sizes of between 4 and 40 bytes.

Via these data structures, any data item (command data, monitor data and configuration parameters) available in the drive can be accessed. For detailed explanations of the format and usage of the input/output data, refer to section 9.4.

9.2 Profibus Interface Connection

Table 8 provides DB-9 connector pin descriptions for Profibus connector CN3.

Table 8: Pin description for Profibus connector CN3

Pin Number	Function	In/Out
1	No connection	-
2	No connection	-
3	Profibus network “B” (positive) data line	In/out
4	RTS signal – direction control for fiber optic network interface	Out
5	DGND – power supply ground internally connected to the interface board’s isolated ground	-
6	VP – power supply +5v internally connected to the interface board’s isolated P5.	-
7	No connection	-
8	Profibus network “A” (negative) data line	In/out
9	RTS signal ground reference – internally connected to the interface board’s isolated ground	-

To connect to the Multicom interface, complete the following steps:

1. Connect the Profibus network cable to the DB9 connector marked “CN3” on the G7 Multicom Option. Refer to the Profibus Specification for detailed network wiring guidelines. Ensure that the Profibus network cable is tightly screwed onto the DB9 connector, and route the cable such that it is located well away from any drive input power or motor wiring. Also take care to route the cable away from any sharp edges or positions where it may be pinched.
2. Grounding is of particular importance for reliable, stable operation. Communication system characteristics may vary from system to system, depending on the system environment and grounding method used. The metallic housing of the DB9 connector (CN3) will be regarded as the “Shield GND” of the Multicom interface. The “Shield GND” should be connected to the shield of the Profibus network cable through the Profibus connector. To ground the network cable shield, therefore, connect a wire to the “Shield GND”, and then connect the other end of the wire to an appropriate ground. For specific requirements regarding protective grounding and the Profibus network, refer to the Profibus Standard (EN 50 170, part 1).

9.3 Unit Addressing

The Profibus node (slave) address is set via parameter F802 (inverter number parameter). Although parameter F802 has an adjustment range from 0-255, only 0-126 is an allowable addressing selection for the Profibus network. Therefore, if parameter F802 is set to 127 through 255, the Multicom interface will default to an address of 126.

9.4 Profibus Exchanged Data Structures

9.4.1 Output (Control) Data Format

The size of the output data structure from the network master to the Multicom interface is modular and selectable from 4 to 40 bytes. The allocation of the maximum 40 bytes of the data structure is comprised of 1 fixed four-byte command, 1 fixed four-byte extended command, 1 fixed four-byte speed reference, 5 configurable four-byte scan data selections (selectable via drive parameters F831-F835), and 1 eight-byte structure for asynchronous parameter accesses. Refer to Table 9 for details.

Table 9: Output (Control) data

Offset	Data	Offset	Data
0	Reserved	20	Parameter F833 setting high byte
1	Reserved	21	:
2	Command high byte	22	:
3	Command low byte	23	Parameter F833 setting low byte
4	Reserved	24	Parameter F834 setting high byte
5	Reserved	25	:
6	Extended command high byte	26	:
7	Extended command low byte	27	Parameter F834 setting low byte
8	Speed reference high byte	28	Parameter F835 setting high byte
9	:	29	:
10	:	30	:
11	Speed reference low byte	31	Parameter F835 setting low byte
12	Parameter F831 setting high byte	32	Action bits / Reserved
13	:	33	Reserved
14	:	34	Parameter number high byte
15	Parameter F831 setting low byte	35	Parameter number low byte
16	Parameter F832 setting high byte	36	Reserved
17	:	37	Reserved
18	:	38	Parameter data to write high byte
19	Parameter F832 setting low byte	39	Parameter data to write low byte

Locations marked “Reserved” in the above table are reserved for future use. Presently, all “Reserved” output data locations are ignored by the drive. Future releases of the drive firmware, however, may use these locations for data transfer.

Throughout the remainder of this section, references may be made to internal ASD parameter numbers and data definitions. For more information regarding the specific accessible ASD parameters, please refer to the appropriate ASD Serial Communication Interface Manual (obtainable from Toshiba).

- **Command Word (Offsets 2 and 3)**

Bit-mapped drive command word internally located at parameter 0xFA06. Table 10 provides the format of this command word.

Table 10: Command Word Format

	Bit	Function	0	1
High Byte	15	Command priority	N/A	Option priority
	14	Speed reference priority	N/A	Option priority
	13	Control selection	Speed control	Torque / position control
	12	Emergency OFF command	N/A	Emergency OFF
	11	Coast stop command	N/A	Coast stop
	10	Error counter reset command	N/A	Reset
	9	Forward / reverse selection	Forward	Reverse
	8	Jog command	N/A	Jog
Low Byte	7	DC injection braking command	N/A	DC injection braking
	6	PI control OFF command	N/A	PI control OFF
	5	Brake release command	N/A	Brake release
	4	Excitation current command	N/A	Excitation current
	3	Brake close command	N/A	Brake close
	2	Fault reset command	N/A	Reset
	1	Reserved	--	--
	0	Run / stop selection	Stop	Run

- **Extended Command Word (Offsets 6 and 7)**

Bit-mapped drive extended command word internally located at parameter 0xFA23. Table 11 provides the format of this extended command word.

Table 11: Extended Command Word Format

	Bit	Function	0	1
High Byte	15	Reverse jog command	N/A	Jog reverse
	14	Forward jog command	N/A	Jog forward
	13	Torque limit selection bit 2	2: Torque limit 3	3: Torque limit 4
	12	Torque limit selection bit 1	0: Torque limit 1	1: Torque limit 2
	11	V/F selection bit 2	2: V/F 3	3: V/F 4
	10	V/F selection bit 1	0: V/F 1	1: V/F 2
	9	Accel/decel selection bit 2	2: Accel/decel 3	3: Accel/decel 4
	8	Accel/decel selection bit 1	0: Accel/decel 1	1: Accel/decel 2
Low Byte	7	Brake test command	Brake close	Brake release
	6	Brake response command	Brake close	Brake release
	5	Reserved	--	--
	4	Reserved	--	--
	3	Preset speed selection bit 4	12: 12th speed 13: 13th speed	14: 14th speed 15: 15th speed
	2	Preset speed selection bit 3	8: 8th speed 9: 9th speed	10: 10th speed 11: 11th speed
	1	Preset speed selection bit 2	4: 4th speed 5: 5th speed	6: 6th speed 7: 7th speed
	0	Preset speed selection bit 1	0: OFF 1: 1st speed	2: 2nd speed 3: 3rd speed

- **Speed Reference Command (Offsets 8 ~ 11)**

Unsigned 16-bit value located at parameter 0xFA07. The data contained in the speed reference command word is the desired speed reference command multiplied by 100, and then converted to hexadecimal. In other words, if a speed reference command of 55.34Hz is desired, then 55.34 x 100 = 5534, which converted to hexadecimal is 0x159E. The speed reference command low byte (offset 11) must therefore contain 0x9E and the next-highest byte (offset 10) must contain 0x15.

If the speed reference command exceeds limiting drive parameters (such as the Upper Limit Frequency or Maximum Frequency), then the drive will ignore it, maintaining its current setting.

- **Drive Command Scan Data (Offsets 12 ~ 31)**

Table 12 provides a list of the available command scan data selections (selectable via drive parameters F831~F835). The "Parameter" column indicates the drive's internal parameter to which the corresponding selection is mapped.

Table 12: Drive Command Scan Data

F831~F835 Setting	Description	Unit	Range	Parameter
0	No selection	-	-	0xFFFF
1	RESERVED	-	-	-
2	RESERVED	-	-	-
3	Incremental speed reference	0.01Hz	0 ~ 500	0xFA08
4	Absolute torque limit	0.01%	0 ~ 25000	0xFA34
5	Positive torque limit	0.01%	0 ~ 25000	0x0441
6	Negative torque limit	0.01%	0 ~ 25000	0x0443
7	Torque command	0.01%	-25000 ~ 25000	0xFA33
8	Speed torque bias	0.01%	-25000 ~ 25000	0x0726
9	Tension torque bias	0.01%	-25000 ~ 25000	0x0727
10	Load balance gain	0.01	0 ~25000	0x0728
11	Drooping gain	0.01	0 ~ 10000	0x0320
12	Speed loop proportional gain	0.1	32 ~ 10000	0x0376
13	Speed loop integral gain	0.1	100 ~ 2000	0x0377
14	Output terminals	-	-	0xFA50
15	Load moment of inertia	0.0001	100 ~ 10000	0xFA35
16	RESERVED	-	-	-

- *Note 1: Items marked as "RESERVED" in Table 12 are reserved for future use. Selecting one of the corresponding values as command scan data will have no effect on drive operation.*
- *Note 2: Although not disallowed, avoid configuring more than 1 scan command data parameter with the same command data selection (for example, do not set both F831 and F832 to "3", etc.). Unexpected drive behavior could result if different data values are written to the corresponding command locations.*
- *Note 3: Parameters F831~F835 are only validated on drive reset or power-up. Therefore, if any of these parameters are changed, be sure to reset the drive to validate the changes.*
- *Note 4: Data range checking is not performed on command scan items. If a value outside of a specific item's valid range is written to the drive, that value will be accepted, but ignored by the drive.*

- **Action Bits / Parameter Number (Offsets 32 ~ 35)**

Parameter action bits and 16-bit parameter number. Refer to section 9.6 for a detailed explanation of these items.

- **Parameter Data (Offsets 38 and 39)**

During parameter writes, this contains the data to write. Refer to section 9.6 for a detailed explanation of this location.

9.4.2 Input (Status) Data Format

The size of the input data structure from the Multicom interface to the network master is modular and selectable from 4 to 40 bytes. The allocation of the maximum 40 bytes of the data structure is comprised of 1 fixed four-byte status, 1 fixed four-byte output speed reference, 6 configurable four-byte scan data selections (selectable via drive parameters F841-F846), and 1 eight-byte structure for asynchronous parameter accesses. Refer to Table 13 for details.

Table 13: Input (Status) data

Offset	Data
0	Reserved
1	Reserved
2	Status high byte
3	Status low byte
4	Operating speed high byte
5	:
6	:
7	Operating speed low byte
8	Parameter F841 setting high byte
9	:
10	:
11	Parameter F841 setting low byte
12	Parameter F842 setting high byte
13	:
14	:
15	Parameter F842 setting low byte
16	Parameter F843 setting high byte
17	:
18	:
19	Parameter F843 setting low byte

Offset	Data
20	Parameter F844 setting high byte
21	:
22	:
23	Parameter F844 setting low byte
24	Parameter F845 setting high byte
25	:
26	:
27	Parameter F845 setting low byte
28	Parameter F846 setting high byte
29	:
30	:
31	Parameter F846 setting low byte
32	Response bits / Reserved
33	Reserved
34	Parameter number response high byte
35	Parameter number response low byte
36	Reserved
37	Reserved
38	Parameter data response high byte
39	Parameter data response low byte

Locations marked “Reserved” in the above table are reserved for future use. Presently, all “Reserved” input data is set to 0 by the drive. Future releases of the drive firmware, however, may use these locations for data transfer.

- **Status Word (Offsets 2 and 3)**

Bit-mapped status word. Table 14 provides the format of this status word.

Table 14 : Status Word Format

	Bit	Function	0	1
High Byte	15	Ready for operation status (not including MOFF)	Not ready	Ready
	14	Drive healthy signal	Alternating heartbeat: "0" for 1s, then "1" for 1s	
	13	Ready for operation status (not including ST)	Not ready	Ready
	12	Ready for operation status (including ST)	Not ready	Ready
	11	Control mode status	Speed control	Torque / position control
	10	Speed limit status	Normal	Speed limiting
	9	Forward / reverse status	Forward	Reverse
	8	Jog status	Normal	Jogging
Low Byte	7	DC injection braking	Normal	DC injection braking active
	6	OL alarm status	Normal	OL alarm
	5	PI control status	Normal	PI control inactive
	4	Alarm status	No alarm	Alarm
	3	Serious fault status	Normal	Serious fault
	2	Run / stop status	Stopped	Running
	1	Alarm stop status	None	Alarm stopped
	0	Fault status	None	Faulted

- **Operating Speed (Offsets 4 ~ 7)**

Obtained from drive parameter 0xFE58. Continuously reports the drive's operating speed. In order to determine the drive's actual output speed, the data contained in the output speed must first be converted from hexadecimal to decimal, and then divided by 100. For example, if offset #6 is 0x12 and offset #7 is 0x34, then 0x1234 converted to decimal is 4660. Dividing this number by 100, the actual operating speed of 46.60Hz is obtained.

- **Drive Status Scan Data (Offsets 12 ~ 31)**

Table 15 provides a list of the available status scan data selections (selectable via drive parameters F841-F846). The "Parameter" column indicates the drive's internal parameter to which the corresponding selection is mapped. More detailed explanations of some of these status items follow Table 15.

Table 15: Drive Status Scan Data

F841~F846 Setting	Description	Unit	Range	Parameter
0	No selection	-	-	0xFFFF
1	Alarm code monitor	-	-	0xFC91
2	Operating speed	0.01Hz	0 ~ 40000	0xFE58
3	Real-time speed feedback	0.01Hz	0 ~ 40000	0xFE61
4	Filtered speed feedback	0.01Hz	0 ~ 40000	0xFE62
5	Internal torque reference	0.01%	-32767 ~ 32767	0xFE56
6	Output current	0.01%	0 ~ 32767	0xFE03
7	Excitation current	0.01%	-32767 ~ 32767	0xFE21
8	Torque current	0.01%	-32767 ~ 32767	0xFE20
9	Overload value	0.01%	0 ~ 10000	0xFE59
10	Accel / Decel torque reduction	0.01%	-32767 ~ 32767	0xFE60
11	Motor counter data	-	0 ~ 65535	0xFE33
12	Fault code	-	-	0xFC90
13	Input terminal	-	-	0xFE06
14	VI input	0.01%	0 ~ 10000	0xFE36
15	RR input	0.01%	0 ~ 10000	0xFE35
16	RX input	0.01%	-10000 ~ 10000	0xFE37

- *Note 1: Parameters F841~F846 are only validated on drive reset or power-up. Therefore, if any of these parameters are changed, be sure to reset the drive to validate the changes.*

Alarm Code Monitor

Bit-mapped alarm code monitor word internally located at parameter 0xFC91. Table 16 provides the format of this alarm code monitor word.

Table 16: Alarm Code Monitor Word Format

	Bit	Function	0	1
High Byte	15	Reserved	--	--
	14	Reserved	--	--
	13	Reserved	--	--
	12	Communication error alarm (logic / RS-485 / message transmission)	N/A	Alarm on
	11	Communication error alarm (scan transmission)	N/A	Alarm on
	10	Cumulative run timer alarm	N/A	Alarm on
	9	Dynamic braking resistor overload alarm	N/A	Alarm on
	8	Over-torque alarm	N/A	Alarm on
Low Byte	7	Low current alarm	N/A	Alarm on
	6	Low control power alarm	N/A	Alarm on
	5	Low main power alarm	N/A	Alarm on
	4	Over-voltage alarm	N/A	Alarm on
	3	Overheat alarm	N/A	Alarm on
	2	Motor overload alarm	N/A	Alarm on
	1	Drive overload alarm	N/A	Alarm on
	0	Over-current alarm	N/A	Alarm on

Fault Code

Current fault code internally located at parameter 0xFC90. Table 17 provides the list of fault codes with descriptions.

Table 17: Fault Codes

Fault Code	Fault Description	Panel Display
0000	No error	NERR
0001	Over-current fault during acceleration	OC1
0002	Over-current fault during deceleration	OC2
0003	Over-current fault during constant-speed run	OC3
0004	Load-side over-current fault at start-up	OCL
0005	Over-current fault of U-phase arm	OCA1
0006	Over-current fault of V-phase arm	OCA2
0007	Over-current fault of W-phase arm	OCA3
0008	Input error-phase fault	EPH1
0009	Output error-phase fault	EPHO
000A	Over-voltage fault during acceleration	OP1
000B	Over-voltage fault during deceleration	OP2
000C	Over-voltage fault during constant running speed	OP3
000D	Drive overload	OL1
000E	Motor overload	OL2
000F	Dynamic braking resistor overload	OLR
0010	Overheat	OH
0011	Emergency OFF	E

Fault Code	Fault Description	Panel Display
0012	EEPROM write error	EEP1
0013	EEPROM initial read error (control EEPROM)	EEP2
0014	EEPROM initial read error (main circuit EEPROM)	EEP3
0015	Main RAM error	ERR2
0016	Main ROM error	ERR3
0017	CPU error	ERR4
0018	Communication interruption error	ERR5
0019	Gate array error	ERR6
001A	Output current detect fault	ERR7
001B	Option board error	ERR8
001C	Flash memory error	ERR9
001D	Under-current fault	UC
001E	Under-voltage fault (main power)	UP1
001F	Under-voltage fault (control power)	UP2
0020	Over-torque fault	OT
0021	Earth fault (software detection)	EF1
0022	Earth fault (hardware detection)	EF2
0023	Fuse error	EFU
0024	Dynamic braking resistor over-current fault	OCR
0025	DC section over-current fault during acceleration	OC1P
0026	DC section over-current fault during deceleration	OC2P
0027	DC section over-current fault during constant-speed run	OC3P
0028	Automatic tuning error	ETN
0029	Drive type error	ETYP
002A	Sink / source selection error	E-10
002B	Electromagnetic brake error	E-11
002C	Encoder disconnected fault	E-12
002D	Speed error	E-13
002E	Positioning error	E-14
0031	Key error	E-17

Input Terminals

Bit-mapped input terminal word internally located at parameter 0xFE06. Table 18 provides the format of this input terminal word.

Table 18: Input Terminals

	Bit	Terminal Name (Expansion Terminals)	Function	Parameter Number	0	1
High Byte	15	(B15)	Input terminal selection 16	F126	OFF	ON
	14	(B14)	Input terminal selection 15	F125	OFF	ON
	13	(B13)	Input terminal selection 14	F124	OFF	ON
	12	(B12)	Input terminal selection 13	F123	OFF	ON
	11	(B11)	Input terminal selection 12	F122	OFF	ON
	10	(B10)	Input terminal selection 11	F121	OFF	ON
	9	(B9)	Input terminal selection 10	F120	OFF	ON
	8	(B8)	Input terminal selection 9	F119	OFF	ON
Low Byte	7	S4	Input terminal selection 8	F118	OFF	ON
	6	S3	Input terminal selection 7	F117	OFF	ON
	5	S2	Input terminal selection 6	F116	OFF	ON
	4	S1	Input terminal selection 5	F115	OFF	ON
	3	RES	Input terminal selection 4	F114	OFF	ON
	2	ST	Input terminal selection 3	F113	OFF	ON
	1	R	Input terminal selection 2	F112	OFF	ON
	0	F	Input terminal selection 1	F111	OFF	ON

- **Response Bits / Parameter Number (Offsets 32 ~ 35)**

Parameter response bits and 16-bit parameter number. Refer to section 9.6 for a detailed explanation of these items.

- **Parameter Data (Offsets 38 and 39)**

During parameter reads, this word contains the requested data response. Refer to section 9.6 for a detailed explanation of this location.

9.5 Diagnostics

When the drive faults, 1 byte of high-priority user diagnostics is supplied to the Profibus master. The format of the diagnostics byte is shown in Table 19.

Table 19: Drive Diagnostics

Bit #:	7	6	5	4	3	2	1	0
	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Drive Faulted

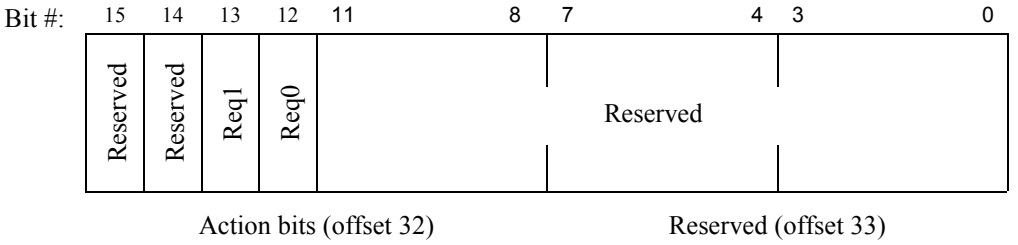
Reserved bits indicated in the above table are currently set to “0” by the Multicom interface, but may be used to transfer additional diagnostics data in future releases. When the drive’s fault condition is cleared, a diagnostics status update is generated indicating the drive’s exit from the faulted state.

9.6 Asynchronous Drive Parameter Access

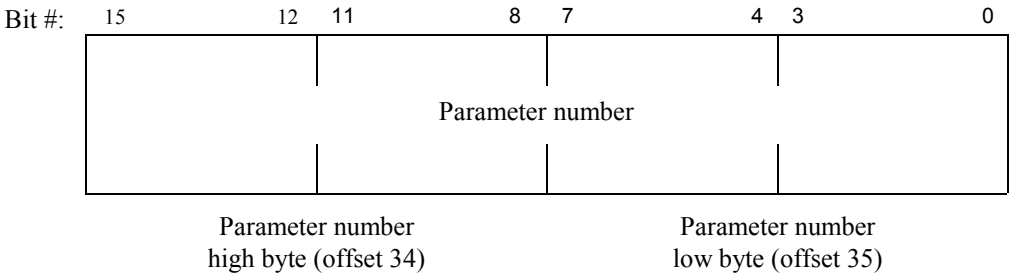
9.6.1 Parameter Number / Action Output Words

To access drive parameters, 2 output words and 2 action bits are provided in the drive's output data structure. The structure of these output words and action bits is as follows:

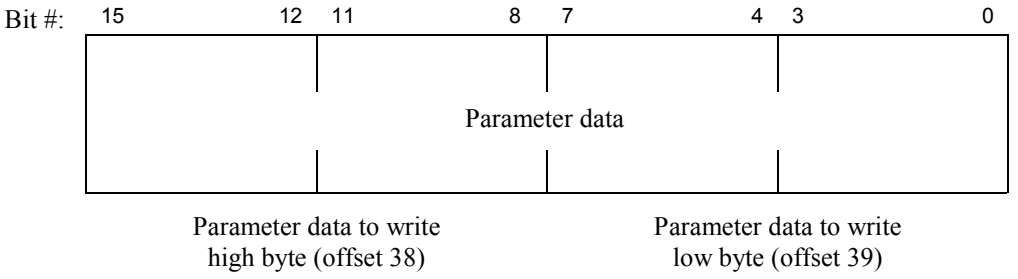
Action Bits



Parameter Number Word



Parameter Data Write Word

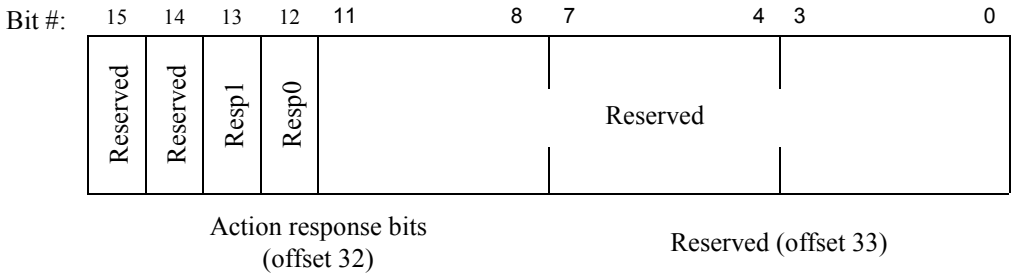


Note that all locations marked "Reserved" are ignored by the Multicom interface.

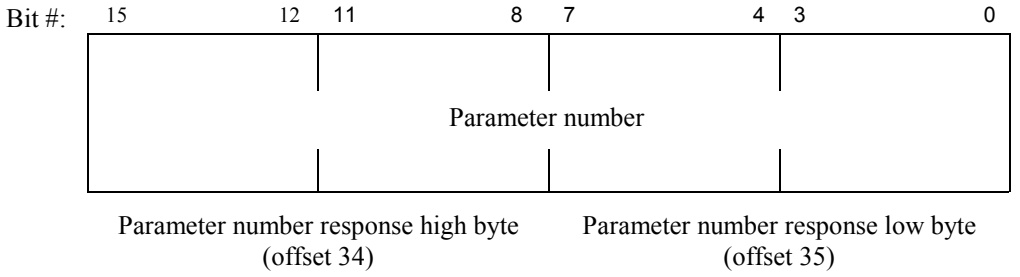
9.6.2 Parameter Number / Action Input Words

The response by the Multicom interface to parameter read and write requests is placed in 2 input words and 2 input bits of the input data structure. The structure of these data items is as follows:

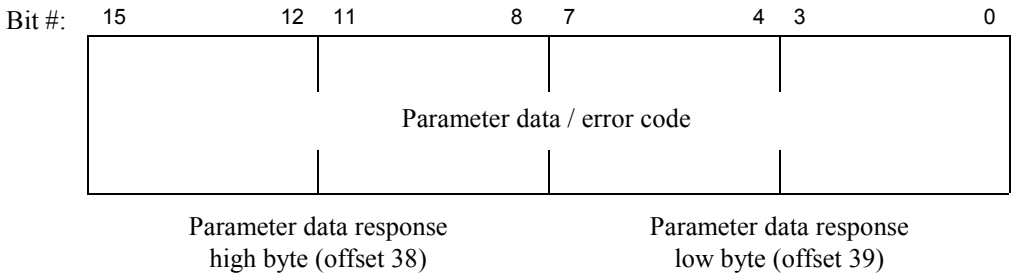
Response Bits



Parameter Number Response Word



Parameter Data / Error Code Response Word



Note that all locations marked “Reserved” are set to 0 by the Multicom interface.

9.6.3 Drive Parameter Access Procedure

In order to read from a drive parameter or write to a drive parameter, two control bits are provided in the drive's output data structure. These bits, labeled Req1 and Req0 in the Action Bits word, can have the following values:

Req1	Req0	Meaning
0	0	No action (idle state)
0	1	Parameter read
1	0	Parameter write (RAM & EEPROM)
1	1	Parameter write (RAM only)

Similarly, when the drive responds to a parameter read or write request, two status bits are provided in the drive's input data structure. These bits, labeled Resp1 and Resp0 in the Action Bits Response word, can have the following values:

Resp1	Resp0	Meaning
0	0	No action (idle state acknowledge)
0	1	Parameter read success acknowledge
1	0	Parameter write success acknowledge
1	1	Error indication

Note that the Multicom interface will respond with Resp1:Resp0 = 1:0 upon a successful parameter write, regardless of whether the write was to RAM & EEPROM or to RAM only.

Performing a parameter read or write action from the Profibus master involves the following process:

1. Send a "no action" code (Req1=0 and Req0=0). Every parameter access must begin from the idle state. Once this state is sent, the Profibus master must then wait for the Multicom interface to respond with an idle state acknowledge (Resp1=0 and Resp0=0).
2. If the action is to be a data write, set the parameter data in the parameter data write word. If the action is to be a data read, the parameter data write word value is irrelevant.
3. Set the parameter number and action code (Req1 and Req0). For an explanation of parameter numbers, refer to section 9.7.
4. Once the Multicom interface receives the read or write request, it will begin processing it. The time required to complete the request depends primarily on the specific register being requested and the drive's internal state at the time of the request, but can vary from several milliseconds to several tens of milliseconds.
5. Once the Multicom interface has completed the request, it will place its response in the action bits response, parameter number response, and data / error code response locations:

- If the request was a read, and the read was performed successfully, this will be indicated to the master by Resp1:Resp0 changing from 0:0 to 0:1. The parameter number response will equal the accessed parameter number, and the resulting data read will be placed in the data / error code response word.
- If the request was a write, and the write was performed successfully, this will be indicated to the master by Resp1:Resp0 changing from 0:0 to 1:0. The parameter number response will equal the accessed parameter number, and the data written to the drive will be reflected in the data / error code response word.
- If an error occurred during the read or write request, this will be indicated to the master by Resp1:Resp0 changing from 0:0 to 1:1. The parameter number response will equal the parameter number that the master was attempting to access, and an error code reflecting the failure cause will be placed in the data / error code response word. For a list of possible error codes, refer to section 9.6.4.

6. In order to perform another parameter read or write, the master must once again send a “no action” code (Req1=0 and Req0=0), and the Multicom interface must once again respond with an idle state acknowledge (Resp1=0 and Resp0=0) before the next read or write action can take place. Until a “no action” code is sent to the Multicom interface, the interface will ignore all data in the action bits, parameter number and parameter write data words. Also, as long as the master sends the “no action” code, the Multicom interface will loop-back in the parameter number response word and parameter data / error code response word whatever data is sent to it in the corresponding output words.

9.6.4 Register Access Error Codes

When a parameter read or write error occurs, one of the following error codes will be returned in the parameter data response word:

Error Code **Meaning**

0x0000 ..... cannot execute (access error)
0x0001 ..... data error (written data value outside of valid range)
0x0002 ..... invalid parameter number
0x0064 ..... attempt to write to a read-only parameter
0x0065 ..... attempt to read from a write-only parameter
0x0066 ..... other / unclassified error

9.7 Parameters

The parameters that can be accessed via the parameter access method outlined in section 9.6 are defined in the Toshiba *ASD Operation Manual* and/or the *ASD Serial Interface Manual*. The accessible parameters, their access behaviors and data ranges may vary depending on the drive’s firmware revision.

The following parameters, which are not implemented in the drive, are used to access local information on the Multicom interface:

Parameter	Function	Read / Write	Adjustment Range
0xFC82	Multicom interface firmware version/revision	Read only	High byte = firmware version Low byte = firmware revision

If an attempt is made to write to this register, error code number 0x0064 (WRITE_TO_READONLY) will be returned in the parameter data/error code field of the acyclic data.

10. RS-485 Interface

This section applies to ASD-MULTICOM-A option boards only.

10.1 Physical Layer

Figure 3 shows the physical layer for the RS-485 portion of the Multicom interface. This circuit diagram is provided as an aid to the system (network) designer to ensure that externally-connected circuitry will provide the required voltages etc. necessary for sufficient and robust communications.

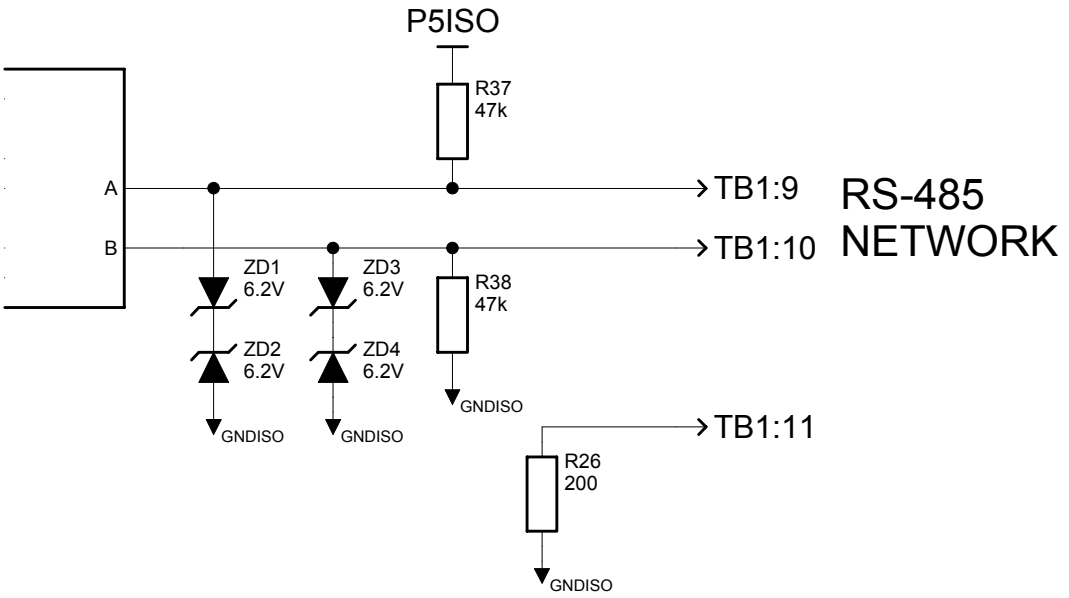


Figure 3: RS-485 Physical Layer

10.2 Modbus RTU

10.2.1 Configuration

Besides the Modbus network selection and configuration parameters (F890-F894) described in Section 8.2, the only other ASD parameter requiring configuration is the ASD's "Inverter Number" parameter (F802). This parameter setting is used as the drive's Modbus station address.

Some important points to note regarding parameter F802:

- Parameter F802 is only validated after a drive reset. Therefore, if this parameter is changed, remember to reset the drive to validate the change.
- The standard factory setting for parameter F802 is 0, which is reserved for Modbus broadcast transmissions. To be valid, this parameter must be set to a value between 1 and 247. If parameter F802 is 0 or 248 ~ 255 when Modbus communications are initialized, the Multicom interface's "Network Status" LED (the lower LED) will flash red to indicate the configuration error, and network communications will not be enabled.

If ASD control (frequency command input, RUN/STOP, etc.) is to be performed via the Modbus network, then the drive's Command Mode Selection and/or Frequency Mode Selection parameters must be configured to use the communication card as the drive's command source location, or the "option priority" bits of the basic command word (Modbus register 0x0A07) must be set accordingly. For information on the specific setting methods and values of the Command Mode and Frequency Mode Selection parameters, please refer to the G7 Adjustable Speed Drive Operation Manual.

10.2.2 Communication Formats

A brief note about Modbus communication formats: According to the *Modicon Modbus Protocol Reference Guide*, the specifications for the Modbus RTU communication mode is as follows:

Coding System: ..... 8-bit binary, hexadecimal 0 ~ 9, A ~ F
Two hexadecimal characters contained in each 8-bit field of the message

Bits per Byte: ..... 1 start bit
8 data bits, least significant bit sent first
1 bit for even/odd parity; no bit for no parity
1 stop bit if parity is used; 2 bits if no parity

Error Check Field: ..... Cyclical Redundancy Check (CRC)

According to the Modicon Modbus specification, therefore, the number of bits per byte in RTU mode is 1 start + 8 data + 1 parity + 1 stop (if parity is used), or 1 start + 8 data + 2 stop (if parity is not used), resulting in an RTU data frame that is fixed at 11 bits per byte.

In addition to these standard specified data frame sizes, the Multicom Modbus interface offers an optional configuration of providing for only 1 stop bit when no parity is selected. As indicated in Table 6 on page 17, by setting parameter F892 (Parity & Stop Bits) to "0", the RTU data frame size is modified to consist of 1 start + 8 data + 1 stop bit = 10 bits per byte.

10.2.3 Modbus/ASD Register Mappings

The Multicom Modbus interface acts as a relatively straightforward network gateway for the ASD into which it is installed. In general, Modbus holding registers (4X references) are directly mapped to corresponding ASD registers (also sometimes referred to as "communication numbers" or "parameter numbers") with a direct 1-to-1 correspondence. The relationship between Modbus holding registers and their ASD register counterparts is as follows:

Modbus holding register = ASD register + 1

This means that in order to access a specific ASD register, simply add 1 to its index and access that Modbus holding register. The reason for this offset is due to the fact that ASD registers begin at index 0, while Modbus holding registers begin at index 1.

The only minor exception to the above 1-to-1 mapping takes place in the "upper address" registers in the ASD. By inspecting the *Toshiba Serial Communications Manual*, one can observe that the ASD registers are divided into two distinct regions within the full 0x0000 ~ 0xFFFF ASD register map: the "lower address" range covers from 0x0000 to 0x09FF, and the "upper address" range covers from 0xFA00 to 0xFFFF (not all values within those ranges access valid ASD registers, of course). For access consistency and because some Modbus clients are unable to access holding registers with indexes greater than 9999_{10} (0x270F), the Multicom Modbus interface automatically maps all "upper address" ASD registers into the contiguous region immediately following the "lower address" range. To take advantage of this feature, simply drop the initial "F" on any register index in the "upper address" range (and add 1 to that number to obtain the corresponding Modbus register), and the register request will automatically access the correct internal ASD register.

For example, if we wish to read ASD register 0xFE06 (input terminal status), we would change the 0xFE06 to 0x0E06, and then add 1 to obtain the resultant Modbus register: 0x0E07 (3591_{10}). Therefore, making a request to read Modbus register 0x0E07 will return the input terminal status located at ASD register 0xFE06. If desired, it is also acceptable to access the "upper address" registers at their original locations, as their default (0xFXXX) locations can still be accessed. Continuing with the previous example, ASD register 0xFE06 can therefore be equally accessed by requesting either Modbus register 0x0E07 or 0xFE07 (65031_{10}).

In order to avoid any possible confusion regarding this register-mapping scheme, this manual will always explicitly use the terms "ASD register" or "Modbus register" where the intended usage may not be clear. If the term "register" is used alone, then "Modbus register" will be the intended meaning by default.

With the exception of the "upper address" register mapping feature explained above and the programmable pointer registers feature detailed in Section 10.2.6, the Multicom Modbus interface does not in any way modify or otherwise alter valid register access requests originating from the Modbus client. By adhering to this design parameter, the availability and interpretation of any Modbus registers is entirely determined by the attached drive. In this way, the Modbus interface allows itself to become virtually "transparent" on the network, essentially allowing the Modbus client to carry on a dialog directly with the drive.

An overview of the entire mapping configuration can be found in Section 10.2.9.

10.2.4 ASD Scan Registers

Although all available ASD command, status and configuration data is accessible via the Modbus interface, there are certain fundamental command and status registers that virtually all applications will likely find useful. These fundamental registers will probably be accessed quite frequently, and "priority handling" of these select registers would therefore benefit network throughput.

For this reason, certain ASD registers can be configured for special handling, which provides very fast access response. These registers are referred to as "scan registers". The Multicom Modbus interface provides three types of scan registers:

1. Fixed (read or write)
2. Configurable read/status
3. Configurable write/command

The fixed scan registers listed in Table 20. These registers provide fast response to the indicated read or write request at all times.

Table 20: Fixed Scan Registers

ASD Register	Modbus Register	Read / Write	Function
0xFA06	0x0A07 (2567_{10})	Write	Basic command
0xFA23	0x0A24 (2596_{10})	Write	Extended command
0xFA07	0x0A08 (2568_{10})	Write	Option board frequency command
0xFE58	0x0E59 (3673_{10})	Read	Output frequency

Table 21 provides a list of the available read/status scan selections. These are selectable via drive parameters F841-F846, which allows a total of six read scan registers to be configured.

Table 21: Drive Status Scan Data

F841~F846 Setting	Function	ASD Register	Modbus Register
0	No selection	N/A	N/A
1	Alarm code monitor	0xFC91	0x0C92 (3218_{10})
2	Output frequency	0xFE58	0x0E59 (3673_{10})
3	Real-time speed feedback	0xFE61	0x0E62 (3682_{10})
4	Filtered speed feedback	0xFE62	0x0E63 (3683_{10})
5	Internal torque reference	0xFE56	0x0E57 (3671_{10})
6	Output current	0xFE03	0x0E04 (3588_{10})
7	Excitation current	0xFE21	0x0E22 (3618_{10})
8	Torque current	0xFE20	0x0E21 (3617_{10})
9	Overload value	0xFE59	0x0E5A (3674_{10})
10	Accel / Decel torque reduction	0xFE60	0x0E61 (3681_{10})
11	Motor counter data	0xFE33	0x0E34 (3636_{10})
12	Fault code	0xFC90	0x0C91 (3217_{10})
13	Input terminal	0xFE06	0x0E07 (3591_{10})
14	VI input	0xFE36	0x0E37 (3639_{10})
15	RR input	0xFE35	0x0E36 (3638_{10})
16	RX input	0xFE37	0x0E38 (3640_{10})

Table 22 provides a list of the available write/command scan selections. These are selectable via drive parameters F831-F835, which allows a total of five write scan registers to be configured.

Table 22: Drive Command Scan Data

F831~F835 Setting	Function	ASD Register	Modbus Register
0	No selection	N/A	N/A
1	RESERVED	N/A	N/A
2	RESERVED	N/A	N/A
3	Incremental speed reference	0xFA08	0x0A09 (2569_{10})
4	Absolute torque limit	0xFA34	0x0A35 (2613_{10})
5	Positive torque limit	0x0441	0x0442 (1090_{10})
6	Negative torque limit	0x0443	0x0444 (1092_{10})
7	Torque command	0xFA33	0x0A34 (2612_{10})
8	Speed torque bias	0x0726	0x0727 (1831_{10})
9	Tension torque bias	0x0727	0x0728 (1832_{10})
10	Load balance gain	0x0728	0x0729 (1833_{10})
11	Drooping gain	0x0320	0x0321 (801_{10})
12	Speed loop proportional gain	0x0376	0x0377 (887_{10})
13	Speed loop integral gain	0x0377	0x0378 (888_{10})
14	Output terminals	0xFA50	0x0A51 (2641_{10})
15	Load moment of inertia	0xFA35	0x0A36 (2614_{10})
16	RESERVED	N/A	N/A

Scan Register Notes

- Items marked as "RESERVED" in Table 22 are reserved for future use. Selecting one of the corresponding values as command scan data will have no effect on drive operation.
- Configurable scan register selection parameters F831~F835 and F841~F846 are only validated on drive reset or power-up. Therefore, if any of these parameters are changed, be sure to reset the drive to validate the changes.
- Data range checking is not performed on command scan items. If a value outside of a specific item's valid range is written to the Modbus interface, that value will be accepted by the interface, but ignored by the drive.
- Command scan data is written to drive RAM only, and therefore not retained when power is lost.
- Initial values for command scan data (before the first network update is received) are 0.
- Basic command (Modbus register 0x0A07) and extended command (Modbus register 0x0A24) registers: for these command words to have an actual effect on the drive's operation, either the drive's "command mode selection" parameter must be set such that option board commands are valid, or the "option priority" bit (bit #15) of the basic command word must be set via Modbus communications.
- Basic command (Modbus register 0x0A07): for a detail of this register, refer to Table 10 on page 23.
- Extended command (Modbus register 0x0A24): for a detail of this register, refer to Table 11 on page 23.
- Option board frequency command (Modbus register 0x0A08): for this value to have an actual effect on the drive's operation, either the drive's "frequency mode selection" parameter must be set such that option board frequency command is valid, or the "option priority" bit (bit #14) of the basic command word must be set via Modbus communications.

10.2.5 Supported Modbus Functions

The Multicom Modbus interface supports three Modbus commands: command 3 (0x03: read holding registers), command 6 (0x06: preset single register) and command 16 (0x10: preset multiple registers). Not all drive registers support all commands (for example, certain drive registers may be read-only or write-only): refer to the *Toshiba Serial Communications Manual* for specific details about the various drive registers. Table 23 indicates the maximum number of registers that can be read/written in one packet transaction.

Table 23: Read / Write Limits

Command	Read Max	Write Max
3	125 registers	N/A
6	N/A	1 register only
16	N/A	123 registers

Except for scan register writes (refer to Section 10.2.4), all register writes update the drive's EEPROM. For this reason, do not write to any single non-scan register more than 10,000 times or EEPROM damage may occur.

10.2.6 Programmable Pointer Registers

Modbus registers 0x0C00 ~ 0x0C1F (3072_{10} ~ 3103_{10}) and 0x0C20 ~ 0x0C3F (3104_{10} ~ 3135_{10}) are collectively used by the Multicom Modbus interface as programmable pointer data and address registers, respectively. Programmable pointer registers (PPR) allow the user to access non-consecutive Modbus registers with only one Modbus transaction.

Registers 0x0C20 ~ 0x0C3F (the PPR "address" registers: 32 total) are used to define other Modbus register addresses from which you would like to read or write, and registers 0x0C00 ~ 0x0C1F (the PPR "data" registers: 32 total) are the actual registers used to access the data pointed to by the address registers.

For example, if you would like to continuously read the data from ASD registers 0xFD00, 0xFE01, 0xFE04 and 0xFE05, the standard Modbus register configuration would require 3 read commands to be issued: one reading 1 Modbus register starting at register 0x0D01, one reading 1 Modbus register starting at register 0x0E02, and one reading 2 Modbus registers starting at register 0x0E05 (recall the "+1" offset between drive and Modbus registers). To conserve network bandwidth and speed processing time, however, the PPRs can be used to allow the same information to be accessed, but by only issuing 1 command which reads 4 Modbus registers.

To configure this function, program as many address registers as necessary (up to 32) in the 0x0C20 ~ 0x0C3F range with the Modbus register numbers you would like to continuously access. In this example, we would write a value of 0x0D01 (the first Modbus register we want to access), to register 0x0C20, a value of 0x0E02 to register 0x0C21, a value of 0x0E05 to register 0x0C22, and a value of 0x0E06 to registers 0x0C23. The data located at the relevant drive registers can then be obtained by accessing the corresponding data registers in the 0x0C00 ~ 0x0C1F range: data register 0x0C00 corresponds to address register 0x0C20, data register 0x0C01 corresponds to address register 0x0C21, etc. Therefore, the 4 registers that are to be monitored can now be accessed simply by issuing 1 holding register read command with a length of 4 starting from Modbus register 0x0C00. The returned data will be the data obtained from ASD registers 0xFD00, 0xFE01, 0xFE04, and 0xFE05 (in that order).

Notes:

- PPR address register setting values are MODBUS registers. That is, Modbus registers = ASD registers + 1.
- PPR address registers are updated immediately when changed (no drive reset is required).
- The values of the PPR address registers (0x0C20 ~ 0x0C3F) are stored in the Modbus interface's nonvolatile EEPROM. Therefore, do not write to any of these registers more than 100,000 times. Typically, these registers would only be written to once, when the drive and Modbus network are first commissioned.

10.2.7 Response Delay Timer Function

As mentioned in section 8.2, ASD parameter F893 contains the setting for a response delay timer function. This function is useful for applications where it may not be desirable for the Modbus interface to respond immediately to the network after a read/write request. An example of this may be when a radio modem that must be switched from receive mode to transmit mode is being used.

The response delay timer is adjustable in 10ms increments from 0s to 2.00s (factory setting = 0s). A response delay of 0s means that there is no artificial delay inserted; response packets will be sent by the Modbus interface as soon as they are available. When non-zero, the delay timer starts when a complete packet is received, and a response will not be sent until the timer has expired (at a minimum). Note that this time value only sets a minimum response delay value - depending on the quantity and location of

registers read / written, more time may actually be required by the Modbus interface before a complete response is formulated and ready to be returned to the network.

The response delay timer value is read only upon initialization. Therefore, if the delay value is changed, the drive must be reset for the new value to take effect.

10.2.8 LED Indicators

If the ASD's "Inverter Number" parameter (F802) is not set to a value between 1 and 247, the Module Status LED will flash red upon initialization to indicate the configuration error.

Whenever a faulty Modbus packet is detected, the Network Status LED will briefly flash red to indicate the faulty packet. This can be used as a helpful indicator when communications are not working, and will usually be the result of incompatible network settings (baud rate, parity, etc.) or reversed RS-485 wires.

10.2.9 Register Summary

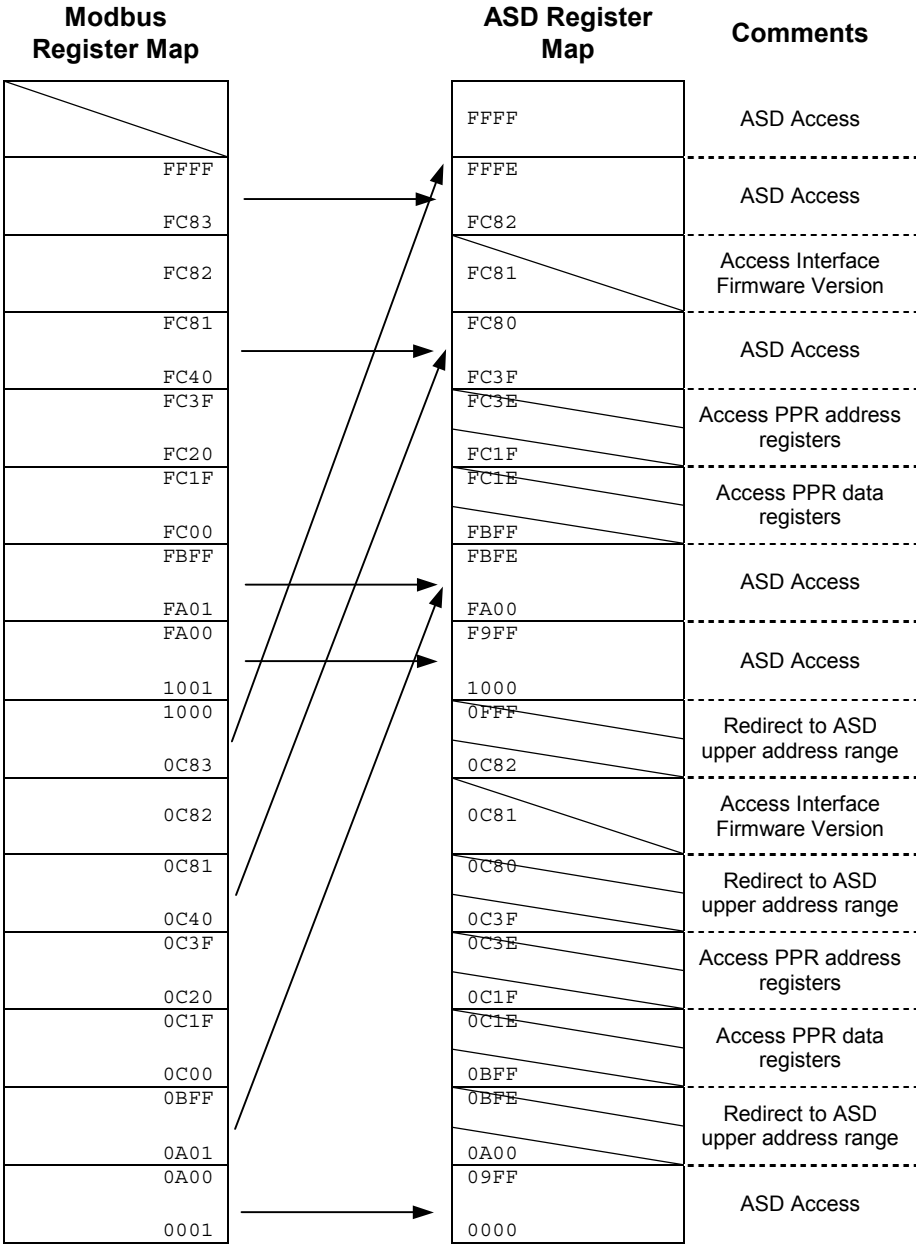
Table 25 presents an overview of all accessible information within the entire Modbus register map. Although the majority of the mapping directly accesses the corresponding ASD registers, not all ASD registers are available. The specific ASD registers that can be accessed are defined in the Toshiba *ASD Operation Manual* and/or the *ASD Serial Interface Manual*. In addition, the accessible registers, their access behaviors and data ranges may vary depending on such issues as the drive's capacity and control firmware revision.

Table 24 lists the Modbus registers that access local information on the Multicom interface. These items are also indicated in Table 25.

Table 24: Local Modbus Interface Access

Modbus Register	Function	Read / Write	Adjustment Range
0x0C00~0x0C1F / 0xFC00~0xFC1F	PPR data registers	According to referenced register	According to referenced register
0x0C20~0x0C3F / 0xFC20~0xFC3F	PPR address registers	Read/Write	0x0001 ~ 0xFFFF (1_{10} ~ 65535_{10})
0x0C82 / 0xFC82	Multicom interface firmware version/revision	Read only	High byte = firmware version Low byte = firmware revision

Table 25: Register Map Overview



11. DeviceNet Interface

This section applies to ASD-MULTICOM-A option boards only. 5-pin pluggable terminal block TB3 provides a standard connection to DeviceNet networks.

11.1 Feature Summary

Application

Toshiba 7-Series ASDs, internally mounted

Terminations

One 5-pin pluggable gold-plated connector for DeviceNet bus connection. Refer to Figure 4 for wiring connections (this information is also silkscreened on the interface PCB next to TB3).

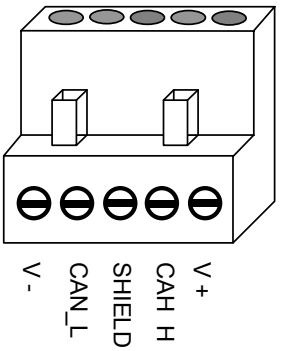


Figure 4: DeviceNet Network Wiring Connections (TB3)

Network Power Supply

According to ODVA DeviceNet Specifications.

LED Indicators

One bicolor red/green Module Status LED and one bicolor red/green Network Status LED. Behavior according to ODVA DeviceNet Specifications

Compatibility

Group 2 Server Only device utilizing the Predefined Master / Slave Connection Set.
Vendor-specific I/O POLL connection (8 bytes of data consumed and 8 bytes of data produced). This product has been self-tested by Toshiba International Corporation and found to comply with ODVA Conformance Test Software Version A-13.

Node Isolation

Network power and signals are optically isolated from the ASD's control power.

Bus Interface
Phillips 82C251 or equivalent transceiver.

11.2 Unit Addressing

The DeviceNet node (slave) address is set via parameter F802 (inverter number parameter). Although parameter F802 has an adjustment range from 0-255, only 0-63 is an allowable addressing selection for the DeviceNet network. Therefore, if parameter F802 is set to 64 through 255, the Network Status LED will light solid red upon initialization to indicate the configuration error. Correct the inverter number parameter setting and reset the drive to remove the error.

11.3 Grounding

Grounding is of particular importance for reliable, stable operation. Communication system characteristics may vary from system to system, depending on the system environment and grounding method used. In general, however, the following grounding checkpoints should be noted when connecting any communications system to adjustable speed drives:

Grounding method checkpoints

1. Make all ground connections such that no ground current flows through the case or heatsink of a connected drive.
2. Do not connect the DeviceNet network SHIELD to a power ground or any other potential noise-producing ground connection (such as a drive's "G/E" terminal).
3. Do not make connections to unstable grounds (paint-coated screw heads, grounds that are subjected to inductive noise, etc.)

For specific requirements regarding protective grounding and the DeviceNet network, refer to the ODVA DeviceNet Specifications.

11.4 Connection Information

11.4.1 Connection Sizes

Connection Instance	Produced	Consumed
Polled I/O (Toshiba assembly)	8 bytes	8 bytes
Polled I/O (AC/DC drive profile)	4 bytes	4 bytes
Explicit Messaging	29 bytes	29 bytes

Notes

- For the Explicit Messaging connection, this is the maximum message length: shorter messages are also acceptable.
- For the Polled I/O connection, if the actual consumed data size is less than the connection instance's consumed_connection_size attribute, the consumed data will be ignored, but the connection will otherwise produce normally. If the actual consumed data size is larger than the connection instance's consumed_connection_size attribute, the consumed data will be ignored and the connection will not produce.

11.4.2 I/O Assembly Instances

The following table indicates which polled I/O assembly instances are currently supported by the DeviceNet Interface:

Number		Type	Name
Decimal	Hex		
20	0x14	Output	Basic speed control output
21	0x15	Output	Extended speed control output
70	0x46	Input	Basic speed status input
71	0x47	Input	Extended speed status input
100	0x64	Output	Toshiba-specific control output
150	0x96	Input	Toshiba-specific status input

For more detailed information about these assembly instances, refer to section 11.5.4.5.

11.5 Object Specifications

This section contains the object specifications for all DeviceNet objects currently supported by the DeviceNet Interface. Table 26 outlines those objects covered:

Table 26: Supported Objects

Object Class	# of Instances	Page
Identity Object	1	49
Message Router	1	51
DeviceNet Object	1	52
Assembly Object	6	54
Connection class	2	58
Control Supervisor Object	1	62
AC/DC Drive Object	1	67
Motor Data Object	1	65
Parameter Class	29	72

For definitions of all data types referred to in these object specifications, refer to the ODVA DeviceNet Specifications. In general, however, the following are some of the most prevalent types:

SINT ..... Signed 8-bit integer value
USINT..... Unsigned 8-bit integer value
BYTE..... Bit string – 8-bits
INT..... Signed 16-bit integer value
UINT..... Unsigned 16-bit integer value
WORD ..... Bit string – 16-bits
UDINT ..... Unsigned 32-bit integer value

11.5.1 Identity Object

Class code 0x01. This object provides identification of and general information about the device.

11.5.1.1 Identity Object Class Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Revision	UINT	Revision of this object	1
2	Get	Max Instance	UINT	Maximum instance number of an object currently created in this class level of the device	1

11.5.1.2 Identity Object Instance Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Vendor	UINT	Identification of vendor by number	71
2	Get	Device Type	UINT	Indication of general type of product	2
3	Get	Product Code	UINT	Identification of a particular product of an individual vendor	2
4	Get	Revision	STRUCT of:	Revision of the item the Identity Object represents	--
		Major Revision	USINT		1
		Minor Revision	USINT		1
5	Get	Status	WORD	Summary status of device	--
6	Get	Serial_ number	UDINT	Serial number of device	Unique for each unit
7	Get	Product Name	SHORT_ STRING	Human-readable identification	Toshiba Multicom ASD Interface

11.5.1.3 Identity Object Common Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x0E	Yes	Yes	Get_Attribute_ Single	Returns the contents of the specified attribute.
0x05	Yes	Yes	Reset	Invokes the Reset service for the device

Please note the following items about the Reset service:

- The Reset service resets only the interface board's DeviceNet driver (not the drive into which the interface is installed).
- Both "Type 0" and "Type 1" resets are supported. With a "Type 0" reset, the DeviceNet driver is simply reset. With a "Type 1" reset, the DeviceNet object's BOI attribute is returned to its factory default setting and then the DeviceNet driver is reset. All other nonvolatile DeviceNet-related configuration parameters are accessible via drive parameters F891-F894 and can therefore be modified via the drive's front panel if desired.

11.5.1.4 Identity Object Specific Services

The Identity Object provides no object specific services.

11.5.2 Message Router

Class code 0x02. The Message Router Object provides a messaging connection point through which a Client may address a service to any object class or instance residing in the DeviceNet interface unit.

11.5.2.1 Message Router Class Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Revision	UINT	Revision of this object	1

11.5.2.2 Message Router Instance Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
2	Get	Number Available	UINT	Maximum number of connections supported.	2

11.5.2.3 Message Router Common Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x0E	Yes	Yes	Get_Attribute_ Single	Returns the contents of the specified attribute.

11.5.2.4 Message Router Specific Services

The Message Router provides no object specific services.

11.5.3 DeviceNet Object

Class Code 0x03. The DeviceNet Object provides for the configuration and status of a DeviceNet port.

11.5.3.1 DeviceNet Object Class Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Revision	UINT	Revision of this object.	2

11.5.3.2 DeviceNet Object Instance Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	MAC ID	USINT	Node address	--
2	Get	Baud Rate	USINT	Baud rate	--
3	Get / Set	BOI	BOOL	Bus-off interrupt	0
4	Get / Set	Bus-Off Counter	USINT	Number of times CAN went to the bus-off state	0
5	Get	Allocation Information	STRUCT of:		
		Allocation Choice Byte	BYTE		0
		Master's MAC ID	USINT	MAC ID of master	0xFF

Notes

- The MAC ID and Baud Rate attributes are not settable via the network (they are set via the drive's parameter settings). Attempting a *Set* service will result in a "Service Not Supported" error.
- The setting of the BOI attribute is saved in the DeviceNet unit's internal EEPROM. If the BOI value is set to TRUE, the DeviceNet interface will attempt to restart the network interface on the occurrence of a CAN bus-off event. This will continue to be the behavior until the Bus-Off Counter attribute achieves a value of 255. If a CAN bus-off event occurs after this point, the unit will not attempt to restart the network interface: it will remain faulted and isolated from the network until the drive is reset or power cycled.

11.5.3.3 DeviceNet Object Common Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x0E	Yes	Yes	Get_Attribute_ Single	Returns the contents of the specified attribute.
0x10	N / A	Yes	Set_Attribute_ Single	Modifies the value of the specified attribute.

11.5.3.4 DeviceNet Object Specific Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x4B	N / A	Yes	Allocate_ Master/Slave _Connection_Set	Requests the use of the Predefined Master/Slave Connection Set.
0x4C	N / A	Yes	Release_Group_2 _Identifier_Set	Indicates that the specified connections within the *Predefined Master/Slave Connection Set* are no longer desired. These connections are to be released (deleted).

11.5.4 Assembly Object

Class code 0x04. The Assembly Object binds attributes of multiple objects, which allows data to or from each object to be sent or received over a single connection.

11.5.4.1 Assembly Object Class Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Revision	UINT	Revision of this object.	2

11.5.4.2 Assembly Object Instance Attributes

The Multicom DeviceNet unit contains 6 static assembly instances, with assigned instance IDs 20, 21, 70, 71, 100 and 150. Refer to section 11.5.4.5 for more details.

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
3	Get or Get / Set	Data	ARRAY	The data contained in the assembly object.	--

Output instances (20, 21 and 100) can be accessed via the Get and Set services, whereas input instances (70, 71 and 150) can only be accessed via the Get service.

11.5.4.3 Assembly Object Common Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x0E	Yes	Yes	Get_Attribute _Single	Returns the contents of the specified attribute.
0x10	N / A	Output instances only	Set_Attribute _Single	Modifies the value of the specified attribute.

11.5.4.4 Assembly Object Specific Services

The Assembly Object for static assemblies provides no object specific services.

11.5.4.5 Assembly Instance Details

As mentioned previously, the Multicom DeviceNet Interface provides the option of three different I/O assembly instance sets. The active set is chosen via ASD parameter F893 (refer to section 8.3). Whenever changing the active assembly set, always remember to reset the drive to active the change.

11.5.4.5.1 Output Instance 20 (Basic Speed Control Output)

This is the ODVA AC/DC Drive Profile Basic Speed Control Output assembly. For more information, refer to the *ODVA DeviceNet Specifications* and the object explanations in this manual related to each of the fields of this assembly instance.

Byte #	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		Run Fwd
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							

11.5.4.5.2 Output Instance 21 (Extended Speed Control Output)

This is the ODVA AC/DC Drive Profile Extended Speed Control Output assembly. For more information, refer to the *ODVA DeviceNet Specifications* and the object explanations in this manual related to each of the fields of this assembly instance.

Byte #	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	NetCtrl			Fault Reset	Run Rev	Run Fwd
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							

11.5.4.5.3 Output Instance 100 (Toshiba ASD Command)

This is a vendor-specific output assembly instance that provides direct access to the most critical control components of the G7 ASD. For more information, refer to the explanations for the referenced attributes contained in the AC/DC Drive Object in section 11.5.8.6 on page 69. Note that bytes #0 and #1 are mapped to the "G7 Command Word" attribute (attribute ID #101) of the AC/DC Drive Object: the specific bits of this command word are shown in detail in the following table simply for ease of use.

Byte #	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	DC Inject. Braking	PI Control ON/OFF	Brake Release	Excitation Curr Cmd.	Brake Close	Fault Reset	Reserved	Run / Stop
1	Command Priority	Speed Ref. Priority	Control Selection	EOFF	Coast Stop	Error Count Reset	FWD / REV	Jog
2	Frequency Command (Low Byte)							
3	Frequency Command (High Byte)							
4	F831 Command Data (Low Byte)							
5	F831 Command Data (High Byte)							
6	F832 Command Data (Low Byte)							
7	F832 Command Data (High Byte)							

11.5.4.5.4 Input Instance 70 (Basic Speed Control Input)

This is the ODVA AC/DC Drive Profile Basic Speed Control Input assembly. For more information, refer to the *ODVA DeviceNet Specifications* and the object explanations in this manual related to each of the fields of this assembly instance.

Byte #	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running1		Faulted
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							

11.5.4.5.5 Input Instance 71 (Extended Speed Control Input)

This is the ODVA AC/DC Drive Profile Extended Speed Control Input assembly. For more information, refer to the *ODVA DeviceNet Specifications* and the object explanations in this manual related to each of the fields of this assembly instance.

Byte #	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Ctrl From Net	Ready	Running2 (REV)	Running1 (FWD)	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							

11.5.4.5.6 Input Instance 150 (Toshiba ASD Status)

This is a vendor-specific input assembly instance that provides direct access to the most often-used status components of the G7 ASD. For more information, refer to the explanations for the referenced attributes contained in the AC/DC Drive Object in section 11.5.8.6 on page 69. Note that bytes #0 and #1 are mapped to the "G7 Status Word" attribute (attribute ID #111) of the AC/DC Drive Object: the specific bits of this status word are shown in detail in the following table simply for ease of use.

Byte #	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	DC Inject. Braking	OL Alarm Status	PI Status	Alarm Status	Serious Fault	Run / Stop Status	Alarm Stop Status	Fault Status
1	Ready (exc. MOFF)	Drive Healthy	Ready (exc. ST)	Ready (inc. ST)	Control Mode	Speed Limit	FWD / REV Status	Jog Status
2	Output Frequency (Low Byte)							
3	Output Frequency (High Byte)							
4	F841 Status Data (Low Byte)							
5	F841 Status Data (High Byte)							
6	F842 Status Data (Low Byte)							
7	F842 Status Data (High Byte)							

11.5.5 Connection class

Class code 0x05. The Connection Class allocates and manages the internal resources associated with both I/O and Explicit Messaging Connections.

11.5.5.1 Connection Class Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Revision	UINT	Revision of this object.	1

11.5.5.2 Connection Class Instance Attributes

The Instance IDs utilized by the DeviceNet Interface connection objects are shown in the following table:

Connection Instance ID #	Description
1	References the Explicit Messaging Connection
2	References the Polled I/O Connection

11.5.5.2.1 Master/Slave Explicit Messaging Connection Object Instance Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	state	USINT	State of the object	--
2	Get	instance_type	USINT	Indicates connection type	0
3	Get	transportClass_ trigger	USINT	Connection behavior	0x83
4	Get	produced_ connection_id	UINT	Placed in CAN ID field when transmitting	0x0403 + (MAC ID << 3)
5	Get	consumed_ connection_id	UINT	CAN ID field value denoting received messages	0x0404 + (MAC ID << 3)
6	Get	initial_comm _characteristics	USINT	Defines producing / consuming message groups	0x21
7	Get	produced _connection _size	UINT	Max number of bytes transmitted across this connection	29
8	Get	consumed _connection _size	UINT	Max number of bytes received across this connection	29
9	Get / Set	expected_ packet_rate	UINT	Defines timing associated with this connection	2500
12	Get / Set	watchdog_ timeout_action	USINT	Inactivity/watchdog timeout action	1
13	Get	produced_ connection_ path_length	UINT	Number of bytes in produced_connection _path attribute	0
14	Get	produced_ connection_ path	Array of USINT	Specifies Application Object(s) whose data is to be produced by this connection	Empty
15	Get	consumed_ connection_ path_length	UINT	Number of bytes in consumed_ connection_path attribute	0
16	Get	consumed_ connection_ path	Array of USINT	Specifies Application Object(s) whose data is to be consumed by this connection	Empty
17	Get	production_ inhibit_time	UINT	Defines minimum time between new data production	0

11.5.5.2.2 Poll Connection Object Instance Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	state	USINT	State of the object	--
2	Get	instance_type	USINT	Indicates connection type	1
3	Get	transportClass_ trigger	USINT	Connection behavior	0x82
4	Get	produced_ connection_id	UINT	Placed in CAN ID field when transmitting	0x03C0 + MAC ID
5	Get	consumed_ connection_id	UINT	CAN ID field value denoting received messages	0x0405 + (MAC ID << 3)
6	Get	initial_comm _characteristics	USINT	Defines producing / consuming message groups	0x01
7	Get	produced _connection _size	UINT	Max number of bytes transmitted across this connection	8
8	Get	consumed _connection _size	UINT	Max number of bytes received across this connection	8
9	Get / Set	expected_ packet_rate	UINT	Defines timing associated with this connection	0
12	Get / Set	watchdog_ timeout_action	USINT	Inactivity/watchdog timeout action	0
13	Get	produced_ connection_ path_length	UINT	Number of bytes in produced_connection _path attribute	6
14	Get	produced_ connection_ path	Array of USINT	Specifies Application Object(s) whose data is to be produced by this connection	20 04 24 96 30 03
15	Get	consumed_ connection_ path_length	UINT	Number of bytes in consumed_ connection_path attribute	6
16	Get	consumed_ connection_ path	Array of USINT	Specifies Application Object(s) whose data is to be consumed by this connection	20 04 24 64 30 03
17	Get	production_ inhibit_time	UINT	Defines minimum time between new data production	0

11.5.5.3 Connection Class Common Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x05	No	Yes	Reset	Used to reset all resettable connection objects.
0x0E	Yes	Yes	Get_Attribute _Single	Returns the contents of the specified attribute.
0x10	N / A	Yes	Set_Attribute _Single	Modifies the value of the specified attribute.

11.5.5.4 Connection Class Specific Services

The Connection Class provides no object specific services.

11.5.6 Control Supervisor Object

Class Code 0x29. The Control Supervisor Object models all the management functions for devices within the "hierarchy of Motor Control Devices".

11.5.6.1 Control Supervisor Object Class Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Revision	UINT	Revision of this object.	1

11.5.6.2 Control Supervisor Object Instance Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
3	Get / Set	Run1	BOOL	Refer to ODVA Run/Stop Event Matrix	0
4	Get / Set	Run2	BOOL	Refer to ODVA Run/Stop Event Matrix	0
5	Get / Set	NetCtrl	BOOL	1=Drive control from DeviceNet	0
6	Get	State	USINT	Refer to DeviceNet Specification	--
7	Get	Running1	BOOL	Refer to DeviceNet Specification	--
8	Get	Running2	BOOL	Refer to DeviceNet Specification	--
9	Get	Ready	BOOL	Refer to DeviceNet Specification	--
10	Get	Faulted	BOOL	1=fault occurred (latched)	--
11	Get	Warning	BOOL	0=no warnings present (this attribute is unused)	0
12	Get / Set	FaultRst	BOOL	0 → 1 = fault reset	0
15	Get	CtrlFromNet	BOOL	1=Drive control is from DeviceNet	--

Note
When the drive is faulted and the FaultRst attribute is set, the interface card will also be reset. Dependent on system timing, therefore, a response to setting this attribute may or may not be produced.

11.5.6.3 Control Supervisor Object Common Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x0E	Yes	Yes	Get_Attribute_ Single	Returns the contents of the specified attribute.
0x10	N / A	Yes	Set_Attribute_ Single	Modifies the value of the specified attribute.
0x05	N / A	Yes	Reset	Resets to the "start-up" state

Note
The Control Supervisor Object's "Reset" service resets only the Control Supervisor Object state machine (attribute #6). It does not reset the drive or the interface card. To reset the drive and interface card when the drive is faulted, access the FaultRst attribute (attribute #12) via either the polled I/O connection or explicit messaging connection. To reset the interface card only, issue a "Reset" service to the Identity Object.

11.5.6.4 Control Supervisor Object Specific Services

The Control Supervisor object provides no object specific services.

11.5.6.5 Control Supervisor Object Attribute Semantics

This section will detail any specific information that may be useful when accessing the attributes of the Control Supervisor Object, whether directly via explicit messaging or indirectly via I/O assembly objects.

Run1 / Run2
Indirectly map to the "run/stop selection" bit (bit #0) of the G7 command word (refer to Table 10 on page 23) via the AC/DC drive profile's Run/Stop Event Matrix.

NetCtrl
Maps directly to "command priority" bit (bit #15) of the G7 command word (refer to Table 10 on page 23). When this attribute (and therefore command word bit #15) is "1", the option command word (derived from the AC/DC drive profile object attributes when AC/DC drive profile I/O assemblies are active) becomes the drive's active command source, regardless of the ASD's *Command Mode* selection parameter. When this attribute is a "0", the option command word will no longer override the *Command Mode* selection parameter, but the option command word may still be used by the ASD as its overall command source if the *Command Mode* selection parameter is set to "*Use Communication Card (option)*".

State / Running1 / Running2 / Ready
Refer to the DeviceNet Specification for details regarding these attributes.

Faulted
Maps directly to the "fault status" bit (bit #0) of the G7 status word (refer to Table 14 on page 26).

Warning
This attribute is not used and will always report "0".

FaultRst
Maps directly to the "fault reset" bit (bit #2) of the G7 command word (refer to Table 10 on page 23).

CtrlFromNet
This attribute mirrors the value set in attribute #5 “NetCtrl”.

11.5.7 Motor Data Object

Class Code 0x28. This object serves as a database for motor parameters.

11.5.7.1 Motor Data Object Class Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Revision	UINT	Revision of this object.	1

11.5.7.2 Motor Data Object Instance Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
3	Get / Set	MotorType	USINT	Type of attached motor	7
6	Get / Set	RatedCurrent	UINT	Rated stator current	--
7	Get / Set	RatedVoltage	UINT	Rated base voltage	--
12	Get / Set	PoleCount	UINT	Number of motor poles	--

11.5.7.3 Motor Data Object Common Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x0E	Yes	Yes	Get_Attribute_ Single	Returns the contents of the specified attribute.
0x10	N / A	Yes	Set_Attribute_ Single	Modifies the value of the specified attribute.

11.5.7.4 Motor Data Object Specific Services

The Motor Data object provides no object specific services.

11.5.7.5 Motor Data Object Attribute Semantics

This section will detail any specific information that may be useful when accessing the attributes of the Motor Data object via explicit messaging.

MotorType

Valid settings for this attribute are those detailed in the *ODVA DeviceNet Specifications* for an "AC Motor Class", namely 3 (PM synchronous), 6 (wound rotor induction) and 7 (squirrel cage induction).

This attribute value is retained in the Multicom board's nonvolatile EEPROM, but is not used in any way for drive control (i.e. it is for user reference only).

RatedCurrent
This attribute indirectly maps to ASD parameter number F600 "*Electronic Thermal Protection #1*" (found in the Motor Parameters Group). This mapping is "indirect" due to parameter F600 being default set in units of % rated drive current. Therefore, when the RatedCurrent attribute is changed with a SET service, the drive's rated current is used as a basis to determine the corresponding percentage value to enter into ASD parameter F600.

For example, if the ASD has a rated current of 5.0A (represented as 50 in 100mA units), and the attached motor has a FLA rated current of 3.5A, then SETting the RatedCurrent attribute to 35 (3.5A represented with its designated 100mA units) will cause parameter F600 to obtain a value of (35/50) x 100% = 70%.

Note that parameter F600 is only read by the Multicom interface upon drive initialization and as the result of a DeviceNet SET service. Therefore, be sure to reset the drive whenever parameter F600 is changed locally via the LCD EOI to validate the new setting.

RatedVoltage
This attribute directly maps to ASD parameter number F306 "*#1 Max Output Voltage*" (found in the Motor Parameters Group). Note that parameter F306 is only read by the Multicom interface upon drive initialization and as the result of a DeviceNet SET service. Therefore, be sure to reset the drive whenever parameter F306 is changed locally via the LCD EOI to validate the new setting.

PoleCount
This attribute directly maps to ASD parameter number F411 "*Number of Motor Poles*" (found in the Motor Parameters Group). Note that parameter F411 is only read by the Multicom interface upon drive initialization and as the result of a DeviceNet SET service. Therefore, be sure to reset the drive whenever parameter F411 is changed locally via the LCD EOI to validate the new setting.

11.5.8 AC/DC Drive Object

Class Code 0x2A. The AC/DC Drive Object models the functions specific to an AC or DC drive.

11.5.8.1 AC/DC Drive Object Class Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
1	Get	Revision	UINT	Revision of this object.	1

11.5.8.2 AC/DC Drive Object Instance Attributes

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
3	Get	AtReference	BOOL	1=Drive actual at reference	--
4	Get / Set	NetRef	BOOL	1=Drive reference from DeviceNet	0
6	Get / Set	DriveMode	USINT	Operation mode	0
7	Get	SpeedActual	INT	Actual drive speed in RPM	--
8	Get / Set	SpeedRef	INT	Speed reference in RPM	0
29	Get	RefFromNet	BOOL	1=Drive reference is from DeviceNet	--
100	Get / Set	Frequency Command	UINT	Frequency command in Hz (x 100)	0
101	Get / Set	Command Word	WORD	Bit-mapped command word	0x0000
102	Get / Set	F831 Command Data	UINT	Write command value to selected item	0
103	Get / Set	F832 Command Data	UINT	Write command value to selected item	0
110	Get	Output Frequency	UINT	Output frequency in Hz (x 100)	--
111	Get	Status Word	WORD	Bit-mapped status word	--
112	Get	F841 Status Data	UINT	Read status value from selected item	--
113	Get	F842 Status Data	UINT	Read status value from selected item	--

Attribute ID	Access Rules	Name	Data Type	Description	Default Value
120	Get / Set	Universal Register	UINT	Universal ASD data register address	0
121	Get / Set	Universal Data	UINT	Universal ASD data	--

11.5.8.3 AC/DC Drive Object Common Services

Service Code	Supported		Service Name	Description of Service
	Class	Instance		
0x0E	Yes	Yes	Get_Attribute_ Single	Returns the contents of the specified attribute.
0x10	N / A	Yes	Set_Attribute_ Single	Modifies the value of the specified attribute.

11.5.8.4 AC/DC Drive Object Specific Services

The AC/DC drive object provides no object specific services.

11.5.8.5 AC/DC Drive Object Detailed Explanations

As can be seen in the table in section 11.5.8.2, the AC/DC drive object is comprised of two independent portions: a standard portion which is associated with the ODVA's AC/DC drive profile (the attributes above the dual wavy table separator lines), and an extended portion which is vendor-specific for the Toshiba G7 ASD (the attributes below the table separator lines). With the exception of the Universal Register and Universal Data attributes (which are always valid and active), these two halves of the object are mutually exclusive in that only one set of attributes will be linked to the drive's actual command and status information at any given time. Which half of the attributes is linked to the drive's command and status information is determined by ASD parameter F983, which selects the active I/O assembly instance set.

As detailed in section 11.5.4, when parameter F893 is set to "0", vendor-specific Toshiba I/O assembly instances 100 and 150 are active. These assembly instances map directly to AC/DC drive object attributes 100-113.

When parameter F893 is set to "1" or "2", ODVA AC/DC drive profile standard I/O assembly instances 20 and 70 or 21 and 71 are active. In part, these assembly instances map directly to AC/DC drive object attributes 3-29.

When the Toshiba I/O assembly instances are active, AC/DC drive object attributes 3-29 are still available via explicit messaging GET/SET services, but these attributes are decoupled from the actual G7 ASD operation. That is to say that status attributes (such as #7 SpeedActual) are not updated to reflect actual drive status, and command attributes (such as #8 SpeedRef) do not affect actual drive operation in any way. In this case, only those attributes that are specific to the Toshiba I/O assembly instances are coupled to the drive's operation. For example, writing to attribute #100 (G7 Frequency Command) will write to the drive's option frequency command, and reading from attribute #110 (G7 Output Frequency) will always return the current value of the drive's operating frequency.

When the ODVA AC/DC drive profile standard I/O assembly instances are active, the same concept detailed in the previous paragraph applies, except that the first half of the AC/DC drive object attributes are coupled to the actual ASD operation, and the second half of the attributes are decoupled (and should therefore be ignored).

11.5.8.6 AC/DC Drive Object Attribute Semantics

This section will detail any specific information that may be useful when accessing the attributes of the AC/DC Drive Object, whether directly via explicit messaging or indirectly via I/O assembly objects.

AtReference
This attribute is "1" whenever SpeedActual is within ±1 RPM of SpeedRef.

NetRef
Maps directly to the "speed reference priority" bit (bit #14) of the G7 command word (refer to *G7 Command Word* below). When this attribute (and therefore command word bit #14) is "1", the option frequency command (derived from SpeedRef when AC/DC drive profile I/O assemblies are active) becomes the drive's active frequency command, regardless of the ASD's *Frequency Mode* selection parameter. When this attribute is a "0", the option frequency command will no longer override the *Frequency Mode* selection parameter, but the option frequency command may still be used by the ASD as its overall frequency command if the *Frequency Mode* selection parameter is set to "*Use Communication Card (option)*".

DriveMode
This attribute has no effect on drive operation: values written to it are for user reference only.

SpeedActual
The SpeedActual attribute is the motor's synchronous operating speed in RPM, and is calculated using the following formula:

$$\text{SpeedActual} = \text{Int}\left[\frac{120 \text{ x Output Frequency (Hz)}}{\text{Number of Motor Poles}}\right],$$

where "Output Frequency" is the inverter's current operating frequency and "Number of Motor Poles" is the value contained in the PoleCount attribute of the Motor Data Object (refer to section 11.5.7). Only the integer portion of the calculated result will be transmitted across the network.

SpeedRef
The SpeedRef attribute value is used in the following calculation to determine the ASD's option frequency command value:

$$\text{Frequency Command (Hz)} = \frac{\text{SpeedRef x Number of Motor Poles}}{120},$$

where "Number of Motor Poles" is the value contained in the PoleCount attribute of the Motor Data Object (refer to section 11.5.7).

RefFromNet
This attribute mirrors the value set in attribute #4 "NetRef".

Frequency Command
Unsigned 16-bit value whose value is the desired ASD option frequency command multiplied by 100. For example, if a frequency command of 55.34Hz is desired, then 55.34 x 100 = 5534_{10} (0x159E). If the frequency command exceeds limiting drive parameters (such as the *Upper Limit Frequency* or *Maximum Frequency*), then the drive will ignore it, maintaining its current setting.

Command Word

Bit-mapped drive option command word. Table 10 on page 23 provides the format of this command word.

F831 Command Data / F832 Command Data

Via ASD parameters F831 and F832, the user has the ability to select two additional high-speed scan command items to be written to the ASD. Table 27 provides a list of the available command scan data selections. The "Parameter" column indicates the drive's internal parameter to which the corresponding selection is mapped. Once selected, the corresponding command data for the selected scan items can be written to the drive via AC/DC drive object attributes #102 and #103.

Table 27: Drive Command Scan Data

F831~F835 Setting	Description	Unit	Range	ASD Parameter
0	No selection	-	-	0xFFFF
1	RESERVED	-	-	-
2	RESERVED	-	-	-
3	Incremental speed reference	0.01Hz	0 ~ 500	0xFA08
4	Absolute torque limit	0.01%	0 ~ 25000	0xFA34
5	Positive torque limit	0.01%	0 ~ 25000	0x0441
6	Negative torque limit	0.01%	0 ~ 25000	0x0443
7	Torque command	0.01%	-25000 ~ 25000	0xFA33
8	Speed torque bias	0.01%	-25000 ~ 25000	0x0726
9	Tension torque bias	0.01%	-25000 ~ 25000	0x0727
10	Load balance gain	0.01	0 ~25000	0x0728
11	Drooping gain	0.01	0 ~ 10000	0x0320
12	Speed loop proportional gain	0.1	32 ~ 10000	0x0376
13	Speed loop integral gain	0.1	100 ~ 2000	0x0377
14	Output terminals	-	-	0xFA50
15	Load moment of inertia	0.0001	100 ~ 10000	0xFA35
16	Extended command	-	-	0xFA23

- *Note 1: Items marked as "RESERVED" in Table 27 are reserved for future use. Selecting one of the corresponding values as command scan data will have no effect on drive operation.*
- *Note 2: Although not disallowed, avoid configuring both scan command data parametes F831 and F832 with the same command data selection (for example, do not set both F831 and F832 to "3", etc.). Unexpected drive behavior could result if different data values are written to the corresponding command locations.*
- *Note 3: Parameters F831 and F832 are only validated on drive reset or power-up. Therefore, if either of these parameters is changed, be sure to reset the drive to validate the changes.*
- *Note 4: Data range checking is not performed on command scan items. If a value outside of a specific item's valid range is written to the attribute (either via explicit messaging or an I/O assembly object), that value will be accepted by the Multicom interface, but ignored by the drive.*

Item #16 in Table 27 (extended command) is a bit-mapped drive command word internally located at parameter 0xFA23. Table 11 on page 23 provides the format of this extended command word.

Output Frequency

Unsigned 16-bit value whose value is the current ASD operating frequency multiplied by 100. For example, if the ASD is currently running at 55.34Hz, then this attribute will be 55.34 x 100 = 5534_{10} (0x159E).

Status Word
Bit-mapped ASD status word. Table 14 on page 26 provides the format of this status word.

F841 Status Data / F842 Status Data
Via ASD parameters F841 and F842, the user has the ability to select two additional high-speed scan status items to be read from the ASD. Starting on page 27 of this manual, Table 15, Table 16, Table 17 and Table 18 provide a list of the available status scan data selections and related supporting information. Once selected, the corresponding status data can be read from the drive via AC/DC drive object attributes #112 and #113.

Universal Register / Universal Data
These attributes provide direct network access to any internal drive data (configuration parameters, command data or status data). To use this powerful feature, just set the Universal Register attribute to the ASD register (also referred to as a "communication number") that you wish to access, and then perform the desired operation ("Get" to read from the ASD register or "Set" to write to it) on the Universal Data attribute. The operation on the Universal Data attribute will be directly performed on the data value contained in the internal drive register indicated by the Universal Register attribute.

Note that data written to or read from the drive is raw data, which is to say that no scaling (multiplier) is applied, and all data is expressed as integer values. Also note that the Set service will invoke a corresponding write request to the drive's internal nonvolatile EEPROM memory, so that written values will be retained by the drive through power-off cycles.

Refer to the *Toshiba Series 7 Serial Communications Interface Manual* for detailed information on available drive registers, their allowable adjustment ranges, and any scaling factors that may apply.

To demonstrate an example operation, let's say we would like to write a value of 85.00Hz to ASD parameter "Maximum Frequency" over DeviceNet via an explicit messaging transaction. The ASD register (communication number) for Maximum Frequency is 0011, which is a value of 0x0011 in hexadecimal or 17 in decimal. Therefore, we would Set the Universal Register attribute to 17_{10} (0x0011). The Maximum Frequency register also has a scaling factor of 0.01Hz associated with it, which means the value that must be written to this register is 85.00Hz / 0.01Hz = 8500_{10} (0x2134). Therefore, all we need to do now is perform a Set service on the Universal Data attribute with a value of 8500_{10}. In this same manner, any available ASD data can be accessed.

If the requested operation cannot be performed (typically due to such reasons as a non-existent ASD register being targeted, a data value that is out of range, or a Set (write) operation that is performed when the drive is running targeting a register that does not allow such action), a corresponding DeviceNet error code will be returned.

11.5.9 Parameter Class

Class code 0x0F. The parameter class provides convenient access to various configuration parameters implemented as attributes of other objects. Table 28 lists the supported parameters and their referenced originating objects. For further information on a specific parameter (such as adjustment range, etc.) refer to the referenced originating object. Further information can also be found in the Electronic Data Sheet (EDS).

Table 28: DeviceNet Interface Configuration Group Parameters

Parameter #	Originating Object	Originating Attribute	Page
1	Motor Data	MotorType	65
2	Motor Data	RateeCurrent	65
3	Motor Data	RatedVoltage	65
4	Motor Data	PoleCount	65
5	Control Supervisor	NetCtrl	62
6	Control Supervisor	State	62
7	Control Supervisor	Running1	62
8	Control Supervisor	Running2	62
9	Control Supervisor	Ready	62
10	Control Supervisor	Faulted	62
11	Control Supervisor	FaultRst	62
12	Control Supervisor	CtrlFromNet	62
13	AC/DC Drive	AtReference	67
14	AC/DC Drive	NetRef	67
15	AC/DC Drive	SpeedActual	67
16	AC/DC Drive	SpeedRef	67
17	AC/DC Drive	RefFromNet	67
18	AC/DC Drive	Frequency Command	67
19	AC/DC Drive	Command Word	67
20	AC/DC Drive	F831 Command Data	67
21	AC/DC Drive	F832 Command Data	67
22	AC/DC Drive	Output Frequency	67
23	AC/DC Drive	Status Word	67
24	AC/DC Drive	F841 Status Data	67
25	AC/DC Drive	F842 Status Data	67
26	AC/DC Drive	Universal Access Register	67
27	AC/DC Drive	Universal Access Data	67
28	DeviceNet	BOI	52
29	DeviceNet	Bus-Off Counter	52

11.6 Network Communication Loss Action

ASD Parameter F892 configures the drive's behavior upon loss of DeviceNet network communications. For the purposes of setting this behavior, the chosen action will be performed both a result of a connection (inactivity) timeout as well as a network fatal fault (such as a loss of network power or network BUSOFF after initial successful network operation).

The primary behavior of the network interface and drive upon loss of communications is dictated by the setting of attribute #12 (watchdog_timeout_action) in the polled I/O connection object of the connection class. The polled I/O connection's watchdog_timeout_action can take on the following three values:

0: Transition to timed out. This is the default value. The connection transitions to the "timed out" state and waits in this state until the connection is reset or deleted.
1: Auto delete. The connection is automatically deleted.
2: Auto reset. The connection remains in the "established" state and the inactivity/watchdog timer is restarted.

When the polled I/O connection's watchdog_timeout_action attribute is configured with a value of either 0 (transition to timed out) or 1 (auto delete), the drive's behavior upon loss of communications is controlled by the setting of ASD parameter F892. When the polled I/O connection's watchdog_timeout_action attribute is configured with a value of 2 (auto reset), no drive action occurs during a timeout condition (the drive continues to operate at its last conditions).

By appropriately configuring ASD parameter F892, therefore, it is possible to create a solution that can provide some level of system "failsafe" operation in the event of master loss or total network failure.

DANGER!

SAFETY WARNING! Because some of these settings will enable the drive to run automatically, the user must ensure that their system poses no danger of personal injury or equipment damage, as they may no longer be able to control the drive from the network due to the loss of communications.

ASD parameter F892 provides the following selections (also refer to Table 7 on page 18):

0 = Set all consumed data to 0
1 = Retain last data values
2 = Issue STOP command to drive
3 = Issue EMERGENCY OFF command to drive
4..18 = Run preset speed #1..#15

Setting "0": This is the default setting. When network communications are lost, the consumed I/O data will be set to 0. This will have the effect of stopping the drive and setting its frequency command to 0.00Hz. Note that the drive will not react to the effective STOP command, etc. unless the drive's command mode selection parameter is set to use the option card as its command source.

Setting "1": The last consumed data is retained.

Setting "2": A STOP command is issued to the drive. Note that the drive will not react to the STOP command unless it is operating from the network command source at the time of the watchdog timeout.

Setting "3": An EMERGENCY OFF command is issued to the drive. Note that the drive will not react to the EMERGENCY OFF command unless it is operating from the network command source at the time of the watchdog timeout. The drive's behavior during an EMERGENCY OFF event can be configured via ASD parameter F603.

Settings "4" through “18”: Command the drive to run preset speeds #1..#15. Preset speeds can be set via ASD parameters F018..F024 and F287..F294. Note that the drive will not react to the preset speed commands unless it is operating from the network command source at the time of the watchdog timeout. Also note that the drive’s RUN/STOP command is not modified when these settings are selected. Therefore, the drive will not actually run the preset speed if it was not already being issued a RUN command at the time of the watchdog timeout.

12. Notes

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