NTAC-2000
Sensorless Flux Vector AC Drive

Drive Instruction Manual

THE AVAILABLE SOLUTION, WORLDWIDE.

NTAC-2000

SUMITOMO
MACHINERY CORPORATION OF AMERICA

Manual
10.075.60.004

Thank you for purchasing the Sumitomo NTAC-2000 AC drive. It is one of the most flexible and capable AC drives available on the market. This instruction manual provides complete documentation for installing and using the drive's extensive set of features.

Should assistance be needed in starting up, programming or troubleshoooting NTAC-2000 drives, free technical support is always available at one of the numbers shown below.

8:00 AM to 5:00 PM (Eastern) Monday-Friday

Phone: 757-485-8236 x354
Fax: 757-485-8234

Digital Pager - Anytime

800-759-4726 PIN 246-9961#

For updates on NTAC-2000 AC drives and other Sumitomo Machinery Corp. of America products, visit our Internet World Wide Web Site at http://www.smcyclo.com.

1 QUICK START CHECKLIST

- ☐ **Read and observe all Safety precautions as detailed in Section 3, Safety.**

- ☐ Read and observe mounting and wiring instructions as detailed in Section 5, Installation.

- ☐ Follow start-up instructions as detailed in Section 6, Start-up.

- ☐ **Verify that the correct motor nameplate information is entered into the drive using the Motor Set-up menu. Refer to Section 8, Programming and Section 8.3.1 for Motor Set-up details. Be sure to initiate the Autotune function in the Motor Set-up menu after entering the motor data.**

- ☐ Run the drive in the Local Mode using the keypad and check direction of rotation. If incorrect, refer to Section 6.3 for details on correcting direction of rotation. Refer to Section 7, Operation for complete details on using the Digital Operator Interface.

- ☐ If the drive is to be controlled by remote run-stop contacts and a speed potentiometer and they are wired as described in Section 5, Installation and Section 13, Typical Connections, transfer control to remote by pressing the SHIFT key followed by the LOC/REM (9) key. The Local LED should extinguish. Close the appropriate contact to run the drive in forward or reverse as desired and adjust the speed with the speed potentiometer. If any problems are noted, refer to Section 12, Troubleshooting.

- ☐ Follow instructions in Section 7, Operation and Section 8, Programming to tailor the drive characteristics and features to best fit the application requirements. Contact SMA technical support at one of the numbers shown on the inside front cover of this manual if additional assistance is needed.

2 CONTENTS

CONTENTS

CAUTION

Read and observe all safety instructions. Do not make withstand voltage tests on any part of the NTAC-2000 AC drive. It is electronic equipment using semiconductors and vulnerable to the high voltages utilized by withstand testing equipment.

During installation, be sure that all terminals are tightened to the recommended torque rating. Refer to Section 5, Installation for torque values.

Handle with care to avoid damage to the AC drive. Do not pick-up the drive by the plastic housing. Instead, use the metal heatsink when lifting and transporting the unit.

ADVERTISSEMENT

Des tensions subsistent aux bornes des condensateurs pendant cinq minutes aprés l'ouverture de circuit d'entrée.

Couper l'alimentation avant d'entreprendre le depannage du système électrique.

ATTENTION

Une protection distincte contre les surintensités, la surcharge et la surchaufee de moteur doit être fournie conformément AU CODE CANADIAN DE L'ÉLECTRICITÉ PREMIER PARTIE et LE NATIONAL DE L'ÉLECTRICITÉ.

3 SAFETY

Safety is an important concern when working with any electrical equipment. AC drives operate at dangerous voltage levels and dangerous voltages can be present for several minutes after power is removed. Only persons experienced with the installation, operation and maintenance of AC drives should be allowed to remove the enclosure cover. Failure to follow proper electrical safety procedures could lead to serious injury or loss of life.

3.1 Danger

This manual will use the following symbol when, due to the nature of the procedure, serious injury or possible loss of life is an issue.

DANGER

The symbol will be accompanied by a boxed description in bold text describing the potential safety issue and steps to take to avoid injury. An example is shown below.

DANGER

HAZARD OF ELECTRICAL SHOCK OR BURN!

POTENTIALLY LETHAL VOLTAGES EXIST IN THIS DRIVE AND MAY REMAIN AT A DANGEROUS LEVEL FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS CONTROLLER, WAIT UNTIL THE BUS CHARGED LAMP GOES OUT AND MEASURE THE DC BUS VOLTAGE TO INSURE THAT IT IS ZERO.

3.2 Caution

In addition to the Danger symbol and typical statement shown above, some actions have a smaller potential for injury but failure to follow proper procedures could cause damage to the drive or to the driven equipment. This manual will use the following symbol when the operation requires care in performing the procedure but conditions are not normally life-threatening.

The symbol will be accompanied by a description in bold text describing the potential safety issue. An example is shown below. Notice that Caution alerts are not boxed.

CONSULT THE MANUFACTURER OF THE MOTOR AND THE DRIVEN MACHINE BEFORE OPERATING THE MOTOR ABOVE RATED SPEED. FAILURE TO DO SO MAY RESULT IN DAMAGE TO EQUIPMENT AND/OR PERSONAL INJURY.

3.3 General Safety Precautions

3.3.1 Always

- Read and understand the contents of this manual before attempting to install or service the AC drive.
- Allow only qualified persons experienced with the installation, set-up and maintenance of power electronic devices to work on this equipment.
- Disconnect power before attempting to work on the drive or connected motor.
- Measure DC bus voltage with a meter capable of handling DC voltage up to 1000 V to insure that the DC bus capacitors have fully discharged before touching any components or terminals in the drive enclosure or before opening the motor conduit box.
- Follow plant and electrical code lockout procedures to insure that power is not accidentally applied while working on the drive, motor or driven machinery.
- Insure that proper grounding procedures have been followed during installation of the AC drive and motor.
- Follow proper procedures for handling static electricity sensitive electronic equipment.
- Insure that the AC line voltage at the drive installation agrees with the drive rated voltage, as imprinted on the ratings label on top of the drive module.

3.3.2 Avoid

- Removing or installing the drive cover while voltage is applied.
- Working on the drive when power is applied unless absolutely necessary for troubleshooting purposes and then only by a qualified electrician.
- Touching the drive heatsink because of the possibility of burns due to elevated temperature.

3.3.3 Never

- Never stand directly in front of the drive when applying power.
- Never connect or disconnect any wiring, either power or control, while power is applied to the drive.
- Never touch any component on an electronic circuit board with power applied. Some components are at DC bus potential.
- Never short the DC bus (+) and (-) terminals to discharge the DC bus capacitors.
- Never run conductors from multiple drives and motors in the same conduit or raceway.

4 INSPECTION AND STORAGE

4.1 Inspection

Always inspect NTAC-2000 AC drives upon receipt to insure that no shipping damage has occurred. If damage is suspected, contact the freight carrier immediately to file a damage claim. Also, contact your local Sumitomo Machinery Corp. of America (SMA) representative or distributor to receive a Return Material Authorization number if inspection indicates damage to the drive. Attempting to install or operate a drive that has been damaged may create a safety hazard.

The following signs may indicate possible shipping damage that should be investigated further:

- Visible damage to the drive shipping container including cuts, tears or punctures.
- Signs that the container may have been dropped such as deformed corners.
- Signs that heavy items may have been stacked on top of the drive container such as caved-in top, bottom or sides.
- Opened containers.
- Loose parts inside the shipping container.
- Evidence of water damage.

4.2 Storage

If the AC drive is not to be installed immediately, it should be returned to its original shipping container and stored in a location that meets the following conditions.

- Temperature maintained within -20°C to +60°C (-4°F to 140°F).
- Not prone to large temperature swings.
- Humidity within a range that will not result in condensation.
- Away from dripping or splashing liquids.
- Atmosphere is free from corrosive gasses and/or conductive dust.
- Free from excessive vibration.

5 INSTALLATION

5.1 Mounting Location

Refer to Section 15, Outline Drawings for mounting dimensions.

NTAC-2000 AC drives are designed to be wall or panel mounted, depending upon the drive enclosure rating. Ambient temperature should be within the drive specification. If drives are installed inside of another enclosure, the specified ambient temperature range must be maintained inside the enclosure containing the drives. The mounting location must be rated to handle the heatsink temperatures of up to 88°C (190°F).

CAUTION

AVOID TOUCHING THE DRIVE HEATSINK DURING AND FOR SEVERAL MINUTES AFTER OPERATION. NORMAL OPERATING TEMPERATURES MAY CAUSE BURNS. INSURE THAT THE MOUNTING LOCATION IS SUITABLE FOR THE EXPECTED TEMPERATURES.

If NEMA 1 rated drives are installed in another enclosure the temperature inside the enclosure must meet the ambient conditions above. The enclosure must be sized according to the heat dissipation of all installed components and additional ventilation supplied, if needed. The enclosure must include a door, cover, etc. to prevent accidental contact with terminals or other drive parts that are at hazardous voltage levels.

In general, the mounting location should meet the following criteria.

- Temperature maintained within the drive specified operating range discussed on the preceding page.
- Not prone to large temperature swings which could cause condensation.
- Humidity maintained within a range that will not result in condensation.
- Away from dripping or splashing liquids unless the enclosure carries a NEMA 4 rating.
- Atmosphere is free from corrosive gasses and/or conductive dust.
- Vibration does not exceed the rating shown in Section 16, Specifications.

Drives must be mounted in a manner to allow sufficient cooling of the heat sinks. Refer to the diagram below for suggested mounting configurations. Note the minimum spacing required to mount multiple drives in close proximity to each other.

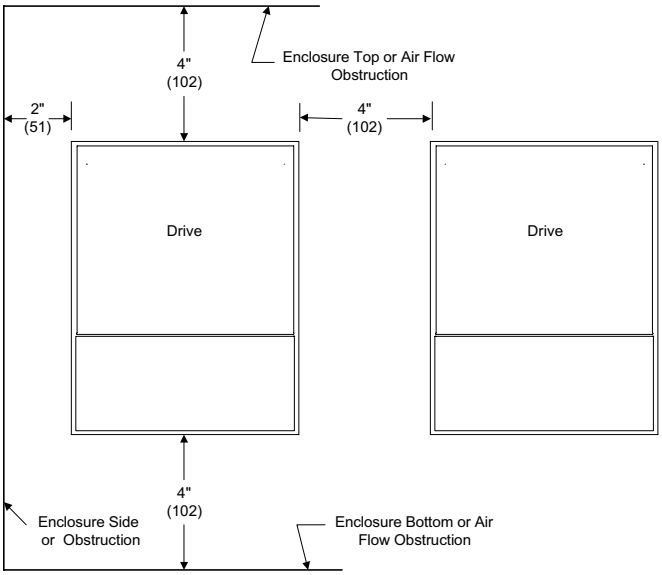


Figure 5.1 Multi-Drive Mounting Configuration

Table 5.1 - Drive Heat Losses

HP	230V Model	Heat Loss (W)	460V Model	Heat Loss (W)
1	NT2012-A75	35	NT2014-A75	49
2	NT2012-1A5	64	NT2014-1A5	77
3	NT2012-2A2	94	NT2014-2A2	101
5	NT2012-3A7	137	NT2014-3A7	140
7.5	NT2012-5A5	215	NT2014-5A5	192
10	NT2012-7A5	276	NT2014-7A5	240
15			NT2014-011	346
20			NT2014-015	436
25*			NT2014-018V	500

* 25 HP drives are rated for variable torque applications only.

If the drive is installed in an area where ambient temperature may drop below freezing when the drive is required to operate, the drive should be installed in an enclosure equipped with a thermostatically controlled space heater with sufficient wattage to maintain temperature in the enclosure above freezing. Space heaters should also be considered when temperature and relative humidity are such that condensation is probable.

5.2 Electrical Installation

DANGER	**HAZARD OF ELECTRICAL SHOCK OR BURN!** **FAILURE TO FOLLOW SAFE ELECTRICAL PRACTICES CAN RESULT IN SERIOUS INJURY OR DEATH. BEFORE COMMENCING INSTALLATION INSURE THAT ALL SOURCES OF POWER ARE TURNED OFF AND LOCKED OUT.**

To gain access to power and control terminals for wiring, it is necessary to remove the wire-way cover from NEMA 1 enclosed drives. It is also more convenient to complete wiring by removing the Digital Operator Interface (DOI). Refer to Figure 5.2 for wire-way removal instructions and Figure 5.3 for DOI removal instructions.

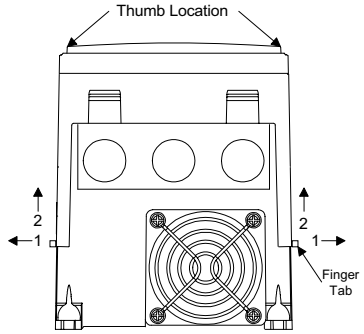
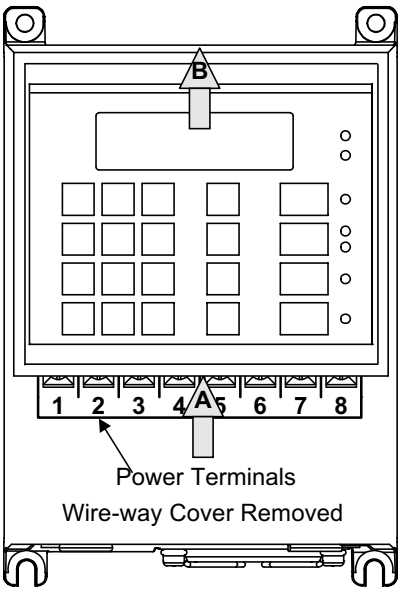


Figure 5.2 - Wire-way Cover Removal

Place thumbs near the edges of the wire-way cover and finger tips under the finger tabs. Pull out in the direction of arrow 1 then up in the direction of arrow 2.



Hook thumb under Digital Operator Interface at the location shown by Arrow A. Place fingers at location shown by Arrow B. Pull out with thumb.

Figure 5.3 - DOI Removal

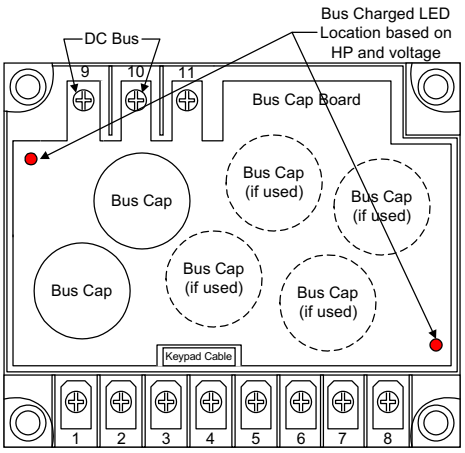


Figure 5.4 - 1 to 5 HP IDM Component Layout

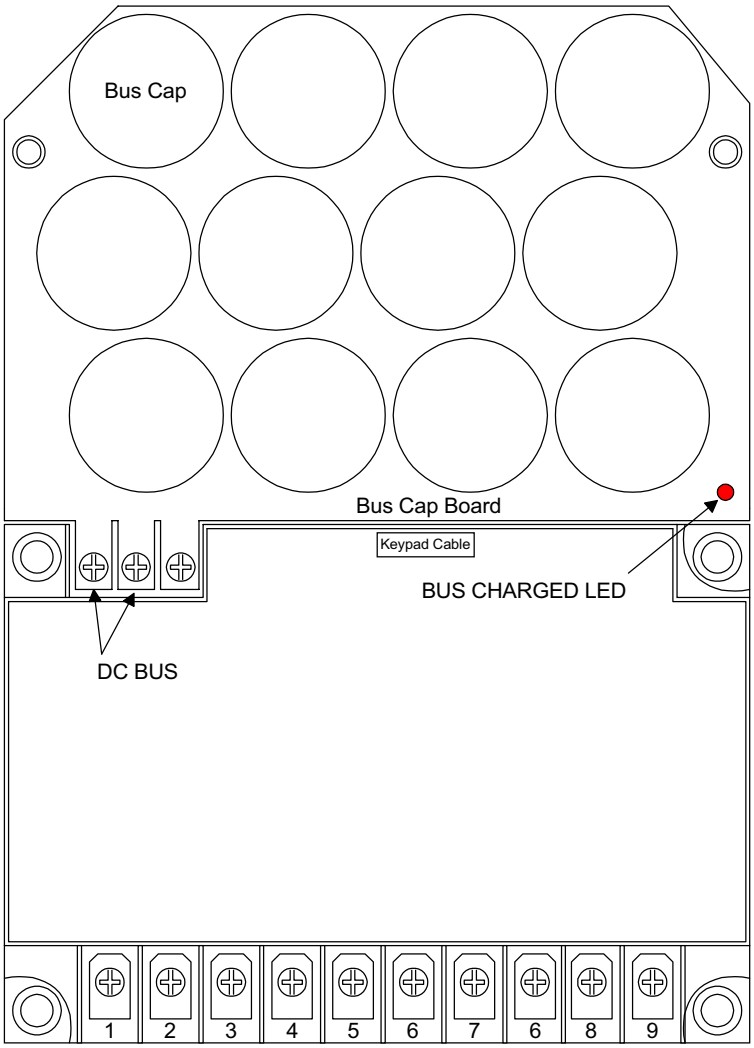


Figure 5.5 - 7.5 to 10 HP Component Layout

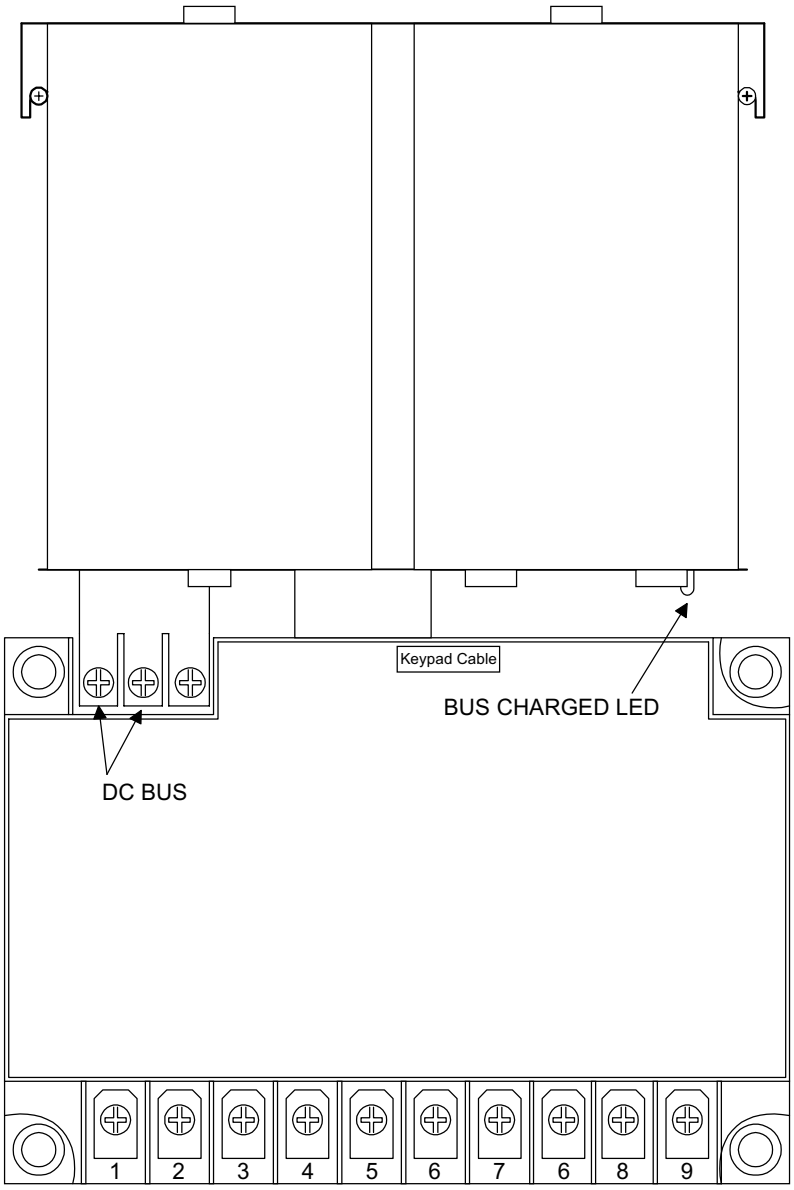


Figure 5.6 - 15 to 20 HP (25 HP VT) Component Layout

NTAC-2000 AC drives must be installed in accordance with the requirements of any National and / or Local Electrical Codes in effect at the point of installation. Installation must be performed by an experienced electrician familiar with the handling of solid state power conversion equipment. In addition to normal electrical safety procedures, the following items must be considered in planning the installation.

5.2.1 Power Wiring

1. Remove all power from sources that feed the AC drive and any associated equipment. Install safety lock-out devices in accordance with standard electrical safety practices.

2. Insure that feeder conductors and motor conductors are sized in accordance with applicable electrical codes. Refer to the drive nameplate or Table 5.2 for drive rated current. If long cable runs between the AC drive and power source are anticipated, insure that the conductors are sized to compensate for voltage drop due to the cable impedance. Failure to do so could result in reduced performance from the AC drive and connected motor.

Table 5.2 - Full Load Amps, Wire & Fuse Ratings

HP	**1**	**2**	**3**	**5**	**7.5**	**10**	**15**	**20**	**25 VT**
Model No. Suffix	-A75	-1A5	-2A2	-3A7	5A5	-7A5	-011	-015	-018V
230V:									
Drive FLA	3.6	6.8	9.6	15.2	22	28			
Min Wire Size (AWG) [1]	14	14	14	12	10	8			
Fuse Rating (A) [2]	15	20	25	40	50	60			
460 V:									
Drive FLA	1.8	3.4	4.8	7.6	11	14	21	27	33
Min Wire Size (AWG) [1]	14	14	14	14	14	12	10	8	8
Fuse Rating (A) [2]	10	10	15	20	25	35	50	60	60

[1] Based on 90°C rated wire in a 30°C ambient. Adjust per NEC or applicable code for different conditions.

Fuses must meet requirements shown in the following table.

Manufacturer	300V Class 230V Drives	600V Class 460V Drives
Bussman	JJN – nnn	JJS – nnn
Gould	A3T – nnn	A6T – nnn
Littlefuse	JLLN – nnn	JLLS - nnn

nnn = fuse ampere rating

3. The available short-circuit current at the drive input terminals must not exceed the drive short-circuit rating as shown in Section 16, Specifications or the drive nameplate. If it does, a line reactor or isolation transformer must be installed ahead of the drive. In addition, a line reactor may be required if the feeder circuit impedance at the drive connection point is less than 1% (short circuit current at the drive connection point is more than 100 times the drive rated current). An impedance value of less than 1% may cause excessive bus capacitor charging current and result in nuisance tripping of circuit breakers or blowing of line fuses when power is applied to the drive. Feeder circuit impedance greater than 5% (short circuit current less than 20 times the drive rated current) may result in loss of performance during periods of high torque demand.

   The drive should be connected directly to the power system through an appropriately sized disconnecting means. The use of a contactor between the drive and power supply should be avoided. If it is absolutely necessary to install a contactor, take action to insure that the contactor is not cycled rapidly to remove and reapply power to the drive. If the contactor is opened while the drive is operating, the drive will decelerate the motor in an attempt to keep the DC Bus charged. The time will vary based on load inertia but if the power is removed long enough, a DC Bus Low fault will occur. Once the fault occurs, power must remain off until the DC Bus voltage drops low enough to remove control power from the drive electronics, otherwise the DC Bus Low fault will remain after power is reapplied. Reapplying power before the NTC thermistor pre-charge circuit has time to cool will result in higher inrush current and possible nuisance blowing of input fuses or circuit breaker tripping.

4. Feeder cables to the AC drive must be run in metallic conduit or covered metal wire-way to minimize radiated electrical interference that could affect nearby electronic devices or cause interference in communication devices. Conduit or wire-way must be properly grounded. In some installations with sensitive electronic equipment, in may be necessary to install a properly sized Radio Frequency Interference (RFI) filter between the AC drive and the power system. Consult the factory for filter recommendations.

5. Do not run motor leads in the same conduit as input power leads. Switching noise on the motor leads will be coupled into the AC line.

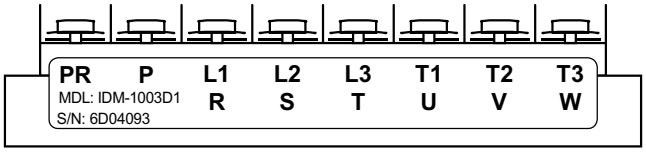
6. Conductors from the drive output to the motor must be run in metallic conduit or covered metal wire-way to minimize radiated electrical interference that could affect nearby electronic devices or cause interference in communication devices. Conduit or wire-way must be properly grounded. In some installations with sensitive electronic equipment, it may be necessary to use shielded cable for the motor conductors.

Do not run power cables from one drive-motor combination in the same conduit or raceway as power cables from another drive-motor combination. This can cause coupling of voltage present in one set of motor leads into another set of motor leads. Potentially damaging voltage transients can occur resulting in damage to the connected motors and a safety hazard can result because even though one of the drives may not be operating, the motor leads can have potentially lethal voltage levels present.

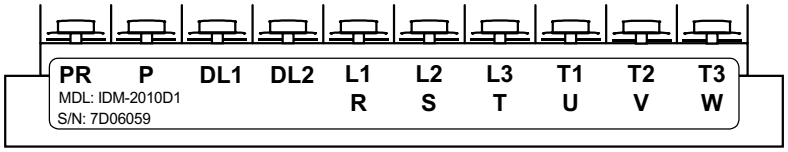
DANGER	**HAZARD OF ELECTRICAL SHOCK OR BURN!** **DO NOT ROUTE MOTOR LEADS FROM MORE THAN ONE DRIVE-MOTOR COMBINATION IN THE SAME CONDUIT OR RACEWAY. DOING SO MAY CAUSE HAZARDOUS VOLTAGE TO BE INDUCED INTO A SET OF MOTOR LEADS EVEN THOUGH THE DRIVE FEEDING THE MOTOR LEADS IS NOT OPERATING AND HAS POWER REMOVED.**

7. Do not run control wiring in the same conduit or wire-way with power wires. Maintain a minimum separation of 36 inches (1 meter) between parallel conduits carrying input power or motor leads and conduits carrying control wires. If it is necessary for power and control wiring to cross, cross at a 90° angle and maintain as much separation as possible.

8. Insure that the correct voltage source is connected to the AC drive input terminals (L1/R, L2/S, L3/T) not the output terminals (T1/U, T2/V, T3/W). Connecting a drive to the wrong voltage can cause equipment misoperation and/or equipment failure resulting in a safety hazard. Connecting AC line voltage to the output terminals will destroy the drive and void the warranty. Refer to Figure 5.7 for power terminal details and Figure 5.9 for a connection diagram.



1 - 5 HP, 230V & 460V



7.5 - 20 HP, 460V
7.5 - 10 HP, 230V

Figure 5.7 - Power Terminal Strip Details

Power Terminal Strip Specifications:

Wire Strip Length: 0.4” (10 mm)
Tightening Torque: 12.0 lb-in (1.36 Nm)

9. Avoid the use of contactors between the AC drive and connected motor. If a contactor or other switching device is used, the contactor or switch must be closed before the AC drive receives a run command and must remain closed during operation of the drive. Opening a contactor during drive operation will result in the drive tripping and displaying the fault message MOTOR FAULT.

10. NTAC-2000 drives uses sensorless flux vector technology that is designed for a single motor connected to the drive. If multiple motors are to be connected to a single AC drive, consult the factory for application assistance. At the very least, an overload device must protect each motor. Protection can be accomplished by a thermal switch embedded in the motor windings or by a current sensitive, inverse-time overload relay sized for the motor full load amperes.

CAUTION

INSURE THAT THE VOLTAGE OF THE AC DRIVE POWER SOURCE MATCHES THE VOLTAGE RATING OF THE DRIVE NAMEPLATE. CONNECTION OF AN INCORRECT VOLTAGE SOURCE MAY RESULT IN MISOPERATION AND/OR FAILURE OF THE AC DRIVE AND MAY RESULT IN A SAFETY HAZARD. DO NOT CONNECT AC LINE POWER TO OUTPUT TERMINALS (T1, T2, T3).

5.2.2 Control Wiring

1. All control signals interfacing with the NTAC-2000 AC drive must be connected using shielded cable. Analog signals for 0 to 10 VDC, remote speed potentiometer or 4 to 20 mADC should be run in shielded, twisted-pair cable. Cable shields for drive inputs must be terminated only at the drive end at the ground terminal provided. Cable shields for drive outputs must be grounded only at the connected device end. Control wiring should be sized in accordance with the following tables. Refer to Figure 5.8 for control terminal details and Figure 5.9 for a connection diagram. Also refer to Appendix A, Typical Connection Diagrams for additional information.

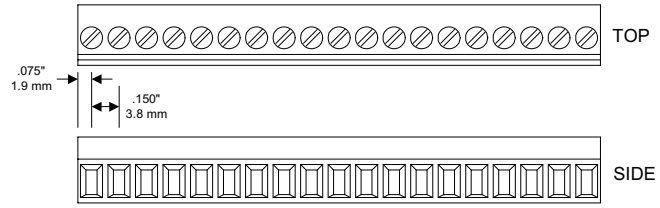


Figure 3.8 - Control Terminal Strip Details

Control Terminal Strip Specifications:

Note: The terminal strip unplugs to simplify wiring.
Wire Strip Length: 0.25" (6.35 mm)
Tightening Torque: 2.0 lb-in (0.25 Nm) **Do Not Over-tighten**
Requires screwdriver with max. tip width of 0.078 inches (2 mm).

Table 5.3 - Control Circuit Terminals - No. Conductors vs. Size

Wire Size (AWG)	Maximum Conductors per Terminal Point
16	1
18	2
20	3
22 - 28	4

Table 5.4 - Control Circuit Wire Size vs. Distance

Maximum Distance	Minimum Wire Size (AWG)
10 ft (3 m) [1]	28 - 24
25 ft (8 m) [1]	22 - 20
100 ft (30 m) [1]	18
200 ft (60 m) [1]	16

[1] Wires carrying analog signals should be shielded, twisted pair. Wires to digital inputs which run for over 10 ft (3 m) or which are in close proximity to sources of electrical interference should be shielded.

2. Do not run control wiring in the same conduit or wire-way with power wires. Maintain a minimum separation of 36 inches (1 meter) between parallel conduits carrying input power or motor leads and conduits carrying control wires. If it is necessary for power and control wiring to cross, cross at a 90° angle and maintain as much separation as possible.

3. Do not connect any of the drive control terminals to an external power source. Control terminals may be connected to remote dry contacts (relays, limit switches, selector switches, etc.) or to open-collector sinking outputs of PLCs, computers, proximity or photo switches.

4. Contact devices (relays, limit switches, selector switches, etc.) interfacing with the AC drive must be suitable for application in a low-energy circuit. Gold-flashed, silver-plated or other low-resistance contacts should be used.

5. A transient suppressor must be installed on the coil of any relay, contactor, solenoid, etc. that is connected to the AC drive or installed in close proximity to the AC drive. Consult the manufacturer of the device for recommended suppressors.

5.2.3 IGBT Rated Motors

Operation of IGBT based AC drives such as NTAC-2000 drives can result in transient voltage conditions that can be damaging to motors under some conditions. The potential for damage increases as the cable length from the drive to the motor increases. Motors used with NTAC-2000 drives should be Inverter or Vector duty, depending on the operating speed range, and suitable for use with IGBT drives. Most motor manufacturers have motor designs suitable for application on IGBT inverters. All Sumitomo Machinery Corp. of America SM-Cyclo® **F-frame** gearmotors shipped after August, 1996 are suitable for use on IGBT Inverters. Even though a motor may be IGBT rated, cable length between the motor and drive should be minimized. Refer to Table 5.5 for recommendations.

If an NTAC-2000 drive is installed to operate an existing motor which is more that two years old and/or the motor was previously controlled by a fixed-speed starter, it is highly likely that the motor is not equipped with IGBT rated insulation. In this event, operation of the drive could result in failure of the motor. A line reactor or transient voltage suppressor installed between the drive and motor may provide the necessary protection. A suggested source of these components is:

TCI
7878 North 86th Street, Milwaukee, WI 53224
Phone: 414/357-4480 Fax: 414/357-4484

Table 5.5 - Recommended Drive to Motor Distance

Carrier Freq. (kHz)	3	6	9	12
Standard Motor Drive to Motor (ft.)	125	80	65	55
IGBT Rated Motor Drive to Motor (ft.)	875	550	400	325

Current generation NTAC-2000 drives operate with a carrier frequency in the range of 4 kHz to 5 kHz.

5.2.4 CE Listing EMC Directive Installation Requirements

CE Listed NTAC-2000 drives are available for use when the installation site is one of the European Community countries. A Declaration of Conformity appears in Section 17, CE Declarations. NTAC-2000 drives meet the requirements of the Low Voltage Directive without modification. Compliance with the EMC (Electromagnetic Compatibility) Directive requires additional equipment and special installation considerations.

A motor drive does not generally function independently. It is a component designed to be integrated into a machine control system, and is generally intended to be installed within another enclosure with other control equipment and devices. It is therefore assumed that the drive is installed in such a manner, and to assure compliance with the EMC Directive, the drive is tested in this configuration. Compliance with the EMC (Electromagnetic Compatibility) Directive requires additional equipment and special installation considerations. The following guidelines must be implemented in addition to standard installation guidelines as described in this manual. Refer to Figure 5.9 on the following page for additional information.

1. The drive must be installed in a metallic enclosure designed to contain radio frequency energy. Basic requirements include RFI gasketing around all door or removable cover joints and continuous welded seams for any enclosure joints.
2. AC line input wiring must be routed in rigid metal conduit or metal-jacketed flexible conduit. The conduit must be securely attached to the enclosure with paint or other insulating material removed at the point of attachment to insure positive electrical contact.
3. A separate ground conductor must be routed inside the conduit carrying the AC line conductors. The ground conductor must be solidly connected to the enclosure grounding stud.
4. The motor must be solidly grounded.
5. Install a 1% minimum impedance line reactor, as required, between the drive and the power source.
6. An approved Radio Frequency Interference (RFI) filter must be installed between the drive and the power source.
7. If required, a load reactor with a minimum of 1% impedance may be installed between the drive and the motor.
8. Shielded power cables must be used to connect the motor to the drive. The shielded cable must include a separate ground conductor tied to the drive heatsink on one end and the motor ground terminal on the other end. The braided shield or drain wire must be grounded to the drive heatsink.

9. Shielded cable must be used for all control wiring entering or leaving the enclosure that contains the AC drive. The shield must be solidly attached to the drive ground terminal.
10. A ferrite bead must be installed on control wire or cable entering or leaving the enclosure that contains the AC drive.

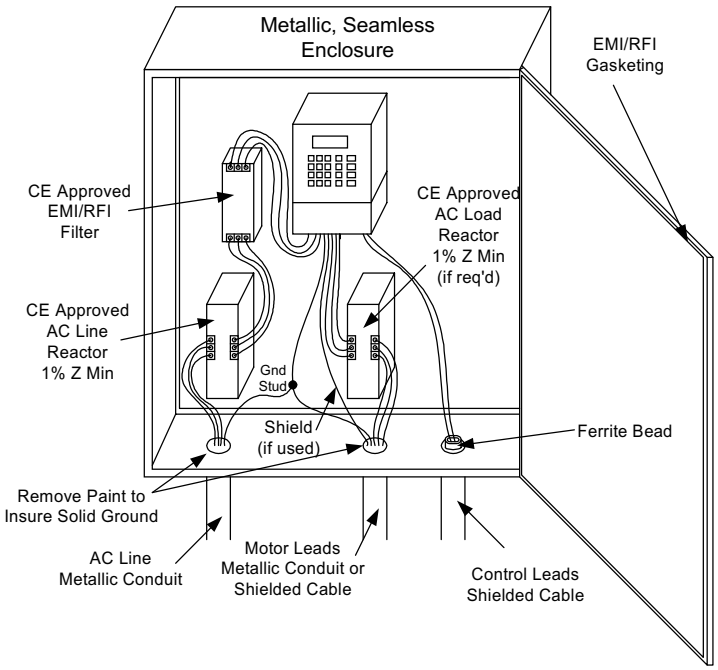


Figure 5.9 – Installation Requirements for EMC Directive

5.2.5 Installation To Meet CE Listing Low Voltage Directive

A power system is unique in its safety concerns and the methods used to ensure the safety of people, animals, plant and equipment. The applicable standard for this product family is prEN50178: 1995 Electronic Equipment for use in Power Installations. This standard details the design requirements and verification testing required for power electronic systems, including motor drive products, and we have self-certified compliance to the Low Voltage Directive according to this standard.

1. 200-230V Applications – NTAC-2000 drives are rated for operation over a voltage range of 200V to 240V, however, the HP (kW) rating is based on motor full load amperes at 230V. When driving a 200V rated motor, to deliver the full nameplate rating the drive must be selected so that its full load ampere rating equals or exceeds the motor nameplate rating. This usually requires the use of a larger drive. The CE mark applies to all 230V class drives as long as the drive is used within its rated current.

2. Derating for 380/400V Drives – NTAC-2000 drives are dual rated for 380/400 or 460V operation and carry a higher full load ampere rating when operated at 380/400V. Derating, i.e. use of a larger drive is usually not required, however, be sure that the drive full load ampere rating equals or exceeds the motor full load ampere rating. The CE mark does not apply to a drive operating at higher than 400V if the motor rated current is above the 460V drive rated current.

3. The drive must be properly grounded by connecting the ground terminal(s) on the drive to a solid earth ground using a conductor with a current rating equal to or greater than the current rating of the AC line feeder conductors. Wire each drive of a multi-drive installation to a common ground point. Do Not daisy chain the ground conductor between drives.

    1. Do Not use an Earth Leakage (Ground Fault) circuit breaker ahead of the drive as a means for personnel protection.

    2. Current limiting fuses must be used in the AC line feeding the drive even if a suitably sized circuit breaker is used. Refer to Section 3.2.1 for fuse recommendations.

    3. The drive relay outputs are not recognized for application in an AC circuit and the capacity in a DC circuit is reduced from 1.0 A to 0.5 A at 30V DC.

5.2.6 Dynamic Braking Resistors

When stopping a typical load connected to the drive motor, the drive decelerates the load at a rate determined by the deceleration ramp time. Braking torque, if required, is supplied by dissipating motor rotational energy (load and motor inertia) via losses in the motor and drive. A small amount of energy can be absorbed by the DC bus filter capacitors. This generally results in a maximum braking torque of about 20% of motor rated torque.

If a combination of factors such as high load inertia, low friction losses and short deceleration ramp time occurs, the drive-motor combination may not have sufficient braking torque to stop or decelerate the load as required. The drive will respond by automatically extending the deceleration ramp time to avoid a DC Bus High fault trip. In this condition, stopping or slowing a load quickly requires a means of dissipating the excess energy. This can be accomplished by connecting a Dynamic Braking (DB) resistor to the terminals provided (P, PR).

If used, DB resistors must be mounted in an area where heat build-up from the resistors will not raise the ambient temperature above the drive's rating. Wiring from the drive to the resistors must be kept as short as possible. Use high-temperature rated wire to connect the resistors to drive terminals P and PR. Polarity of the connection is not important.

If desired, a temperature protective device can be installed in close proximity to the DB resistor to protect against excessive duty cycle. If used, the temperature switch should be coordinated with the maximum operating temperature of the resistor. The temperature switch must be normally closed (i.e. open on high temperature and the contacts must be wired to a drive digital input programmed for External Fault, NC. Refer to Section 8, Programming for additional details.

Note that a failure of the drive DB transistor could potentially result in the DB resistor being in the circuit continuously. This would cause very high resistor temperature leading to eventual resistor failure. Protection of the resistor in this event cannot be achieved via a temperature switch wired as described above. The switch must be wired to drop out a line contactor or trip a shunt-trip circuit breaker ahead of the drive.

Heavy duty-cycle operation of the resistors can result in resistor temperatures in excess of 300°C (572°F). The resistors must not be located near any flammable material or mounted on a surface that could be damaged by radiated heat in this temperature range.

The following table lists optional DB resistor kits available from SMA. The resistors are conservatively selected to provide approximately 150% braking torque with a 10% duty cycle while maintaining a resistor temperature of about 100°C (about 33% of maximum) rise above ambient. The result is longer life and/or less sensitivity to misapplication.

Voltage	HP	kW	DBR Model No.	Ohms	Watts
200 - 230	1	0.75	DBR200-300E	200	300
	2	1.5	DBR80-300E	80	300
	3	2.2	DBR70-400E	70	400
	5	3.7	DBR40-600E	40	600
	7.5	5.5	DBR20-1300E	20	1300
	10	7.5	DBR20-1300E	20	1300
380 - 460	1	0.75	DBR750-200E	750	200
	2	1.5	DBR750-300E	750	300
	3	2.2	DBR250-400E	250	400
	5	3.7	DBR160-600E	160	600
	7.5	5.5	DBR63-1300E	63	1300
	10	7.5	DBR63-1300E	63	1300
	15	11	DBR36-2000E	36	2000
	20	15	DBR28-2600E	28	2600

If a non-SMA supplied resistor is to be used, it should be sized according to the following formulas:

Resistance: (Ohms)

$$R = \frac{V_{DC}^2}{6 \cdot HP \cdot T_B}$$

Power: (Watts)

$$P = HP \cdot T_B \cdot \Delta T \cdot D$$

Where: V_{DC} = 820 for 460V Drive
V_{DC} = 410 for 230V Drive
HP = Drive HP
T_B = Braking Torque (%)
ΔT = Resistor Temp. Rise Factor*
= 9 for 33% Rated Rise
= 6 for 66% Rated Rise
= 3 for 100% Rated Rise
D = Duty Cycle (Per Unit (P.U.) - % / 100)

100% rated rise temperature is generally 300°C or higher

Example: 5 HP, 460V Drive to develop 150% braking torque with a duty cycle of 6 seconds stopping each minute (10% or 0.1 P.U.). To minimize cost, the resistor will be allowed to reach its maximum rated temperature.

$$R = \frac{820^2}{6 \cdot 5 \cdot 150} = \frac{672400}{4500} = 149.42\Omega$$

$$P = 5 \cdot 150 \cdot 3 \cdot 0.1 = 225W$$

Note: The closest standard, commercially available resistor or resistor combination would generally be selected.

To avoid damage to the drive DB transistor, resistor ohmic values must not be less than shown in the following table.

Drive HP	230V Line	460V Line
1, 2	50Ω	200Ω
3	35Ω	140Ω
5	20Ω	80Ω
7.5	15Ω	60Ω
10	10Ω	40Ω
15		30Ω
20, 25		20Ω

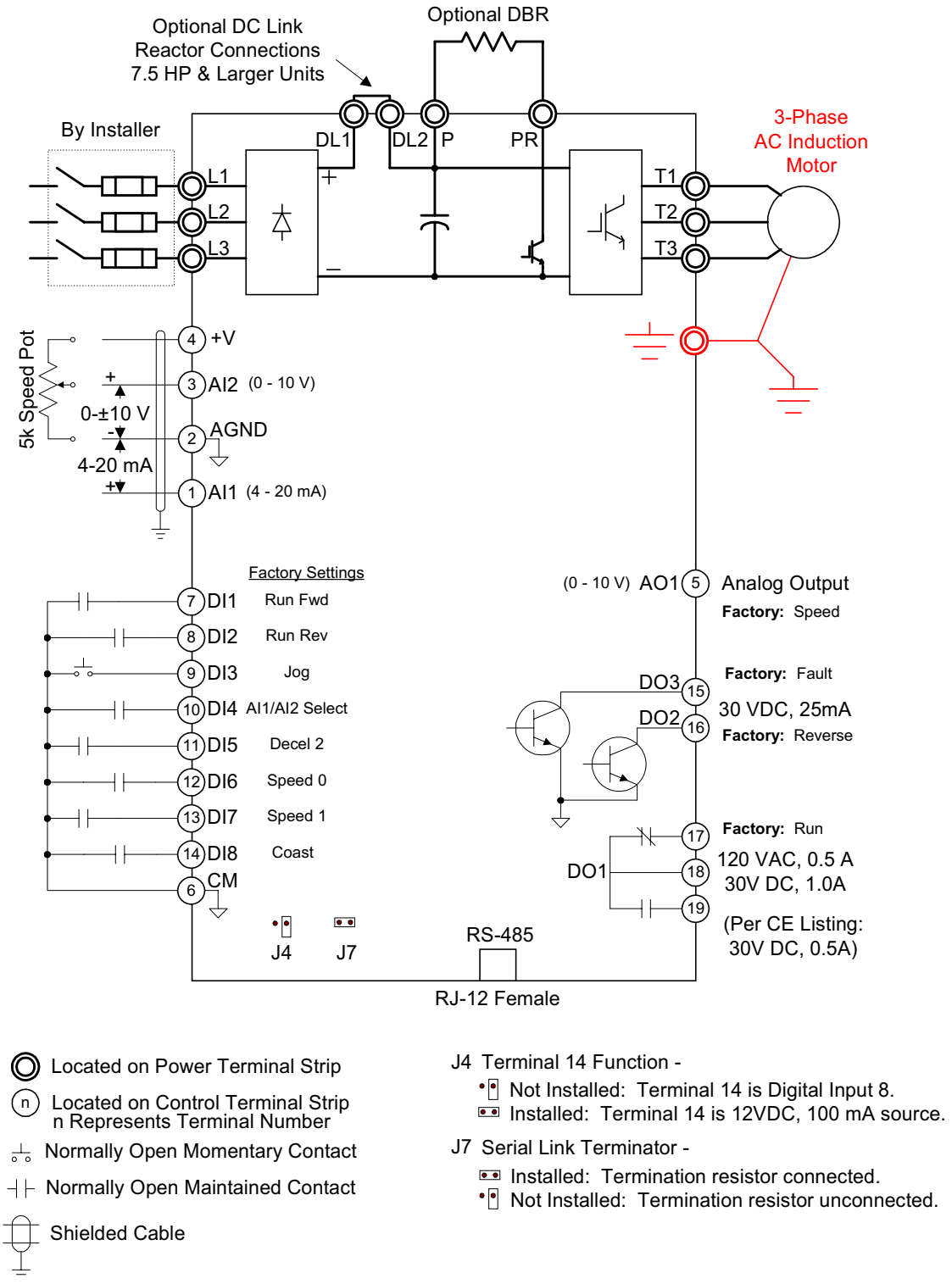


Figure 5.10 – NTAC-2000 Connection Diagram

6 START-UP

6.1 Start-up Instructions – Before Application of Power

1. Insure that installation has been completed as described in Section 5, Installation and in accordance with national and local electrical codes. Inspect the input power wiring and motor wiring to insure that the input leads connect to terminals L1/R, L2/S, L3/T and that the motor leads connect to T1/U, T2/V, T3/W. Connecting AC line power to the motor terminals will destroy the drive and void the warranty.

2. Insure that the drive cover is in place or, if the drive is installed in another enclosure, that the enclosure door is closed and securely fastened.

3. Insure that the motor is connected for the correct voltage and that leads are properly terminated and insulated from each other and from ground.

4. Insure that the motor frame and drive are properly grounded.

5. Verify that the driven load can be safely operated or, if not, that the motor is uncoupled from the connected load. Note: When initially operating a 3-phase AC motor, the direction of rotation is undetermined. If the driven machinery can be damaged by rotation in the wrong direction, uncouple the motor from the load before attempting to operate the drive.

CAUTION

IF THE DRIVEN LOAD CAN BE DAMAGED BY ROTATION IN THE WRONG DIRECTION, UNCOUPLE THE MOTOR FROM THE LOAD BEFORE APPLYING POWER TO THE AC DRIVE AND ATTEMPTING TO OPERATE THE MOTOR.

6.2 Start-up Instructions – Initial Application of Power

1. Remove any safety lockout devices from the fused disconnect switch or circuit breaker feeding the AC drive.

2. When energizing any electrical apparatus for the first time, it is good safety practice to avoid standing directly in front of the device. Be sure to wear safety glasses.

 DANGER	**HAZARD OF ELECTRICAL SHOCK OR BURN!** **DO NOT STAND DIRECTLY IN FRONT OF ANY ELECTRICAL DEVICE WHEN INITIALLY APPLYING POWER. FOLLOW GOOD SAFETY PRACTICE INCLUDING THE USE OF SAFETY GLASSES.**

3. Close the disconnecting means feeding the AC drive. Observe the installation for any indication of problems including signs of arcing, unusual noises or odors, or the appearance of smoke or fire. Immediately disconnect power if any of the above conditions are observed and determine the cause of the problem.

 DANGER	**HAZARD OF ELECTRICAL SHOCK OR BURN!** **POTENTIALLY LETHAL VOLTAGES EXIST IN THIS DRIVE AND MAY REMAIN AT A DANGEROUS LEVEL FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS CONTROLLER, WAIT UNTIL THE BUS CHARGED LAMP GOES OUT AND MEASURE THE DC BUS VOLTAGE TO INSURE THAT IT IS ZERO.**

6.3 Start-up Instructions – After Application of Power

1. Refer to the Operation Section for layout and identification of Digital Operator Interface (DOI) components. Observe the DOI on the front of the drive or on the front door of an enclosure if the interface is remote mounted. The LCD display should be active. After an initial power-up message, the default factory setting is for the top line to display Motor Speed in RPM and for the bottom line to display Motor Torque in %FL (percent of Full Load). Note that the display may read differently on OEM supplied equipment or if different factory programming was specified. The Fault LED to the right of the display should not be illuminated. The Stop LED to the right of the Stop (0) button should be illuminated.

2. If, from observations above, the drive appears to be ready, continue with step 3. If the fault LED is blinking or if the LCD display does not display characters, refer to the Troubleshooting Section.

3. Following procedures described in Section 7, Operation and Section 8, Programming, enter the motor nameplate data in the Motor set-up menu. Note that the drive will probably run with factory default data, however, performance may not be optimized. If an SM Cyclo® Gearmotor of the same HP and voltage as the drive is the connected motor, this step is not necessary since SM Cyclo gearmotor data is loaded by default. In either case, after the correct motor data is entered, perform the Auto tune function as described in Section 8, Programming.

Important: Two methods of Auto tuning are available. Standard Auto tuning (the factory default) does not cause motor rotation. Extended Auto tuning performs standard Auto tuning followed by motor rotation at about 50% speed for up to 30 seconds. If Extended Auto tuning is performed, be sure that the motor and driven machine are free to rotate and that all safety procedures are followed. If a brake motor is used, the brake must be released during extended auto tuning.

 DANGER	**AUTOTUNE MAY CAUSE MOTOR ROTATION** **THE AUTOTUNE PROCEDURE MAY CAUSE ROTATION OF THE MOTOR. VERIFY THAT IT IS SAFE TO OPERATE THE MACHINE BEFORE INITIATING THE AUTOTUNE PROCEDURE. AVOID CONTACT WITH THE DRIVEN LOAD**

4. Unless specified otherwise or modified by an OEM, the drive ships configured for local control (i.e. from the drive mounted DOI). The Local LED to the right of the LCD display should be illuminated. If so, press the Run (I) button. The motor should start and accelerate to low operating speed. If it does not, refer to the Programming and Troubleshooting Sections.

   If the Local LED is not illuminated, press the SHIFT key followed by 9 (Loc/Rem). This will force the local override mode. After verifying that the drive operates properly in the local mode, control can be returned to remote by pressing the SHIFT $\rightarrow$ LOC/REM combination again.

 DANGER	**HAZARD OF ELECTRICAL SHOCK OR BURN!** **POTENTIALLY LETHAL VOLTAGES EXIST IN THIS DRIVE AND MAY REMAIN AT A DANGEROUS LEVEL FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS CONTROLLER, WAIT UNTIL THE BUS CHARGED LAMP GOES OUT AND MEASURE THE DC BUS VOLTAGE TO INSURE THAT IT IS ZERO.**

5. Verify that the Forward LED is illuminated and that the motor is rotating in the desired direction. If rotation direction is incorrect, stop the drive by pressing the Stop (0) button. Remove power and lock-out the disconnecting device and, after insuring that the DC bus voltage has decayed, change motor direction by reversing any two of the motor leads on drive terminals T1/U, T2/V, T3/W. Note: If the driven load cannot safely operate in reverse, a reverse disable function is available in the Advanced setup menu. Refer to Section 8, Programming for additional details.

Note: The heatsink fan(s) is (are) thermostatically controlled and will start and stop automatically when the cooling is required. Approximate turn-on and turn-off temperatures are 50°C and 45°C respectively. Heatsink temperature can be monitored using the Present Status function in the Maintenance Mode. Refer to Section 7, Operation and Section 12, Troubleshooting for additional details.

7 OPERATION

7.1 Digital Operator Interface

NTAC-2000 AC drives are supplied with a Digital Operator Interface (DOI) attached to the front of the drive. The DOI can be used to operate the drive, change program parameters and to display drive operating conditions. The DOI can be remote mounted up to 10 feet from the drive using the optional remote mounting kit. Refer to Figure 7.1 below for DOI layout and component identification.

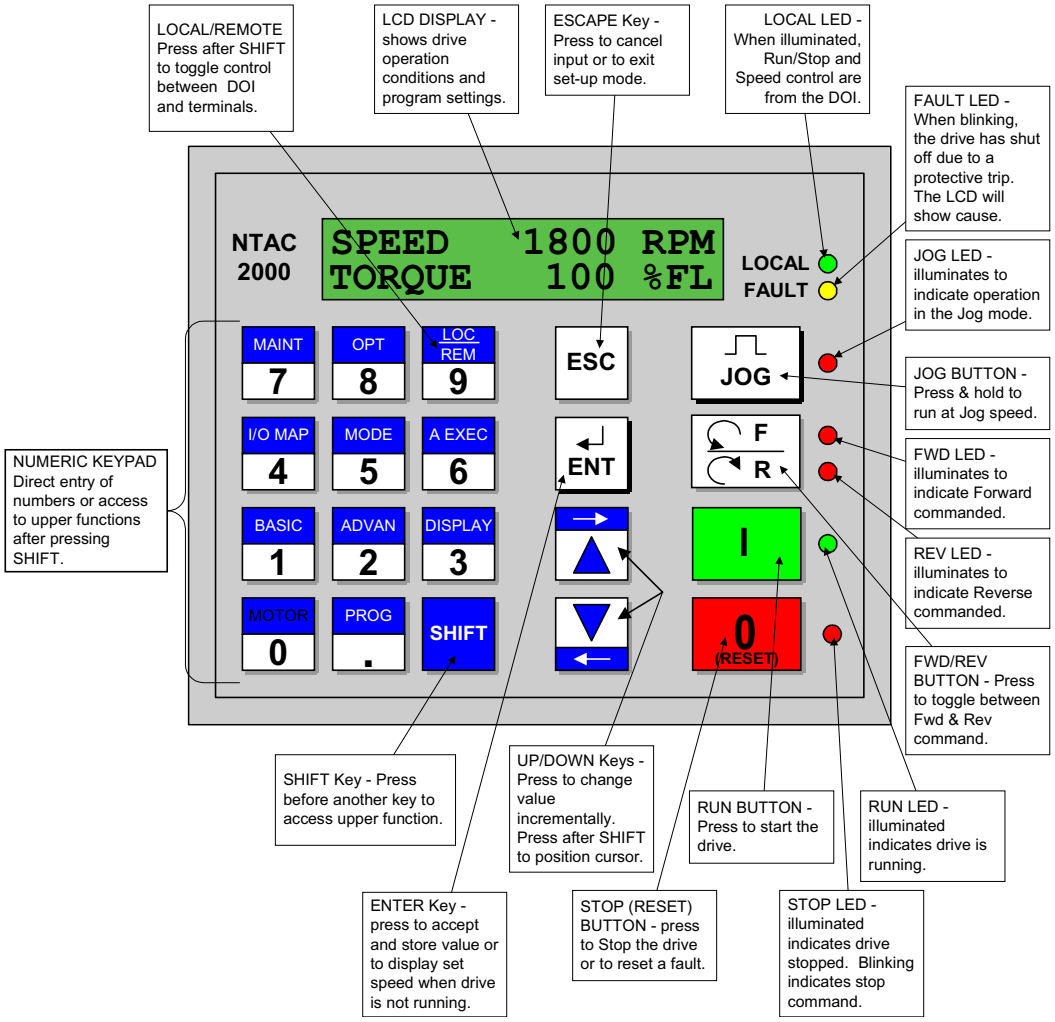


Figure 7.1 – Digital Operator Interface Layout & Identification

7.2 Using the Digital Operator Interface

The Digital Operator Interface (DOI) provides a means of complete control of the NTAC-2000 AC drive without the need for additional hardware. Run and Stop keys allow the drive to be started and stopped, the Forward/Reverse key allows the direction of rotation to be selected (note that Reverse operation can be locked-out by setting the proper parameter) and the motor can be jogged at a preset speed. A detailed description of the DOI is provided on the following pages.

7.3 LCD Display Details

The drive can be set up to control motor speed or torque and speed may be configured in the factory default (RPM) or any engineering units desired using a rate multiplier programmed in a drive parameter along with a user-entered data label and units. A typical display is shown in Figure 7.2 below.

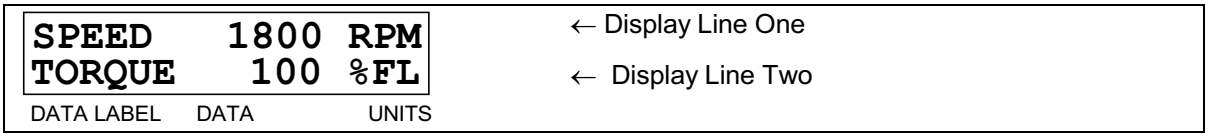


Figure 7.2 – LCD Display

Any of several functions can be programmed for line one of the display. Refer to Section 8.3.4, Display Setup and Section 8.3.6, Control Mode Setup for details. The function programmed for line one is the drive's controlled variable. The factory default is motor speed in RPM units. If the DOI is selected as the Control Source (see Section 8.3.6, Control Mode Setup), the Up / Down arrow keys or the number keys can be used to enter a new value for line one.

If Speed Follower is selected as the Control Mode, line one can be configured to display in engineering units by applying a multiplier to motor speed. For example, if the drive is operating a conveyor that runs at 100 feet per minute (FPM) at a motor speed of 1800 RPM, the display can be configured for "Custom" and a multiplier of 100 / 1800 = 0.056 entered in the custom multiplier parameter. In addition the units label can be changed to read FPM. The result is that the speed will be displayed as 0 to 100 FPM instead of 0 to 1800 RPM.

Some applications such as baking conveyors require that the dwell time in the oven be set in seconds. This results in speed being inversely proportional to the command value entered via the keypad. NTAC-2000 drives also have this capability. Refer to Section 8.3.4 for additional details on setting custom display units.

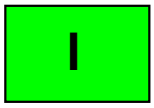
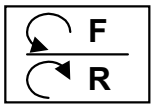
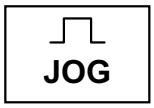
Line two is identical to line one except that line two is for monitoring only. In addition, there are more preprogrammed choices available for display on Line two. Line two is also used to display other operation and fault indication messages. Refer to Section 8.3.4 for details on setting up the display.

Note that should a fault occur, a fault message will override the normal information on line 2 until the fault is reset. A history of the last 4 faults can be viewed via the Fault History option in the Maintenance Mode. Refer to Section 12, Troubleshooting for additional information.

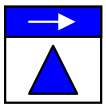
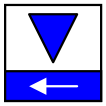
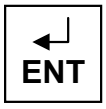
7.4 Operation from the Digital Operator Interface

When local control is selected, the Digital Operator Interface (DOI) allows control of drive operation. The description below explains the function of the DOI keys. Refer to Section 7.5, Remote Operation for details on using external control devices to start and stop the drive.

Keypad Function Description

Keypad Symbol	Control Function	Description of Operation
	Run Key Color – Green	Momentarily pressing this button causes the drive to start and accelerate to set speed.
	Stop (Reset) Key Color – Red	Momentarily pressing this button causes the drive to stop. Note: The Stop button functions even when remote operation is selected. If a fault trip occurs, pressing this button will reset the drive.
	Forward – Reverse Key	Momentarily pressing this button toggles the direction command to the drive. Note that the motor direction does not change instantly. The drive decelerates using the selected decel ramp time, reverses and accelerates using the selected accel ramp time.
	Jog Key	Press and hold this button to operate the motor at the programmed Jog speed in the direction selected by the Forward/Reverse pushbutton.

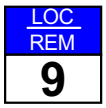
Keypad Function Description (continued)

Keypad Symbol	Control Function	Description of Operation
	Increase Key (Up Arrow)	**Drive Run Mode:** Press briefly to increase the value on line one of the display by one unit. Press and hold to increase continuously. **Drive Program Mode:** Increases a numeric value or moves to next menu choice. Refer to Section 8, Programming for additional details. Note: Press and release SHIFT then press this key to move the display cursor one position to the right.
	Decrease Key (Down Arrow)	**Drive Run Mode:** Press briefly to decrease the value on line one of the display by one unit. Press and hold to decrease continuously. **Drive Program Mode:** Decreases a numeric value or moves to next menu choice. Refer to Section 8, Programming for additional details. Note: Press and release SHIFT then press this key to move the display cursor one position to the left.
	Enter Key	**Drive Run Mode:** Enter a new value for line one using the numeric keypad and press Enter to confirm the new value. **Drive Program Mode:** From Parameter Monitor – enters Parameter Edit mode. From Parameter Edit Mode - saves current parameter value and exits edit mode.

Keypad Function Description (continued)

Keypad Symbol	Control Function	Description of Operation
ESC	Escape Key	**Drive Run Mode:** Press to cancel input from the numeric keypad and restore the old value. **Drive Program Mode:** Press to exit a program menu, to move up one level in the menu structure or to cancel numeric data entered and restore the old value.
SHIFT	Shift Key	Press and release then press a number or arrow key to select the upper function. For example, press SHIFT + 0 to enter the Motor Setup programming mode.
MOTOR 0	Zero (Motor) Key	Press to enter a numeric zero in Drive Run and Drive Program Modes. Press after SHIFT to enter the Motor Setup Program Mode.
BASIC 1	One (Basic) Key	Press to enter a numeric one in Drive Run and Drive Program Modes. Press after SHIFT to enter the Basic Setup Program Mode.
ADVAN 2	Two (Advan) Key	Press to enter a numeric two in Drive Run and Drive Program Modes. Press after SHIFT to enter the Advanced Setup Program Mode.
DISPLAY 3	Three (Display) Key	Press to enter a numeric three in Drive Run and Drive Program Modes. Press after SHIFT to enter the Display Setup Program Mode.
I/O MAP 4	Four (I/O Map) Key	Press to enter a numeric four in Drive Run and Drive Program Modes. Press after SHIFT to enter the Input / Output Map Setup Program Mode.
MODE 5	Five (Mode) Key	Press to enter a numeric five in Drive Run and Drive Program Modes. Press after SHIFT to enter the Control Mode Setup Program Mode.

Keypad Function Description (continued)

Keypad Symbol	Control Function	Description of Operation
	Six (A. Exec) Key	Press to enter a numeric six in Drive Run and Drive Program Modes. Press after SHIFT to enter the Auto-Execute Setup Program Mode.
	Seven (Maint) Key	Press to enter a numeric seven in Drive Run and Drive Program Modes. Press after SHIFT to enter the Maintenance Mode.
	Eight (Opt) key	Press to enter a numeric eight in Drive Run and Drive Program Modes. Press with SHIFT to enter the Option Setup Program Mode. Note: The Option Setup Program Mode is reserved for future use.
	Nine (Loc/Rem) Key	Press to enter a numeric nine in Drive Run and Drive Program Modes. Press with SHIFT to toggle between external (terminal strip) control (if programmed) and local (DOI) control. Note: For safety reasons, Local/Remote does not function if the motor is running.
	Decimal (Prog) Key	Press to enter a decimal point in Drive Run and Drive Program Modes. Press with SHIFT to enter the Program Mode at a specified parameter number entered using the numeric keypad. See Section 8, Programming for details.

7.5 Remote Operation

The Control Source and/or Run-Stop Command are configured in the I/O Map Set-up menu. The drive can be set up to operate either partially or completely from external devices connected to the Control Terminal Strip. Refer to Figure 7.3 below for terminal strip layout. Control can be transferred to and from the Digital Operator Interface by pressing the Shift→LOC/REM combination. Refer to Section 8, Programming for complete details. When the Local LED is on, the Local (DOI) Speed Follower mode is selected. When the Local LED is out, part or all of the control is remote or a mode other than Speed Follower is in effect.

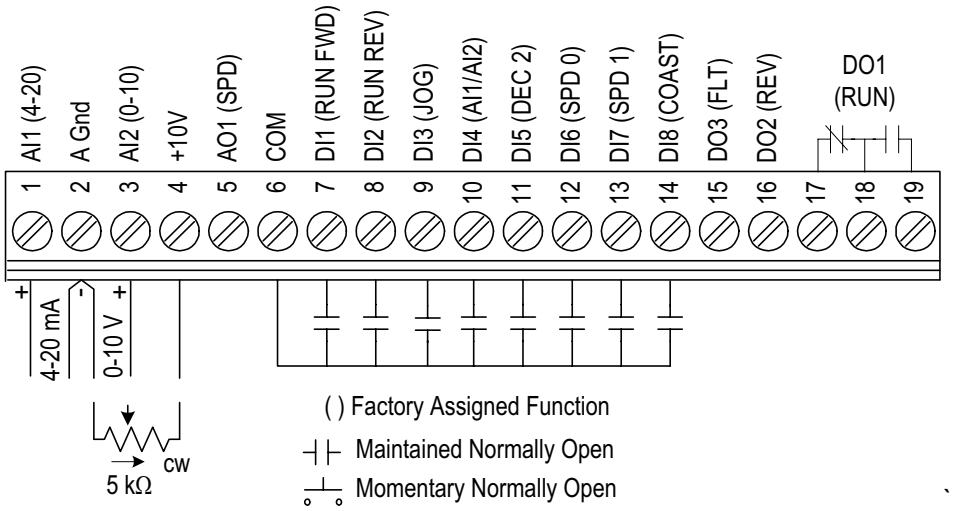


Figure 7.3 – Control Terminal Strip Details

A. Analog Inputs (AI1, 4 to 20 mA & AI2, 0 to ± 10 V) -

Analog inputs AI1 and AI2 can be used to set the drive reference (speed, torque, etc.) from remote devices as shown in Figure 7.3. The factory default setting is for Remote reference control from the terminal strip. This can be changed by setting the proper program function. Refer to Section 8, Programming for instructions on how to do this.

If desired, full local control (from the Digital Operator Interface DOI) can be achieved by pressing the SHIFT → LOC / REM key combination to force the Local Speed Follower Override mode. This does not disturb the programming for Control Source and Run-Stop command.

It is normal practice to connect either a 4-20 mA signal or a 0-10 V signal but not both at the same time. There are some applications which can benefit from allowing connection of both signals and 1) having the drive select which one to use, 2) having the drive sum the two signals to develop the reference command or 3) using one for a setpoint and the other for feedback. The first can be accomplished by using the default setting for Digital Input DI4 – AI1/AI2 Selection. This is common in pump or fan applications where control may be remote from a 4-20 mA signal or from a manual speed potentiometer. Summing or setpoint can be accomplished by programming the desired control mode. Refer to Section 8, Programming for instructions.

B. Analog Output (AO1) –

The drive is equipped with one Analog Output rated for 0 to 10 V. The output can be programmed for any of several functions including Speed, Torque, etc. Refer to Section 8, Programming for details.

Figure 7.3 shows the analog output. Insure that the load impedance of the connected device is at least 10 kΩ.

C. Digital Inputs (DI1 – DI8) –

The drive is equipped with 8 Digital (On – Off) Inputs. These inputs operate at 5 VDC and are active low that means to turn the input on, connect it to the CM (common) terminal, terminal 6. Do not connect an external voltage source greater than 24 VDC to these inputs. Note that the function of these inputs is programmable and Figure 7.3 shows the factory default settings.

Refer to Section 8, Programming for instructions for programming the inputs for other functions. Also refer to Section 13, Typical Connection Diagrams for additional information.

D. Digital Outputs (DO1 – DO3)

The drive is equipped with 3 Digital (On – Off) Outputs. One of these outputs (DO1) is a form C relay and the other two are open collector transistors. Each of the outputs can be assigned a number of different functions through the I/O Map programming menu. Refer to Section 8, Programming for details. Figure 7.3 shows the factory defaults.

8 PROGRAMMING

NTAC-2000 AC drives have factory default parameters as shown in the following tables. Factory defaults are adequate for many applications and may not require modification. In the event that changes are desired, they can be accomplished in one of two ways. First, the Digital Operator Interface (DOI) allows access to parameters for monitoring and changing. Second, a new set of program parameters can be downloaded to the drive using the standard RS-485 serial communications link and programming software available for IBM compatible PCs running Microsoft Windows 95®, Windows 98® or Windows NT®. More details on serial communications are provided later.

8.1 Digital Operator Interface (DOI)

Refer to Section 7, Operation, for a description of the DOI. All keys necessary to accomplish set up of the drive are provided. The LCD display on the DOI will provide language prompts as a guide to programming. Please review the functional description of all of the keys described in Section 7.

8.2 NTAC-2000 Drive – Programming Overview

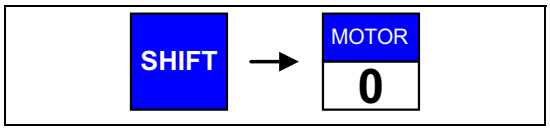
8.2.1 General Instructions for Programming

The Programming Mode can be entered in one of two ways. The first, and most common way, is to press a key combination consisting of the SHIFT key followed by the key corresponding to the menu branch to be entered. For example, SHIFT → MOTOR enters the motor set-up menu.

An alternate way is to press SHIFT and the PROG key, followed by a parameter number (using the numeric keypad) and ENT. This alternate mode is handy when it is desired to return to a specific parameter without scrolling through the menu choices. For example, SHIFT → PROG, 1-0-1, ENT goes directly to ACCEL TIME 1.

8.2.2 Menu Parameter Access

Consider the following example for accessing the programming mode in the Motor Setup menu.



The general procedure to use the menu parameter access mode is detailed below. This mode is very handy when a parameter change is required and the manual is not available.

A. Press and release the SHIFT key.

B. Press the desired Menu key. If, after pressing the SHIFT key, it is desired not to enter the programming mode, simply press the SHIFT key a second time or press ESC (Escape).

C. The LCD display will show one of the following displays depending on the drive running state or whether a password is required. The following examples show the Motor Setup mode.

SPEED 0 RPM **TORQUE 0 %FL**	Normal Operating (Monitor) Mode
ENTER PASSWORD n	Menu is password protected (see Section 8.2.4) or press ESC (Escape) to cancel.
SET-UP BASIC **ENT TO VIEW**	Press ENT (Enter) to proceed.

D. After the above steps are completed the display will show the first parameter in the selected menu branch as shown in the example below. This is the parameter Monitor Mode.

LCD Display in Parameter Monitor Mode

MOTOR VOLTS **460 VAC**	← Parameter Name ← Current Value

E. Use the UP/DOWN arrow keys to scroll the available choices in a menu branch and display the programmed values. The parameter name and current value will change accordingly.

F. After selecting the desired parameter, press ENT (Enter) to enter the parameter Edit Mode. A character in the parameter value will begin blinking. Parameters in the Basic and Display menus can be changed while the drive is running. All others require that the drive be stopped.

MOTOR VOLTS DRIVE RUNNING	Run Locked Parameter: Line 2 will display “DRIVE RUNNING” for about 2 seconds and return to the monitor mode.

LCD Display in Parameter Edit Mode - Blinking block cursor.

MOTOR VOLTS 460 VAC	Use the numeric keypad or the UP/DOWN arrows to change the value.

G. If the parameter to be edited is a numeric value, it can be changed incrementally by using the UP/DOWN arrow keys or by entering the new value with the numeric keypad. If the parameter is multiple choice (example TRUE, FALSE), use the UP/DOWN arrow keys to scroll through the available choices.

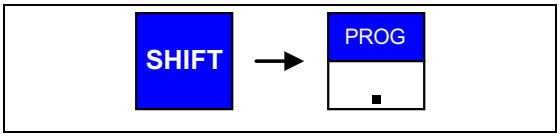
H. Once the desired value is set, press ENT (Enter) to save the new value and exit the Edit Mode or ESC (Escape) to exit the Edit Mode and restore the previous value.

I. Repeat steps E – H for each parameter to be changed.

J. Press ESC one or more times to return to the drive operation mode.

8.2.3 Direct Parameter Access

The following keystroke combination is used to enter the direct parameter access programming mode. The manual or catalog with a listing of parameter numbers is required to use this mode.



A. Press and release the SHIFT key.

B. Press the PROG key. If, after pressing the SHIFT key, it is desired not to enter the programming mode, simply press the SHIFT key a second time or press ESC (Escape). The LCD display will ask for the parameter number as shown below.

GOTO PARAMETER NUMBER 0	Display prompting for parameter number entry.

C. At the prompt, enter the parameter number that is to be accessed. Parameter numbers are listed beginning later in this Section and are shown in the parameter table in Appendix B.

GOTO PARAMETER **NUMBER** 11	Use the numeric keypad to enter the desired parameter number and press ENT.

D. If the menu group where the parameter is located is password protected, enter the password at the prompt and press ENT (Enter).

ENTER PASSWORD n	Menu is password protected (see Section 8.2.4) or press ESC (Escape) to cancel.

E. The LCD display will show the parameter in the parameter Monitor Mode as shown in the example below.

LCD Display in Parameter Monitor Mode

MOTOR VOLTS **460 VAC**	← Parameter Name ← Current Value

F. Press ENT (Enter) to enter the parameter Edit Mode. If the parameter is not run locked, a digit in the parameter value will begin blinking to indicate the Edit mode.

MOTOR VOLTS **DRIVE RUNNING**	Run Locked Parameter: Line 2 will display “DRIVE RUNNING” for about 2 seconds and return to the monitor mode.

LCD Display in Parameter Edit Mode - Digit Blinking in reverse.

MOTOR VOLTS **460 VAC**	Use the numeric keypad or the UP/DOWN arrows to change the value.

G. If the parameter to be edited is a numeric value, it can be changed incrementally by using the UP/DOWN arrow or by entering the new value with the numeric keypad. If the parameter is multiple choice (example TRUE, FALSE), use the UP/DOWN arrow keys to scroll through the available choices.

H. Once the desired value is set, press ENT (Enter) to exit the Edit Mode and save the new value or ESC (Escape) to exit the Edit Mode and restore the previous value.

I. If desired, additional parameters is the same menu group can be monitored or edited. Use the UP/DOWN arrow keys to scroll the parameter list and repeat steps F – H for each parameter to be changed.

J. After all settings are made in the menu branch press ESC (Escape) two times to return to the drive operation mode.

8.2.4 Password Entry Procedure

If a menu is password protected, access to any parameters in that menu are prevented until the correct password has been entered. The flow diagram in Figure 8.1 shows the password entry process.

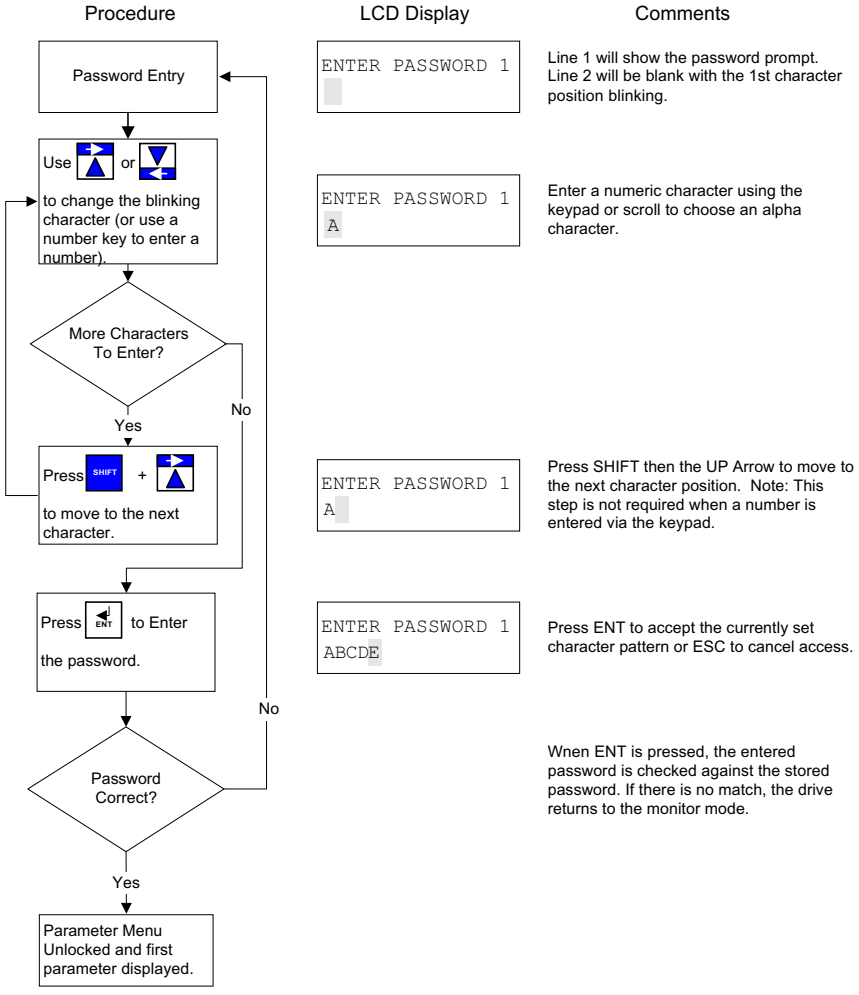


Figure 8.1 – Password Entry Flow Diagram

8.3 Programming Menu Overview

8.3.1 Motor Set-up Program Menu

Keystrokes To Access Menu	Access Control
SHIFT → MOTOR 0	1. Monitor while running – Yes 2. Change while running – No 3. Security – Password 2

Although the drive may run with the factory values, optimum performance requires that the motor nameplate data be entered into the program parameters detailed below and on the following page and the Auto tune function initiated.

Motor Set-up Parameters

Name	No.	Description & Setting Procedure	Factory
MOTOR VOLTS	11	The motor rated voltage from the nameplate. Type: Numeric (nnn) Range: 160-480. Setting Method: Keypad / Arrows.	230 (460) V
MOTOR RATED AMPS	12	Motor Full Load Amps (FLA) from the nameplate. Type: Numeric (nnn.n). Range: 0.1 to 200.0. Setting Method: Keypad / Arrows.	SMA Gear-motor
MOTOR HP [1]	13	The motor nameplate HP. Type: Numeric (nnn.n). Range: 0.1 to 100.0 (Drive Rated ± 2 standard HP sizes). Setting Method: Keypad / Arrows.	Drive Rated
MOTOR RATED FREQ	14	The motor nameplate frequency. Type: Numeric (nnn). Range: 30 – 400. Setting Method: Keypad / Arrows.	60 Hz
MOTOR BASE SPEED	15	The motor nameplate rated speed not synchronous speed. Type: Numeric (nnnn). Range of Values: 500-3600. Setting Method: Keypad / Arrows.	SMA Gear-motor

[1] The drive can be configured to operate a motor larger than its rating, however, the drive continuous rating cannot exceed the drive nameplate HP.

Motor Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
AUTO-TUNE DRIVE	16	Selectable: Standard/Extended Initiates an auto tuning function where the drive outputs power to the motor to calculate several motor parameters. Extended autotuning results in motor shaft rotation. Standard autotuning is adequate for most applications but Extended provides slightly better low speed operation and enhanced starting torque. **Motor data must be reentered and Autotune reinitiated any time the motor changes or after a Parameter Reset function is executed.**	Standard

DANGER	**POSSIBLE MOTOR ROTATION AND MACHINE MOTION!** **POWER IS APPLIED TO THE MOTOR DURING AUTOTUNING. AVOID CONTACT WITH THE MOTOR AND CONNECTED LOAD AS UNEXPECTED MOTION MAY OCCUR.**

MAX-IMUM SPEED	17	The motor maximum allowed operating speed. Type: Numeric (nnnn). Range: 500 – 9999. Setting Method: Keypad / Arrows.	1800 RPM
MINIMUM SPEED [2]	18	The minimum continuous operating speed of the motor. Type: Numeric (nnnn). Range of Values: 0 – 3600. Setting Method: Keypad / Arrows.	90 RPM
JUMP SPEED 1 LOW	19	Sets the low end of the jump speed band 1. Zero disables. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	0 RPM

Motor Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
JUMP SPEED 2 LOW	20	Sets the low end of the jump speed band 2. Zero disables. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	0 RPM
JUMP SPEED 3 LOW	21	Sets the low end of the jump speed band 3. Zero disables. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	0 RPM
JUMP SPEED BAND	22	This value is added to the value in each Jump Speed Low value to determine the high end of the jump speed range. Set to zero to disable. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	0 RPM

[2] Absolute minimum speed is determined by the number of motor poles. Setting a value of zero in this parameter will cause the drive to automatically configure for the lowest constant torque operating speed available for the particular motor.

8.3.2 Basic Set-up Program Menu

Keystrokes To Access Menu	Access Control
SHIFT → BASIC 1	1. Monitor while running – Yes 2. Change while running – Yes 3. Security – Password 1

Basic Set-up Parameters

Name	No.	Description & Setting Procedure	Factory
ACCEL TIME 1	101	Sets the primary acceleration time to go from zero to maximum speed. Type: Numeric (nnn.n). Range: 0.1 – 999.9. Setting Method: Keypad / Arrows.	10.0 S
DECEL TIME 1	102	Sets the primary deceleration time to go from maximum speed to zero. Type: Numeric (nnn.n). Range: 0.1 – 999.9. Setting Method: Keypad / Arrows.	10.0 S
ACCEL TIME 2	103	Sets the secondary acceleration time to go from zero to maximum speed. Type: Numeric (nnn.n). Range: 0.1 – 999.9. Setting Method: Keypad / Arrows.	10.0 S
DECEL TIME 2	104	Sets the secondary deceleration time to go from maximum speed to zero. Type: Numeric (nnn.n). Range: 0.1 – 999.9. Setting Method: Keypad / Arrows.	10.0 S
ACCEL/ DECEL MODE	105	Sets whether Linear or S-curve acceleration/deceleration is used. Type: Multiple Choice Range: LINEAR, S-CURVE Setting Method: Up/Down Arrows.	LINEAR
DECEL SHIFT SPD	106	Sets the speed at which the drive shifts from Decel Time 2 to Decel Time 1. Set to zero to disable. Type: Numeric (nnnn). Range: 0- 9999. Setting Method: Keypad / Arrows.	0 RPM

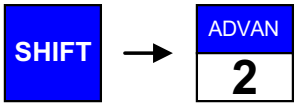
Basic Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
FAST STOP DECEL	107	Sets the deceleration time used if one of the digital inputs configured as Fast Stop is active. Type: Numeric (nn.n). Range: 0.1 – 10.0. Setting Method: Keypad / Arrows.	10.0 S
JOG SPEED	108	Sets the operational speed if the Jog button is pressed and held or if one of the digital inputs is set to Jog and the input is active. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	180 RPM
JOG ACCEL TIME	109	Sets the acceleration time during a jog cycle. Type: Numeric (nn.n). Range: 0.1 – 10.0. Setting Method: Keypad / Arrows.	0.5 S
JOG DECEL TIME	110	Sets the deceleration time during a jog cycle. Type: Numeric (nn.n). Range of Values: 0.1 – 10.0. Setting Method: Keypad / Arrows.	0.5 S
PRESET SPEED 1	111	Sets the operation speed when the digital inputs are configured to select preset speed number 1. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	100 RPM
PRESET SPEED 2	112	Sets the operation speed when the digital inputs are configured to select preset speed number 2. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	300 RPM
PRESET SPEED 3	113	Sets the operation speed when the digital inputs are configured to select preset speed number 3. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	600 RPM
PRESET SPEED 4	114	Sets the operation speed when the digital inputs are configured to select preset speed number 4. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	900 RPM

Basic Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
PRESET SPEED 5	115	Sets the operation speed when the digital inputs are configured to select preset speed number 5. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	1200 RPM
PRESET SPEED 6	116	Sets the operation speed when the digital inputs are configured to select preset speed number 6. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	1500 RPM
PRESET SPEED 7	117	Sets the operation speed when the digital inputs are configured to select preset speed number 7. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	1800 RPM
DC BRAKE TIME	118	Sets the duration of DC injection braking. Set to zero to disable. Type: Numeric (nn.n). Range: 0.0 – 60.0. Setting Method: Keypad / Arrows.	0.5 S
DC BRAKE AMPS	119	Sets the DC injection braking current as a percentage of Drive rated amps. Type: Numeric (nnn). Range: 0 – 100. Setting Method: Keypad / Arrows.	25 %

8.3.3 Advanced Set-up Program Menu

Keystrokes To Access Menu	Access Control
	1. Monitor while running – Yes 2. Change while running – No 3. Security – Password 2

Advanced Set-up Parameters

Name	No.	Description & Setting Procedure	Factory
RETRY AT-TEMPTS	201	Sets the number of times that the drive will automatically reset after a fault condition. Type: Numeric (nn). Range: 0 – 10. Setting Method: Keypad / Arrows.	0

POSSIBLE AUTOMATIC RESTART!

IF 2-WIRE CONTROL IS SELECTED AND THE RUN COMMAND INPUT IS CLOSED, THE MOTOR WILL AUTOMATICALLY RESTART UPON EXPIRATION OF THE RETRY DELAY TIME IF THE RETRY ATTEMPTS VALUE IS SET TO ANYTHING OTHER THAN ZERO.

RETRY DELAY	202	Sets the minimum time which must pass before an automatic reset is attempted. Type: Numeric (nnn.n). Range: 0.1 – 600.0. Setting Method: Keypad / Arrows.	10.0 S
STOP MODE	203	Sets whether the drive Ramps or Coasts to stop after receiving a Stop command. Type: Multiple Choice. Range: RAMP, COAST. Setting Method: Up/Down arrows.	RAMP
RE-VERSE ENABLE	204	A setting of TRUE enables reverse operation of the drive. Type: Multiple Choice. Range of Values: TRUE, FALSE. Setting Method: Up/Down arrows.	TRUE

Advanced Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
CATCH ON THE FLY	205	A setting of TRUE will cause the drive to search for and match the speed of a coasting motor when restarting after a momentary power outage or fault trip. Type: Multiple Choice. Range: TRUE, FALSE. Setting Method: Up/Down arrows.	FALSE
SPEED DETECT LEV	206	A digital output set for SPEED DETECT HI is active when Actual Speed ≥ SPEED DETECT LEV. A digital output set for SPEED DETECT LO is active when Actual Speed < SPEED DETECT LEV. See SPEED LEV DELAY below and Digital Output configuration in the I/O Map menu. Set to zero to disable. Type: Numeric (nnnn). Range: 0 – 9999. Setting Method: Keypad / Arrows.	0 RPM
SPEED LEV DELAY	207	Sets the time that must pass before a Speed Detect output will become active. Type: Numeric (nn.n). Range: 0.0 – 60.0. Setting Method: Keypad / Arrows.	0.0 S
TORQ DETECT LEV	208	A digital output set for TORQUE DETECT HI is active when Actual Torque ≥ TORQ DETECT LEV. A digital output set for TORQUE DETECT LO is active when Actual Torque < TORQ DETECT LEV. See TORQ LEV DELAY below and Digital Output configuration in the I/O Map menu. Set to zero to disable. Type: Numeric (nnn). Range: 0 – 150. Setting Method: Keypad / Arrows.	0 %FL
TORQ LEV DELAY	209	Sets the time that must pass before a Torque Detect Output will become active. Type: Numeric (nn.n). Range: 0.0 – 60.0. Setting Method: Keypad / Arrows.	0.0 S

Advanced Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
MOTOR TORQ LIMIT	210	Sets the maximum torque that the motor can develop when the motor is driving the load. Type: Numeric (nnn). Range: 10 – 300% of motor rating. Setting Method: Keypad / Arrows.	150 %FL
REGEN TORQ LIMIT	211	Sets the maximum braking torque that the motor can develop when the load is overhauling the motor or the drive is decelerating. Note: Optional dynamic braking resistor may be required. Type: Numeric (nn.n). Range: 10 – 200% of motor rating. Setting Method: Keypad / Arrows.	150 %FL
SPEED UP/DN	212	Determines whether the drive will ramp to the last set speed or to minimum speed when 2 digital inputs are assigned to the SPEED UP & SPEED DN functions. Type: Multiple Choice. Range: RESET – Reset to zero speed. MAINTAIN – Maintain last speed. Setting Method: Up/Down arrows.	RESET
FOLLOWER LOSS	213	Sets the action of the drive in response to the 4-20 mA analog signal dropping below 3 mA. Type: Multiple Choice. Range: DISABLE – Do not detect a follower loss. TRIP – Cause a fault trip and drive shutdown. Setting Method: Up/Down arrows.	DISABLE

Advanced Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
MAINT ALERT TIME	214	Setting a value other than zero will cause display line two to indicate MAINT ALERT after the operation hours since reset equal or exceed the set value. This can be used as an indicator to perform Preventive Maintenance such as motor lubrication. Type: Numeric (nnnnn). Range of Values: 0 – 65535. Setting Method: Keypad / Arrows.	0 HR
COMM ADDRESS	215	Sets the drive address for serial communications. Zero is reserved as the "broadcast" address. Type: Alphanumeric α. Range: 1 – 9, A – Z. Setting Method: Up/Down arrows.	1
COMM SPEED	216	Sets the communication speed (bits per second) of the serial communication link. This must agree with the rate set for the host computer. Type: Multiple Choice. Range: 1200, 2400, 4800, 9600, 19200 Setting Method: Up/Down arrows.	9600 BPS
COMM ERROR	217	Sets the drive response to loss of communications. Type: Multiple Choice. Range: ALARM – Annunciate loss but continue operation. TRIP – Cause a fault trip and drive shutdown. Setting Method: Up/Down arrows.	TRIP
COMM DOWN TIME	218	The host must access the drive before the set time expires to prevent a communication error. Set to zero to disable. Type: Numeric (nnn). Range: 0 – 600. Setting Method: Keypad / Arrows.	0 S

Advanced Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
PASS-WORD 1 SET	219	Sets the character pattern of up to 5 characters for the password to access Basic Menu parameters. Type: Alphanumeric (aaaaa). Range: 0 – 9, A – Z, space. Setting Method: Numeric Keypad for numeric values or Up/Down arrows for alpha values.	All spaces (No Pass-word)
PASS-WORD 2 SET	220	Sets the character pattern of up to 5 characters for the password to all except Basic and Maintenance Menu parameters. Type: Alphanumeric (aaaaa). Range: 0 – 9, A – Z, space. Setting Method: Numeric Keypad for numeric values or Up/Down arrows for alpha values.	All spaces (No Pass-word)
OL ALERT LEVEL	221	Sets the percent of drive overload capacity that causes a digital output set to Overload Trip Alert to become active when the drive is operating above rated output current. Type: Numeric (nnn). Range: 10 – 100. Setting Method: Keypad / Arrows.	100
ORIENT OVER-RIDE	222	If a digital input is set for Orient and the orient input is not received within the set time for Orient Override, the drive will stop. See the digital input configuration in the I/O Map menu for additional information. Type: Numeric (nn.n). Range: 0.0 – 60.0. Setting Method: Keypad / Arrows.	1.0 S
PRO-POR-TION GAIN	223	Sets the proportional gain when the SET POINT control mode is selected. Type: Numeric (nn.n). Range: 0.1 to 10.0. Setting Method: Keypad / Arrows.	1.0

Advanced Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
INTE-GRAL GAIN	224	Sets the integral gain when the SET POINT control mode is selected. Type: Numeric (nnnn). Range: 0.01 to 1.00 Setting Method: Keypad / Arrows.	1.00
INERTIA	225	Allows setting of an inertia factor which allows drive performance to be optimized when driving high inertia loads. The factory value configures the drive for a load inertia approximately 2X motor inertia. Higher values slow speed regulation response. Type: Numeric (nnn). Range: 0 to 100 Setting Method: Keypad / Arrows.	20
PARA-METER RESET	226	Pressing ENT when displaying this parameter resets all drive parameters to their factory or OEM set values. This function does not affect the AutoExec parameters. **NOTE: After executing this function, it is necessary to reenter motor data and reinitiate the Auto tune function.**	N/A
RESET RUN TIME	227	Pressing ENT when displaying this parameter reset the drive running time to zero.	N/A
SPEED REGU-LATOR	228	Enables or disables the speed regulator function. Type: Multiple Choice Range: ENABLED – Speed regulator is fully functional DISABLED – Drive runs in a pseudo V/F mode	ENABLED

8.3.4 Display Set-up Program Menu

Keystrokes To Access Menu	Access Control
SHIFT → DISPLAY 3	1. Monitor while running – Yes 2. Change while running – Yes 3. Protection – Password 1

Display Set-up Parameters

Name	No.	Description & Setting Procedure	Factory
LANG-UAGE	301	Used to select the language in which messages are displayed. Type: Multiple Choice. Range: ENGLISH, SPANISH. Setting Method: Up/Down arrows.	ENGLISH
SPEED UNITS	302	Used to select the way speed is shown on line 1 of the display when the control mode is set for Speed Follower. Data shown on line 1 is the controlled variable and can be changed by the keypad, remote terminals or serial port. Type: Multiple Choice. Range: SPEED RPM – Speed in RPM. SPEED % - Speed in % rated. CUSTOM - (custom label, rate multiplier and units see parameters 304 – 307). Setting Method: Up/Down arrows.	SPEED (RPM)

Display Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
LINE 2 DISPLAY	303	Used to select the information shown on line 2 of the display. Type: Multiple Choice. Range: SPEED (RPM or %) TORQUE (%FL) FREQ – Output Freq. (HZ) SET PT – Set Point (%) I OUT – Output Current A V OUT – Output Voltage (VAC) V BUS – DC Bus Voltage (VDC) I REF – 4 to 20 mA input (MA) V REF – 0 to 10 V input (VDC) ENERGY – Energy used (kWH) POWER – Output power (KW) R TIME – Operating (HR) CUSTOM - (custom label, rate multiplier and units). NOT USED – 2nd line blank. Setting Method: Up/Down arrows.	TORQUE (%FL)
CUSTOM MLT FCN	304	Determines whether the speed display is direct or inverse acting. If direct acting, increasing value indicates increasing speed. If inverse acting, increasing value indicates decreasing speed. Type: Multiple Choice Range: SPEED, 1/SPEED (time) Setting Method: Up/Down arrows.	
CUSTOM MULT	305	Multiplier applied to motor speed to convert speed to engineering units when CUSTOM is selected for Speed or Line 2 display. Range changes based on selection of Custom Multiplier Function parameter. CUSTOM MULT FCN = SPEED Type: Numeric (n.nnnn) Range: 0.0001 to 6.5535 CUSTOM MULT FCN = 1/SPEED Type: Numeric (nnn.nn) Range: 0.01 to 655.35 Setting Method: Keypad / Arrows.	1.0000 SPEED or 1.00 1/SPEED

Display Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
CUSTOM LABEL	306	Allows a custom data label of up to 6 characters to be set. Type: Multiple Choice Range: 0 – 9, A – Z, space Setting Method: Up/Down arrows.	CUSTOM
CUSTOM UNITS	307	Allows a custom units label of up to 3 characters to be set. Type: Multiple Choice Range: 0 – 9, A – Z, space Setting Method: Up/Down arrows.	CUS

8.3.5 I/O (Input/Output) Map Set-up Program Menu

Keystrokes To Access Menu	Access Control
SHIFT → I/O MAP 4	1. Monitor while running – Yes 2. Change while running – No 3. Protection – Password 2

I/O Map Set-up Parameters

Name	No.	Description & Setting Procedure	Factory
DIGITAL IN	401	Press ENT (Enter) to view Digital Inputs and assigned functions.	
DIGITAL IN DI1	402	Configures Digital Input 1 for Run Forward (2-wire) or Stop (3-wire) control. Type: Multiple Choice. Range: RUN FWD, STOP. Setting Method: Up/Down arrows.	RUN FWD
DIGITAL IN DI2	403	Configures Digital Input 2 to function as described below Type: Multiple Choice. Range: RUN REV REVERSE (direction select only) START FORWARD START REVERSE SPEED UP, SPEED DN JOG FORWARD, JOG REVERSE ACCEL 2, DECEL 2, COAST EXT FAULT (NO), EXT FAULT (NC) FAST STOP, RESET, ORIENT SPEED 0, SPEED 1, SPEED 2 IN1, IN2, IN3, IN4 AI1/AI2 Select JOG REVERSE (0106 or later) REMOTE STOP (NC) (0106 or later) FWD ENABLE, REV ENABLE (010E or later) AUTOTUNE Initiate (0108 or later) NO FUNCTION Setting Method: Up/Down arrows.	RE-VERSE

I/O Map Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
DIGITAL IN DI3	404	See Description for DIGITAL IN 2	JOG
DIGITAL IN DI4	405	See Description for DIGITAL IN 2	AI1/AI2
DIGITAL IN DI5	406	See Description for DIGITAL IN 2	DECEL 2
DIGITAL IN DI6	407	See Description for DIGITAL IN 2	SPEED 0
DIGITAL IN DI7	408	See Description for DIGITAL IN 2	SPEED 1
DIGITAL IN DI8	409	See Description for DIGITAL IN 2	COAST
ANALOG IN	410	Press ENT (Enter) to view the Analog Input configuration list.	
AI1 MINIMUM	411	Sets value which results in drive minimum speed. Set minimum larger than maximum for inverse action. Type: Numeric (nn.n). Range: 4.0 – 20.0. Setting Method: Keypad / Arrows.	4.0 MA
AI1 MAX-IMUM	412	Sets value which results in drive maximum speed. Set maximum smaller than minimum for inverse action. Type: Numeric (nn.n). Range: 4.0 – 20.0. Setting Method: Keypad / Arrows.	20.0 MA
AI2 MODE	413	Determines if the analog voltage input is Unipolar (0 to 10 VDC) or Bipolar (-10 to +10 VDC). Type: Multiple Choice. Range: UNIPOLAR (0 TO +V) BIPOLAR (–V TO +V). Setting Method: Up/Down arrows.	UNI-POLAR
AI2 DEAD BAND	414	Sets the region around zero on the analog voltage input where no change in the drive output occurs. Type: Numeric (n.n). Range: 0.0 – 5.0. Setting Method: Keypad / Arrows.	0.0 V

I/O Map Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
AI2 MINIMUM	415	Sets value which results in drive minimum speed. Set minimum larger than maximum for inverse action (AI2 MODE = UNIPOLAR). Type: Numeric (nn.n). Range: 0.0 – 10.0. Setting Method: Keypad / Arrows.	0.0 V
AI2 MAXIMUM	416	Sets value which results in drive maximum speed. Set maximum smaller than minimum for inverse action (AI2 MODE = UNIPOLAR). Type: Numeric (nn.n). Range: 0.0 – 10.0. Setting Method: Keypad / Arrows.	10.0 V
DIGITAL OUT	420	Press ENT (Enter) to view Digital Outputs and assigned functions.	
DIGITAL OUT DO1 (Relay)	421	Configures Digital Output 1 to function as described below. Type: Multiple Choice. Range: RUN FAULT AT SPEED SPEED DETECT HI / LO REVERSE TORQUE DETECT HI / LO OUT 1, OUT 2, OUT 3 OL TRIP ALERT BRAKE (Motor Brake Control) Setting Method: Up/Down arrows.	RUN
DO2 OC)	422	See Description for DO1	REVERSE
DO3 OC)	423	See Description for DO1	FAULT

I/O Map Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
ANALOG OUT	430	Configures the 0 to 10 VDC analog output to function as described below. Type: Multiple Choice. Range: SPEED – 10 V = max. speed. TORQUE – 10 V = 200% rated. OUTPUT AMPS – 10 V = 200% rated current. POWER – 10 V = 200% rated. OUTPUT VOLTS – 10 V = rated output volts. DC BUS VOLTS – 10 V = 1000 V dc bus. Setting Method: Up/Down arrows.	SPEED

8.3.6 Control Mode Set-up Program Menu

Keystrokes To Access Menu	Access Control
SHIFT → MODE 5	1. Monitor while running - Yes 2. Change while running – No 3. Optional Password – Level 2

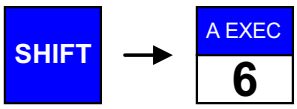
Control Mode Set-up Parameters

Name	No.	Description & Setting Procedure	Factory
CON-TROL MODE	501	Sets up the operating mode of the drive to one of five possible states as shown below. Type: Multiple Choice. Range: SPEED FOLLOWER – Drive follows speed command. SPEED SETPOINT – PI control (AI1 is always feedback). TORQUE FOLLOWER – Drive follows torque command. TORQUE SETPOINT - PI control (AI1 is always feedback). AUTO EXECUTE – drive runs internal program. See Section 7, AutoExec Programming. Setting Method: Up/Down arrows.	SPEED FOL-LOWER

Control Mode Set-up Parameters

Name	No.	Description & Setting Procedure	Factory
CONTROL SOURCE	502	Sets the source of the signal that controls the Follower or Set Point command. Type: Multiple Choice Range: LOCAL – the drive keypad. REMOTE – terminal strip (AI1 or AI2) except AI2 only when setpoint mode is selected. SUM – terminal strip (AI1 + AI2). (Speed or Torque follower only) SERIAL PORT – RS-485 port. Setting Method: Up/Down arrows.	REMOTE
RUN-STOP COM-MAND	503	Sets the source of the drive run command. Type: Multiple Choice. Range: LOCAL – the drive keypad. REMOTE – terminal strip. SERIAL PORT – RS-485 port. Setting Method: Up/Down arrows.	REMOTE
KEYPAD FUNC-TION	504	Provides a means of disabling the keypad. Note: For safety reasons, the Stop (0) button is always functional. Type: Multiple Choice. Range: UNLOCKED, LOCKED Setting Method: Up/Down arrows.	UN-LOCKED

8.3.7 AutoExec (Automatic Execution) Set-up Program Menu

Keystrokes To Access Menu	Access Control
	1. Monitor while running – Yes 2. Change while running – No 3. Optional Password – Level 2

Refer to Section 10, AutoExec Programming for details on the operation of instructions described below. In order to use the Auto Execute mode, the Control Mode must be set for AUTO EXECUTE. The entered program will begin executing when the drive receives a Run command from the keypad or terminal strip and will stop executing when the END statement is reached or the drive receives a stop command.

AutoExec Set-up Parameters

Name	No.	Description & Setting Procedure	Factory
COUNT 1 =	601	Presets counter number 1. Type: Numeric (nnnnn). Range: 0 to 65535. Setting Method: Keypad / Arrows.	0
COUNT 2 =	602	Presets counter number 2. Type: Numeric (nnnnn). Range: 0 to 65535. Setting Method: Keypad / Arrows.	0
TIMER 1 =	603	Presets timer number 1. Type: Numeric (nnnnn). Range: 0 to 65535. Setting Method: Keypad / Arrows.	0 S
TIMER 2 =	604	Presets timer number 2. Type: Numeric (nnnn.n). Range: 0.0 to 6553.5. Setting Method: Keypad / Arrows.	0.0 S
SINGLE STEP MODE	605	Allows a program to be tested by executing only one step at a time. Type: Multiple Choice Range: TRUE, FALSE Setting Method: Up/Down arrows.	FALSE

AutoExec Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
CLEAR PRO-GRAM	606	Allows an entire AutoExec program to be erased by setting all steps to END. Also clears counter and timer presets to zero. Press ENT (Enter) to clear.	
STEP (1…32)	607	Steps 1 through 32 make up the program to be executed when the drive receives a run command. Any of the following instructions can be entered in any step.	END
	610	MOTOR COMMAND – allows control of motor operation and direction. Type: Multiple Choice. Range: RUN FORWARD, RUN REVERSE, STOP Setting Method: Press ENT to enter edit mode, Up / Down arrows to choose.	
	611	SET SPEED – allows control of the motor speed. Type: Multiple Choice. Range: AI1 – 0-10 V controls speed. AI2 – 4-20 mA controls speed. LOCAL – keypad controls speed. SERIAL PORT – RS-485 port controls speed. PRESET SPEED 1…7–drive runs at the preset speed selected. Setting Method: Press ENT to enter edit mode, Up / Down arrows to choose.	
	612	ACCEL/DECEL MODE – sets which ramp time will be used. Acceleration and Deceleration time 1 is used by default. Type: Multiple Choice. Range: ACCEL1, ACCEL2, DECEL 1, DECEL 2. Setting Method: Press ENT to enter edit mode, Up / Down arrows to choose.	

AutoExec Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
	613	TIMER ADJUST – controls the specified timer as shown below. Type: Multiple Choice. Range: TIMER1 START, TIMER1 STOP, TIMER1 RESET, TIMER2 START, TIMER2 STOP, TIMER2 RESET Setting Method: Press ENT to enter edit mode, Up / Down arrows to choose.	
	614	COUNTER ADJUST – controls the specified counter as shown below. Type: Multiple Choice. Range: COUNT1 DEC – subtract 1. COUNT1 RESET – reset to (COUNT 1 =) value. COUNT2 DEC – subtract 1. COUNT2 RESET – reset to (COUNT 2 =) value. Setting Method: Press ENT to enter edit mode, Up / Down arrows to choose.	
	615	SET OUTPUT – turns ON the specified digital output. Note that the output must be assigned in the I/O MAP menu. Type: Multiple Choice. Range: OUT1, OUT2, OUT3 Setting Method: Press ENT to enter edit mode, Up / Down arrows to choose.	
	616	CLEAR OUTPUT – turn OFF the specified digital output. Note that the output must be assigned in the I/O MAP menu. Type: Multiple Choice. Range: OUT1, OUT2, OUT3 Setting Method: Press ENT to enter edit mode, Up / Down arrows to choose.	

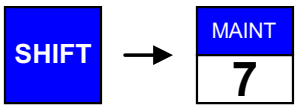
AutoExec Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
	617	GOTO STEP – branches program flow to the specified step. Type: Numeric (nn) Range: 1 to 32 Setting Method: Press ENT to enter edit mode, use number key to enter step number.	
	618	IF COMMAND – functions like the computer language statement If – Then – Else to test for a specified condition. Example: • If - the condition is true • Then – execute the next step. • Else – skip the next step. Type: Multiple Choice. Test Conditions: COUNT1 = 0 COUNT1 > 0 COUNT2 = 0 COUNT2 > 0 TIMER1 = 0 TIMER1 > 0 TIMER2 = 0 TIMER2 > 0 Setting Method: Press ENT to enter edit mode, Up / Down arrows to choose.	

AutoExec Set-up Parameters (continued)

Name	No.	Description & Setting Procedure	Factory
	619	IF IN – similar to IF COMMAND statement above but tests the state of digital inputs configured as IN1, IN2, IN3, IN4. Type: Numeric. Range: 0 = OFF, 1 = ON 2..9 = X (don't care). Example: To test for IN1 On, IN2 Off and IN3, IN4 doesn't matter or are not used, set the test pattern to 10XX. TRUE results if there is an exact match and FALSE if there is not. Setting Method: Press ENT to enter edit mode, use number keys to enter the test pattern. Note: all 4 inputs must be tested even if all 4 are not used.	
	620	IF NOT IN – similar to IF IN above except TRUE results if there is not an exact match and FALSE if there is an exact match. Range: 0 = OFF, 1 = ON 2..9 = X (don't care). Setting Method: Press ENT to enter edit mode, use number keys to enter the test pattern. Note: all 4 inputs must be tested even if all 4 are not used.	
	621	END – the default value for all steps. Note: END must appear in the first unused program step and any steps after the step containing the END statement will be ignored.	
	622	INSERT STEP – allows program editing by inserting a program step before the currently displayed step. Press ENT to insert a step.	
	623	DELETE STEP – allows program editing by deleting the current program step. Press ENT to delete a step.	

8.3.8 Maintenance Menu

Keystrokes To Access Menu	Access Control
	1. Access while running – Yes 2. Password – No

Refer to Section 12, Troubleshooting for information on using the Maintenance Mode to solve drive or external equipment problems.

Maintenance Mode Parameters

Name	No.	Description
FAULT HISTORY	701	Accesses the stored fault sub-menu. Press ENT to access, then the Up/Down arrows to view.
FAULT 1	702	Shows the most recent fault (if any) otherwise shows NONE.
FAULT 2	703	Shows the 2nd most recent fault (if any) otherwise shows NONE.
FAULT 3	704	Shows the 3rd most recent fault (if any) otherwise shows NONE.
FAULT 4	705	Shows the 4th most recent fault (if any) otherwise shows NONE.
PRESENT STATUS	710	Shows the current operating status of the drive. Press ENT to access, then the Up/Down arrows to view.
SPEED	711	Shows motor speed in RPM.
FREQ	712	Shows drive output frequency in HZ.
TORQUE	713	Shows motor torque in %FL.
SET PT	714	Shows the value of the feedback in %.
I OUT	715	Shows drive output current in A.
V OUT	716	Shows the drive output voltage in VAC.
V BUS	717	Shows the drive dc bus voltage in VDC.
I REF	718	Shows the 4-20 ma reference input in MA.
V REF	719	Shows the 0-10 v reference in VDC.
ENERGY	720	Shows drive energy consumed in KWH since reset.
POWER	721	Shows the drive output power in KW.
R TIME	722	Shows the drive running time in HR.
CUSTOM	723	Shows speed in custom units, if defined in the Display Set-up.
ROTATE	724	Shows the commanded rotation direction (FWD/REV).
TEMP	725	Shows the heatsink temperature in °C.

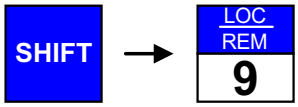
Maintenance Mode Parameters (Continued)

Name	No.	Description
DIGITAL INPUTS	730	Shows the assigned function and state of Digital Inputs. (Function, 0 = off, 1 = on). Press ENT to access, then the Up/Down arrows to view.
DI1	731	FUNCTION n
DI2	732	FUNCTION n
DI3	733	FUNCTION n
DI4	734	FUNCTION n
DI5	735	FUNCTION n
DI6	736	FUNCTION n
DI7	737	FUNCTION n
DI8	738	FUNCTION n
DIGITAL OUTPUTS	740	Shows the assigned function and state of Digital Outputs. (Function, 0 = off, 1 = on). Press ENT to access, then the Up/Down arrows to view.
DO1	741	FUNCTION n
DO2	742	FUNCTION n
DO3	743	FUNCTION n
CLEAR FAULTS	750	Clears the Fault History data. Press ENT to clear.
RESET KWH	770	Resets the energy monitor to zero. Press ENT to reset.
SOFTWARE VERSION	780	Shows the version of the drive EPROM software

8.3.9 Option Programming Mode

The Option Programming Mode is reserved for future use.

8.4 Local – Remote Override Mode

Keystroke Combination


Normally, the Control Source and the Run-Stop Command are set in the Control Mode menu to meet the application requirements that may include remote terminal strip or serial port control. This keystroke combination allows the user to override programming in the Control Mode menu and force Local Speed Follower control. The following description details the four possible cases.

Case 1: CS – DOI R/S – DOI	Executing the Local/Remote command will have no effect since all control is programmed to be Local (from the DOI). The Local LED will be illuminated indicating total DOI control.

Case 2: CS – DOI R/S – Remote	**1st Press:** Executing the Local/Remote command will force the Run/Stop command to be from the DOI. The Local LED will illuminate. The Control Source is not affected because it is already programmed to be from the DOI. **2nd Press:** Executing the Local/Remote command will restore Run/Stop command back to the terminals or serial port as programmed. The Local LED will extinguish.

Case 3: CS – Remote R/S – DOI	**1st Press:** Executing the Local/Remote command will force the Control Source to be from the DOI. The Local LED will illuminate. The Run/Stop command is not affected because it is already programmed to be from the DOI. **2nd Press:** Executing the Local/Remote command will restore Control Source back to the terminals or serial port as programmed. The Local LED will extinguish.

Case 4: CS – Remote R/S – Remote	**1st Press:** Executing the Local/Remote command will force the Control Source and Run/Stop command to be from the DOI. The Local LED will illuminate. **2nd Press:** Executing the Local/Remote command will restore Control Source and Run/Stop command back to the terminals or serial port as programmed. The Local LED will extinguish.

CS = Control Source, R/S = Run/Stop, DOI = Digital Operator Interface.
Note: AutoExec Mode is considered Remote even if the Run-Stop command is set to Local for keypad control.

9 Detailed Parameter Description and Drive Set-up

9.1 Motor Maximum and Minimum Speed

Parameter Name	Par. No.	Menu	Allowed Range
MAXIMUM SPEED	17	MOTOR	500 to 9999 RPM
MINIMUM SPEED	18	MOTOR	0 to 3600 RPM

Figures 9.2 and 9.3 show a graphical representation of the effects of these parameters.

MAXIMUM SPEED: Will not allow the motor to exceed the value set in this parameter even if the Control Source command calls for a higher operating speed. Also, when the drive control mode is set for Torque Follower or Torque Setpoint and motor load is lost or very low, motor speed will not exceed this value.

MINIMUM SPEED: When started, the motor will accelerate to at least the value set in this parameter, even in the absence of a speed command.

Notes:

1. The MAXIMUM SPEED value must always be set higher than the MINIMUM SPEED value.
2. Absolute Minimum Speed is calculated by the drive based on Motor Base Speed and will override any lower value set in this parameter

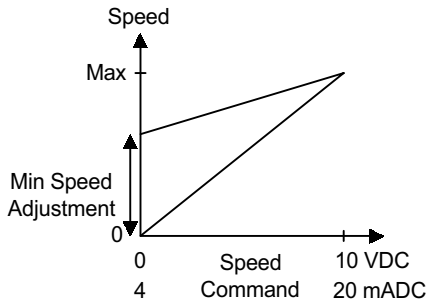


Figure 9.2 – Minimum Speed Parameter

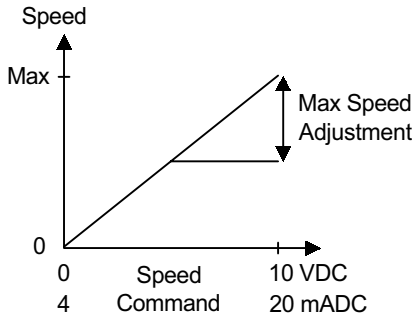


Figure 9.3 – Maximum Speed Parameter

9.2 Configuring & Selecting Accel. And Decel. Times

Parameter Name	Par. No.	Menu Location	Allowed Range
ACCEL TIME 1	101	BASIC	0.1 to 999.9 S
DECEL TIME 1	102	BASIC	0.1 to 999.9 S
ACCEL TIME 2	103	BASIC	0.1 to 999.9 S
DECEL TIME 2	104	BASIC	0.1 to 999.9 S
ACCEL/DECEL MODE	105	BASIC	LINEAR, S-CURVE
DECEL SHIFT SPD	106	BASIC	0 to 9999 RPM
FAST STOP DECEL	107	BASIC	0.1 to 10.0 S
JOG ACCEL TIME	109	BASIC	0.1 to 60.0 S
JOG DECEL TIME	110	BASIC	0.1 to 60.0 S

Refer to Figures 9.4, 9.5 and 9.6 for a graphical representation of the affects of these parameters.

ACCEL TIME 1 (Primary Acceleration Time): Sets the time for the drive to ramp from zero to maximum speed.

ACCEL TIME 2 (Secondary Acceleration Time): Sets the time for the drive to ramp from zero to maximum speed when one of the Digital Inputs is configured for ACCEL 2 and the input is active.

DECEL TIME 1 (Primary Deceleration Time): Sets the time for the drive to ramp from maximum speed to zero.

DECEL TIME 2 (Secondary Deceleration Time): Sets the time for the drive to ramp from maximum speed to zero when one of the following conditions is met:

1. One of the Digital Inputs is configured for DECEL 2 and the input is active.
2. The DECEL SHIFT SPEED value is set to something other than zero (see below).

ACCEL/DECEL MODE (Acceleration / Deceleration Mode): Selects either LINEAR or S-CURVE accel/decel. If S-Curve is selected, there is a short variable ramp rate on the bottom and top of the accel/decel ramp to limit jerk.

DECEL SHIFT SPD (Deceleration Shift Speed): If the value in this parameter is set above zero, when the drive is decelerating using DECEL TIME 1 and this speed is reached, the drive will automatically shift to DECEL TIME 2 for the remainder of the deceleration ramp.

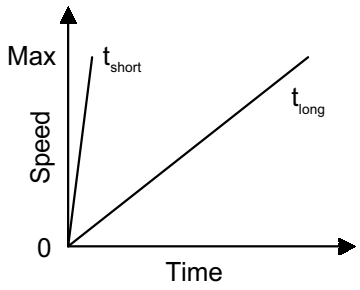
FAST STOP DECEL (Fast Stop Deceleration Time): If a stop command is received and a Digital Input configured for FAST STOP is active, the drive will use the FAST STOP DECEL time for the ramp to stop. Depending on load and motor inertia, a dynamic braking resistor may be required to dissipate motor rotational energy and allow short ramp times. Note: this function must not be used as an emergency stop function to protect personnel or equipment because no braking torque is available if the drive loses power or if a fault trip occurs.

JOG ACCEL TIME (Jogging Acceleration Time): Sets the time for the drive to ramp from zero to maximum speed when the drive is in the jog mode either from the Digital Operator Interface Jog key or from a Digital Input configured as JOG.

JOG DECEL TIME (Jogging Deceleration Time): Sets the time for the drive to ramp from maximum speed to zero when the drive is in the jog mode either from the Digital Operator Interface Jog key or from a Digital Input configured as JOG.

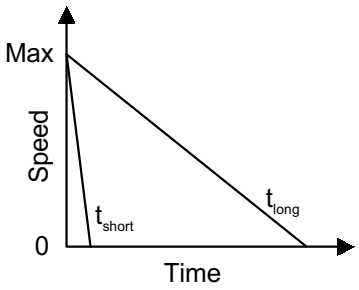
Notes:

1. All acceleration and deceleration times are based on a speed change of from zero to the value set in the Maximum Speed parameter. If a smaller speed change is commanded, the time will be proportionally shorter. For example, if the ACCEL TIME 1 is set for 10 seconds, the motor will accelerate from zero to max. speed in 10 seconds or zero to ½ max. speed in 5 seconds.
2. All ramp times are dependent on motor and load inertia. If the available motor torque cannot accelerate the load in the programmed time, the drive will automatically extend the time in an attempt to avoid a motor stall condition.
3. The primary acceleration and deceleration times are always used by default.



Acceleration Time

A. Accel Time 1, 2 & Jog



Deceleration Time

B. Decel 1 & 2, Jog, Fast Stop

Figure 9.4 – Acceleration & Deceleration Times

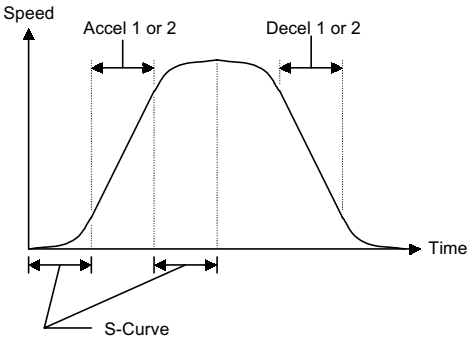
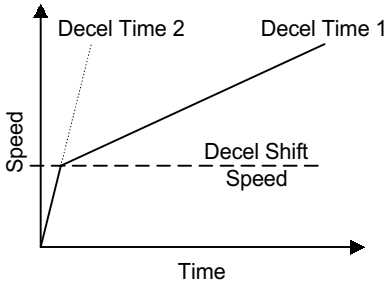
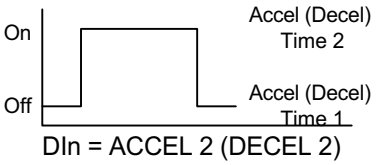


Figure 9.5 – S-Curve Ramp Mode



A. Decel Shift Speed



B. Selection Using Digital Inputs

Figure 9.6 – Accel or Decel Time Selection

9.3 Configuring and Selecting Preset Speeds

Parameter Name	Par. No.	Menu	Allowed Range
PRESET SPEED 1	111	BASIC	0 to 9999 RPM
PRESET SPEED 2	112	BASIC	0 to 9999 RPM
PRESET SPEED 3	113	BASIC	0 to 9999 RPM
PRESET SPEED 4	114	BASIC	0 to 9999 RPM
PRESET SPEED 5	115	BASIC	0 to 9999 RPM
PRESET SPEED 6	116	BASIC	0 to 9999 RPM
PRESET SPEED 7	117	BASIC	0 to 9999 RPM
DIGITAL IN DI(2-8)	403-409	I/O MAP	SPEED 0, 1, 2

See Figure 9.7 on the following page for a graphical representation of the effects of these parameters.

PRESET SPEED (1 TO 7): These parameters allow from 1 to 7 preset speeds to be preprogrammed and selected by configuration of 1, 2 or 3 of the Digital Inputs to select the speed to be used as the speed command. Digital Inputs configured as preset speed selection function in a binary fashion as shown in the truth table below where 0 equals the input is open and 1 equals the input is closed (connected to the Common terminal).

DIGITAL INPUTS			
SPEED 0	SPEED 1	SPEED 2	SPEED
0	0	0	Control Source
1	0	0	Preset Speed 1
0	1	0	Preset Speed 2
1	1	0	Preset Speed 3
0	0	1	Preset Speed 4
1	0	1	Preset Speed 5
0	1	1	Preset Speed 6
1	1	1	Preset Speed 7

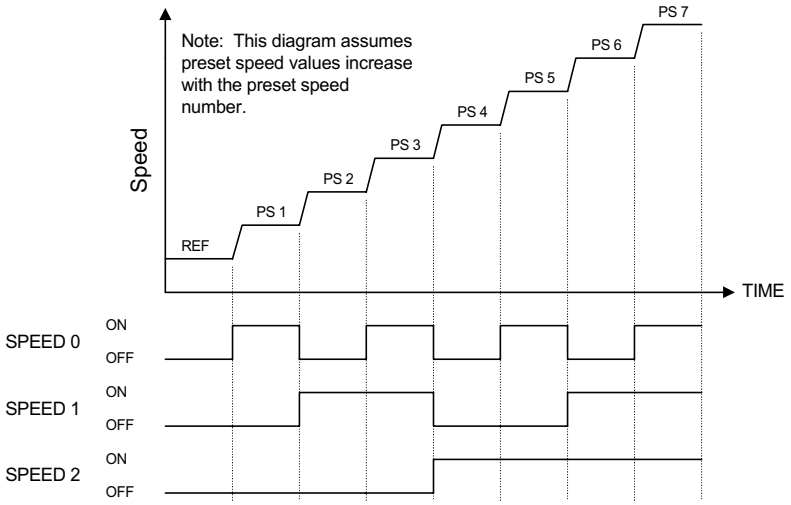


Figure 9.7 – Preset Speed Selection

9.4 Configuring Jump (Skip) Speeds

Parameter Name	Par. No.	Menu	Allowed Range
JUMP SPEED 1 LOW	18	MOTOR	0 to 9999 RPM
JUMP SPEED 2 LOW	19	MOTOR	0 to 9999 RPM
JUMP SPEED 3 LOW	20	MOTOR	0 to 9999 RPM
JUMP SPEED BAND	21	MOTOR	0 to 9999 RPM

Refer to Figure 9.8 for a diagram of the effects of these parameters.

JUMP SPEED 1 – 3 LOW: Sets the low end of a band of operation where the drive will ramp through on increasing or decreasing speed but will not operate continuously. It is possible to set up to 3 bands, each covering a different range of speeds.

JUMP SPEED BAND: The value in this parameter is added to the value set in a Jump Speed Low parameter to get the top end of the jump speed band. For example, if JUMP SPEED 1 LOW = 900 RPM and JUMP SPEED BAND = 200 RPM the drive will not operate continuously from 900 to 1100 RPM.

Note: The JUMP SPEED BAND value is the same for all jump speed settings.

Configuring Jump Speeds (continued)

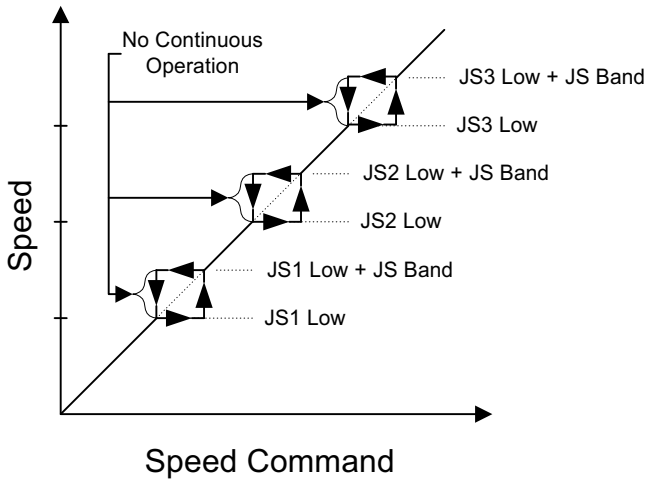


Figure 9.8 – Jump Speed Bands

9.5 Function and Configuration of DC Braking

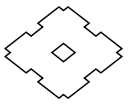
DC braking is a means of providing stopping torque by the injection of DC current into the motor to create a stationary magnetic field. DC injection braking is not to be confused with Dynamic Braking where stopping torque is developed by placing a resistor across the drive DC bus to dissipate motor and load rotational energy as heat.

DC braking is more effective than dynamic braking at low speeds and can be used to produce more repeatable stopping characteristics. DC braking is active when the DC BRAKE time parameter is set to any value other than zero.

Parameter Name	Par. No.	Menu	Allowed Range
DC BRAKE TIME	118	BASIC	0.0 to 60.0 S
DC BRAKE AMPS	119	BASIC	0 to 100 %

DC BRAKE TIME: Determines how long DC braking is applied when the drive is stopping. Keep this value to a minimum to avoid excessive heat build-up in the motor. Setting a value of zero disables DC braking.

DC BRAKE AMPS: Determines how much braking torque the motor develops. Again, keep this value as low as practical to minimize motor heating.



Configuring DC Braking (Continued)

Notes:

1. DC braking time and voltage should be kept to the minimum values that provide the required stopping characteristics.
2. Excessive use of DC braking can cause motor overheating and premature failure.
3. DC braking turns on when the drive is stopping and the decel ramp reaches minimum operational speed (not the same as the Minimum Speed set in the Motor Set-up menu.
4. DC braking does not function when the coast to stop mode is selected.

9.6 Configuring Speed Detect Level Sensing

Parameter Name	Par. No.	Menu	Allowed Range
SPEED LEVEL	206	ADVAN	0 to 9999 RPM
SPEED DELAY	207	ADVAN	0.0 to 60.0 S
DIGITAL OUT	421..423	I/O MAP	SPEED DETECT HI/LO

Figure 9.9 shows a graphical view of the effect of these parameters.

SPEED LEVEL (Speed Detect Level): Setting a value greater than zero, causes a Digital Output assigned to the SPEED DETECT HI function to turn on after the time set for SPEED DELAY when the motor is operating at or above this value. SPEED DETECT LO is similar except the output is activated when the speed drops below the setting.

SPEED DELAY (Speed Detect Delay): - Sets the time delay for the Speed Detect HI or Speed Detect LO output.

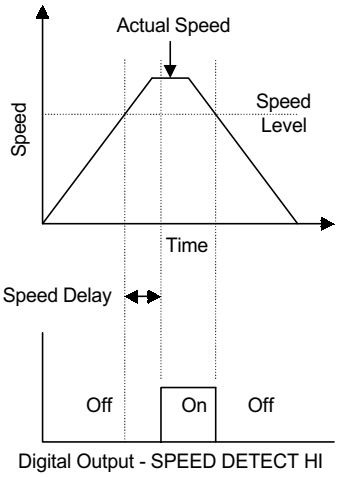


Figure 9.9 – Setting Speed Level Detection

9.7 Configuring Torque Detect Level Sensing

Parameter Name	Par. No.	Menu	Allowed Range
TORQ LEVEL	208	ADVAN	0 to 150 %FL
TORQ DELAY	208	ADVAN	0.0 to 60.0 S
DIGITAL OUT	421..423	I/O MAP	TORQUE DETECT HI/LO

Figure 9.10 shows a graphical view of the effect of these parameters.

TORQ LEVEL (Torque Detect Level): Setting a value greater than zero, causes a Digital Output assigned to the TORQUE DETECT HI function to turn on after the time set for TORQUE DELAY when the motor is operating at or above this value. TORQUE DETECT LO is similar except the output is activated when the speed drops below the setting.

TORQ DELAY (Torque Detect Delay Time: - Sets the time for the Torque Detect HI or Torque Detect LO output.

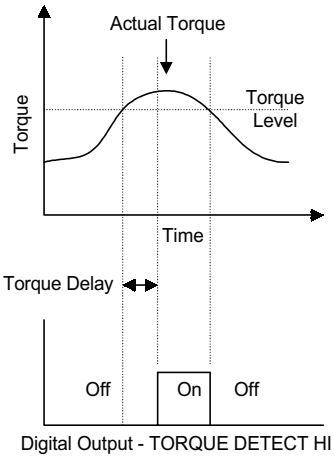


Figure 9.10 – Setting Torque Level Detection

9.8 Torque Limiting (Motoring & Regenerating)

Parameter Name	Par. No.	Menu	Allowed Range
MOTOR TORQ LIMIT	210	ADVAN	0 to 300 %FL
REGEN TORQ LIMIT	211	ADVAN	0 to 200 %FL

Figures 9.11 and 9.12 show graphical views of the effect of these parameters.

MOTOR TORQ LIMIT Torque Limiting when Motoring (Driving): The value set in this parameter controls the maximum torque that the motor is allowed to produce when the motor is driving the load. Reaching this level during acceleration causes the acceleration time to be extended to avoid stalling the motor. Reaching this level during steady-state operation causes the motor speed to decrease in an attempt to pull out of an overload condition.

REGEN TORQ LIMIT (Torque Limit When Regenerating): - The value set in this parameter controls the maximum retarding torque that the motor is allowed to produce when the load is overdriving the motor causing regeneration of power into the drive. This effectively controls the braking torque.

Notes:

1. Regeneration involves the return of energy from the motor to the drive. Anything more than a very low level of regeneration requires the addition of optional dynamic braking resistors to dissipate the energy or connection of the drive DC bus into a circuit capable of handling the energy.
2. If the overhauling load torque exceeds the value set for regeneration torque limit, the motor may be driven into an over speed condition and the drive will fault trip.

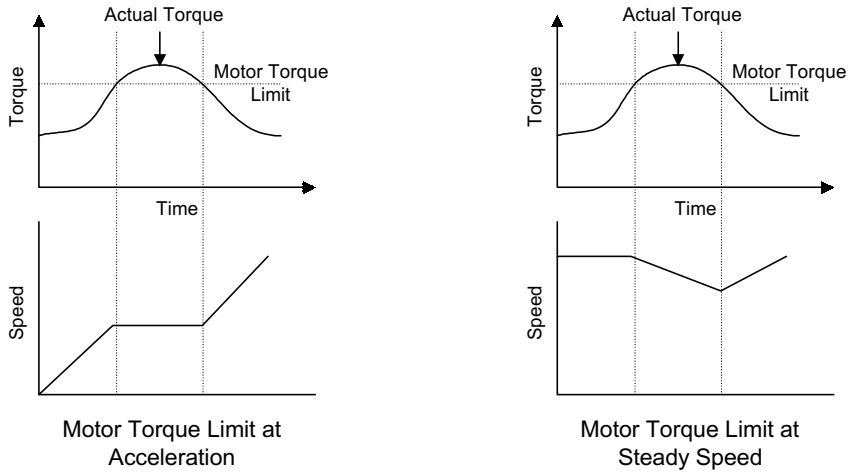


Figure 9.11 – Motor Torque Limit

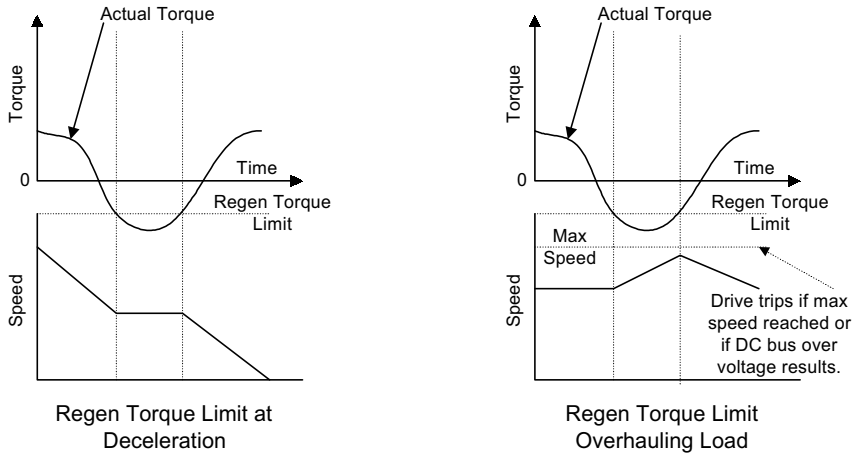


Figure 9.12 – Regeneration Torque Limit

9.9 Speed Up/Down (Electronic Motorized Speed Pot)

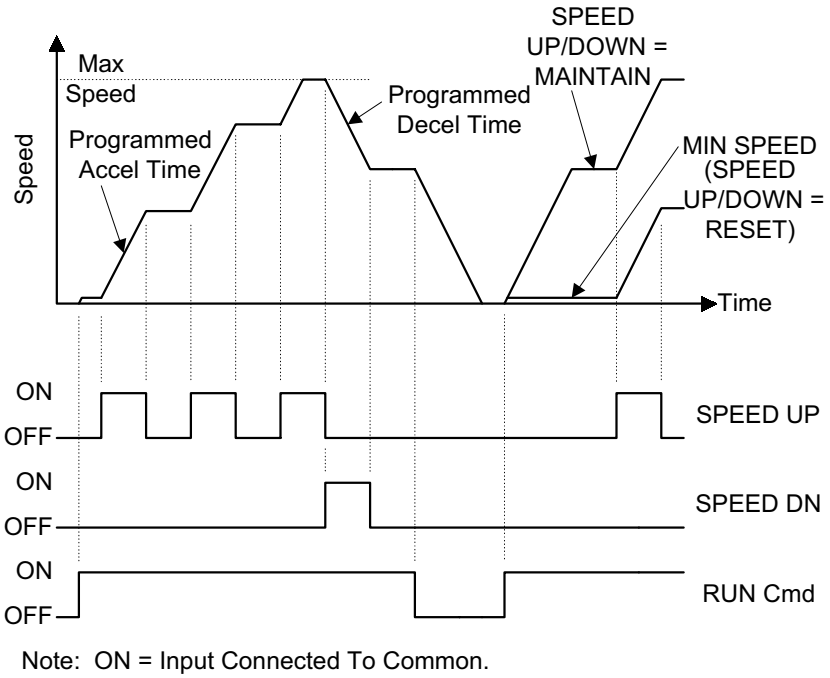
Parameter Name	Par. No.	Menu	Allowed Range
SPEED UP/DOWN	212	ADVAN	RESET, MAINTAIN
DIGITAL IN (DI2 – DI8)	403-409	I/O MAP	SPEED UP, SPEED DN

Figure 9.13 shows a graphical view of the effect of these parameters.

Function:

SPEED UP/DOWN: - This parameter is used to set the drive action after a stop sequence when two of the digital inputs are set for SPEED UP and SPEED DN to emulate operation of a motor operated speed potentiometer. When this parameter is set to MAINTAIN and the drive is restarted, the drive speed will ramp to the last set speed. If it is set to RESET, the drive will ramp to and remain at minimum speed until the digital input assigned to SPEED UP is connected to the Common terminal.

DIGITAL IN DI2 to DI8: - If one of the digital inputs is assigned to the SPEED UP function, connecting it to the Common terminal will cause the drive speed to increase at the programmed accel ramp rate until either maximum speed is reached or until the input is opened. The drive will hold this speed until an input assigned to the SPEED DN function becomes active or a stop command is received. The drive will then decelerate at the programmed decel ramp rate.



Note: ON = Input Connected To Common.

Figure 9.13 – Electronic Motorized Speed Potentiometer

9.10 Setting Passwords

Parameter Name	Par. No.	Menu	Allowed Range
PASSWORD 1 SET	219	ADVAN	5 Char. Max.
PASSWORD 2 SET	220	ADVAN	5 Char. Max.

Two levels of password protection are available for use. Either, both or neither may be used. Password 1 protects items in the Basic & Display Menus and Password 2 protects all others except Maintenance that has no need for protection.

Drives are shipped with the password set to all spaces (i.e. no password) and free access to all parameters is provided. Figure 9.14 shows a diagram of available password characters and Figure 9.15 shows a flow diagram of the password entry process.

Function:

PASSWORD 1, 2 SET: - When the password set procedure is started, the cursor (blinking character) is located in the first character position. Use the UP or DOWN arrow keys to scroll through a list of available characters, or, if the character to be entered is numeric, press the desired number key. If a number is directly entered, the cursor will move to the next position. If the UP/DOWN keys are used to enter a character, press SHIFT and then press the UP Arrow key to move the cursor to the next position. Repeat the process for each character to be entered up to 5 maximum.

Notes:

1. Initial drive configuration should be completed before setting a password. This will save time and steps when programming.
2. Passwords made up of Alpha characters such as a name are easier to remember, but numeric only passwords are easier to set and enter.
3. If the password is forgotten, no protected parameters can be accessed. If the drive was purchased direct from Sumitomo or from an authorized Sumitomo distributor, contact Sumitomo for assistance. If the drive was installed on equipment supplied by an OEM, contact the equipment OEM for assistance. In either case, have complete nameplate information, including the drive serial number available.

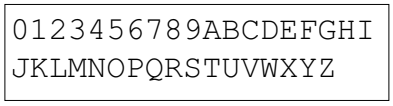


Figure 9.14 – Available Password Characters

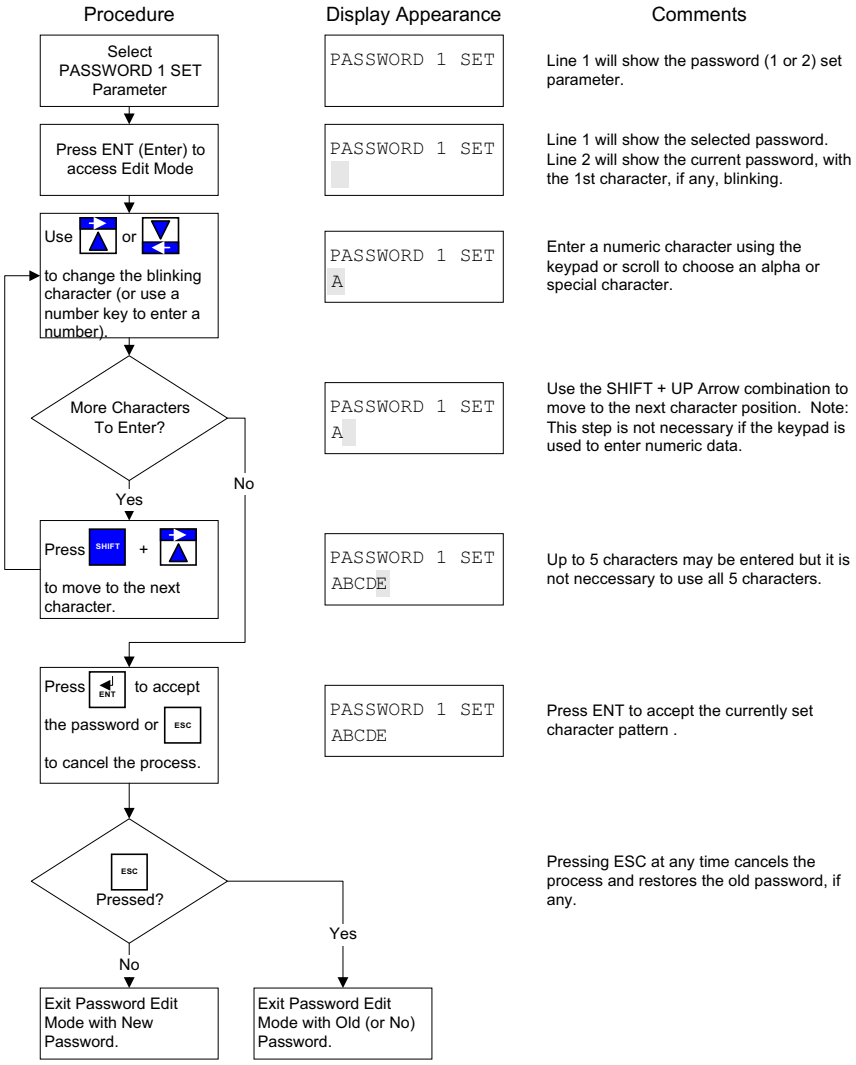


Figure 9.15 – Password Setting Flow Diagram

9.11 Setting the Overload Trip Alert Level

Parameter Name	Par. No.	Menu	Allowed Range
OL ALERT LEVEL	221	ADVAN	10 to 100 %
DIGITAL OUT (DO1-3)	421-423	I/O MAP	

NTAC-2000 AC drives incorporate an inverse time overload protection feature. The greater the overload, the shorter the operating time. The drive can operate at 150% of its rated capacity for one minute. It can operate at 110% of its rated capacity for several minutes.

If an alarm of an impending overload trip is desired, setting the overload alert trip level to less than 100% and assigning one of the digital outputs to OL TRIP ALERT can provide advanced notice. How much notice depends on the severity of the overload and the setting of the OL ALERT LEVEL function.

Figure 9.16 shows the operation of these parameters.

Function:

OL ALERT LEVEL (Overload Alert Detect Level): - Sets the overload capacity where an output set for OL ALERT LEVEL will become active.

DIGITAL OUT (DO1 – DO3) – Digital Output Assignment: Assigns the digital output that will be used to activate the alarm.

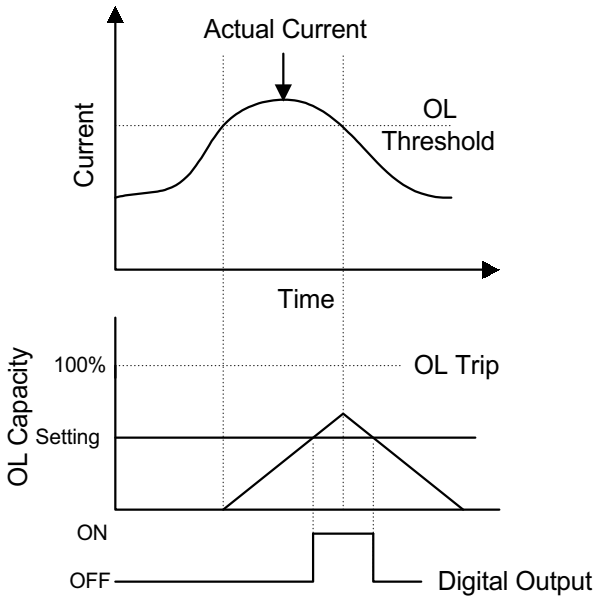


Figure 9.16 – Overload Trip Alert Operation

9.12 Using the Orient Function

Some applications can benefit from a means of stopping in the same relative position. This function can be accomplished by connecting a sensor such as a proximity or photo switch to one of the digital inputs assigned to the ORIENT function. When the Orient function is used and the drive receives a stop command, the drive will decelerate to minimum speed and continue to operate until the ORIENT input becomes active. At that time, the drive will immediately stop and DC braking will be applied, if desired. By adjusting the sensor position to compensate for load inertia, reasonably repeatable stopping position can be achieved.

In the event of a sensor failure, the orient input may never become active. The ORIENT OVERRIDE time will stop the drive as a safety measure.

Parameter Name	Par. No.	Menu	Allowed Range
222		ADVAN	0.0 to 60.0 S
DIGITAL IN (DI2 – DI8)	403-409	I/O MAP	

Function:

ORIENT OVERRIDE (Orient Override Time): - Sets the maximum time that the drive can operate while waiting for the digital input assigned to the ORIENT function to become active (connected to Common).

DIGITAL IN (DI2 – DI8) – Digital Input Assignment: Assigns the digital input which will be used as the ORIENT input.

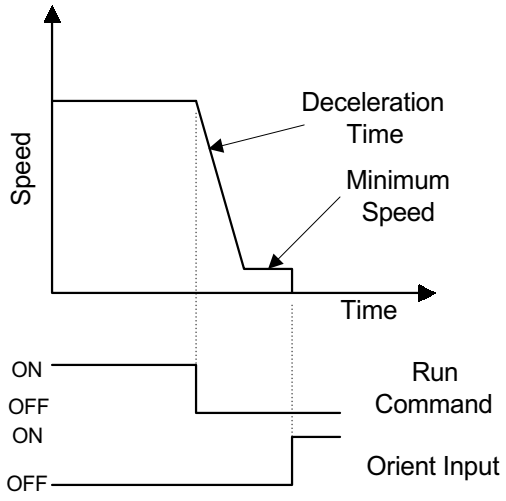


Figure 9.17 – Orient Function Operation

9.13 Setting Custom Speed Label, Units and Multiplier

It is often desired to have drive speed indicated in engineering units other than RPM or %. NTAC-2000 drives provide a means of entering a custom speed label up to 6 characters and a custom units label up to 3 characters. In addition, a multiplier referenced to motor speed can be applied to scale the LCD readout properly.

Parameter Name	Par. No.	Menu	Allowed Range
SET SPEED UNITS	302	DISPLAY	RPM, %, CUSTOM
LINE 2 DISPLAY	303	DISPLAY	RPM, %, CUSTOM
CUSTOM MULT FCN	304	DISPLAY	SPEED, 1/SPEED
CUSTOM MULT	305	DISPLAY	0.0001 to 65.535
CUSTOM LABEL	306	DISPLAY	6 Char. Max.
CUSTOM UNITS	307	DISPLAY	3 Char. Max.

Function:

SET SPEED UNITS: - If the drive is configured in the Control Mode menu to operate in the SPEED FOLLOWER mode, line 1 of the LCD display shows the controlled variable (i.e. speed) in the desired units. Three choices are available. Speed in RPM, Speed in % of rated or Custom. Selecting CUSTOM causes the data entered in the CUSTOM LABEL and CUSTOM UNITS parameters to be shown on line 1 and motor speed is multiplied by the value entered in the CUSTOM MULT parameter.

LINE 2 DISPLAY: - Line 2 of the LCD display can be configured to show any one of several drive conditions. If CUSTOM is selected, line 2 functions as described for Set Speed Units above.

CUSTOM MULT FCN (Custom Multiplier Function): - Allows the speed display to be direct or inverse acting. When SPEED is set for the Custom Multiplier Function, the display reads increasing speed with increasing speed command. When 1/SPEED (time) is set for the Custom Multiplier Function, the display reads the inverse of speed which is time. Increasing the command will command the drive to decrease speed to increase the time it takes to do some function.

Setting Custom Speed Label, Units and Multiplier (continued)

CUSTOM MULT (Custom Multiplier): - When CUSTOM is selected for Speed Units or Line 2 display and SPEED is selected for CUSTOM MULT FCN, the motor speed in RPM is multiplied by the value in this parameter to determine the value to be displayed. This is used to calibrate the display as required. For example, suppose the motor is driving a conveyor that runs 90 ft/min when the motor is running 1750 RPM. A value of 90/1750 (0.0571) would be entered in this parameter.

When 1/SPEED is set for CUSTOM MULT FCN, the display value is inversely proportional to speed or directly proportional to time. The custom multiplier is calculated by

$$\text{Custom Mult} = \frac{\text{Display Value X Speed Command}}{\text{Max Speed}}$$

$$\text{Example: CM} = \frac{\text{10 sec X 1000 RPM}}{\text{1800 RPM}} = 5.56$$

If CUSTOM is selected for Speed Units and the drive is in the Speed Follower mode, speed commands can be entered directly in the custom units instead of motor RPM.

CUSTOM LABEL: - A custom data label of up to 6 characters can be used to make the speed display more meaningful to the application. For example, instead of SPEED, a pump application might be configured to display FLOW or PUMP 1. Refer to Figure 9.18 on the following page.

When the custom label edit mode is entered, the blinking cursor is in the first character position. Use the UP or DOWN Arrow key to scroll through available choices. When the desired character is displayed, move to the next character position by pressing SHIFT and then pressing the UP Arrow key. Repeat this process until all characters are set. Press ENT to save the label and exit the edit mode or press ESC to exit the edit mode without saving.

CUSTOM UNITS: - Set up is similar to CUSTOM LABEL described above except that a maximum of 3 characters are allowed. Using the pump example from above, the units label might be set for GPM (Gallons Per Minute).

Setting Custom Speed Label, Units and Multiplier (continued)

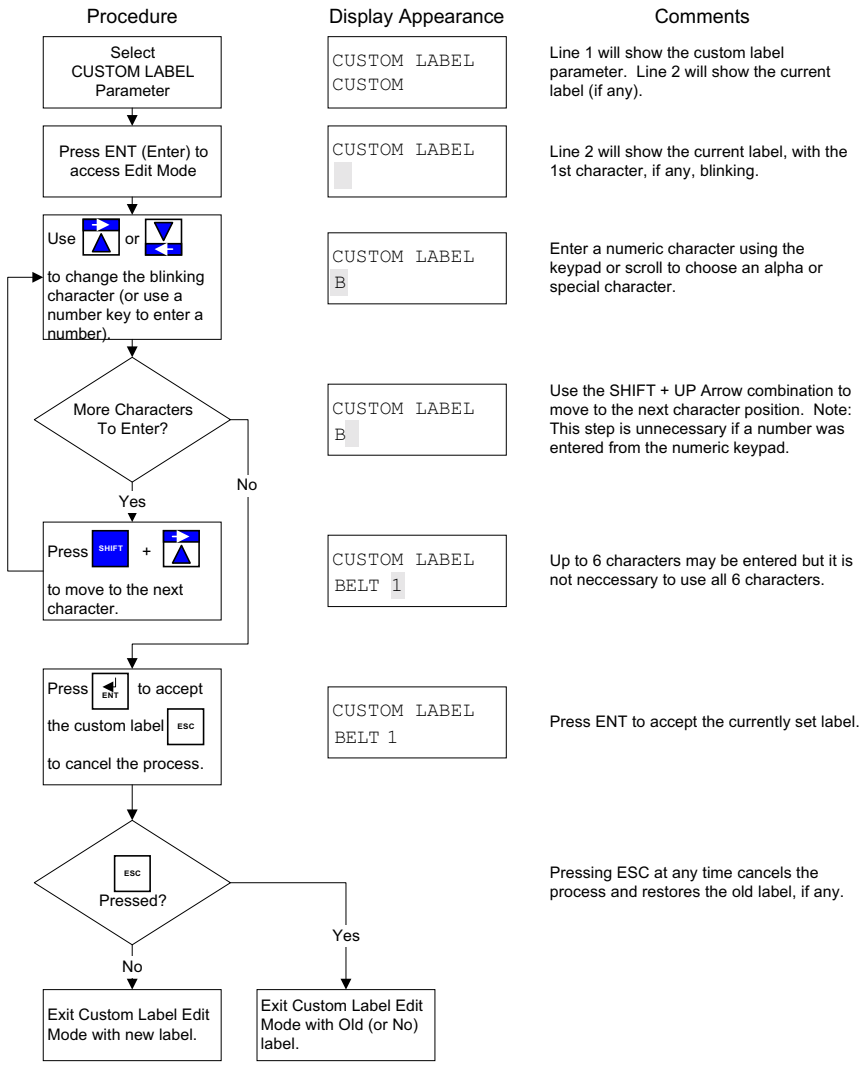


Figure 9.18 – Custom Label Entry Procedure

9.14 Configuring Digital Inputs (I/O MAP Menu)

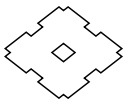
Each of the digital inputs can be assigned a specific function as described below. In the table below, NO = Normally Open and NC = Normally Closed. Access the I/O Map menu as directed in Section 8.3.5. When the drive display indicates the following

DIGITAL IN ENT TO VIEW

press ENT to view input assignments. Use UP / DOWN to view the desired input and current assignment. Press ENT to edit that input. Use UP / DOWN to view the available choices. Press ENT to save the choice and exit or ESC to exit without saving. Repeat for each digital input desired. Press ESC to exit the view mode.

Parameter Name	No.	Available Choices (Contact Type)
DIGITAL IN DI1	402	RUN FWD (2-wire, maintained NO) STOP (3-wire, momentary, NC)
DIGITAL IN DI2 DIGITAL IN DI3 DIGITAL IN DI4 DIGITAL IN DI5 DIGITAL IN DI6 DIGITAL IN DI7 DIGITAL IN DI8	403 404 405 406 407 408 409	RUN REV (maintained, NO)[1] START FORWARD (momentary, NO)[2] START REVERSE (momentary, NO)[2] REVERSE (maintained, Open = FWD) SPEED UP (momentary, NO) SPEED DN (momentary, NO) JOG FORWARD (momentary, NO) RESET (momentary, NO) ACCEL 2 (maintained, Open = Accel 1) DECEL 2 (maintained, Open = Decel 1) COAST (maintained, NO) EXT FAULT (NO) (momentary, NO) EXT FAULT (NC) (momentary, NC) FAST STOP (maintained, NC) ORIENT (maintained, NO) SPEED 0 (maintained, NO) SPEED 1 (maintained, NO) SPEED 2 (maintained, NO) IN1, IN2, IN3, IN4 (maintained, NO) AI1/AI2 Select (maintained, Open = AI2) JOG REVERSE (momentary, NO) REMOTE STOP (momentary, NC) FWD/REV ENABLE (maintained, NC) AUTOTUNE (momentary, NO) NO FUNCTION (input not assigned)

[1] Digital Input DI1 must be set to RUN FWD to use this function.
[2] Digital Input DI1 must be set to STOP to use this function.



Configuring Digital Inputs (continued)

Refer to Section 13, Typical Connections for examples.

Function:

DI1 (RUN FWD, STOP): - Selecting RUN FWD puts the drive into a 2-wire control mode. Connecting the input to CM causes the drive to ramp to the set speed in the default forward direction and opening the input causes the drive to stop. Selecting STOP puts the drive into a 3-wire control mode. This contact must be continuously connected to common for the drive to run. Momentarily breaking the connection initiates a stop sequence. When STOP is selected, at least one other digital input must be assigned to START FORWARD or START REVERSE.

DI2 – DI8:

RUN REV: - This input is used as a maintained Run Reverse input when DI1 is set for RUN FWD. This allows two separate contacts to control forward operation and reverse operation. If a single run input is required and a Forward-Reverse selector switch is desired, use the REVERSE function instead.

REVERSE: - Connect to common to select reverse direction.

START FORWARD: - 3-wire start input. Use a momentary NO push-button to connect this input to common to start the drive in the forward direction. Note: DI1 must be set to STOP.

START REVERSE: - 3-wire start input. Same as Start Forward except selects the reverse direction.

SPEED UP: - Connect to CM to increase speed at the accel ramp time. Open to hold the last speed.

SPEED DN: - Connect to CM to decrease speed at the accel ramp time. Open to hold the last speed.

JOG FORWARD, JOG REVERSE: - While connected to common, causes the drive to run at Jog speed in the corresponding direction.

Configuring Digital Inputs DI2 – DI8 (continued)

RESET: - Momentarily connecting to common resets a drive fault trip condition. The input must open to allow the drive to operate.

ACCEL 2: - Connect to common to force the drive to use Acceleration Time number 2. When open or unassigned, the drive will use Acceleration Time number 1.

DECEL 2: - Connect to common to force the drive to use Deceleration Time number 2. When open or unassigned, the drive will use Deceleration Time number 1 unless the DECEL SHIFT SPD value is set to a value higher than minimum speed.

COAST: - Connect this input to common prior to initiation of a Stop command to cause the drive to coast to stop instead of ramp to stop.

EXT FAULT (NO): - Connect to common to cause a drive fault trip.

EXT FAULT (NC): - Disconnect from common to cause a drive fault trip.

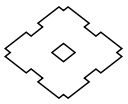
FAST Stop: - Connect this input to CM causes the drive to use the Fast Stop deceleration time setting. Note: Setting fast deceleration rates may require connection of a dynamic braking resistor to absorb motor and load rotational energy.

 DANGER	**FAST STOP IS NOT TO BE USED FOR EMERGENCY STOP BECAUSE LOSS OF POWER OR A FAULT TRIP RESULTS IN LOSS OF BRAKING TORQUE.**

ORIENT: - Assigning this function to a digital input puts the drive into a Shaft Orient stopping mode. Refer to Section 9.12 for details. When stopping is initiated, the drive will decel to minimum speed and wait for this input to close to complete the stop cycle.

SPEED 0, SPEED 1, SPEED 2: - Preset speed selection. Refer to Section 9.3 for details.

IN1, IN2, IN3, IN4: - AutoExec Mode inputs. When the control mode is selected as AUTOEXEC, the drive will execute an internally stored sequence of instructions. Some of these instructions can test the status of digital inputs assigned to these functions and take appropriate action based on the state of the input. Refer to Section 10, AutoExec Mode for details.



Configuring Digital Inputs (continued)

AI1/AI2: - Analog Input selector. Determines which of the analog inputs is the Control Source when the Control Source function is set to Remote. When the input is connected to common, AI1 (4-20mA) is the Control Source and AI2 is ignored. When open or when the function is not used AI2 (0-10V) is the Control Source.

9.15 Configuring Analog Inputs

Two analog inputs are available for use in the application. Analog input AI1 is 4 – 20 mADC and AI2 is 0 – 10 VDC. Access the I/O Map set-up as described in Section 8.3.5. Press the Down arrow key until the drive display indicates as shown below.

ANALOG IN ENT TO VIEW

Press ENT to view the functions. Use UP / DOWN to choose the desired function and current setting. Press ENT to edit the function. Use the number keys or UP / DOWN to change the value. Press ENT to save the new value and exit or ESC to exit without saving. Press ESC to exit the view mode.

Parameter Name	No.	Available Range
AI1 MAXIMUM	411	4.0 to 20.0 mADC
AI1 MINIMUM	412	4.0 to 20.0 mADC
AI2 MODE	413	UNIPOLAR (0 to +V) BIPOLAR (-V to +V) (± sets direction)
AI2 DEAD BAND	414	0.0 to 5.0 VDC
AI2 MAXIMUM	415	0.0 to 10.0 VDC
AI2 MINIMUM	416	0.0 to 10.0 VDC

Function:

AI1 MAXIMUM: - Sets the level of the input signal which results in maximum speed. There must be at least 8.0 mA difference in the AI1 Maximum and AI1 Minimum values for the drive to operate over a complete speed range. Setting AI1 Maximum less than AI1 Minimum causes inverse operation where the speed decreases with increasing signal. See Figure 9.19 for details.

AI1 MINIMUM: - Sets the level of the input signal which results in minimum speed. See AI1 Maximum, above for details.

AI2 MODE: - Setting UNIPOLAR results in the drive speed being adjusted by the magnitude of the signal. Rotation direction is controlled by a digital input or by the FWD / REV button on the Digital Operator Interface (DOI). Setting BIPOLAR results in the drive speed being controlled by the magnitude of the signal and the rotation direction controlled by the polarity of the signal. See Figure 9.21 for details.

AI2 DEAD BAND: - (sometimes called offset) sets a value that must be exceed by the input signal before the drive will start. See Figure 9.21 for details.

AI2 MAXIMUM: - Sets the level of the input signal which results in maximum speed. There must be at least 5.0 V difference in the AI2 Maximum and AI2 Minimum values for the drive to operate over a complete speed range. Setting AI2 Maximum less than AI2 Minimum causes inverse operation where the speed decreases with increasing signal. See Figure 9.20 for details.

AI2 MINIMUM: - Sets the level of the input signal which results in minimum speed. See AI2 Maximum above for details.

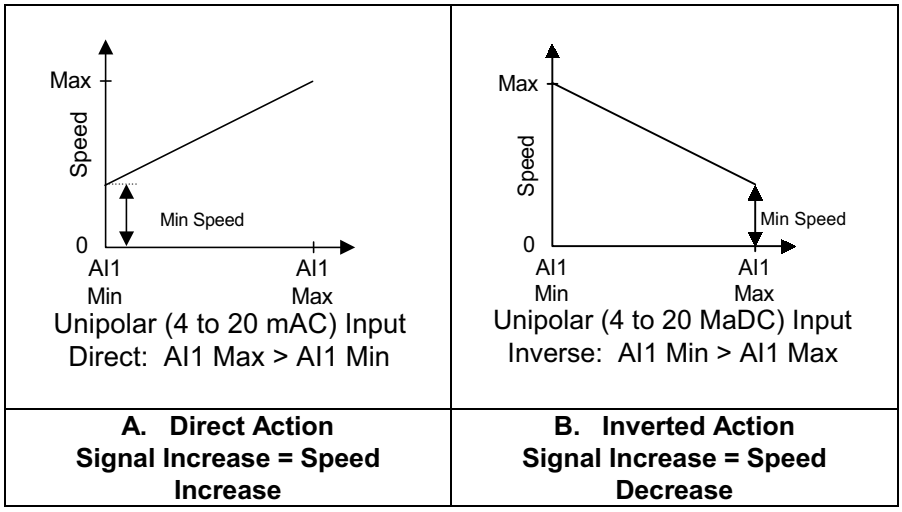


Figure 9.19 – Analog Input AI1 (4-20 mA)

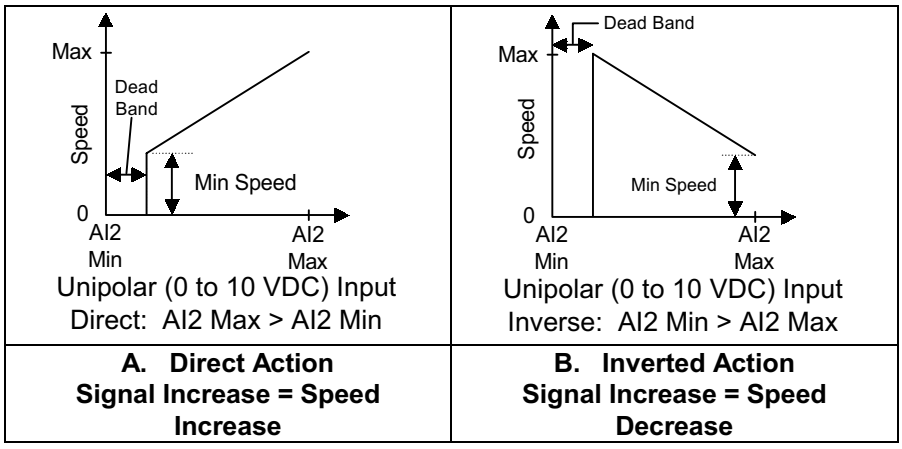
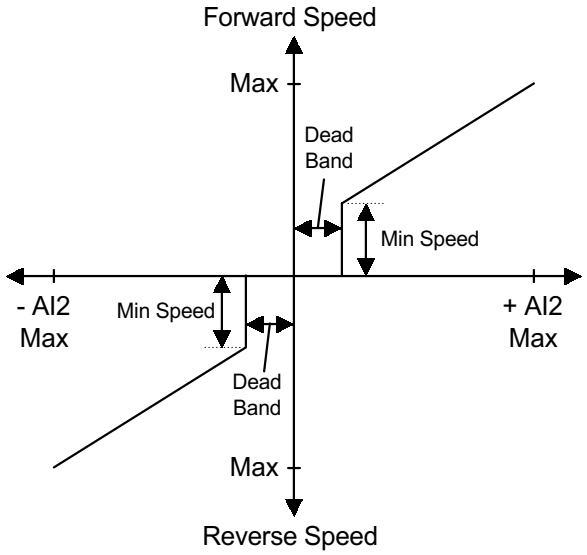


Figure 9.20 – Analog Input AI2 (0 – 10 V) Unipolar Mode

Note: When a non-zero value is set for AI2 Dead Band, the drive does not run when the 0 to 10 VDC signal is below the dead band value.

Configuring Analog Inputs (continued)



Bipolar (-10 to +10 VDC) Input

Figure 9.21 – Analog Input AI2 Bipolar Mode

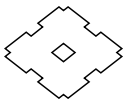
Note: When operating in the Bipolar mode, AI2 Min must not be set greater than AI2 Max.

9.16 Configuring Digital Outputs

Three digital (on-off) outputs are available for use in the application. Two are open collector transistor and one is a Form C relay. Each of the outputs can be assigned a specific function as described below. Access the I/O Map set-up as described in Section 8.3.5. Press the Down arrow key until the display indicates as shown below.

DIGITAL OUT ENT TO VIEW

Press ENT to view output assignments. Use UP / DOWN to view the desired output and current assignment. Press ENT to edit that output. Use UP / DOWN to view the available choices. Press ENT to save the choice and exit or ESC to exit without saving. Repeat for each digital output desired. Press ESC to exit the view mode.



Parameter Name	No.	Available Choices
DO1 (RELAY) DO2 (OC) DO3 (OC)	421 422 423	RUN FAULT AT SPEED REVERSE DIRECT SPEED DETECT (HI or LO) TORQUE DETECT (HI or LO) OUT1, OUT2, OUT3 OL TRIP ALERT BRAKE

Function:

RUN: - Active when the drive starts and remains active during the deceleration ramp until the drive stops. If Coast to Stop is selected or a digital input configured for Coast is active, the drive stops immediately, the Run output becomes inactive, and the motor coasts to stop.

FAULT: - Active anytime the drive trips on a protective fault. Resetting the drive changes the Fault output back to inactive.

AT SPEED: - Active when the actual speed is within ±10 RPM of commanded speed.

REVERSE: - Active when the drive is operating in the reverse direction.

SPEED DETECT HI: - Active when the drive is operating at or above the value set in the Speed Level parameter for the time set in the Speed Delay parameter.

SPEED DETECT LO: - Active when the drive is operating below the value set in the Speed Level parameter for the time set in the Speed Delay parameter.

TORQUE DETECT HI: - Active when the drive is operating at or above the value set in the Torque Level parameter for the time set in the Torque Delay parameter.

TORQUE DETECT LO: - Active when the drive is operating below the value set in the Torque Level parameter for the time set in the Torque Delay parameter.

OUT1, OUT2, OUT3: - These outputs are controlled by a sequence of instructions entered in the AutoExec mode. Refer to Section 10, AutoExec Mode for details.

Configuring Digital Outputs (continued)

OL TRIP ALERT: - Active when the drive is operating in an overload condition and the accumulated overload capacity is at or above the value set in the OL ALERT LEVEL parameter.

BRAKE: - Active when the drive is running but not during DC braking. This output is ideal for control of a mechanical brake on a motor. Refer to Section 13.6, for example.

9.17 Setting the Control Mode

The drive can be set to operate in any of several modes as described below to provide application flexibility.

Parameter Name	Par. No.	Menu	Allowed Range
CONTROL MODE	501	MODE	(See below)
CONTROL SOURCE	502	MODE	(See below)
RUN-STOP COMMAND	503	MODE	(See below)

Function:

CONTROL MODE: - This parameter sets the way the drive will operate in the application. Selecting the proper Control Mode will allow optimum performance. Available choices and a description of each are shown below.

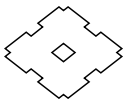
1. SPEED FOLLOWER – This is the factory default mode. The drive will follow a speed command with the source of the command set by the CONTROL SOURCE parameter.

2. SPEED SETPOINT – The drive compares a desired value related to speed with process feedback and regulates drive speed to maintain the process variable at the desired value. Feedback is always Analog Input AI1 (4-20 mA). The source of the setpoint command is set by the CONTROL SOURCE parameter.

3. TORQUE FOLLOWER – The drive will follow a torque command with the source of the command set by the CONTROL SOURCE parameter.

4. TORQUE SETPOINT – Similar to Speed Setpoint above but torque is the controlled variable and feedback must originate from a device capable of measuring torque or something related to torque such as tension.

5. AUTO EXECUTE – The drive will execute a sequence of instructions which are programmed using the AutoExec set up mode. Refer to Section 7, AutoExec Mode for details.



Setting the Control Mode (continued)

CONTROL SOURCE: - Sets the location of the command which controls drive speed, torque or setpoint. Available choices and a description of each are shown below.

1. LOCAL – The Digital Operator Interface (DOI) is the source.

2. REMOTE – AI1 and/or AI2 is the source. Note: When the Control Mode is set for Speed Setpoint or Torque Setpoint, AI2 (0-10V) is the Control Source and AI1 (4-20mA) is the feedback.

3. SUM – Can only be used when Control Mode is set to Speed Follower or Torque Follower. The resultant command is the algebraic sum of AI1 and AI2. The resultant command is calculated as follows:

   AI1: AI1 MIN = 0%, AI1 MAX = 100%
   AI2: AI2 MIN = 0%, AI2 MAX = 100%
   Result = AI1% + AI2% $\leq$ 100%

   The SUM function is generally used when a master reference is used for several drives and it is desired to trim the reference to an individual drive using a trim pot or dancer roll pot.

4. SERIAL PORT – The RS-485 communication port is the source. Refer to Section 11, Serial Communications for details.

RUN-STOP COMMAND: - Sets the location of the command that Starts and Stops the drive. Available choices and a description of each are shown below.

1. LOCAL – The 1 (RUN) and 0 (STOP) buttons on the Digital Operator Interface control Run / Stop.

2. REMOTE – Run and Stop commands originate from the control terminal strip. See Section 6.4.14, Configuring Digital Inputs for details.

3. SERIAL PORT – Run and Stop commands originate from the RS-485 communication port. Refer to Section 11, Serial Communications.

9.18 Locking-Out Digital Operator Interface Control

The function of the DOI can be locked to prevent unauthorized operation of the drive.

Parameter Name	Par. No.	Menu	Range
KEYPAD FUNCTION	504	MODE	UNLOCKED, LOCKED

Function:

KEYPAD FUNCTION: - Enables or disables operation of the Digital Operator Interface.

UNLOCKED – The DOI functions normally.
LOCKED – Only the stop button and the SHIFT → PROG key combination is functional. Unlock the keypad by pressing SHIFT → PROG and Parameter Number (5-0-5). Then press ENT. Enter the password if prompted and press ENT. Press ENT to edit the keypad locked function and select UNLOCKED.

Notes:

For safety reasons, the Stop button is always active.

10 AUTOEXEC MODE

10.1 AutoExec Overview

The AutoExec (Automatic Execution) mode of operation incorporated into the NTAC-2000 AC drive provides the ability to store and execute a sequence of instruction to automate a process, often without the need for external logic controllers. The AutoExec mode includes the following capabilities:

1. Two 16-bit general-purpose counters, each with the ability to be preset to any value up to 65,535. Each counter can be decremented and reset under program control and tested for zero or not zero status.

2. Two 16-bit general-purpose timers. One settable in seconds up to 65,535 (over 18 hours) and the other settable in tenths of a second up to 6553.5. Each timer can be started, stopped or reset under program control in addition to tested for zero or not zero status.

3. Up to four general-purpose inputs which can be tested under program control. Inputs can be connected to external sensors such as limit switches, proximity switches, photo switches, etc. and used to control drive action based on the status of the inputs.

4. Up to three general-purpose outputs (1 form C-relay and 2 open collector transistors) which can be turned on or off under program control to activate external devices.

5. Up to 100 mA of 12 VDC power to supply external relays, sensors, etc.

6. A simple but powerful programming language, detailed on the following pages, for implementation of the application program.

7. Memory capacity for storage of up to 32 program steps enables development of programs involving considerable sophistication.

10.2 Using the AutoExec Mode

Before using the AutoExec mode in an application, the application must be broken down into a series of steps involving motor operation at one or more speeds, external event triggers such as switches opening or closing which cause some response in the drive or program, control of external devices based on the status of the drive or program, implementation of time delays which wait for some action to be completed and

determination of repetitive cycles, if any, which may repeat indefinitely or for a specific number of times. It is often helpful to draw a flow diagram as a means of understanding the application sequence of operation.

Several examples shown in a latter part of this section provide a description of the application and a sample AutoExec program to implement the desired operation. Comments are included to explain the function of individual steps.

Using the AutoExec mode requires that a program be developed and entered beginning with STEP 1. Section 8, Programming, gives an overview of the AutoExec mode programming language. Additional programming details including a detailed description of each instruction and an example of its usage is provided in Section 10.3. If the program will use any of the internal timers or counters, these should be preset to the desired value by using the COUNT n = or TIMER n = parameters.

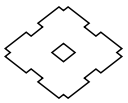
Before an AutoExec mode program can be executed, the drive must be placed in the AutoExec mode by accessing the Control Mode menu and selecting AUTO EXECUTE. This menu can be accessed as shown in Section 8, Programming. Note that the default control mode is SPEED FOLLOWER.

After a program is entered and the control mode is set to AUTO EXECUTE, the program will begin executing when the drive receives a Run command either Local (from the keypad), Remote (from the terminal strip) or from the Serial Port. Note that even though a Run command is received, the motor does not start until a RUN FORWARD or RUN REVERSE motor command instruction is executed by the program.

When a program is being tested for the first time, it may be a good idea to place the AutoExec program in the Single Step mode. This is done by setting the SINGLE STEP MODE parameter to TRUE. This will cause the drive to execute one program step at a time each time the Run command is toggled. The display will also show the step being executed. Caution should be used in single-stepping the program to insure that an instruction using a timer or testing for an input condition is executed at the proper time. Failure to do so could result in an instruction to stop the motor not being executed when anticipated and the motor continuing to operate longer than desired.

CAUTION

USE CARE WHEN SINGLE-STEPPING AN AUTO-EXEC MODE PROGRAM. SOME STEPS WHICH DEPEND ON TIMER OR EXTERNAL INPUT FUNCTIONS MAY OPERATE DIFFERENTLY THAN EXPECTED RESULTING IN OVERTRAVEL OF THE DRIVEN LOAD.



Once the program is tested and debugged, full automatic operation can be accomplished by setting the SINGLE STEP MODE parameter to false. When the drive receives a Run command, the program will begin executing at STEP 1 and continue until an END statement is encountered or until the Run command is removed.

10.3 AutoExec Programming Language

The AutoExec mode programming language is broken down into functional blocks based on the action to be taken. Each functional block has one or more modifiers which can be set to carry out the explicit task. The functional blocks and modifiers are described in detail on the following pages along with an example of their use.

Accessing the AutoExec mode and entering instructions is covered in Section 8, Programming.

10.3.1 MOTOR COMMAND

This is the basic command to control motor running or stopped condition. Three modifiers as listed below are available.

A. RUN FORWARD – Starts the motor in the Forward direction using the default acceleration time (ACCEL TIME 1) unless a previous step has changed the ramp time to ACCEL TIME 2.
B. RUN REVERSE – Starts the motor in the Reverse direction using the default acceleration time as described for RUN FORWARD.
C. STOP – Stops the motor at the default deceleration time unless a previous step has changed the ramp time to DECEL TIME 2.

The example of Motor Command usage shown below starts the motor in the forward direction. Note that since no speed command has been received, the motor would run at minimum speed.

```
STEP 1
RUN FORWARD
```

10.3.2 SET SPEED

This is the basic command to control motor speed. Eleven modifiers are available and are described below.

A. PRESET SPEED 1..7 – Causes the motor to run at the speed set in the corresponding preset speed parameter in the Basic menu.
B. AI1 – causes the speed to be set by the 4-20 mA analog input.
C. AI2 – causes the speed to be set by the 0 – 10 VDC analog input.
D. LOCAL – (default) the speed is set by the local keypad.
E. SERIAL PORT – causes the speed to be set by the RS-485 communications port.

The example of Motor Command usage shown below causes the motor to run at preset speed number 4.

STEP 2 PRESET SPEED 4

Combining the first two steps into a simple program would cause the motor to start and RUN FORWARD and accelerate using ACCEL TIME 1 to the value set in PRESET SPEED 4. Note that the two steps could be reversed with the speed command being given before the run command. Either of the two programs shown below are valid and will accomplish the same result.

Program Listing 1
STEP 1 RUN FORWARD
STEP 2 PRESET SPEED 4

Program Listing 2
STEP 1 PRESET SPEED 4
STEP 2 RUN FORWARD

It is permissible to change motor speed during operation by introducing another SET SPEED command without stopping the motor. The last SET SPEED instruction executed will control the speed. An example shown later will use this capability.

10.3.3 ACCEL/DECEL MODE

This command controls which of the two acceleration times or which of the two deceleration times will be used when a RUN FORWARD, RUN REVERSE or STOP Motor Command is processed. Note that the Accel/Decel mode defaults to ACCEL TIME 1 and DECEL TIME 1 unless specifically changed before a Motor Command or Set Speed Instruction is executed. See the Command modifiers below.

A. ACCEL 1 – Acceleration Time 1 is used as the accel time. Note that this is the default and it is not necessary to use the ACCEL 1 instruction unless an ACCEL 2 instruction has been executed and it is desired to shift back to ACCEL 1.
B. ACCEL 2 – Acceleration Time 2 is used as the accel time.
C. DECEL 1 – Deceleration Time 1 is used as the decel time. Same note as for ACCEL 1 applies.
D. DECEL 2 – Deceleration Time 2 is used as the decel time.

An example of usage will be shown later.

10.3.4 TIMER ADJUST

The Timer Adjust command is used to control the 2 available internal timers as detailed in the description of modifiers below.

A. TIMER 1 START – Starts the timing cycle for Timer 1. Note that Timer 1 must be preset to some value other than zero by setting the “TIMER 1 =” parameter.
B. TIMER 1 STOP – Used to interrupt the timing cycle for Timer 1 before it reaches zero. If the timer is allowed to complete its cycle and reach zero, it automatically stops.
C. TIMER 1 RESET – Resets Timer 1 to the value set in the “TIMER 1 =” parameter. Timers do not automatically reset when they reach zero. A specific reset instruction is required.
D. TIMER 2 START – Same as Timer 1 Start above except the “TIMER 2 =” parameter is used to preset the timer.
E. TIMER 2 STOP – Same as Timer 1 Stop above.
F. TIMER 2 RESET – Same as Timer 1 Reset above.

The example below starts timer 1.

STEP 3 TIMER1 START

10.3.5 COUNTER ADJUST

The Counter Adjust command is used to control the 2 available internal counters as detailed in the description of modifiers below.

A. COUNT1 DEC – Counter 1 decrement – subtracts one from counter 1 each time the instruction is encountered. This instruction is commonly used in loops to determine how many times something is done. Note that the counter must be preset to some value other than zero using the “COUNT 1 =” parameter.
B. COUNT1 RESET – Resets counter 1 to the value set in the “COUNT 1 =” parameter.
C. COUNT2 DEC – Counter 2 decrement. Same as counter 1.
D. COUNT2 RESET – Same as Counter 1 reset.

The example below subtracts one from Counter 1.

```
STEP 3
COUNT1 DEC
```

10.3.6 SET OUTPUT

Turns the output specified in the modifier ON.

A. OUT1 – Digital output assigned to the OUT1 function using the I/O MODE set up menu.
B. OUT2 – Digital output assigned to the OUT2 function.
C. OUT3 – Digital output assigned to the OUT3 function.

The example below turns on output 1.

```
STEP 3
SET OUT1
```

10.3.7 CLEAR OUTPUT

Turns the output specified in the modifier OFF.

A. OUT1 – Digital output assigned to the OUT1 function using the I/O MODE set up menu.
B. OUT2 – Digital output assigned to the OUT2 function.
C. OUT3 – Digital output assigned to the OUT3 function.

The example below turns off output 1.

```
STEP 3
CLEAR OUT1
```

10.3.8 GOTO STEP

This instruction is used to interrupt the sequential flow of the program and transfer control immediately to the specified step. The target step for the GOTO is entered via the numeric keypad and must be a valid step number used in the program.

The example below transfers program execution from what would be the next step to execute, Step 4, directly to Step 7, effectively skipping Steps 4, 5 and 6. The GOTO instruction is commonly used with an IF COMMAND, IF IN or IF NOT IN instruction to branch program flow under certain conditions. Examples will be shown later.

```
STEP 3
GOTO STEP 7
```

10.3.9 IF COMMAND

The IF COMMAND is used like the computer language IF-THEN-ELSE statement which can cause an interruption in the sequential flow of a program depending on the result of the test condition. If the test condition is True, the next program step is executed or, if the test condition is False, the next program step is skipped. Test conditions are shown below.

A. COUNT1 = 0 – if Counter 1 is zero the result is TRUE.
B. COUNT1 > 0 – if Counter 1 is not zero the result is TRUE.
C. COUNT2 = 0 – Same as COUNT1 = 0 above.
D. COUNT2 > 0 – Same as COUNT1 > 0 above.
E. TIMER1 = 0 – if Timer 1 has timed-out the result is TRUE.
F. TIMER1 > 0 – if Timer 1 is still timing the result is TRUE.
G. TIMER2 = 0 – Same as TIMER1 = 0 above.
H. TIMER2 > 0 – Same as TIMER1 > 0 above.

The following example tests for Timer 1 not equal to zero.

```
STEP 3
IF TIMER1 > 0
```

10.3.10 IF IN

The IF IN command is used to test the state of Digital Inputs configured as IN1, IN2, IN3 or IN4. From zero to all four inputs may be used in the program but they must first be assigned to the IN1..IN4 function using the I/O MAP menu. The following conditions are available for creating the test pattern. Note that all 4 inputs must be included in the test pattern, even if they are not being used.

A. 1 (Logic 1 or On) – an input is connected to common.
B. 0 (Logic 0 or Off) – an input is not connected to common.
C. X (Don't Care) – the input is not used or its state does not matter for the particular test.

The example below tests for IN1-On, IN2-Off and IN3, IN4 not used. A True result will occur only if IN1 is connected to common and IN2 is not connected to common.

```
STEP 3
IF IN 10XX
```

10.3.11 IF NOT IN

This instruction works just like the IF IN instruction described above except the logic is reversed. True results if the input conditions do not match the test pattern. The test conditions are the same as described above. The example below will produce a True result only if IN1 is not connected to common and IN2 is connected to common.

```
STEP 3
IF NOT IN 10XX
```

10.3.12 END

END is the factory default for all steps prior to program entry. At least one END instruction must occur in a program.

10.4 AutoExec Examples

10.4.1 Run for Preset Time

The simple program shown will cause the motor to start in the forward direction using Acceleration Time 1, run at 900 RPM for 10 seconds and then stop. Assume that the Run command will be LOCAL (i.e. the Digital Operator Interface).

The following drive parameters must be preset before executing the program.

A. The preset speed to be used must be set to 900 RPM using the Basic Menu. Assume that PRESET SPEED 4 is to be used since the factory default setting is 900 RPM.
B. The timer to be used (assume Timer 1) must be preset to 10 seconds using the TIMER = parameter in the AutoExec Menu.

Program Step	**Comments**
STEP 1 PRESET SPEED 4	Sets the speed command to Preset Speed number 4.
STEP 2 RUN FORWARD	Starts the motor in the forward direction. It will accelerate to the speed called for by Preset Speed 4 using Acceleration Time 1.
STEP 3 TIMER1 START	Timer 1 begins timing.
STEP 4 IF TIMER1 > 0	Tests the status of Timer 1. If it is still timing, the result is True and Step 5 is executed, otherwise, Step 6 is executed.
STEP 5 GOTO STEP 4	Loop back to Step 4 and wait for Timer 1 to reach zero.
STEP 6 STOP MOTOR	After Timer 1 reaches zero. The motor is stopped.
STEP 7..STEP 32 END	No other steps are used so they are left at the default End.

The resulting operation is displayed graphically on the following page in Figure 10.1.

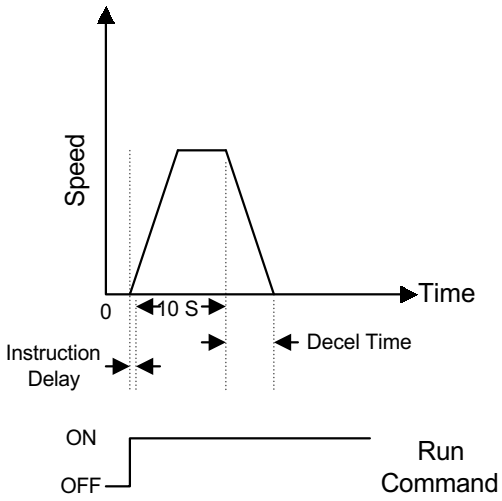


Figure 10.1 – Run for Preset Time Timing Diagram

Several things are important to note from the Timing Diagram above.

1. Timer 1 begins timing upon the execution of STEP 3. There is a very short, approximately 100 μS per step, execution time which should not be a factor in most programs but could result in accumulated error if significant looping is performed. Another possibility would be to start Timer 1 prior to executing the Run Forward command.

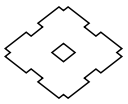
2. The total running time is the setting of Timer 1 plus the drive deceleration time from the actual operating speed when the Stop command is executed. In this example, using the default deceleration time of 10 s and assuming 900 RPM operating speed, total running time is actually 15 seconds and is calculated using the formula shown.

$$T_R = T_1 + \frac{S_A}{S_M} \cdot T_D$$

Where:

T_R = Total Running Time
T_1 = Setting for Timer 1
T_D = Deceleration Time
S_A = Actual Speed
S_M = Maximum Speed

If the total operation time is desired to be 10 seconds, the setting of Timer 1 must be adjusted to compensate for the deceleration time from the actual operating speed to zero when the Stop command is executed. In the preceding example, Timer 1 would be set to 5 seconds instead of 10 seconds.



3. The deceleration time setting should be confirmed by actual operation of the motor with the connected load. The drive will compensate for high inertia loads by automatically extending the deceleration time to prevent an over voltage trip. If deceleration time is critical, dynamic braking resistors may be required.

4. The above program will execute only one time when the Run command is received, even if the Run command remains applied. Repeated execution of the program requires that the Run command be cycled.

10.4.2 Indexing Based on Time

The program from the preceding example could be modified slightly to provide a solution to a common application requirement. Indexing a conveyor belt by running for a preset time and stopping to wait for a process to take place and repeating the cycle. Previous program steps are repeated for clarity beginning on the following page.

Operation of this program assumes the preset conditions as shown in the previous example plus the following:

A. Since Timer 1 was used for the running time, Timer 2 will be used for the time while stopped. Assuming 30 seconds stopped, the “TIMER2 =” parameter will be set to 30.

Program Step	**Comments**
STEP 1 PRESET SPEED 4	Sets the speed command to Preset Speed number 4.
STEP 2 RUN FORWARD	Starts the motor in the forward direction. It will accelerate to the speed called for by Preset Speed 4 using Acceleration Time 1.
STEP 3 TIMER1 START	Timer 1 begins timing.
STEP 4 IF TIMER1 > 0	Tests the status of Timer 1. If it is still timing, the result is True and Step 5 is executed, otherwise, Step 6 is executed.
STEP 5 GOTO STEP 4	Loop back to Step 4 and wait for Timer 1 to reach zero.
STEP 6 STOP MOTOR	After Timer 1 reaches zero. The motor is stopped.
STEP 7 TIMER1 RESET	Reset Timer 1 to its preset value.
STEP 8 TIMER2 START	Timer 2 Begins Timing.

Indexing Based on Time (Continued)

Program Step	Comments
STEP 9 IF TIMER2 > 0	Tests the status of Timer 2. If it is still timing, the result is True and Step 10 is executed, otherwise, Step 11 is executed.
STEP 10 GOTO STEP 9	Continue looping back to Step 9 until Timer 2 reaches zero.
STEP 11 TIMER2 RESET	After Timer 2 reaches zero, reset Timer 2 to its preset value.
STEP 12 GOTO STEP 2	Start executing the program again beginning with Step 2.
STEP 13..STEP 32 END	No other steps are used so they are left at the default End.

The program will begin executing when a Run command is received and will continue to execute until the Run command is removed. Also, the Timing Diagram shown in Figure 10.1 has been modified to show the effect of the new instructions and is shown in Figure 10.2 on the following page.

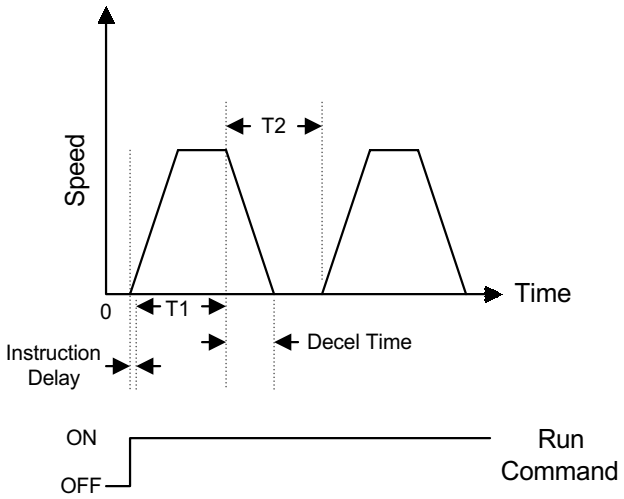
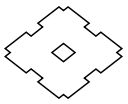


Figure 10.2 – Timed Indexing Application

The comments shown under Figure 10.1 apply plus the following additional.

1. Note that steps were added to reset both timers. This is required in programs which execute multiple times.

2. The Stopped timer, Timer 2, value must be adjusted to compensate for the deceleration ramp time since the Start Timer instruction is executed immediately after the Stop motor instruction.



3. Accuracy can be improved by setting minimal values for acceleration and deceleration times with the understanding that times can automatically be increased by the drive to compensate for the motor ability to accelerate or decelerate the load.

Overall improved performance can result from eliminating the interaction between acceleration, deceleration and timer settings by using position sensing and several of the drive digital inputs and outputs as shown in the next example.

10.4.3 Indexing Based on Position With Dwell Time

The following example shows some of the power of the AutoExec functionality by expanding the previous time based indexing into a more functional position based indexing scheme. Position is sensed by external photo switches for slow-down and final stop and an internal timer is used for the dwell time that the belt is stopped. In addition, dwell time is not dependent on the deceleration ramp time. The dwell timer is started when the motor actually stops instead of when a Stop command is executed.

Functioning of this program assumes the following parameter settings have been made to the drive.

A. Digital Input DI2 is assigned the function IN1 as described in the I/O Map set-up procedures and is used for a slow-down photo switch.
B. Digital Input DI3 is assigned the function IN2 and is used for a final stop photo switch.
C. Digital Input DI4 is assigned the function IN3 and is connected to Digital Output 2 to sense drive running.
D. Digital Output DO2 is assigned the function RUN as described in the I/O Map set-up procedures and DO2 is connected to DI4 via an external jumper wire.
E. Timer 1 is used as the dwell timer controlling how long the belt stops between indexes and is preset to 30 seconds using the “TIMER 1 =” parameter in the AutoExec menu.
F. The desired indexing speed is 900 RPM so the factory default value for Preset Speed 4 is used.
G. The desired “creep” speed is 100 RPM so the factory default value for Preset Speed 1 is used.
H. ACCEL TIME 1 is set for 1 second.
I. DECEL TIME 1 is set for 1 second.
J. DECEL TIME 2 is set for 0.1 second to improve stopping accuracy.

One possible program solution is shown beginning on the following page.

Program Step	Comments
STEP 1 PRESET SPEED 4	Sets the speed command to Preset Speed number 4.
STEP 2 RUN FORWARD	Starts the motor in the forward direction.
STEP 3 IF NOT IN 1XXX	Check if slow down photo switch wired to IN1 is Not On. If not, the result is True, execute Step 4. Else, execute Step 5. IN2, IN3 & IN4 are not considered.
STEP 4 GOTO STEP 3	Loop back to Step 3 and wait for the test pattern to match.
STEP 5 PRESET SPEED 1	Shift to Preset Speed 1 which is programmed for a low "creep" speed.
STEP 6 IF NOT IN X1XX	Check if final stop photo switch wired to IN2 is Not On. If not, the result is True, execute Step 7. Else, execute Step 8.
STEP 7 GOTO STEP 6	Loop back to Step 6 and wait for the test pattern to match.
STEP 8 DECEL 2	Shift to decel time 2 for a faster stop.
STEP 9 STOP	Stops the motor using decel time 2.
STEP 10 IF NOT IN X10X	If the final stop photo switch is Not On and the Drive Run output Not Off, execute Step 11. Else, execute Step 12.
STEP 11 GOTO STEP 10	Continue looping back to Step 10 until the test pattern matches.
STEP 12 TIMER1 START	Begin the dwell timing.
STEP 13 IF TIMER1 > 0	Test for Timer 1 still timing. If True execute Step 14. Else, execute Step 15.
STEP 14 GOTO STEP 13	Continue looping back to Step 13 until Timer 1 reaches zero.
STEP 15 DECEL 1	Shift back to decel time 1.
STEP 16 TIMER 1 RESET	Reset Timer 1 to its preset value.
STEP 17 GOTO STEP 1	Return to Step 1 and repeat the program.
STEP 18..32	END. Default setting.

The preceding program will begin executing when a Run command is received and will continue until the Run command is removed. A timing diagram is shown in Figure 10.3 on the following page.

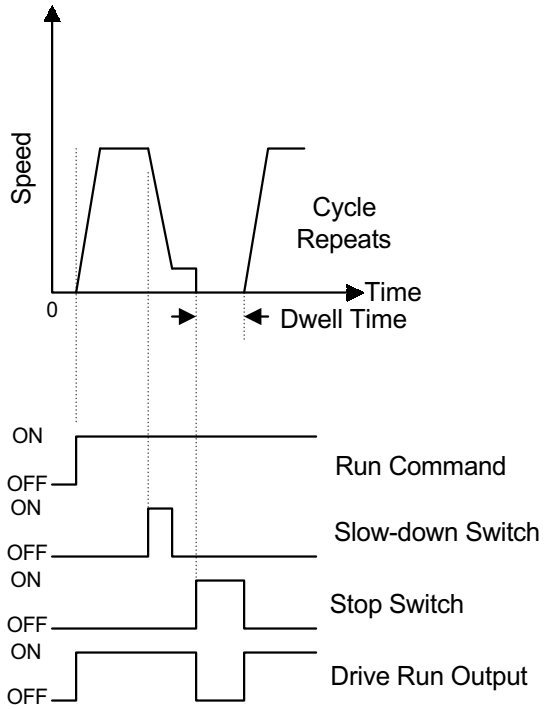


Figure 10.3 – Indexing With Position & Dwell

10.4.4 Indexing with Cycle Counter

Some applications require that an operation be performed for a specific number of complete cycles and then the process is stopped. The AutoExec mode includes two counters which can be used to automate the process. Consider the preceding example of position indexing with dwell and add the requirement that the indexing is to occur 100 times and then stop and turn on a light to indicate finished.

In addition to the conditions preset from the previous example we must also:

A. Preset the counter to be used to the number of cycles. This is done by setting the “COUNT 1 =” parameter to 100.
B. Assume the Finished light is connected to Digital Output DO1 which is a form C relay using the common and Normally Open terminals. DO1 must be assigned the OUT1 function in the I/O Map menu.

For brevity, the previous program can remain unchanged up through STEP 16 and will not be repeated here. Beginning with STEP 17 the program is modified as shown on the following page.

STEP 17 COUNT1 DEC	Decrements (subtracts 1) from counter 1.
STEP 18 IF COUNT1 > 0	Test for counter 1 not equal to zero. If not, the result is True and Step 19 is executed. Else, the result is False and Step 20 is executed.
STEP 19 GOTO STEP 1	Return to Step 1 and repeat the program.
STEP 20 SET OUT1	Turns on the Finished light.
STEP 20..32	END. Default setting.

10.5 AutoExec Program Editing

Three instructions are provided which allow editing of existing programs. These instructions allow the entire program to be deleted, allow a step to be deleted or allow a step to be inserted.

10.5.1 CLEAR ALL STEPS

The clear all steps parameter is used to clear an AutoExec program from the drive memory by resetting all of the steps 1 through 32 to END. This function is executed by entering the AutoExec set-up mode, scrolling the display to the CLEAR ALL STEPS parameter and pressing the ENT key. Caution, once ENT has been pressed, any existing program is unrecoverable.

10.5.2 INSERT STEP

This instruction is used in the Step Editing mode when it is desired to modify a program by inserting a step before the currently displayed step. The current step and any following steps are automatically pushed down by one.

Two words of caution when using this instruction. First, insure that the step to be inserted will not result in more than 32 total steps in the program because when existing steps are shifted down, any instruction in Step 32 is lost. Second, insertion of a step does not automatically update GOTO statements so it will be necessary to edit steps with the GOTO instruction manually to insure the program functions correctly.

10.5.3 DELETE STEP

This instruction is used in the Step Editing mode when it is desired to delete the current step. The step immediately below the deleted step will move up to take its place and all following steps will move up accordingly. As in the Insert Step instruction above, it will be necessary to manually edit any GOTO statements.

11 SERIAL COMMUNICATIONS

11.1 General

NTAC-2000 AC drives are equipped as standard with a serial communication port. Serial communication can be used for real-time control of the drive, for data logging or for parameter upload and download. The hardware configuration used conforms to the Electronic Industries Association RS-485 standard. RS-485 is designed to be more compatible with industrial applications where there is a need for longer communication distances and a greater potential for electrical noise.

In addition to good noise immunity and long transmission distance, another advantage of RS-485 is that it is suitable for multi-drop installations meaning that more than one device can be connected to a single serial communication channel. In fact, the EIA standard allows up to 32 devices on the serial communication link with each device having a unique address. The protocol implemented in the NTAC-2000 AC drive also allows broadcast commands that all drives receive simultaneously.

NTAC-2000 AC drives can be controlled by any computer (laptop, desktop, industrial, etc. or any PLC which has an RS-485 serial port and is configured for the proper communication protocol. Note that most laptop and desktop computers are equipped with one or two RS-232 ports and an RS-232 to RS-485 converter is required. These devices are inexpensive and readily available from many industrial computer supply houses such as B & B Electronics (Model 485SD9TB), 707 Dayton Road, Ottowa, IL, Phone: 815/433-5100 or can be purchased from Sumitomo Machinery Corp. of America (Catalog No. RS232-485-9).

There are a number of different ways to implement RS-485 with the two most common being a 4-wire full-duplex (2-twisted pairs with one pair for transmit and the other pair for receive) and a 2-wire half-duplex (1-twisted pair used for transmit and receive). NTAC-2000 drives use the half-duplex approach and the communication link is set up in a Host-Drive configuration.

In a Host-Drive configuration, the Host (computer, PLC, etc.) originates all communication and the Drives monitor the communication link. When a Drive detects a communication including its assigned address, it processes the information and responds with an acknowledgment that the message was received and executed or with an error message if the message was not received properly. Drives never originate communication. If the drive status is to be monitored, the Host must poll the Drive requesting the specific piece of information. The Drive will respond accordingly.

11.2 RS-485 Hardware Configuration

The RS-485 serial communications port is set up as a female RJ-12, (6-pin) telephone style connector as shown in Figure 11.1.

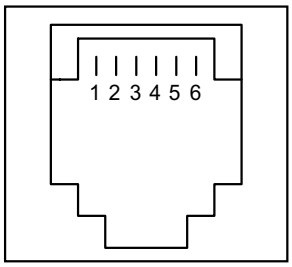


Figure 11.1 – Drive RJ-12 Connector (Front View)

Cabling must be configured as shown in Figure 11.2a, b, or c. Note that Pin 1 (+12 VDC) and Pin 2 (Power Supply Ground) are not normally used. They are available if some type of external device such as an RS-232 to RS-485 converter is used and it requires that power be supplied from the serial link. Also note that Pin 6 is not used.

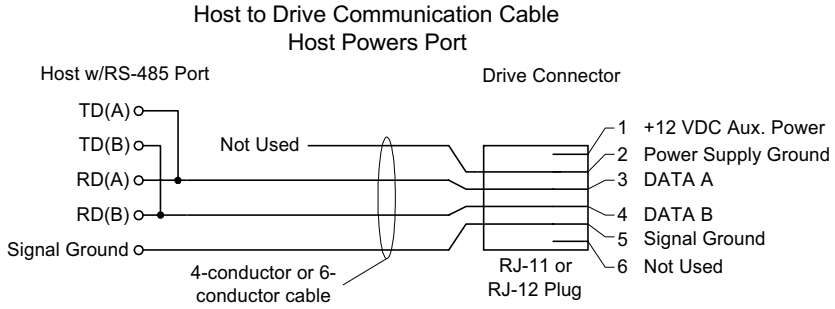


Figure 11.2a – Host to Drive Communications Cabling

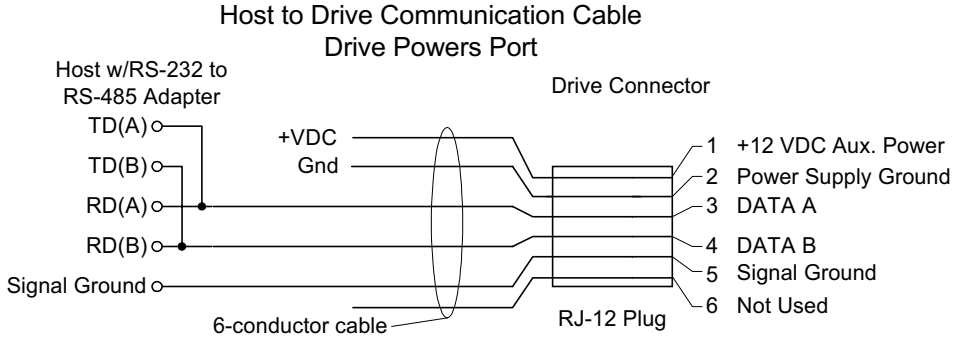


Figure 11.2b – Host to Drive Communication Cabling

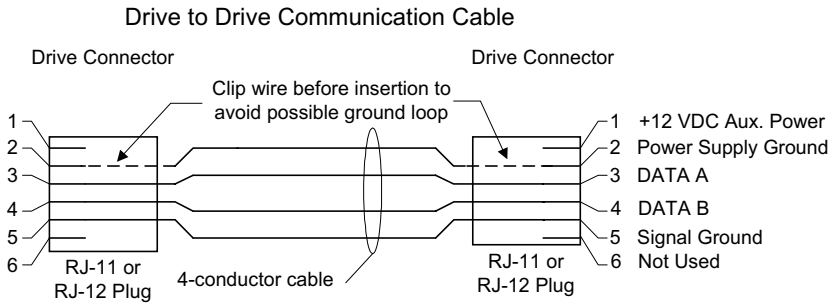


Figure 11.2c – Drive to Drive Communication Cabling

If the +12 VDC and Ground conductors are not used, a standard RJ-11 telephone plug can be used. RJ-11 is identical to RJ-12 except that Pins 1 and 6 are not present.

When wiring multiple drives on a single serial communication link (commonly called multi-drop), it is important to insure that the cabling is installed properly. It will also be necessary to use a Y- adapter at each drive except the last one on the link so that communication cable can be daisy-chained from one drive to the next. Pre-made cable with the connectors already installed should be avoided because pin 2 (Power Supply Ground) of the drive serial ports should not be connected together. Doing so may cause a ground loop resulting in communication errors. In addition, pre-made telephone extension cable is manufactured with connectors “crossed” so that pin 2 on one end of the cable connects to pin 5 on the other end, etc.. The pin-out of the NTAC-2000 serial port connector was designed so that accidental reversal of the connectors will not cause damage, however, the communications will not function.

CAUTION

DO NOT USE PREMADE TELEPHONE JUMPER CABLES TO CONNECT DRIVES TO EACH OTHER OR TO THE HOST. TELEPHONE CABLES ARE CONSTRUCTED WITH CONNECTORS REVERSED THAT WILL RESULT IN MISOPERATION.

When attaching RJ-11 or RJ-12 connectors to the ends of the cable, insure that the conductors are connected in a “straight-through” fashion and not “reversed” or “crossed”. In other words, insure that the same wire color connects to pins 2, 3, 4 & 5 on each end of the cable. Also, after stripping the cable jacket, clip the wire that would connect to pin 2 before crimping the connector in place. Note that a special connector crimping tool is required to make up the communication cable or pre-made length of cable can be ordered from SMA.

When configuring a communication link for multi-drop, routing of the cable is important to insure error-free communication. Cable must be routed from the Host to the first drive and from the first drive to the second drive using a Y-adapter and so on as shown in Figure 11.3. This is commonly called daisy chaining.

A 100 Ω termination resistor is required on each end of the link to insure balanced impedance. The termination resistor should be an integral part of the host device but should be verified by reading the instructions supplied with the RS-485 port adapter and added externally if required. Each NTAC-2000 is equipped with a 100 Ω termination resistor and a termination jumper J7 to connect the termination resistor in the circuit. The drive is shipped with the jumper removed. In a single drive link, the termination jumper must be installed. In a multi-drop circuit, only the last drive in the serial link should have the termination jumper installed.

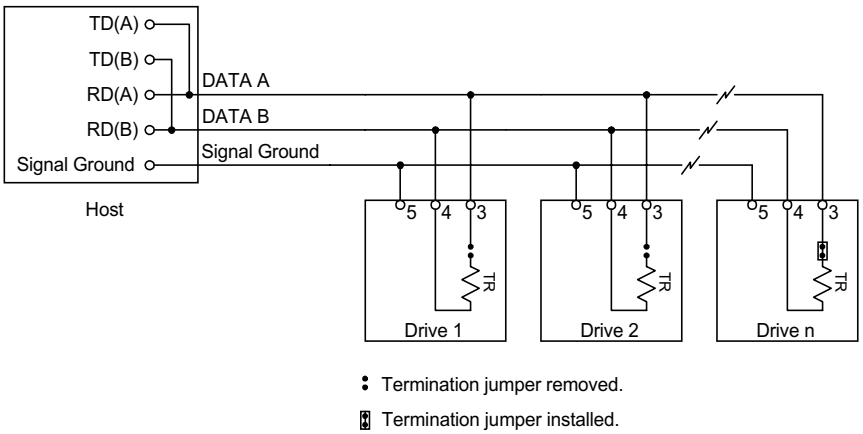
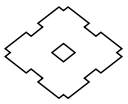


Figure 11.3 – Multi-Drop Configuration

The termination jumper is supplied in a small bag taped to the side of the drive. If required, the termination jumper should be inserted on both pins identified as J7. J7 is located on the rear of the Digital Operator Interface circuit board. Locate the small relay just above the Input / Output terminal strip and note the small diagram on the top of the relay. The arrows point to the location of jumpers J4 and J7.

If serial communication is not to be used at the time of drive installation but may be used in the future, it is a good idea to insert the termination jumper on only one of the two pins to insure that it will not be misplaced.



11.3 Communications Protocol

A communications protocol determines how the data is formatted so that it can be understood by both parties. Both the host and drives must utilize the same protocol if communications are to be established and error-free data transfer is to occur. The protocol also includes a means of detecting errors in communications so that invalid commands are not processed.

NTAC-2000 AC drives are configured to receive and transmit information using the ASCII (American Standard Code for Information Interchange) protocol. The ASCII protocol defines the way data is organized to represent different alphabet, numeric and control characters and also defines the organization of data into 7 or 8 bit blocks to define the characters. NTAC-2000 drives communicate using the following characteristics:

Data Length	8 – bits (fixed)
Communication Speed	Programmable: 1200, 2400, 4800, 9600, 19200 bps
Stop Bit	1 (fixed)
Parity	None (fixed)
Communication Method	Half-Duplex (transmit & receive over the same wires)

The host must be configured to match the communication parameters set in the drive. The host must also be programmed to send commands to the drive and handle responses from the drive. SMA will offer a Microsoft Windows 95 or Windows NT compatible software package for drive control and parameter maintenance. SMA is also developing a communication function library compatible with common programming languages. Contact your SMA distributor or representative for details.

If SMA supplied serial communication software is not used, the user must develop the serial communication drivers for the hardware platform to be used. Request the NTAC-2000 Communication Protocol Guide.

12 TROUBLESHOOTING

NTAC-2000 AC drives incorporate a number of features which assist in determining why operation is not as expected. Problems could result from operation of drive protective circuits which result in a fault trip, improper configuration of analog or digital inputs, or misconnection or failure of external devices controlling the drive. NTAC-2000 drives have capabilities to help detect and correct any of the above conditions.

12.1 Maintenance Mode

The Maintenance Mode offers a real-time look at drive configuration and performance while the drive is operating. It can be accessed by pressing the SHIFT → MAINT (7) key combination as described in Section 7, Operation and Section 8, Programming.

After entering the Maintenance Mode, several options will be available. These include the ability to view a fault history, view current status and view the assignments and status of digital inputs and outputs.

12.1.1 Fault History

The drive has the ability to store the past 4 fault trips in non-volatile memory. Access the Maintenance Mode as described in Section 6, Programming. The first choice presented will be FAULT HISTORY. Press the ENT (Enter) key to view the fault history. The most recent fault will be displayed. Use the Down arrow key to scroll through additional faults, if any, in the reverse order that they occurred. A table of fault codes and descriptions is shown on the following page. If no fault is recorded, the display will show NONE.

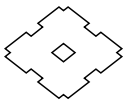


Table 12.1 – Maintenance Mode Fault Codes & Descriptions

Fault Code	Description
IGBT ERROR	An abnormal condition has occurred in the drive inverter section.
GROUND FAULT	The drive ground fault protection has been activated.
OVER CURRENT	The drive has exceeded its instantaneous or short-time current rating.
DC BUS LOW	The DC bus voltage is low.
DC BUS HIGH	The DC bus voltage is high.
MOTOR OVERLOAD	The inverse time over current protection has been activated.
HS OVER TEMP	The drive heatsink temperature has exceeded the maximum safe operating temperature.
COMM ERROR	Communication between the host and drive or drive and keypad has not been received within the allotted time.
SINGLE PHASE	The drive is receiving single-phase input power and is operating at more than its single-phase input rating.
MOTOR PARAMETER	An out-of-range parameter has been entered for the motor.
MOTOR FAULT	No motor connected or the drive is unable to stop the motor within 10 sec of the set decel time.
EXTERNAL FAULT	A digital input configured for External Fault has been activated.
EEPROM FAULT	The drive EEPROM data is not valid.
AUTO EXEC ERROR	An error has occurred in the AutoExec program execution mode.
AI1 NO SIGNAL	4-20 mA signal is below 3.5 mA
OL ALERT	An overload trip is imminent if current is not reduced below rated amps.
PS FAULT	There is a problem with the drive power supply.
A/D OFFSET FAULT	An A/D converter is out of tolerance.

12.1.2 Present Status

Access the Maintenance Mode as described in Section 8, Programming. The first choice presented will be FAULT HISTORY. Press the Down arrow key one time until the display shows PRESENT STATUS. Press the ENT (Enter) key to view the present status. Press the Up or Down arrow keys to scroll through the list of available information. Table 12.2 below describes the available information.

Table 12.2 – Maintenance Mode Present Status

Display Information	Description
SPEED	Displays the motor speed in RPM.
FREQ	Displays the drive output frequency in HZ.
TORQUE	Displays the motor torque in % of full load.
SET PT	Displays the set point value in % of maximum if the speed or torque setpoint mode is being used.
I OUT	Displays the drive output current in Amps.
V OUT	Displays the drive output voltage in VAC.
V BUS	Displays the DC bus voltage in VDC.
I REF	Displays the value of the 4-20 mADC signal.
V REF	Displays the value of the 0-10 VDC signal.
ENERGY	Displays the accumulated energy used in kWH since the value was reset.
POWER	Displays the instantaneous output power in kW.
R TIME	Displays the number of hours of operation to the nearest hour since the value was reset.
CUSTOM	Displays motor speed in user-defined units.
ROTATE	Displays the direction of rotation.
HS TEMP	Displays the heatsink temperature in °C.

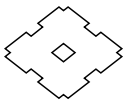
Information on use of the above information in troubleshooting is described later in this section.

12.1.3 Digital Input Monitoring

Each of the eight digital inputs can be monitored for its assigned function and current status (Active or Inactive). An input is active if it is connected to CM (Common) and Inactive if it is open.

Access the Maintenance Mode as described in Section 8, Programming. The first choice presented will be FAULT HISTORY. Press the Down arrow key until the display shows DIGITAL INPUTS. Press the ENT (Enter) key to view the current assignment and status. Press the Up or Down arrow keys to scroll through the eight digital inputs. An example of the information presented is shown below.

DIG INPUT DI1 STOP 1	Digital Input 1 information is displayed. The assigned function is Stop. 0 = Input Inactive 1 = Input Active



12.1.4 Digital Output Monitoring

Each of the three digital inputs can be monitored for its assigned function and current status (On or Off). If the output is the relay output DO1, its Off state is shown on the diagrams in this manual. If the output is DO2 or DO3, open collector transistors, the On state results in the collector terminal being pulled to power supply common.

Access the Maintenance Mode as described in Section 8, Programming. The first choice presented will be FAULT HISTORY. Press the Down arrow key until the display shows DIGITAL OUTPUTS. Press the ENT (Enter) key to view the current assignment and status. Press the Up or Down arrow keys to scroll through the three digital outputs. The display will indicate as described above for Digital Inputs.

12.1.5 Clear Fault History

Accessing this function can clear the four-fault history. Access the Maintenance Mode as described in Section 8, Programming. The first choice presented will be FAULT HISTORY. Press the Down arrow key until the display shows CLEAR FAULTS. Press the ENT (Enter) key to clear the faults. Note: Once cleared, the action cannot be undone and fault history is lost.

12.1.6 Reset kWH

The drive records the energy consumed in kWH and can display the information from the Maintenance Mode or on line two of the display, if so configured. This value can be reset as described below.

Access the Maintenance Mode as described in Section 8, Programming. The first choice presented will be FAULT HISTORY. Press the Down arrow key until the display shows RESET KWH. Press the ENT (Enter) key to reset to zero.

12.1.7 Software Version

Drive capabilities may be enhanced or parameters may change in different versions operation software. The software version can be useful when discussing drive functions with the factory.

Access this information as follows. Access the Maintenance Mode as described in Section 8, Programming. The first choice presented will be FAULT HISTORY. Press the Down arrow key until the display shows SOFTWARE VERSION. The version number is displayed on line two in the format Ver. `nnnnK-nnnnI` where the K indicates the keypad software version and the I indicates the IDM software version.

In the event that it becomes necessary to replace a drive keypad or IDM, it is important to maintain compatibility of software versions. The drive serial number will be required when ordering a replacement part.

12.2 Basic Troubleshooting

Troubleshooting is most effective if a logical process is followed in identifying the symptom and checking the conditions that could cause the observed symptoms. Basic symptoms are shown in Table 12.1 below. Observe the symptoms and chose the path which best describes the symptoms. Then, proceed to the referenced section and follow the detailed troubleshooting procedure presented.

Table 12.1 – Basic Troubleshooting Symptoms

Observed Symptom	**Detailed Troubleshooting Steps**
Will Not Start	Sections 12.3.1, Motor Will Not Run-Local Keypad or 12.3.2, Motor Will Not Run-Remote Terminals.
Starts but Will Not Accelerate	Section 12.3.3, Motor Will Not Accelerate
Accelerates Too Slowly	Section 12.3.4, Acceleration Too Slow
Decelerates Too Slowly	Section 12.3.5, Deceleration Too Slow
Cannot Control Speed	Sections 12.3.6, No Speed Control Local or 12.3.7, No Speed Control Remote.
Stops Unexpectedly – No Fault Indication	Section 12.3.8, Drive Stops – No Fault Code Displayed
Stops Unexpectedly – Fault LED Illuminated	Section 12.4, Troubleshooting With Fault Codes
Unstable speed control or extremely rough rotation at low speeds.	Drive not Auto tuned or Auto tuned with incorrect motor data. Note that if the Parameter Reset procedure is executed, motor data must be reentered and Auto tune repeated.

12.3 Detailed Troubleshooting

12.3.1 Motor Will Not Run – Local Keypad

A. If the fault LED is illuminated, proceed directly to Section 12.4, Troubleshooting With Fault Codes.

B. The LCD display should be showing characters and either the Forward or Reverse LED should be on. If not, the input power may be faulty. With power applied, measure the voltage from L1/R to L2/S, from L2/S to L3/T and from L1/R to L3/T. The voltage should be balanced and within ±10% of the input voltage imprinted on the drive nameplate. If it is not, determine the cause and correct the problem.

HAZARD OF ELECTRICAL SHOCK OR BURN!

POTENTIALLY LETHAL VOLTAGES EXIST IN THIS DRIVE. USE EXTREME CARE WHEN MAKING TESTS WITH POWER APPLIED. ONLY EXPERIENCED ELECTRICIANS SHOULD BE ALLOWED TO REMOVE DRIVE ACCESS COVERS.

C. If the previous step indicates that the correct line voltage is being received. Open the disconnect feeding the drive and install a safety lock-out device.

HAZARD OF ELECTRICAL SHOCK OR BURN!

POTENTIALLY LETHAL VOLTAGES EXIST IN THIS DRIVE AND MAY REMAIN AT A DANGEROUS LEVEL FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS CONTROLLER, WAIT UNTIL THE BUS CHARGED LAMP GOES OUT AND MEASURE THE DC BUS VOLTAGE TO INSURE THAT IT IS ZERO.

D. After insuring that the DC bus voltage has decayed to zero, remove the Digital Operator Interface (DOI) from the front of the drive and verify that the ribbon cable connecting the DOI to the Integrated Drive Module (IDM) is securely seated in the connectors on both ends.

E. If the check is Step D above does not uncover any problems, the drive may be defective. Contact Sumitomo for assistance. Have complete drive nameplate information available when calling.

F. If the LCD is operating normally, verify that the Local LED is illuminated. If not, remote control from the terminal strip or serial port has been selected from the Control Mode setup menu. Press the SHIFT key followed by 9 (Loc/Rem) to force local control.

G. Press the Run (I) key and observe the Run LED to the right of the key. It should illuminate. If it does not, contact Sumitomo for assistance.

H. If the Run LED is illuminated, and Line 1 of the LCD display is set to show speed, enter a speed command of about 200 RPM using the numeric keypad and press ENT (Enter). The motor should accelerate to the set speed. If it does, local operation appears to be normal.

I. If it was necessary to force local control using the SHIFT → LOC/REM combination and remote control is desired, return control to remote by pressing SHIFT→LOC/REM again. The Local LED should extinguish. Then, refer to Section 12.3.2, Motor Will Not Run – Remote Terminals.

12.3.2 Motor Will Not Run – Remote Terminals

A. Verify that the Local LED on the Digital Operator Interface (DOI) is <u>not</u> illuminated. If it is illuminated, the drive may be in the local override mode. Press the SHIFT key followed by the 9 (LOC/REM) key. If the drive has been programmed properly, the Local LED will go out. If not, continue with Step B below.

B. Either the Run-Stop command or the Speed/Torque Reference command or both can be transferred to the remote terminals but the drive must be programmed to do so.

C. Access the Control Mode setup menu as described in Section 8, Programming. Follow the steps to set the Control Mode, Control Source and Run-Stop Command. After completion, exit the Control Mode setup menu.

D. Access the I/O Map setup menu and determine the state of digital input DI1. Determine if maintained run (2-wire control) or momentary start-stop pushbuttons (3-wire control) is to be used and configure DI1 accordingly. If DI1 is programmed for STOP, then one other input DI2 to DI8 must be programmed for START FORWARD or START REVERSE. Exit the I/O Map setup menu.

E. Verify that wiring to the terminals is correct. Refer to Section 13 for several typical connection diagrams.

F. If the Local LED is still illuminated, press the SHIFT key followed by the 9 (LOC/REM) key. The Local LED should extinguish.

G. Verify proper operation from remote terminals. If operation is not successful, continue with the next step.

H. Check the assignment and status of digital inputs using the Maintenance Mode as described earlier in this section and follow Step I or J below depending on the desire for 2-wire or 3-wire control.

I. If 2-wire control is desired, verify that DI1 is set to RUN FWD. While monitoring DI1 from the Maintenance Mode, close the contact which commands the drive to run. The display should show the DI1 status as “RUN FWD 1” where the 1 indicates the input is on. If the display shows “RUN FWD 0” the input is not on. Verify that DI1 is connected to COM via the run contact. If in doubt, remove the wiring from DI1 and place a jumper from DI1 to COM. If the display does not show “RUN FWD 1”, contact the factory for assistance.

J. If 3-wire control is desired, the stop circuit must be wired with a momentary, normally-closed contact from DI1 to COM. Refer to Appendix A for typical connection diagrams. Verify that DI1 is set to STOP and the display shows “STOP 1”. If the display shows “STOP 0”, determine the fault in the stop circuit. Also verify that one other digital input DI2 to DI8 is set for START FORWARD or START REVERSE. While monitoring the digital input set for START FORWARD or START REVERSE, press the start pushbutton. The display should show “START (direction) 1”. If not, determine the fault with the start circuit.

K. If the above steps have been performed and the Maintenance mode indicates correct assignment and functioning of digital inputs, verify that the drive operates in the Local mode by following the steps in Section 12.3.1.

L. If proper operation in Local is confirmed but remote operation is still not possible, contact Sumitomo for assistance.

12.3.3 Motor Will Not Accelerate

A. Verify that there is no obstruction or jam condition in the power transmission system coupling the motor to the driven machine.

 DANGER	**POSSIBLE UNEXPECTED MACHINE OPERATION!** **REMOVE ALL POWER FROM THE DRIVE AND INSTALL SAFETY LOCKOUT DEVICES TO INSURE THAT THE MACHINE DOES NOT START UNEXPECTEDLY.**

B. Verify that the Run LED to the right of the Run key illuminates when the start command is received, either from the keypad, from remote terminals or from the serial port. If not, follow the steps in Section 12.3.1 for Local Control or 12.3.2 for remote control.

C. Select Local Control from the Digital Operator Interface (DOI) if necessary by pressing the SHIFT key followed by 9 (LOC/REM) and insure that the Local LED is illuminated. Attempt to increase speed by entering a value equal to or less than motor rated speed using the numeric keypad and pressing enter. Check the motor speed on the LCD display and by observing the motor.

D. If motor now accelerates and control was previously remote (Local LED not illuminated), follow the troubleshooting steps in Section 12.3.7. If the motor shaft is not rotating, the drive may not be configured properly for the motor or there may be insufficient starting torque. Complete the following steps to determine the necessary action.

E. Access the Motor setup menu as directed in Section 8, Programming and verify proper motor data was entered in each of the parameters. Correct if necessary. Initiate the Autotune function in the Motor setup menu.

F. Access the Advanced setup menu as directed in Section 8, Programming and determine the setting of the Motor Torque Limit parameter. Increase to the maximum of 200% if necessary.

G. Attempt to start the motor. If the start and acceleration is successful, improper configuration was the problem. If starting and acceleration is not successful continue with the next step.

H. Access the Maintenance mode and select Present Status. Select Torque and press the Run key. When starting a heavy load, Torque and Current will approach the setting in the Motor Torque Limit parameter. Monitor the Torque and Output Current (I OUT) in the Maintenance mode while attempting to start the motor. If these values do not approach the setting of Motor Torq Limit, verify that correct motor data is entered and initiate the Autotune function.

I. Press the Run key and, using a clamp-on ammeter, verify that the current in all three motor legs is balanced. If the current is not balanced, check the drive output voltage from terminals T1/U to T2/V, from T2/V to T3/W and from T1/U to T3/W. All three readings should be balanced within 2%. If not, contact Sumitomo for assistance, otherwise, remove all power from the drive and install a safety lock-out. Verify that the motor is connected for the proper voltage.

DANGER	**HAZARD OF ELECTRICAL SHOCK OR BURN!** **POTENTIALLY LETHAL VOLTAGES EXIST IN THIS DRIVE AND MAY REMAIN AT A DANGEROUS LEVEL FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THE DRIVE OR THE MOTOR, WAIT UNTIL THE BUS CHARGED LAMP GOES OUT AND MEASURE THE DC BUS VOLTAGE TO INSURE THAT IT IS ZERO.**

J. If all checks above are satisfactory, the motor-drive combination does not produce enough starting torque and size must be increased. Contact Sumitomo for assistance.

12.3.4 Acceleration Too Slow

A. If the Local LED is not illuminated, press the SHIFT key followed by 9 (LOC/REM) to force local control.

B. If the top line of the display is set for SPEED in RPM, enter the motor rated speed from numeric keypad and press ENT.

C. Press the Run key and monitor the time from starting until the motor reaches the set speed. Press the Stop key to stop the motor.

D. Access the Basic setup menu as directed in Section 8, Programming and compare the setting for ACCEL TIME 1 with the value from Step C above.

E. If the setting for ACCEL TIME 1 is about the same as the time measured in Step C, the acceleration time can probably be shortened. While viewing the setting for ACCEL TIME 1, press ENT to enter the parameter edit mode. Enter the desired acceleration time using the numeric keypad and press ENT to save the new setting. Press the Run key and monitor the time from starting to rated speed. If the time is satisfactory, no further action is required. Exit the Basic setup menu.

F. If the setting for ACCEL TIME 1 is shorter than the time measured in Step C, the drive is automatically extending the acceleration time to prevent motor stall. Access the Motor setup menu and verify that proper motor data is entered. Also, access the Advanced setup menu and verify that the Motor Torque Limit parameter is set to the maximum of 200%. If any settings are changed, Press the Run key and again monitor the acceleration time. If the time is not improved, the load inertia and starting torque requirements do not allow faster acceleration with the current motor-drive combination. Contact Sumitomo for assistance.

12.3.5 Motor Decelerates Too Slowly

A. Access the Maintenance mode as described earlier in this section and select Present Status. Press ENT to enter the Present Status monitor mode and use the Down arrow key to select the DC bus voltage (V BUS).

B. Start the drive and increase motor speed to near nameplate rated speed.

C. Stop the drive and monitor the value for V BUS.

D. If the value reaches 400 VDC (230V drive) or 750 VDC (460V drive), the drive is automatically extending the deceleration time to prevent an over voltage trip. A shorter deceleration time will require an optional dynamic braking resistor.

E. If the value does not exceed the values in D above, it is possible to shorten the deceleration time. Access the Basic setup menu and display the setting for DECEL TIME 1. Press ENT to edit the current value. Set the new value using the numeric keypad and press ENT to save the value. Exit the Basic menu and retry from Step B above. If the new setting is satisfactory. No further action is necessary. If addition of a dynamic braking resistor is required, contact Sumitomo for assistance.

12.3.6 No Speed Control – Local

A. Verify that the Local LED is illuminated. If not press the SHIFT key followed by 9 (LOC/REM) to force the local override mode. Both run-stop and speed control are now from the Digital Operator Interface (DOI).

B. Start the drive by pressing the Run key and use the Up/Down arrow keys or enter a speed via the numeric keypad followed by ENT. If the drive will not go to the new speed, stop the drive and access the Control Mode setup menu. Verify that the control mode is set for SPEED FOLLOWER. If it is, the drive may be defective. Contact Sumitomo for assistance.

C. If both of the above tests are successful and the Local LED was not illuminated in Step A, it is probable that the Control Source setting in the Control Mode setup menu is improperly set. The control source allows speed control from either LOCAL (the DOI), REMOTE (the terminal strip) or SERIAL PORT. If local speed control is required, insure that the Control Source parameter is set to LOCAL. Use the RUN-STOP COMMAND parameter to set the source of the run-stop signal as desired. Note that it is possible to have local speed control and remote start-stop.

12.3.7 No Speed Control – Remote

A. Verify that the Local LED is not illuminated. If it is illuminated, attempt to transfer to remote control by pressing the SHIFT key followed by 9 (LOC/REM). If the transfer is successful, the Local LED will go out.

B. If the Local LED will not go out, the CONTROL SOURCE parameter or the RUN-STOP COMMAND parameters may be set incorrectly for the desired mode. Access the Control Mode setup menu as directed in Section 8, Programming and select CONTROL SOURCE. If anything other than REMOTE is displayed, press ENT to enter the parameter edit mode and used the Up or Down arrow key to select the desired value. Press ENT to save the new value and exit the edit mode. If no further changes are required, press ESC to exit the Control Mode setup menu.

C. Press the SHIFT key followed by 9 to transfer to remote control. The Local LED should go out.

D. Access the Maintenance Mode and select Present Status. Use the Down arrow key to select AI1 or AI2 as desired. Vary the value of the input signal and observe the respective display. If the display does not change as expected, troubleshoot the source of the signal confirming that input polarity is correct.

E. Start the drive using external contacts or the local Run key depending on the source set for the run-stop command.

F. Input a zero to 10 VDC signal to analog input AI2 with positive connected to AI2 and negative connected to A GND. The drive speed should increase. If it does not, stop the drive and access the I/O Map setup menu. Access the DIGITAL IN settings and determine if any of the inputs are configured for AI1/AI2 selection. If so, note the Digital Input assigned this function and, looking at the control terminal strip, verify that it is not connected to CM. Note: If the only remote signal available is 4-20 mA, jumper the +10 VDC terminal to AI2 to get a speed command of 10 volts which should command maximum speed.

G. While in the I/O Map setup menu, access the ANALOG IN settings and view the settings for AI2 MINIMUM and AI2 MAXIMUM. Insure that there is at least 5 VDC difference between the settings for AI2 MINIMUM and AI2 MAXIMUM. Change one of the settings, if necessary to achieve at least a 5 VDC span.

H. If speed is to be controlled by a 4 – 20 mADC signal, one of two things must be done. Either one of the digital inputs must be assigned the function of AI1/AI2 select and it must be connected to common either by jumper or through a selector switch; or, the Control Source setting in the Control Mode setup menu must be set to SUM which adds the value of AI1 and AI2. Refer to Section 8, Programming for details.

I. Contact Sumitomo if you are unable to resolve the problem.

12.3.8 Drive Stops – No Fault Code Displayed

A. Check to see if the unexpected stop occurred during a power interruption. If so, the drive will reset automatically when power is reapplied. If the drive restarts when commanded, correct the problem with the power source if the problem occurs repeatedly.

B. If run-stop control is set for remote, check external wiring to insure that loose connections or external safety interlocks are not the cause.

C. If unable to resolve the problem, contact Sumitomo for assistance.

12.4 Troubleshooting With Fault Codes

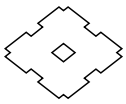
If the drive trips due to a protective circuit trip, the Fault LED will illuminate and the reason for the trip will be displayed on line two of the LCD display. Observe the fault message and proceed according to the instructions below. Note that a history of the last four faults is maintained in the drive memory and can be accessed through the Maintenance mode menu as described earlier in this section.

12.4.1 IGBT ERROR

One or more of the outputs TI/U, T2/V, T3/W may be (or may have been) shorted to ground. The most likely cause is a phase to ground short in the motor winding. **Remove all power from the drive and install a safety lockout device.** Disconnect the motor from the drive and megger the motor. If any problem is found, repair or replace the motor.

HAZARD OF ELECTRICAL SHOCK OR BURN!

POTENTIALLY LETHAL VOLTAGES EXIST IN THIS DRIVE AND MAY REMAIN AT A DANGEROUS LEVEL FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS DRIVE OR MOTOR, WAIT UNTIL THE BUS CHARGED LAMP GOES OUT AND MEASURE THE DC BUS VOLTAGE TO INSURE THAT IT IS ZERO.



Another possible cause is faulty wiring to the motor. While power is removed and locked-out from the previous step, disconnect the wires from the drive terminals T1/U, T2/V, T3/W and from the motor. Megger the wires with respect to ground and each other. Make sure drive and motor are properly grounded. Replace or repair wiring if necessary.

High humidity areas can result in moisture build-up in the motor windings and a gradual breakdown of motor insulation integrity. If this is the suspected cause, remove the motor and send to a qualified motor repair shop for evaluation and reconditioning.

If the motor and all wiring check OK and the fault occurs repeatedly when trying to start the drive, the IDM may be defective. Contact Sumitomo for assistance.

12.4.2 OVERCURRENT

The most likely cause is excessive starting torque requirements or high peak torque transients in the driven load. The drive can operate at 150% of rated current for 60 seconds and 200% of rated current for about 3 seconds. If the motor torque limit parameter in the Advanced setup menu is set above 150%, the problem may be solved by reducing the setting to 150% or lower. Note that this will reduce starting torque that may not be acceptable for the application.

Another possible cause is sudden very large increases in load. If the load is impacting in nature, such as a punch press, it may be necessary to increase the value of the Inertia parameter in the Advanced setup menu. This will dampen the response of the speed regulator and allow motor speed to droop during sudden load increases.

Attempting to start a spinning motor with the Catch-on-the-fly parameter in the Advanced setup menu set to false may also cause this trip. Also, if the problem occurs during rapid acceleration or deceleration, it may be necessary to lengthen the respective accel or decel time.

12.4.3 DC BUS LOW

This fault indicates that the DC bus voltage dropped below an acceptable value to maintain operation. The most likely cause is loss of, or momentary interruption of AC line power. When normal power is restored, the fault will automatically reset. If this fault occurs frequently, attempt to locate the cause for the under voltage condition. One possible cause is line starting of large motors. If unable to resolve the problem, contact Sumitomo for assistance in selecting a line reactor or isolation transformer.

If the fault will not reset or if it occurs immediately when attempting to start the drive, a DC bus capacitor or the Integrated Drive Module may be defective. Contact Sumitomo for assistance.

12.4.4 DC BUS HIGH

Determine if the fault occurs when the drive is stopping or ramping from a higher to a lower speed. If it does, the likely cause is excessive load inertia causing the DC bus voltage to increase to the trip level. The drive will attempt to compensate by increasing the deceleration time to keep the DC bus voltage below the trip level, however, very fast deceleration times may not allow the drive sufficient time to respond. Increase the setting of the deceleration time or, if fast deceleration time is required, install optional dynamic braking resistors.

Also, check to see if the load is overhauling the drive such as a conveyor with a downward incline or a hoist lowering a load. The drive will try to compensate by allowing the motor speed to increase. If this is undesirable or if the maximum speed limit is reached, an optional dynamic braking resistor will be required.

If the fault cannot be attributed to rapid deceleration or an overhauling load, the most likely cause is a transient over voltage condition on the AC line. A major cause is the switching of power factor correction capacitors either by a utility, in conjunction with starting large motors or by operation of automatic power factor controllers. If the fault occurs repeatedly, record the time of the fault and the occurrence of external events over a few days. If the fault happens at about the same time each day, the most likely cause is utility switching of power factor caps. Contact the utility for assistance.

12.4.5 MOTOR OVERLOAD

This fault will occur when the inverse time rating of the drive/motor overload protection has been exceeded. The drive can output 150% of its rated current for 60 seconds and lower overload values for longer times. Reduce the load on the motor and reset the fault. If the fault occurs repeatedly, check for binding or jam conditions in the driven machine. If no problems can be found, the drive-motor combination is probably undersized for the application.

12.4.6 AI1 NO SIGNAL

This fault occurs if a 4-20 mADC signal is used for speed control or feedback and the signal drops below 4 ma indicating a failure in the transmitter or a wire break. Correct the reason for loss of signal or access the Advanced setup menu and change the setting for the FOLLOWER LOSS parameter to DISABLE (the factory default).

12.4.7 HS OVER TEMP (Heatsink Over Temperature)

This fault indicates that the drive heatsink safe operating temperature has been exceeded. Check the following conditions. Access the Maintenance mode and view the Present Status. Press ENT to access present status indications. Use the down Arrow key to view HS TEMP. Verify that the heatsink cooling fan operates anytime the temperature is above about 50°C (122° F). Note: the fan is thermostatically controlled and will turn on at approximately 50°C (122° F) and turn off at approximately 45°C (113° F).

If the fan is operating as described, verify that there are no obstructions to cooling air flow. If the fan does not operate, try to spin the blades manually, if the fan will not rotate or is difficult to turn, contact Sumitomo for assistance in obtaining a replacement fan. Remove any lint or dust that may have collected on the fan intake or on the heatsink fins. Using low-pressure compressed air, blow any foreign material from the drive heatsink fins.

Verify that the ambient temperature is at or below 40° C (104° F) or that the proper derating factors have been applied for higher ambient or altitudes over 3300 ft (1000 m). Also insure that a 230V drive operating from single-phase input is properly derated as described in Section 5, Installation.

12.4.8 COMM ERROR

This fault will be displayed if the drive Digital Operator loses communication with the IDM or if the drive RS-485 serial port is used to control the drive and the COMM DOWN TIME parameter is set to something other than zero and a communication event does not occur within the COMM DOWN TIME setting. Refer to Section 8, Programming for information on setting communication parameters.

12.4.9 SINGLE PHASE

This fault indicates that the drive is receiving single-phase input power and is operating at above the allowed power level. Drives rated for 230V can operate with single-phase input as long as they are derated as described in Section 16, Specifications.

If the power supply is supposed to be 3-phase, check for and correct the single-phase condition. Look for a blown fuse or faulty circuit breaker and for corroded or loose terminations.

12.4.10 MOTOR PARAMETER

This fault indicates that incompatible data has been entered in the Motor setup menu. Verify that correct motor nameplate data was entered and correct if necessary. If no problem can be found, contact Sumitomo for assistance.

12.4.11 MOTOR FAULT

The following possible situations can cause a motor fault.

- Attempting to run the drive without a motor connected. Avoid the use of a contactor between the drive and motor. If a contactor is absolutely necessary, sequencing must be controlled so that the contactor is closed before the drive is started and must remain closed during drive operation, including deceleration and stopping.

- Deceleration of an overhauling load or high inertia load which takes more than 10 seconds beyond the programmed decel ramp time. Note that the drive will automatically extend the decel time to prevent over voltage trips due to excessive regenerative energy.

- Loss of motor load during torque mode operation which results in an over speed condition.

12.4.12 EXTERNAL FAULT

For this fault to occur, one of the digital inputs must be configured for either EXT FAULT NO (External Fault Normally Open) or EXT FAULT NC (External Fault Normally Closed). Check the integrity of a contact connected between this input and CM. A common use of these inputs is to connect a motor thermostat (usually normally closed) to cause the drive to shut off if the motor reaches excessive temperature.

12.4.13 EEPROM FAULT

This fault indicates possible corruption of data in the EEPROM (Electrically Erasable Programmable Read Only Memory) chip that stores the drive operation parameters. Remove power from the drive and wait a few minutes to insure complete decay of internal power supplies. Reapply power to the drive. If the fault is still present, contact Sumitomo for assistance. If the fault is cleared but recurs, look for sources of transient electrical interference, such as unsuppressed contactor coils, and install manufacturer recommended suppression devices.

12.4.14 AUTO EXEC ERROR

This fault indicates that an error has occurred in an AutoExec mode program. Access the AutoExec setup mode as directed in Section 8, Programming and Section 10, AutoExec Mode. Verify that the program contains at least one END statement. Also verify that GOTO instructions do not jump to non-existent program steps. If unable to resolve the problem, contact Sumitomo for assistance.

12.4.15 PS FAULT

This fault indicates that one of the regulated voltages produced by the drive power supply is out of tolerance. Removing power from the drive and waiting until the LCD goes blank is the only way to reset this fault. Reapply power and if the fault does not reset, the drive IDM module must be replaced. Contact SMA for assistance.

12.4.16 A/D OFFSET ERROR

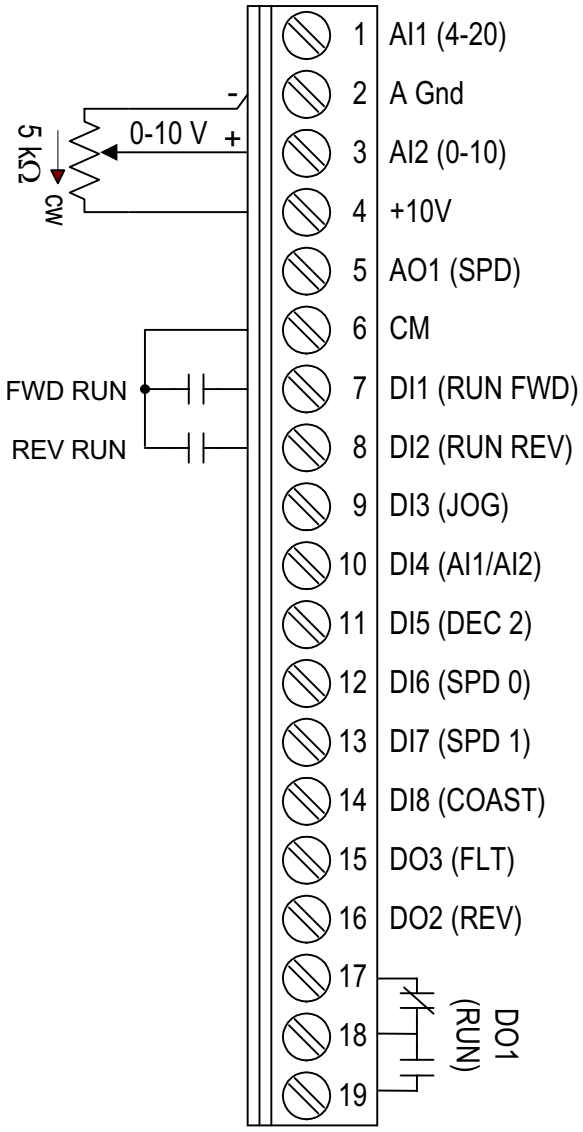
This fault indicates that the Analog to Digital converter that monitors motor output voltage and current is out of tolerance. The drive IDM module must be replaced. Contact SMA for assistance.

12.4.17 OL ALERT

This is not a fault code resulting from a trip condition but indicates that an overload trip is imminent if unless the drive or motor current drops below its rated value. The overload alert level is configured in the Advanced setup menu. Refer to Section 8, Programming for additional information.

13 TYPICAL CONNECTIONS

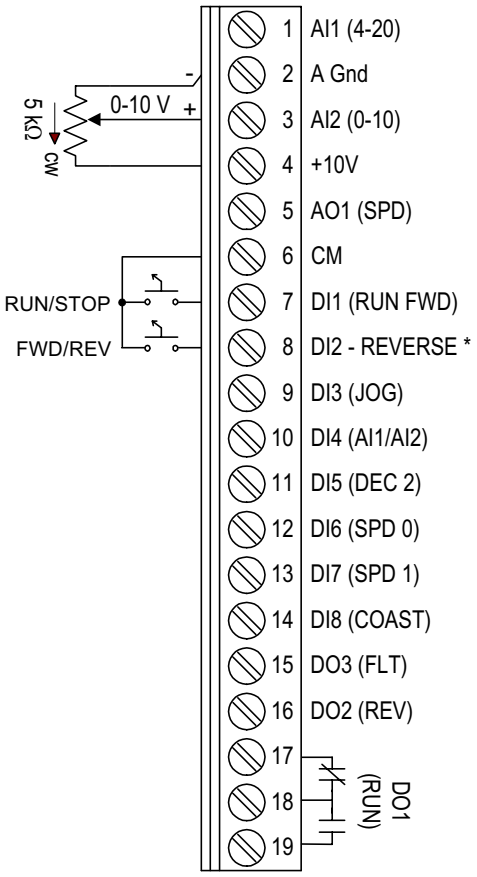
13.1 Maintained Fwd Run & Rev Run



⊣⊢ Maintained Normally Open ( ) Factory Assigned Function

Close and maintain FWD RUN contact to connect DI1 to Common (CM). This causes the drive to run in the forward direction. Open FWD RUN and the drive stops. Close and maintain RUN REV contact to connect DI2 to CM. This causes the drive to run in the reverse direction. Note: If RUN REV is closed while the drive is running in forward or RUN FWD is closed while the drive is running in reverse, the input will be ignored.

13.2 Run – Stop & Fwd – Rev Selector Switches

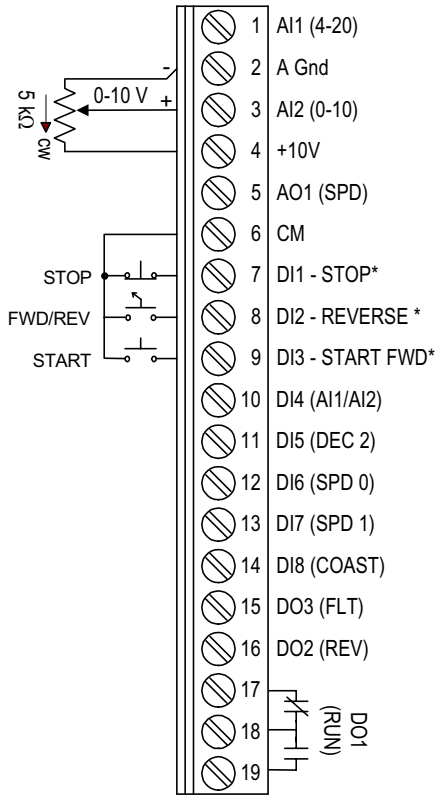


2-Position, 1-Pole Selector Switch ( ) Factory Assigned Function

* Use I/O Map to Change from Factory Default

Close RUN/STOP selector switch to connect DI1 to Common (CM). This causes the drive to run in the default (FWD) direction. Open RUN and the drive stops. Close FWD/REV selector switch to connect DI2 to CM. This selects the Reverse direction. If the drive is already running, it will ramp down, reverse and ramp up to set speed.

13.3 Momentary Start-Stop w/ Fwd-Rev Selector



2-Position, 1-Pole Selector Switch

Momentary Normally Open

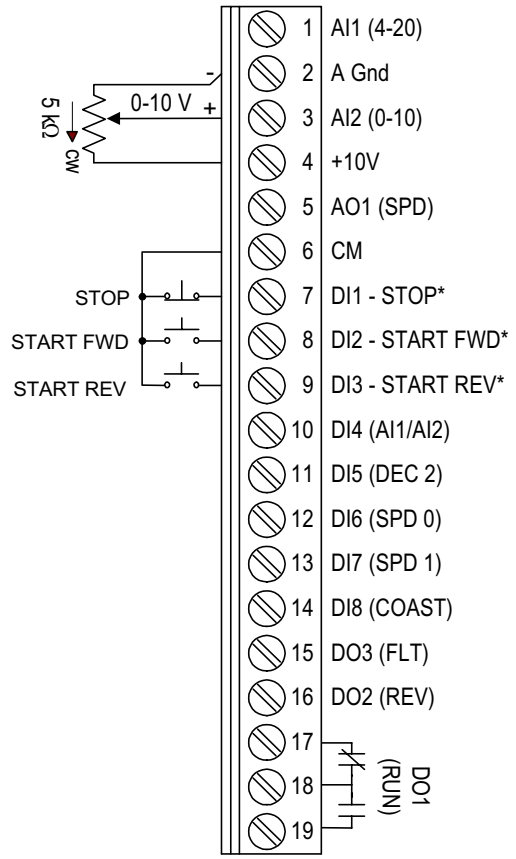
Momentary Normally Closed

( ) Factory Assigned Function

* Use I/O Map to Change from Factory Default

Normally Closed STOP pushbutton is connected to DI1. Normally Open START pushbutton is connected to DI3. FWD/REV selector switch is connected to DI2. When START is pressed, the drive starts in the direction selected by the FWD/REV switch. It continues to run, even after START is released until either STOP is pressed, power is lost or the drive fault trips. Direction can be changed while running by changing the position of FWD/REV.

13.4 Momentary Start Fwd, Start Rev & Stop

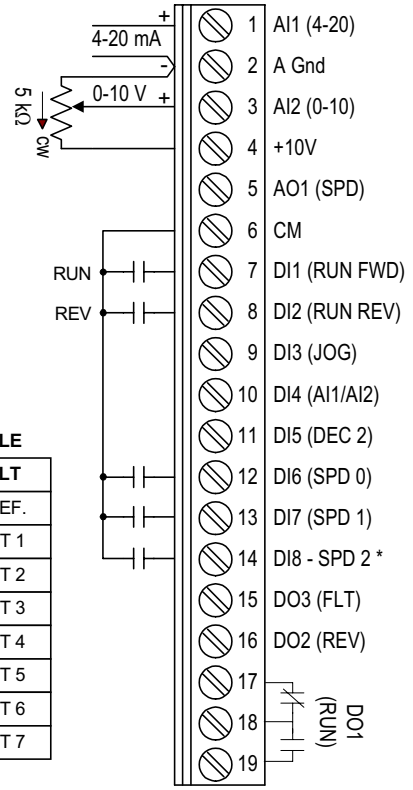


( ) Factory Assigned Function * Use I/O Map to Change from Factory Default

Momentary Normally Open Momentary Normally Closed

Normally Closed STOP pushbutton is connected to DI1. Normally Open START FWD pushbutton is connected to DI2. Normally Open START REV pushbutton is connected to DI3. When either START is pressed, the drive starts in the selected direction. It continues to run, even after START is released until either STOP is pressed, power is lost or the drive fault trips. START has no effect if STOP is held open. Direction can be changed while running by pressing the other START pushbutton.

13.5 Preset Speed Selection



SPEED SELECT TRUTH TABLE

SPD 2	SPD 1	SPD 0	RESULT
0	0	0	MAIN REF.
0	0	1	PRESET 1
0	1	0	PRESET 2
0	1	1	PRESET 3
1	0	0	PRESET 4
1	0	1	PRESET 5
1	1	0	PRESET 6
1	1	1	PRESET 7

0 = Open 1 = Connected to CM

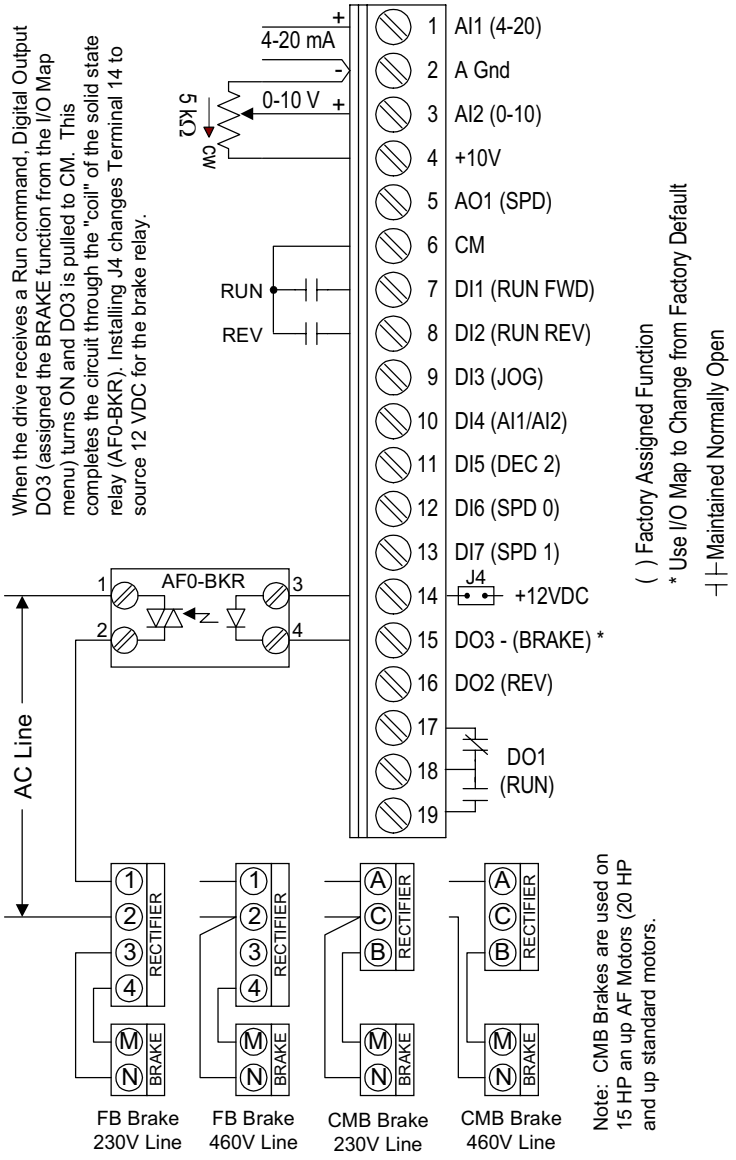
⊣⊢ Maintained Normally Open ( ) Factory Assigned Function

* Use I/O Map to Change from Factory Default

Preset speed selection is accomplished by connecting a Digital Input set to SPEED 0, SPEED 1 or SPEED 2 to CM. Selection is binary as shown in the truth table.

SPEED 0 can be used for Main Ref. and 1 preset, SPEED 0 & SPEED 1 for Main Ref. and 3 presets and SPEED 0, SPEED 1 & SPEED 2 for Main Ref. and 7 presets.

13.6 Sumitomo Brake-motor Brake Connection



14 DRIVE PARAMETER TABLES

14.1 Motor Set-up

Main Menu		Range	Factory	User	Units
Parameter Name	**No.**				
MOTOR VOLTS	11	160 – 480	230 or 460		VAC
MOTOR RATED AMPS	12	Rating Dependent	SMA Gearmotor		A
MOTOR HP	13	Rating Dependent	Drive Rated		HP
MOTOR RATED FREQ	14	30 – 400	60		HZ
MOTOR BASE SPEED	15	400 – 3600	SMA Gearmotor		RPM
AUTOTUNE DRIVE	16	STANDARD EXTENDED	STANDARD		-
MAXIMUM SPEED	17	500 – 9999	1800		RPM
MINIMUM SPEED	18	0 – 1800	90		RPM
JUMP SPEED 1 LOW	19	0 – 9999	0 (Disabled)		RPM
JUMP SPEED 2 LOW	20	0 – 9999	0 (Disabled)		RPM
JUMP SPEED 3 LOW	21	0 – 9999	0 (Disabled)		RPM
JUMP SPEED BAND	22	0 – 9999	0 (Disabled)		RPM

14.2 Basic Set-up

Main Menu		Range	Factory	User	Units
Parameter Name	No.				
ACCEL TIME 1	101	0.1 – 999	10		S
DECEL TIME 1	102	0.1 – 999	10		S
ACCEL TIME 2	103	0.1 – 999	10		S
DECEL TIME 2	104	0.1 – 999	10		S
ACCEL/DECEL MODE	105	LINEAR / S-CURVE	LINEAR		-
DECEL SHIFT SPD	106	0 – 9999	0 (Disabled)		RPM
FAST STOP DECEL	107	0.1 – 10	10		S
JOG SPEED	108	0 – 9999	180		RPM
JOG ACCEL TIME	109	0.1 – 10	0.5		S
JOG DECEL TIME	110	0.1 – 10	0.5		S
PRESET SPEED 1	111	0 – 9999	100		RPM
PRESET SPEED 2	112	0 – 9999	300		RPM
PRESET SPEED 3	113	0 – 9999	600		RPM
PRESET SPEED 4	114	0 – 9999	900		RPM
PRESET SPEED 5	115	0 – 9999	1200		RPM
PRESET SPEED 6	116	0 – 9999	1500		RPM
PRESET SPEED 7	117	0 – 9999	1800		RPM
DC BRAKE TIME	118	0.0 – 60.0	0.5		S
DC BRAKE AMPS	119	0 – 100	25		%

14.3 Advanced Set-up

Main Menu		Range	Factory	User	Units
Parameter Name	No.				
RETRY ATTEMPTS	201	0 – 10	0		-
RETRY DELAY	202	0.1 – 600	10		S
STOP MODE	203	RAMP / COAST	RAMP		-
REVERSE ENABLE	204	TRUE / FALSE	TRUE		-
CATCH ON THE FLY	205	TRUE / FALSE	FALSE		-
SPEED DETECT LEV	206	0 – 9999	0 (Disabled)		RPM
SPEED LEV DELAY	207	0.0 – 60	0.0		S
TORQ DETECT LEV	208	0 – 150	0 (Disabled)		%FL
TORQ LEV DELAY	209	0.0 – 60	0.0		S
MOTOR TORQ LIMIT	210	10 – 300	150		%FL
REGEN TORQ LIMIT	211	10 – 200	150		%FL
SPEED UP/DN	212	RESET / MAINTAIN	RESET		-
FOLLOWER LOSS	213	DISABLE / TRIP	DISABLE		-
MAINT ALERT TIME	214	0 – 65535	0 (Disabled)		HR
COMM ADDRESS	215	1-9, A-Z	1		-
COMM SPEED	216	1200 / 2400 / 4800 / 9600 / 19200	9600		BPS
COMM ERROR ACT	217	ALARM / TRIP	TRIP		-
COMM DOWN TIME	218	0 – 600	0 (DISABLED)		S
PASSWORD 1 SET	219	0-9, A-Z, space (5 Char. Max.)			-
PASSWORD 2 SET	220	0-9, A-Z, space (5 Char. Max.)			-
OL ALERT LEVEL	221	10 – 100	100		%
ORIENT OVERRIDE	222	0.0 – 60.0	1.0		S
PROPORTION GAIN	223	0.1 – 10.0	1.0		-
INTEGRAL GAIN	224	0.01 – 1.00	1.00		-
INERTIA	225	0 – 100	20		-
PARAMETER RESET	226	ENT to reset			-
RESET RUN TIME	227	ENT to reset			-
SPEED REGULATOR	228	ENABLE/DISABLE	ENABLE		-

14.4 Display Set-up

Main Menu		Range	Factory	User	Units
Parameter Name	No.				
LANGUAGE	301	ENGLISH SPANISH	ENGLISH		-
SET SPEED UNITS	302	SPEED (RPM) SPEED (%) CUSTOM	SPEED (RPM)		- - -
LINE 2 DISPLAY	303	ABOVE CHOICES + TORQUE FREQ SET PT I OUT V OUT V BUS I REF V REF ENERGY POWER R TIME NOT USED	TORQUE		%FL %FL HZ % A VAC VDC MA VDC KWH KW HR -
CUSTOM MULT FCN	304	SPEED, 1/SPEED	SPEED		-
CUSTOM MULT	305	0.0001 to 6.5535	1.0000		-
CUSTOM LABEL	306	0-9, A-Z, space (6 Char. Max.)	-		-
CUSTOM UNITS	307	0-9, A-Z, space (3 Char. Max.)	-		-

14.5 Control Mode Set-up

Main Menu		Range	Factory	User	Units
Parameter Name	No.				
CONTROL MODE	501	SPEED FOLLOW SPEED SETPOINT TORQUE FOLLOW TORQ SETPOINT AUTO EXECUTE	SPEED FOLLOWER		-
CONTROL SOURCE	502	LOCAL REMOTE SUM SERIAL PORT	LOCAL		-
RUN-STOP COMMAND	503	LOCAL REMOTE SERIAL PORT	LOCAL		-
KEYPAD FUNCTION	504	UNLOCKED LOCKED	UNLOCKED		-

14.6 I/O Map Set-up

Menu (Main & Sub)		Range	Factory	User	Units
Parameter Name	No.				
DIGITAL IN	401				
DIGITAL IN DI1	402	RUN FWD / STOP	RUN FWD		-
DIGITAL IN DI2	403	RUN REV	RUN REV		-
DIGITAL IN DI3	404	REVERSE	JOG		-
DIGITAL IN DI4	405	START FORWARD	AI1-AI2 SELECT		-
DIGITAL IN DI5	406	START REVERSE	DECEL 2		-
DIGITAL IN DI6	407	SPEED UP – DN	SPEED 0		-
DIGITAL IN DI7	408	JOG FORWARD	SPEED 1		-
DIGITAL IN DI8	409	JOG REVERSE	COAST		-
		ACCEL 2 / DECEL 2 RESET / COAST EXT FAULT – NO EXT FAULT – NC FAST STOP ORIENT SPEED 0 / 1 / 2 IN1/IN2/IN3/IN4 AI1-AI2 Select JOG REVERSE [1] REMOTE STOP [1] AUTOTUNE [2] FWD ENABLE [3] REV ENABLE [3]			
ANALOG IN	410				
AI1 MINIMUM	411	4.0 – 20.0	4.0		MA
AI1 MAXIMUM	412	4.0 – 20.0	20.0		MA
AI2 MODE	413	UNIPOLAR 0 TO +V BIPOLAR –V TO +V	O TO +V		-
AI2 DEAD BAND	414	0.0 – 5.0	0.0		V
AI2 MINIMUM	415	0.0 – 10.0	0.0		V
AI2 MAXIMUM	416	0.0-10.0	10.0		V

[1] This function available in keypad software version 0106 or later.
[2] This function available in keypad software version 0108 or later.
[3] This function available in keypad software version 011E or later.

I/O Map Set-Up (Continued)

Menu (Main & Sub)		Range	Factory	User	Units
Parameter Name	No.				
DIGITAL OUT	420				
DO1 (RELAY)	421	RUN FAULT	RUN		-
DO2 (OC)	422	AT SPEED	REVERSE		-
DO3 (OC)	423	SPEED DET HI/LO	FAULT		-
		TORQUE DET HI/LO REVERSE OUT 1 / OUT 2 OUT 3 OL TRIP ALERT BRAKE			
ANALOG OUT 0-10V	430	SPEED / TORQUE OUTPUT AMPS POWER OUTPUT VOLTS DC BUS VOLTS	SPEED		-

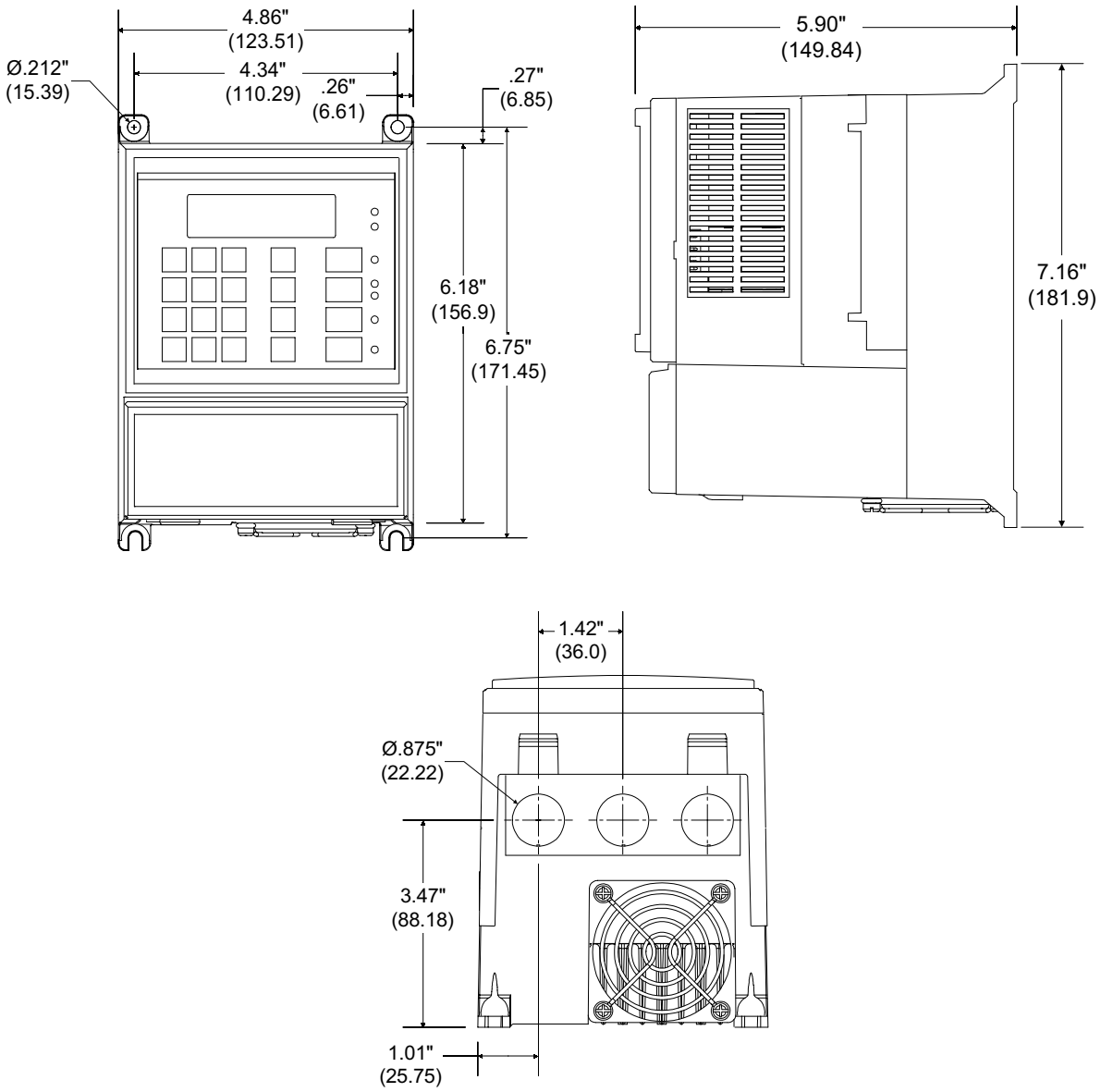
14.7 Maintenance Mode

Main Menu		Sub-Menu (if used)		Units
Parameter Name	No.	Parameter Name	No.	
FAULT HISTORY	701	FAULT 1	702	-
		FAULT 2	703	-
		FAULT 3	704	
		FAULT 4	705	
PRESENT STATUS	710	SPEED	711	RPM
		FREQ	712	HZ
		TORQUE	713	%FL
		SET PT	714	%
		I OUT	715	A
		V OUT	716	VAC
		V BUS	717	VDC
		I REF	718	MA
		V REF	719	VDC
		ENERGY	720	KWH
		POWER	721	KW
		R TIME	722	HR
		CUSTOM	723	CUS
		ROTATE	724	-
		HS TEMP	725	°C
DIGITAL INPUTS	730	DIG INPUT DI1	731	-
		DIG INPUT DI2	732	-
		DIG INPUT DI3	733	-
		DIG INPUT DI4	734	-
		DIG INPUT DI5	735	-
		DIG INPUT DI6	736	
		DIG INPUT DI7	737	-
		DIG INPUT DI8	738	-
DIGITAL OUTPUTS	740	DIG OUTPUT DO1	741	-
		DIG OUTPUT DO2	742	-
		DIG OUTPUT DO3	743	-
CLEAR FAULTS	750	ENT to clear		-
RESET KWH	770	ENT to reset		-
SOFTWARE VERSION	780	Read Only		-

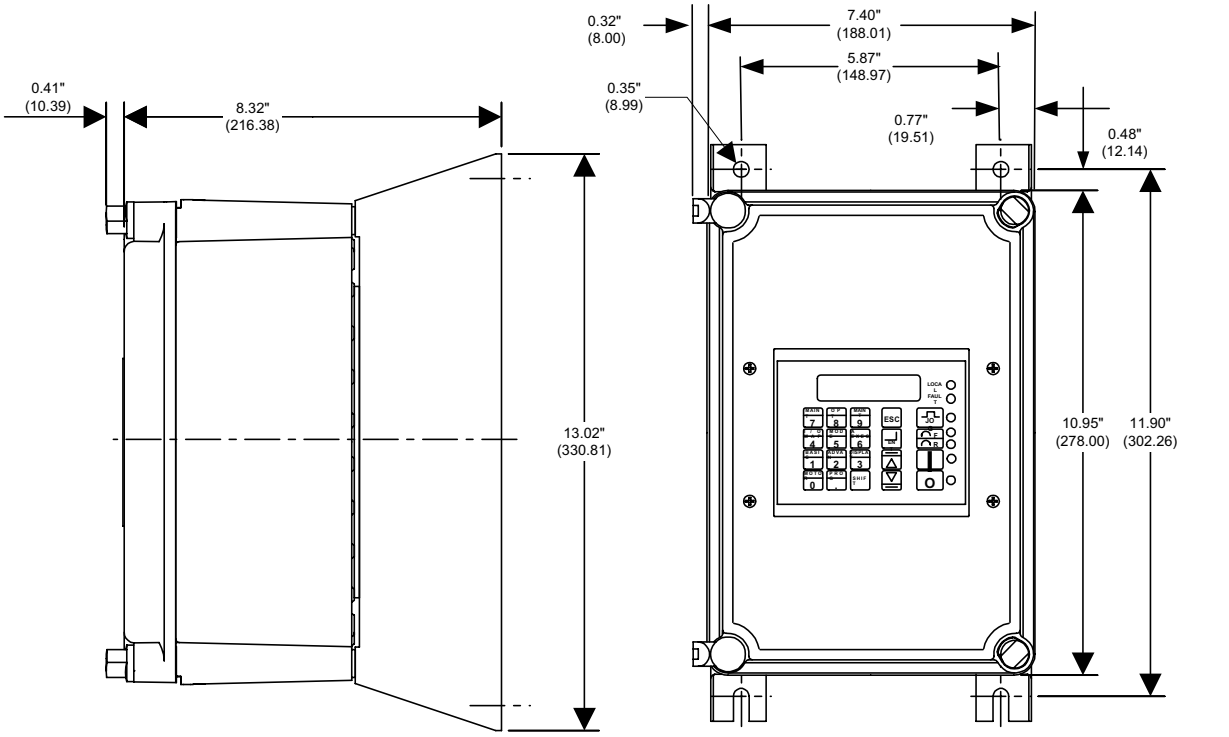
15 OUTLINE DRAWINGS

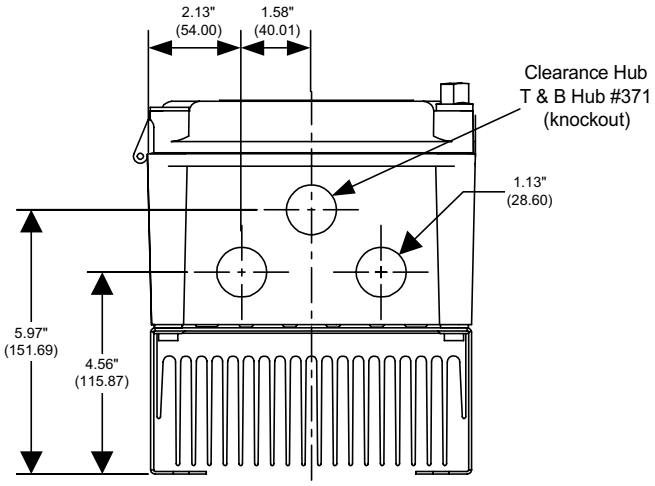
15.1 1 – 5 HP Outline Drawings

15.1.1 - NEMA 1 Enclosed 1-5 HP Drives



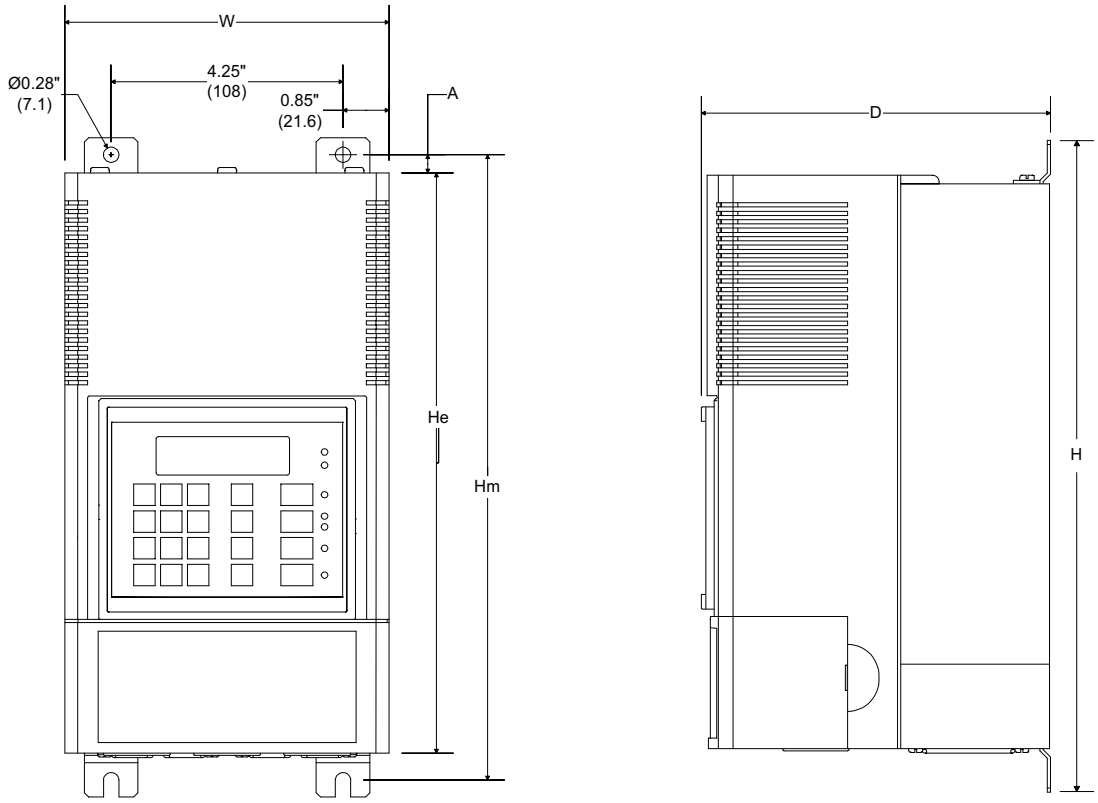
15.1.2 – NEMA 4 Enclosed 1-5 HP Drives



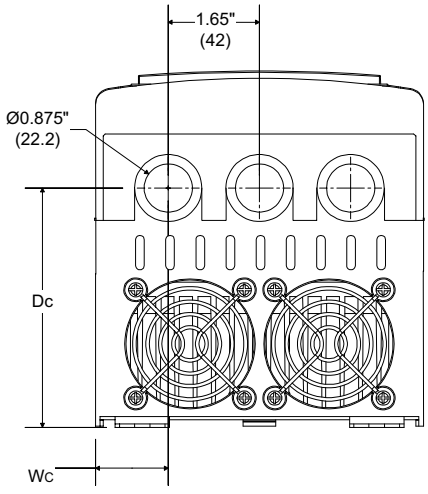


NEMA 4 Enclosure
1 HP to 5 HP in
230 Volt & 460 Volt for
NTAC-2000 AC Drives

15.2 7.5-20 HP (25 HP VT) Outline Drawings (NEMA 1)



HP	H	Hm	He	W	A	D	Dc	Wc
7.5 – 10	12.36” (314)	11.5” (292.1)	10.67” (271)	6.15” (156)	0.33” (8.5)	6.48” (164.6)	4.35” (110.5)	1.42” (36.1)
15 – 25	14.84” (377)	13.88” (352.6)	13.03” (331)	6.22” (158)	0.30” (7.6)	8.73” (221.7)	6.71” (170.4)	1.32” (33.5)



16 SPECIFICATIONS

16.1 380 – 460V Ratings

380 – 460 V, 3 Phase Input, 50/60 Hz

Rated FLA	HP	kW	NEMA 1 Model
2.6	1	0.75	NT2014-A75
3.4	2	1.5	NT2014-1A5
4.8	3	2.2	NT2014-2A2
7.6	5	3.7	NT2014-3A7
11.0	7.5	5.5	NT2014-5A5
14.0	10	7.5	NT2014-7A5
21.0	15	11	NT2014-011
27.0	20	15	NT2014-015
33.0	25*	18*	NT2014-018V

*Variable torque rating only. Short term rating 120% for 1 minute.

16.2 200 – 230V Ratings

200 – 230 V, 3-Phase Input, 50/60 Hz

Rated FLA	HP	kW	NEMA 1 Model
3.6	1	0.75	NT2012-A75
6.8	2	1.5	NT2012-1A5
9.6	3	2.2	NT2012-2A2
15.2	5	3.7	NT2012-3A7
22.0	7.5	5.5	NT2012-5A5
28.0	10	7.5	NT2012-7A5

Derating Information for 230V single-phase input.
1 and 2 HP 230V units can be used on single-phase input without derating. All other sizes, derate as follows:
3 HP motor with single-phase input to the drive, use a 5 HP drive.
5 HP motor with single-phase input to the drive, use a 10 HP drive.
All units output 3-phase power and must be used with a 3-phase induction motor.

16.3 Input Power

Function	Description
Displacement Power Factor	0.95
Short Circuit Current Rating	10,000 AIC maximum at the controller input terminals
Line Impedance	1% Minimum to 5% Maximum
Line Distortion	Controller can operate with total line distortion (including external sources) of up to 10% as defined by IEEE-519
Phase Unbalance	Permissible voltage unbalance of 3% per IEEE-446
Input Phase Loss	Input phase loss protection permits reduced capacity operation. Excessive load causes protective circuit trip.

16.4 Output Power

Function	Description
Control Method	Sensorless Flux Vector Control (consult factory before applying in multiple motor per drive applications).
Compatible Motors	AC Induction Motor, 2 pole (3600 RPM) to 12 pole (600 RPM)
Motor Protection	Inverse time trip up to 150% of rated current for 60 seconds
Motor / Controller HP Rating	Motor HP must be within ± 2 NEMA standard HP ratings of the Drive HP. Continuous operating current cannot exceed drive rated amps.
Output Torque	Continuous: 100% of motor rated torque over a 100:1 speed range Intermittent: 200% of motor rated torque for 3 s, 150% for 60 s
Overload Capacity	200% of rated current for 3 seconds, 150% for 60 seconds

16.5 Control

Function	Description
Frequency Control Range	0.1 to 400 Hz (9999 RPM Maximum)
Const. Torque Speed Range	0.6 to 60 Hz (100:1) without encoder feedback
Speed Regulation	± 0.5% of base speed
Speed Resolution	Digital Control: 1 RPM Analog Control: 7 RPM (1800 RPM Base)
Frequency Accuracy	Digital Control: 0.01 %, Temperature 0°C – 40°C (32°F – 104°F) Analog Control: 0.1 %, Temperature 25°C ± 10°C (77°F ± 18°F)
Control Modes	Speed / Torque Follower, Speed / Torque Setpoint, AutoExec
Speed Follower Command	0 to ±10 VDC or 4 – 20 mADC (Direct or Inverted), Keypad, Serial Port
Speed Setpoint Command	0 – 10 VDC, Local Keypad, Serial Port. Feedback: 4 – 20 mADC
Torque Follower Command	0 to ±10 VDC or 4 – 20 mADC (Direct or Inverted), Keypad, Serial Port
Torque Setpoint Command	0 – 10 VDC, Local Keypad, Serial Port. Feedback: 4 – 20 mADC
AutoExec Mode	Drive can store and execute internal program of up to 32 steps
Preset Speeds	1 to 7 selected in binary fashion by assigning 1 to 3 Digital Inputs
Serial Communications	EIA RS-485 multi-drop (RJ-12 Female Connector), ASCII Protocol, Programmable 1200, 2400, 4800, 9600, 19200 bits per second. Contact SMA for communication protocol information if required to develop communication drivers for automation equipment.

16.6 Input / Output

Function	Description
Digital Inputs	8: Active low, pulled-up through 4.7kΩ to 5 VDC, Programmable: DI1: Run Fwd (2-wire control) Stop (3-wire control) DI2-DI8: Run Rev, Start Forward, Start Reverse, Reverse, Speed Up, Speed Dn, Jog Forward, Jog Reverse, Reset, Accel 2, Decel 2, Coast, External Fault-NO/NC, Fast Stop, Orient, Speed 0, Speed 1, Speed 2, IN1-IN4, AI1/AI2 Select Note: Maximum input voltage at digital input terminals is 30 VDC. Inputs can be directly interfaced to open collector PLC or other digital outputs.
Analog Inputs	AI1: 4 to 20 mADC (direct or inverted) AI2: 0 to 10 VDC (direct or inverted) or –10 to +10 VDC
Digital Outputs	2: Open Collector Transistor (30 VDC, 50 mADC max) 1: Form C Relay (120 VAC, 0.5 A or 30 VDC, 1.0 A max) Programmable: Run, Fault, At Speed, Speed Detect HI/LO, Torque Detect HI/LO, Reverse, OUT1-OUT3, OL Trip Alert, Brake
Analog Output	1: 0 to 10 VDC, 10 mADC max. Programmable: Speed, Torque, Output Amps, Output Volts, Power, DC Bus Volts

16.7 Protection, Environmental & Approvals

Function	Description
Protection	Output SC & GF, OL, Over/Under Voltage, Phase Loss, Over Temp, Follower Loss, Comm. Error, Motor Fault, Motor Parameter, External Fault, AutoExec Error, IGBT Error, EEProm Error
Enclosure	NEMA 1, NEMA 4/12 (optional)
Ambient Temperature	0° C to 40° C (32° F to 104° F)
Storage Temperature	-20° C to 60° C (-4° F to 122° F)
Altitude	Full Rating 0 to 1000 m, Derate 2% per 300 m over 1000 m
Relative Humidity	Maximum 95%, non-condensing
EMI Immunity	IEC 1000-4-3, Level 1 from 80 to 1000 MHz
Mounting Location	Protected from direct sunlight, conductive dust and corrosive gases
Vibration	Maximum 1 G, less than 20 Hz; Maximum 0.2 G, 20 to 50 Hz
Agency Listings	UL, cUL (Canadian UL), CE (with proper installation) Refer to Section 3, Installation.

17 CE DECLARATIONS

Refer to Declaration of Conformity and Declaration of Harmless Incorporation on the following pages. Sumitomo Machinery Corp. of America maintains a Technical Construction File (TCF) containing documentation, including third-party test reports, supporting our claim of compliance. Documentation contained in the TCF is available for viewing during normal business hours at:

Sumitomo Machinery Corp. of America
4200 Holland Blvd.
Chesapeake, VA 23323 USA

A copy of the TCF may be made available to certain authorized government agencies if information contained in this file is required by the agency to support our claim. Appropriate duplication fees may apply.

CE DECLARATIONS

Declaration of Conformity

According to ISO/IEC Guide 22 – 1982 and EN45014

Manufacturer's Name:	Sumitomo Machinery Corp. of America
Manufacturer's Address:	4200 Holland Blvd. Chesapeake, VA 23323 USA
Declares That the Following Product:	
Product Name	NTAC-2000 AC Drives having Model Numbers: NT2012-A75 – NT2012-7A5 NT2014-A75 – NT2014-015 NTB2012-A75 – NTB2014-7A5 NTB2014-A75 – NTB2014-015
Conforms to the Following Specifications:	
Safety:	UL-508C prEN50178-1995
EMC: Electromagnetic Emissions	EN55011-1991: Class A
Electrostatic Discharge	EN61000-4-2: 4kV contact, 8kV air discharge
Radiated Susceptibility	EN6100-4-3: 10V/m 80-1,000 MHz
Electrical Fast Transient	EN61000-4-4: +2kV on Power and Control Lines
RF Conducted Immunity	EN61000-4-6: 10V 0.15-80 MHz

Supplementary Information:

The listed drive products were tested in a representative configuration using appropriately sized AC Induction (asynchronous) motors at rated load.

Authorized Signature:

J. B. Mitchell, PE Date

Declaration of Harmless Incorporation

Manufacturer's Name:	Sumitomo Machinery Corp. of America
Manufacturer's Address:	4200 Holland Blvd. Chesapeake, VA 23323 USA
Declares That the Following Product:	
Product Name	NTAC-2000 AC Drives having Model Numbers: NT2012-A75 – NT2012-7A5 NT2014-A75 – NT2014-015 NTB2012-A75 – NTB2014-7A5 NTB2014-A75 – NTB2014-015
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Electrical Fast Transient	EN61000-4-4: +2kV on Power and Control Lines
RF Conducted Immunity	EN61000-4-6: 10V 0.15-80 MHz

Supplementary Information:

The manufacturer further declares that the NTAC-2000 drive product family including models listed above will not harm personnel, animals or property, nor will it interfere with the conformity of any other system in which it is incorporated, when installed, operated and maintained in accordance with documentation supplied by the manufacturer.

Authorized Signature:

J. B. Mitchell, PE Date

18 INDEX