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Industrial
Devices
Corporation

S6961 and S6962

One and Two-Axis Microstepping SmartDrives



User's Manual

Version 2.0 **PCW-4757**

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Industrial Devices Corporation (IDC) strives to maintain effective communication with all users and potential users of our products. If you have any questions or concerns regarding this technical manual or the product it covers, please contact:

Industrial Devices Corporation
3925 Cypress Drive
Petaluma, CA 94954

TEL: **(800) 747-0064** FAX: **(707) 789-0175**

OUTSIDE THE U.S. CALL **(707) 789-1000**

WEB SITE: **www.idcmotion.com**

EMAIL: info@idcmotion.com

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Chapter 1 - Overview

IDC's S6961 and S6962 one and two-axis SmartDrives combine a top of the line mircostepping drive with a powerful, but easy to use machine controller. We offer a single-axis version (S6961) and a dual-axis version (S6962). The S6962 has two axes of independently selectable motor resolution and current settings. Both products incorporate IDC's 6.0 Amp, 160 VDC, recirculating microstepping drive with a motion/machine controller in a single, compact package. 8-Amp drives and controls are available as an option (-8A), and automatically include a fan kit. Up to 24 digital I/O are available to control other machine functions. Up to 8 of these can be configured as analog inputs or outputs.

The S6961/2 series of SmartDrives also feature IDC's proprietary anti-resonance circuitry. Most step motor users have probably experienced a phenomenon known as mid-range instability, which can cause a step motor to stall between 13 and 18 revolutions per second. Since microstepping alone does not address mid-range instability, IDC's S6961/2 SmartDrives use advanced anti-resonance circuitry to virtually eliminate stalls due to mid-range instability. This dramatically improves the usable torque from the motor.

IDC's powerful SmartDrive controllers provide excellent value when your application calls for any of the following:

- A small, 1 or 2-axis machine controller
- A "motion node" to a master PLC or PC
- A cost effective operator interface
- Thumbwheel data inputs
- Flexible I/O capabilities
- On-board OPTO I/O modules (analog or digital)

The S6961/2 SmartDrives also feature a programming/operator interface keypad (FP220) which allows you to quickly and easily configure and program your system. Initial setup and configuration will, in most cases, require only a few minutes using the keypad. While the SmartDrives also fully support PC-based RS-232C programming, the setup and configuration sections of this manual primarily emphasize the keypad approach. RS-232C commands and setup definitions are in a separate chapter. We strongly recommend using a keypad with your first SmartDrive application.

This manual has been designed to help you successfully install, program, and operate your SmartDrive System. If you have any questions that this manual does not adequately answer, please contact our factory application engineers at (800) 747-0064 or (707) 789-1000.

Use Chapter 2 - *Shipping Contents* to verify that you have received everything you ordered.

Chapter 3 - *Quick Start* will help you quickly confirm basic system operation.

Chapter 4 - *Using the Keypad* describes IDC's keypad interface.

Chapter 5 - *Configuring Your System* covers the steps required to configure your specific equipment and application. It includes step-by-step keypad instructions on entering setup parameters. This chapter covers initial motor settings, I/O configuration, and defining the

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mechanics of your system. IDC's Windows based Application Developer also follows the same menu structure described here.

Chapter 6 - *Programming Commands* provides an alphabetical list of SmartDrive commands including syntax, ranges, defaults, and programming examples for each command.

Chapter 7 - *Programming Your Application* provides detailed program and application examples and strategies. Other topics include variable usage, user menus, math functions, and analog I/O. Our *IDeal*™ command language is generally regarded as the easiest motion control language in the industry. It is both easy to remember and intuitive, without sacrificing flexibility or power.

Chapter 8 - *Programming with Serial Communication* is for users who plan to use the SmartDrive in an RS232C-hosted mode, or for those who wish to program and configure the drive via RS232C. IDC's Application Developer program follows a standard Windows dialog-box structure for straightforward configuration and programming of the SmartDrive. This section also covers RS232C command syntax and definition for users who are not using Windows.

Chapter 9 - *Hardware Reference* provides SmartDrive mounting information, detailed I/O schematics, motor drawings, cables, and specifications.

Chapter 10 - *Troubleshooting* lists a series of common application problems along with their symptoms and solutions.

Included with this manual is the *IDCMotion*™ disk set. IDC's Application Developer is automatically installed on your hard drive by running the setup program on Disk 1 of the *IDCMotion*© disk set. This disk also includes a readme file containing the latest information on software features. The readme file also contains a program listing of demo program included with Application Developer.

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Chapter 2 - Shipping Contents

Before connecting any equipment, please examine your order to ensure that all parts were received. If any part of your order is missing, please call IDC Customer Support at: (800) 747-0064.

If you ordered P/N S6961 or S6962, you will receive:

1. S6961/2 with mounting bracket attched to back of control.
2. Keypad attached to control w/3 mounting-balls.
3. Keypad mounting gasket.
4. Keypad mounting template.
5. Keypad cable.
6. 5-position AC power cord.
7. Application Developer software.
8. S6961/2 User's Manual.
9. Black label to cover switch settings.
10. 4 short screws for minimum-width mounting.
11. IDC screwdriver.



If you ordered P/N S6961-FK or S6962-FK, you will receive:

1. S6961/2 with fan kit & fan bracket attached to back of control.
2. Standard mounting bracket for minimum-width mounting (side attachment) if desired.
3. Keypad attached to control w/3 mounting-balls.
4. Keypad mounting gasket.
5. Keypad mounting template.
6. Keypad cable.
7. 5-position AC power cord.
8. Application Developer software.
9. S6961/2 User's Manual.
10. Black label to cover switch settings.
11. 4 short screws for minimum-width mounting.
12. IDC screwdriver.



If you ordered P/N S6961NP or S6962NP, you will receive:

1. S6961/2 with mounting bracket attached for minimum-width mounting.
2. 4 long screws for moving mounting bracket to back for minimum-depth mounting.
3. 5-position AC power cord.
4. Application Developer software.
5. S6961/2 User's Manual.
6. Black label to cover switch settings.
7. 4 short screws for minimum-width mounting.
8. IDC screwdriver.



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If you ordered P/N S6961NP-FK or S6962NP-FK, you will receive:

1. S6961/2 with fan kit attached to back of control, and mounting bracket attached to side for minimum-width mounting.
2. Fan-mounting bracket for optional minimum-depth mounting (attaches to fan housing).
3. 4 short screws for optional mounting bracket.
4. 5-position AC power cord.
5. Application Developer software.
6. S6961/2 User's Manual.
7. Black label to cover switch settings.
8. IDC screwdriver.



If you ordered P/N FP220, you will receive:

1. Keypad.
2. 3 keypad mounting balls (in case you decide to mount the keypad directly to the S6961/2).
3. Keypad cable.
4. Keypad mounting gasket.
5. Keypad mounting template.



S6961/2 Accessories Currently Available



RPACK-1
External Regenerative Power Dissipation Module



PCS-5004
PC-Keypad Cable for copying programs between Keypad and PC



FK1 Fan Kit
For High Performance Applications



PCS-4852
SmartDrive to PC Cable

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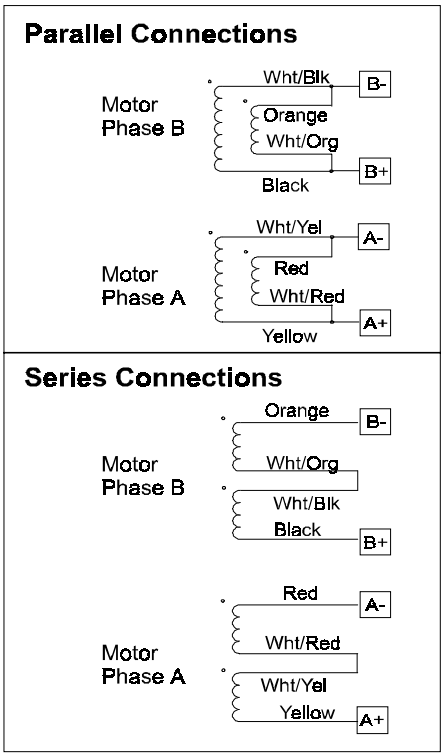
Chapter 3 - Quick Start

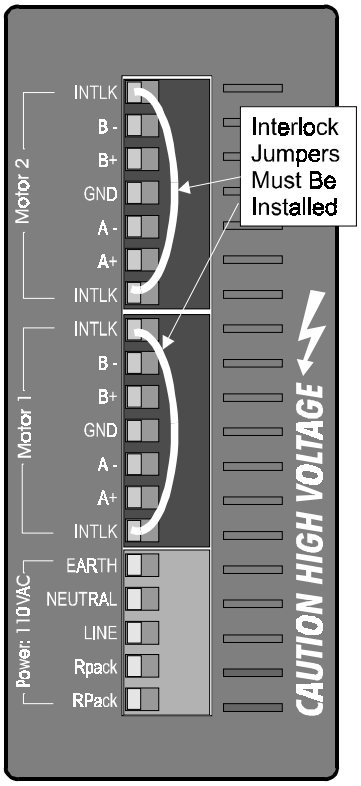
The purpose of the Quick Start chapter is to help an experienced motion control user quickly set up and bench test an S6961/2 SmartDrive and an IDC step motor. The following directions assume that the user is familiar with step motors, step motor drives, controls, and their related electrical connections. Please refer to Chapter 5, "*Configuring Your System*" for more detailed explanations of these procedures.

The IDC Keypad (FP220) is highly recommended for the easiest possible setup and programming of your application. For Quick Start, it is assumed that a keypad is used, even though serial communication may be used later.

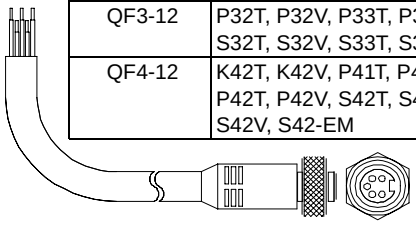
Connect The Motor(s)

If using a non-IDC motor, see "*Non-IDC Motors*" in Chapter 5 for connection information. If using an IDC supplied motor with an IDC Quick Disconnect Cable, see the table below for color code details. For IDC motors with "flying leads", the proper series and parallel connections are shown below.





Wire Color on Quick Disconnect Cables	S6961/2 Connection
Red w/ Black	B-
Red w/ White	B+
Green	*GND
Red w/ Yellow	A-
Red	A+
*Gray-colored Quick Disconnect Cables are shielded - connect shield to GND.	



IDC Quick Disconnect Cables	
IDC P/N	**IDC Motor Applicability**
QF3-12	P32T, P32V, P33T, P33V, P33V-EQ, S32T, S32V, S33T, S33V
QF4-12	K42T, K42V, P41T, P41V P42T, P42V, S42T, S42T-EM, S42V, S42-EM

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Side Panel Settings

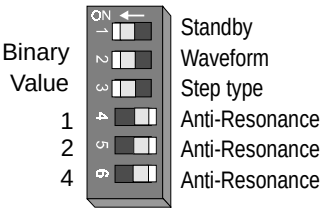
Use the table below to configure the Motor Current, Inductance, and Anti-Res switches for the IDC motor you are using. If using a non-IDC motor, please refer to Chapter 5, *Configuring Your System*.

IDC Motor	Series (T) Connection					Parallel (V) Connection				
	Current	Inductance	Unloaded Anti-res			Current	Inductance	Unloaded Anti-res		
			SW4	SW5	SW6			SW4	SW5	SW6
S12	1.1A	8	ON	ON	ON	2.2	4	ON	ON	ON
S21	1.2A	16	ON	ON	ON	2.4	4	ON	OFF	ON
S22	1.5A	16	ON	ON	ON	3.0	4	ON	ON	OFF
S23	1.7A	16	OFF	OFF	ON	3.5	4	OFF	ON	OFF
S32	2.8A	8	OFF	ON	OFF	5.6	4	ON	OFF	OFF
S33	3.5A	8	OFF	ON	OFF	7.0	4	ON	OFF	OFF
S42	6.0A	4	ON	OFF	OFF	7.9	4	OFF	OFF	OFF
P21						1.3	20	OFF	ON	ON
P22						2.0	16	ON	OFF	ON
P31						2.9	12	OFF	ON	OFF
P32						3.3	28	ON	OFF	OFF
P33						4.0	24	ON	OFF	OFF
P41						5.7	12	ON	OFF	OFF
P42						*6.6	20	ON	OFF	OFF
P43						*6.6	28	OFF	OFF	OFF
K31						2.9	12	ON	OFF	OFF
K32						3.4	28	ON	OFF	OFF
K33						3.3	28	ON	OFF	OFF
K41						5.7	12	ON	OFF	OFF
K42						*6.4	12	ON	OFF	OFF
K43						*6.6	28	OFF	OFF	OFF

Series Settings N/A on P21-K43

*Current shown applies to optional 8-Amp drive. Set standard 6-Amp drive current to 6.0 Amps.

To make the appropriate **Anti-Res** setting, round to the nearest available value (0-7) and set the corresponding binary weighted dip-switches. The example to the right shows a setting of N=0. (ON=1, OFF=0).



Note:
The **Resolution** settings are read only at power-up. Subsequent changes to these settings have no effect until power is cycled. The other settings (**Current, Waveform, Standby, Inductance, Anti-Resonance**, and **Phase Offsets**) may be adjusted while the motor is energized and moving.

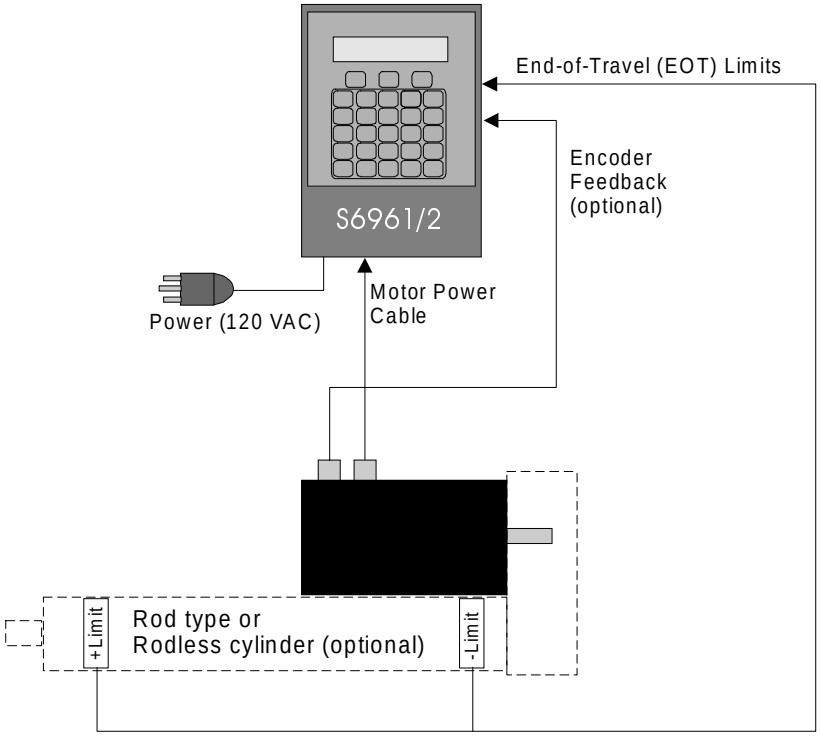
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Apply Power

CAUTION
The motor will be enabled when the drive is powered-up.

When power is applied, the display briefly shows Model # and Firmware Revision, then changes to the Main Display. The Main Display continuously shows the position of each axis on the top line and the status of Inputs 1-8 and Outputs 1-8 on the bottom line.

```
+0.0000   +0.0000
00000000  00000000
```



Jog the Motor

```
------- RUN -------
PROG  JOG  TEST
```

1. Press RUN.
2. Press JOG (F2).
3. Press ← → keys to jog each axis (use ↑ and ↓ keys to jog axis two on the S6962).
4. Change the Jog Speed by pressing High (F2) or Low (F1) and jog again.

Run [TEST MOVE] Program

```
------- RUN -------
PROG  JOG  TEST
```

Press ESC to return to the Main Display.

1. Press RUN.
2. Press TEST(F3).
3. Press MOVE (F3) to start the move.
4. Select F1to jog axis 1, F2 to jog both axes, or F3 to jog axis 2. The motor(s) will move forward one revolution, then backward one revolution, and stop.

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Chapter 4 - Using the Keypad

This chapter will help the first-time user understand the basics of using the IDC Keypad. The keypad was designed to provide operators the quickest possible way to configure an application, and though it functions primarily as an operator interface, it is equally effective as a programming and troubleshooting tool. If you have chosen to program your application using RS-232C, you may want to skip this chapter.

Keypad Hardware Features describes physical settings and adjustments that facilitate operator access for programming and best viewing of the keypad display. *Keypad Features* and *Description of Keys* provide an overview of functionality.The *Keypad Menu Structure* section gives the programmer a broad overview of how the setup and programming menus operate. Detailed information about each setup parameter is presented in Chapter 5 - *Configuring Your System.*

While keypad programming and system configuration are defined by IDC, run-time operation (how the machine operator interfaces with the SmartDrive) falls completely within your control.

Here are some of the operating functions you can program with the SmartDrive:

- Run a program on power-up, on input signal from a PLC, or RS-232C host command
- Within a program, prompt the operator for any program variable (the number of parts to run, size of parts, speed, etc.)
- Run a part or program by name
- Lock-out operators from programming functions

For more information on programming your SmartDrive's operator interface, see Chapter 6 - *Programming Commands*, and Chapter 7 - *Programming Your Application.*



Keypad Features

- Easy-to-read, two-line, 40-character, back-lit, supertwist display
- Can be sealed to IP65 (NEMA 4) washdown environment
- Large, scratch-proof keys with audible and tactile feedback
- Connects to SmartDrive and other IDC controls with remote cable
- Allows application programs to be copied from one SmartDrive to another, or to/from a PC.

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Keypad Hardware Features

Setting DIP Switches to Limit Access to Keypad Menus

Four DIP switches on the back of the keypad provide a means of preventing access to certain keypad menus. If access to a menu is denied, pressing that menu key will have no effect. For example, if **1** is **ON**, and **2** is **OFF**, the operator will be able to stop motion by pressing the **ESC** (escape) key, but will not be able to access the **RUN** menus to select another program. (This is a hardware inhibit, and is independent of any firmware or setup parameter in the Smart Drive)

DIP Switch Settings				Keypad Functionality
1	2	3	4	
OFF	OFF	*	*	Full keypad functionality
OFF	ON	*	*	No access to RUN, ESC, EDIT, COPY, DEL menus
ON	OFF	*	*	No access to RUN, EDIT, COPY, DEL menus
ON	ON	*	*	No access to EDIT, COPY, DEL menus
* Reserved for future functions.				

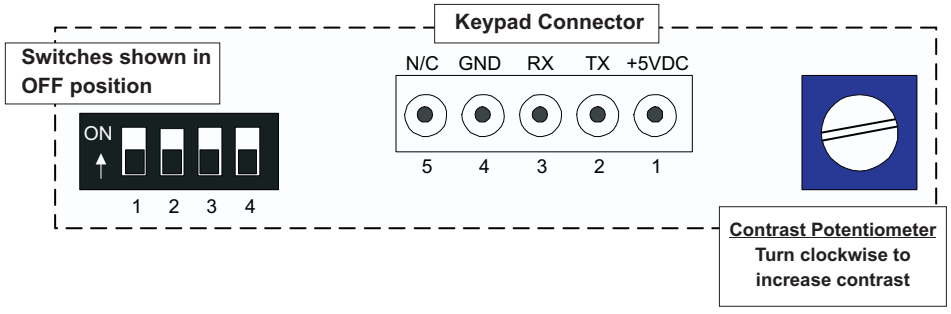
Notes: Power must be cycled before DIP switch setting changes take effect.
Access to the **JOG** menu can be enabled or disabled from software.

Using Passwords to Limit Access to Keypad Functions

Another method of limiting access to keypad functions is to assign “passwords” when configuring your setup parameters. See “Configuring Your Miscellaneous Setup Parameters” in Chapter 5 for more information on passwords. Please note that DIP switch settings have priority over passwords.

Adjusting Contrast

On the back of the keypad there is a plastic potentiometer, adjustable with a flathead screwdriver. This is used to adjust the contrast on the LCD display. If the SmartDrive and keypad were purchased together, this adjustment has been made by IDC. Some adjustment may still be necessary to accommodate unusual lighting or viewing angles.



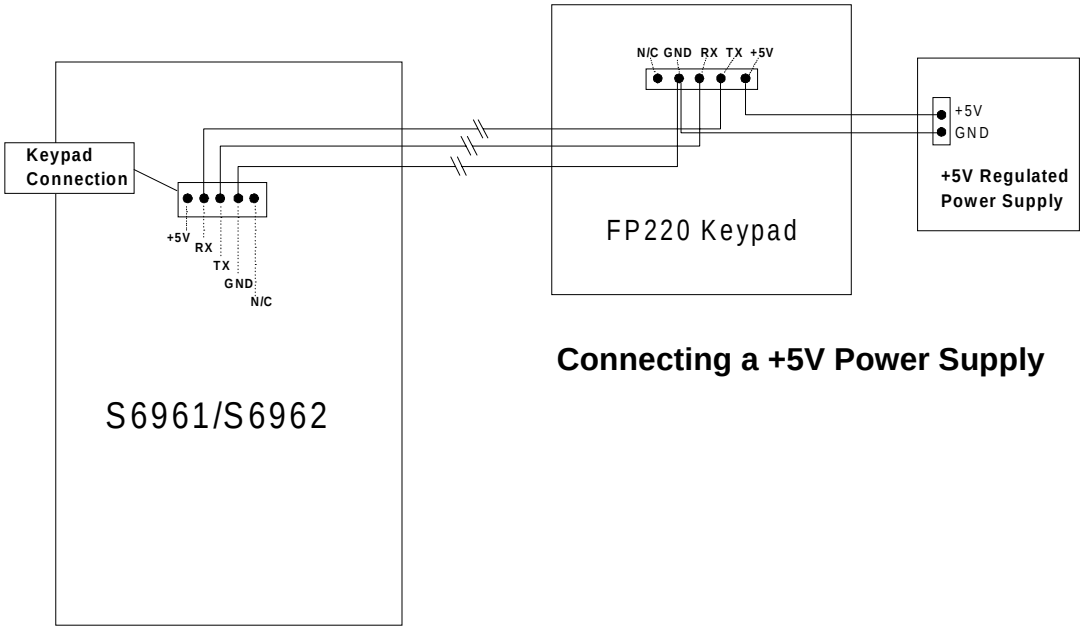
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Remote-Mounting the Keypad

The keypad can easily be mounted and sealed to NEMA 4 specifications by using the included mounting gasket and 6-foot communication cable. **The gasket must be installed with its adhesive side facing toward the mounting enclosure** (not toward the keypad). A pressure seal is formed between the gasket and the keypad, while the adhesive maintains a seal between the gasket and the enclosure. An FP220 Keypad Mounting Template is included with every keypad.

Warning
Your Keypad can be damaged if mounting screws are allowed to extend more than 0.2" into the Keypad.

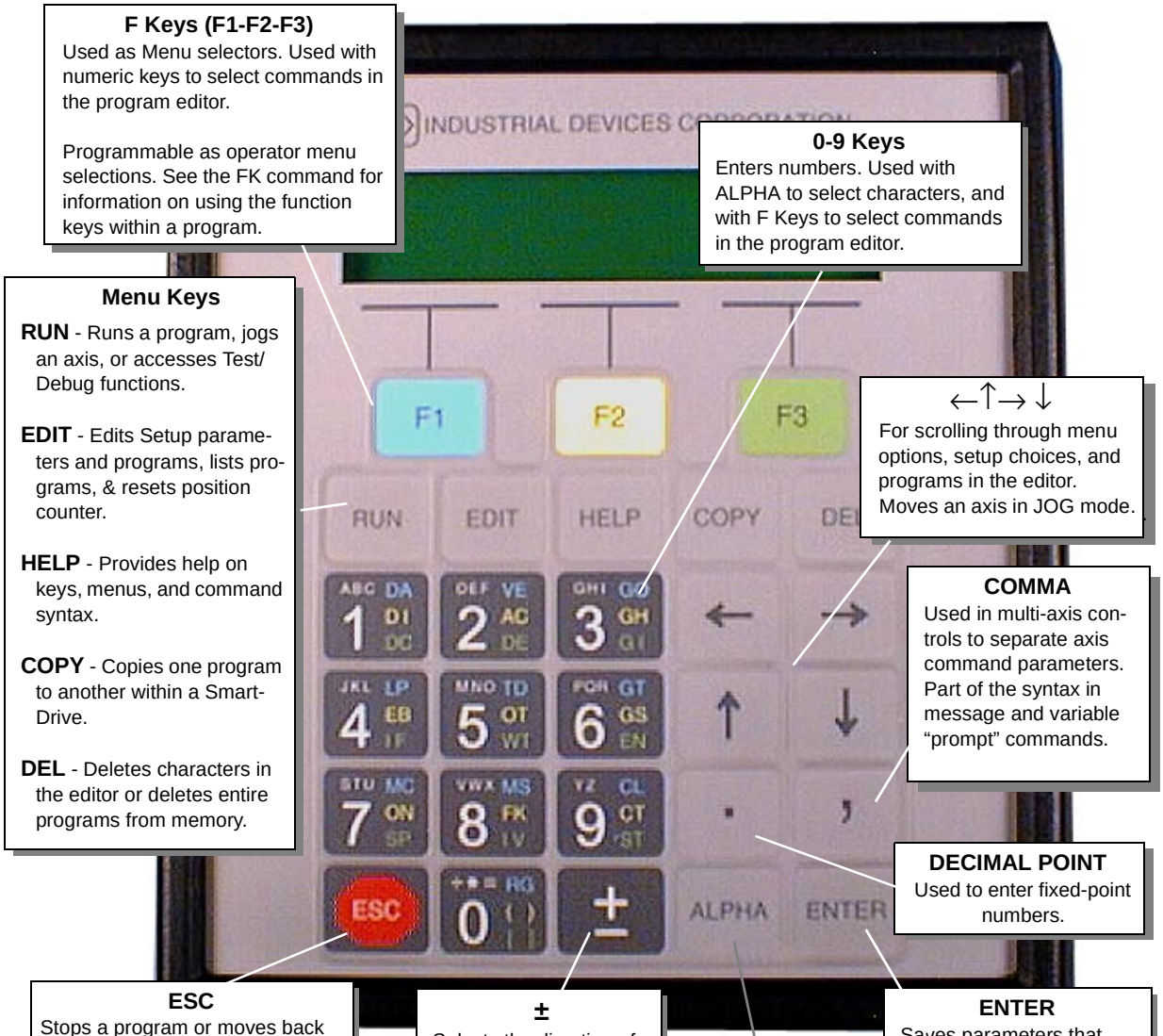
Note: The keypad cable may be extended if necessary. At longer distances, users may be required to provide a separate, regulated 5 VDC (500mA) supply to power the keypad (example shown below).



Connecting a +5V Power Supply

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Functions of the Keypad Keys



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Keypad Menu Structure

Most operations from the Keypad are menu-driven. A menu consists of a title bar on the top display line and as many as three options (or sub-menus) at a time on the bottom display line. Each option is displayed above one of the function keys, F1, F2, or F3. Press a function key to select the corresponding option.

The following table shows the Menus which are accessible from the Main Display by pressing the RUN, EDIT, HELP, COPY and DEL keys:

Main Menu Keys and Associated Menus - Press Once to Begin

Menu Options	RUN	EDIT	HELP	COPY	DEL
	PROG (F1) Run programs by name or number.	**PROG (F1)** Edit or write programs.	**In Main Menu:** Provides help on the function of RUN, EDIT, or COPY.	**PROGRAM (F1)** To copy programs within a control.	**PROGRAM** Deletes an entire program, or characters in the editor.
	JOG (F2) Jog either axis at low or high speeds - Press F1 or F2, and any arrow key (←↑→↓)	**SETUP (F2)** Configure system components and operating limits.	**In Menus:** Provides help on moving about in menus.	**TO PAD (F2)** To upload a control's memory to the keypad.	
	TEST (F3) Run programs in trace mode, amplifier shutdown and reset, test outputs, or moves.	**POS (F3)** Reset axis position to zero? YES (F1) NO (F3)	**In Sub-Menus:** Explains setup choices.	**FROM (F3)** To download keypad memory to a control.	
		LIST (↓) (F1) Directory of stored programs, memory usage and available space.	**In the Editor:** Provides command descriptions.		

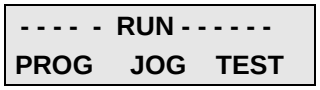
If a menu has more than three options, arrows will appear on both sides of the display to indicate that more options are available. Press the appropriate arrow key to cycle, one display at a time, through all options in that menu. To exit a menu without making a selection, or to back up one menu level, press ESC.

NOTE: ESC backs up one menu in SETUP, and returns the user to the Main Display elsewhere.

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Using the RUN Menus

Pressing the RUN key displays a set of sub-menus. Access the sub-menus by pressing F1 (PROG), F2 (JOG), or F3 (TEST). Following are instructions for various activities within each sub-menu



Select PROG To Run a Program

To run an existing program by program number



1. Press F1 (PROG).
2. Press program number 1-199 using numeric keys (1-400 with 30K option).
3. Press ENTER.

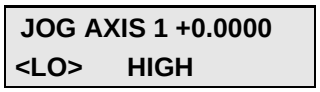
To run an existing program by name



1. Press PROG(F1).
2. Press ↑ and ↓ keys to scroll through the list of available programs until you find the program you want.
3. Press ENTER.

Select JOG To Jog the Motor

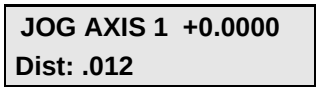
To jog the motor



1. Press RUN.
2. Press JOG (F2).
3. Press ←↑ and ↓ → keys to jog the motor.

Change between LO and HIGH speeds with the F1 and F2 keys. Jog speeds and accelerations can be changed in the EDIT > SETUP > JOG menu.

To jog an incremental distance



1. Press RUN.
2. Press JOG (F2).
3. Enter the desired distance number (i.e., 0.012).
4. Press and release an arrow key to make the motor move this distance. The arrow pressed determines the direction of the move.
5. Repeat steps 3 and 4 until desired position is reached. Repeatedly pressing the arrow keys will jog the same distance until a new distance is defined. This feature is intended for very fine, final positioning. The incremental jog speed is therefore fixed at a *very* low speed.

Note: Pressing ESC at any time will terminate the incremental JOG mode.

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Using TEST For Testing and Debugging

TEST Sub-Menus

TRACE

The trace feature allows you to debug programs by sequentially executing one program command at a time.

```
↑ TRACE PROGRAM ↓
>_
```

1. Press RUN > TEST > TRACE.
2. Enter the program name or number.
3. Press ENTER.

```
PR:5  LP:1  GS:0
DI8000
```

The top line displays the program number, the number of nested loops, and the number of nested routines. The bottom line shows the command to be executed when you press ENTER. Each time you press ENTER, the displayed command will be executed. Pressing ESC halts program execution. TRACE mode is not currently supported during homing operations.

OUTPUT

This feature allows you to test the SmartDrive's outputs, as well as the devices to which it is connected, by forcing them on and off.

```
Test Output #1
←↑      ON      ↓→
```

1. Press RUN > TEST > OUTPUT.
2. Press ← → keys to scroll through outputs 1-8.
3. Press ↑ ↓ keys to turn the output ON and OFF.
4. Press ESC and you will be prompted as shown here:
5. Make your selection and the display will immediately return to the Main Display.

```
Save Output States
YES          NO
```

```
+0.0000
00000000  00000000
```

Please use caution when connected to live devices.

MOVE

This selection moves your motor shaft one user-defined unit forward and backward. This allows you to verify basic motor, encoder, and amplifier operation.

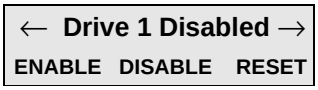
```
------ TEST MOVE ------
Axis 1
```

1. Press RUN > TEST > MOVE.
2. Press F1, F2, or F3 to select the axis to move.

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SHUTDN (Shutdown)

Selecting SHUTDN allows you to enable or disable the axis. When a drive is disabled, the amplifier is off and your motor has no power. The shaft can easily be manually rotated. RESET is applicable only to the B8961/2.



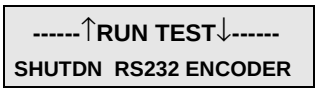
1. Press RUN > TEST.
2. Press ↑ or ↓ until SHUTDN appears above F1.
3. Press SHUTDN.
4. Press ENABLE or DISABLE.

RS232

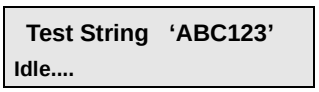
The RS232 feature allows for testing and debugging of daisy chain terminal communications through the keypad, thus eliminating the need for a PC terminal connection.

Testing Serial Transmit

1. Press RUN > TEST.
2. Press ↑ or ↓ until RS232 appears above F2.
3. Press RS232.
4. In the Test Connection menu press TRANSMIT. The SmartDrive will now transmit the string “ABC123”every 5 seconds.







Testing Serial Receive

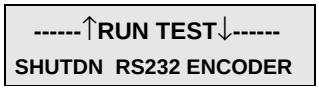
1. In the Test Connection menu press RECEIVE.
2. Any character received on the terminal port will be displayed on the keypad.



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ENCODER

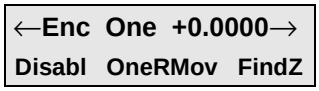
The ENCODER sub-menu allows you to perform three different tests to determine if encoders are working properly.



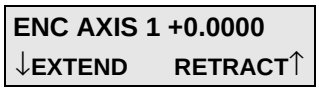
1. Press RUN > TEST.
2. Press ↑ or ↓ until ENCODER appears above F3.
3. Press ENCODER.
4. Press desired encoder test (described below).
5. Use the ← or → arrows to select the axis of the encoder to be tested.

Note: the encoder tests are performed by toggling the F1, F2, and F3 buttons.

Disabl/Enable (F1) allows you to disable the amplifier and manually turn the motor shaft. As you turn the shaft, you should see position changes on the first line of the display, i.e. plus (+) positions in one direction and minus (-) positions the other direction.



OneRMov (F2) allows you to command the motor to turn one full revolution in either direction. Selecting **OneRMov** gives you two choices: **EXTEND** moves the shaft in one direction, and **RETRACT** moves it back.



FindZ (F2) commands the motor to rotate until it finds the Z pulse position. This allows you to accurately center the position of the Home switch.



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Using the EDIT Menus

Pressing the EDIT key reveals three sub-menus called PROG, SETUP and POS:

```
- - - - ↑ EDIT ↓ - - - - -
PROG   SETUP   POS
```

Pressing the ↑ or↓ key reveals three more EDIT sub-menus called LIST and TUNING:

```
- - - - - ↑ EDIT ↓ - - - - -
 LIST  TUNING
```

Access the PROG, SETUP, POS, LIST, and TUNING menus by pressing the appropriate function key. Descriptions of these sub-menus follow:

Using the PROG Sub-menu to Create and Edit Motion Control Programs

This menu allows you to edit an existing program, or enter a new program from the keypad. Use the numeric keys to enter a program number to start a new motion program, or use the ↑ and ↓ keys to scroll through the list of existing programs.

To Create a New Program:

1. Press EDIT
2. Press F1 (PROG) and you will see a display with a blinking cursor as shown to the right.

```
-- ↑ EDIT PROGRAM ↓--
>_
```

3. Enter an identifying number that will be used later to call up the program. The number you enter may be from 1-199 (1-400 with 30k memory option), but do not use a number that is already being used for another program. If the SmartDrive contains several programs, scroll the list to determine a number that has not been used.

   Note: You may assign a name, rather than a number, to your program if you wish. See “Naming Your Programs” later in this chapter.

4. Press ENTER. You will see a completely blank display screen with only a blinking cursor in the upper left corner. The SmartDrive is now ready to accept a program.

```
_
```

5. Once inside the program editor, you will enter commands by pressing a function key and then a numeric key. Examples of creating, saving, naming, and editing programs follow:

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Entering Commands with the Number Keys

Examples of entering commands found on the number 2 key (and on other number keys):



- To enter VE (the upper command), press F1 (blue), then press the #2 key.
- To enter AC (the middle command), press F2 (yellow), then press the #2 key.
- To enter DE (the lower command), press F3 (green), then press the #2 key.
- Press ENTER to insert a space before entering the next command.

Note: All commands that may be used by the SmartDrive are not on keypad keys. See *Chapter 6 - Programming Commands*, for a listing of all available commands.

Step-by-Step Example of Entering a New Program

(You must be inside the program editor as accomplished in steps 1 through 5 on the previous page)

To enter the program **AC.3 VE2 DI1 GO**:

1. Press F2.
2. Press the #2 key. This will enter the AC command.
3. Press the decimal or period key (adjacent to the #9 key).
4. Press the #3 key.
5. Press ENTER.
6. Press F1.
7. Press the #2 key. This will enter the VE command.
8. Press the #2 key.
9. Press ENTER.
10. Press F2.
11. Press the #1 key. This will enter the DI command.
12. Press the #1 key.
13. Press ENTER.
14. Press F1.
15. Press the #3 key. This will enter the GO command. You will see the display shown here:

AC.3 VE2 DI1 GO

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To Save the Program:

1. Press ESC (red octagon in lower left corner or keypad). You will see a "Save Program" query as shown to the right.
2. Press F1 (YES) or F3 (NO).

Save Program _?	
YES	NO

To Edit an Existing Program:

Follow the same steps as in "To Create a New Program", and remember that:

- Inside the editor, pressing ENTER inserts spaces, which are used as delimiters for commands.
- Pressing DEL deletes characters.
- The left and right arrows (← or →) scroll through programs one character at a time.
- The up and down arrows (↑ or ↓) scroll through programs one line at a time.

Naming Programs

Any or all of the programs stored in the non-volatile memory of the SmartDrive can be given descriptive names in addition to the program number that the SmartDrive assigns it. Program names must be put inside of square brackets, [program name], at the start of a program. The name can be up to 14 characters, but the first 10 must be unique. They can, like variables, be nearly any combination of characters.

Programs or subroutines are often named to help "self document" a program. It is usually easier to remember and understand a name then a number. You may call a program or branch to them by name.

This feature also makes it easier for operators to run programs and easier for the programmer to develop systems requiring operator interfacing with our keypad. Suppose your system will run 20 different parts and each part has a different program. With a SmartDrive, all you have to do is name each of your programs so an operator will easily recognize them. When the keypad RUN key is pressed, instead of entering a number, simply scroll through the list of program names (possibly part names) using the↑ and↓ keys. When the desired part is displayed, simply press ENTER to run the program for that part.

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Entering Characters Using The Alpha Key

The ALPHA key allows you to enter almost any character into a program from the keypad. You will find this desirable if you want to:

- Name your programs or subroutines
- Call your subroutines by name
- Make variable names descriptive
- Use operator messages or prompts
- Send messages over RS-232C
- Use commands not on the keypad, such as EA or “ ”

General Rules for Using the ALPHA key

- Any letter and character located above a number on a numeric key may be inserted into a program, i.e. the A, B, or C above #1 on the #1 key.
- Press a numeric key 4, 5, and 6 times to access the lower case letters.
- You must press ALPHA prior to each character you wish to enter.
- Press the ← or → arrow key to move the cursor to the next space.
- Press ALPHA to move the cursor more than one space. For example, if you want to leave more than one space between words in a message to an operator.

Entering a Character (those found above numbers on Keypad)

Example: to insert the A, B, or C on the #1 key:

1. Press ALPHA.
2. Press the #1 key once to enter A, press it twice to enter B, or press it three times to enter the C.

Using ↑ ↓ Arrow Keys for Additional ALPHA Characters

The 19 special characters shown to the right are available by pressing ALPHA and scrolling through the list using the arrow keys.

<	>	?	!	@	#	%	&	_	|
:	;	\	'	"	↑	↓	←	→	

1. Press ALPHA.
2. Press ↑ or ↓ to scroll through the list until the desired character is displayed.
3. When you find the desired character press ALPHA or ENTER to insert the character. The character will be displayed and the cursor will move one space to the right.
4. Scroll through the list to select your next character, or press ESC to leave the editor.

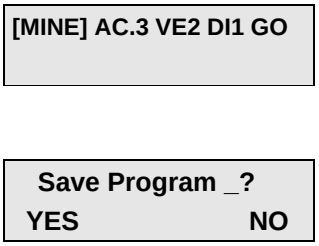
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Example of Naming a Program

Add the name [MINE] to the program created earlier (AC.3 VE2 DI1 GO).

To insert [MINE]:

1. Press F3.
2. Press 0 (zero) key.
3. Press ALPHA.
4. Press #5 key.
5. Press ALPHA.
6. Press #3 key three times.
7. Press ALPHA.
8. Press # 5 key two times.
9. Press ALPHA.
10. Press #2 key two times.
11. Press the → key to move cursor to the right of the bracket.
12. Press ESC. You will be prompted as shown.



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Using the SETUP Sub-Menus for Configuring Your System

The following table shows the structure within the **EDIT > SETUP** sub-menu. For complete descriptions of each system parameter in the SETUP sub-menus, see *Configuring Your System*.

Sub-Menu	Setup Parameter	Description of Setup Parameter
MOTOR	TYPE	Motor parameters
	D-RES	Drive resolution
	DIR	Direction of travel
ENC	MODE	Select open/closed loop mode
	E-RES	Encoder resolution
	FOL-ERR	Following error
	IN-RANGE	Position maintenance window
	PMGAIN	Position maintenance gain
	PMMAX	Position maintenance maximum velocity
MECH	DIST	Distance Units
	RATIO	Scale distance to preferred user units
	BKLASH	Electronic backlash compensation (not implemented)
	VEL	Speed units
	VMAX	Critical speed limit
	ACCEL	Acceleration units
	AMAX	Maximum rate of acceleration/deceleration
I/O	INPUTS	Input functions
	OUTPUTS	Output functions
	OPTOS	OPTO module configuration
	OUTSTS	State of output on Power-up, Fault, or Stop
	LIMITS	End-of-Travel Switch Polarity
JOG	ACCEL	Jog acceleration
	LO-VEL	Low jog velocity
	HI-VEL	High jog velocity
	ENABLE	Enable/disable jog in RUN menu
HOME	MODE	Homing method
	EDGE	Edge of home switch
	SWITCH	Type of home switch
	OFFSET	Position counter offset
	DIR	Final homing direction (positive or negative)
PROG	PWR-UP	Program to run on power up, if any
	SCAN	How to scan program select inputs
	DELAY	Program Select de-bounce time
RS-232C	ECHO	Echo characters
	UNIT#	Serial address
MISC	DISP	Format Display
	STOP-RATE	Decel rate when stop input activated
	TEST	Enable Test Menu (not currently implemented)
	FAULT	Polarity - Fixed Active Low in S6961/2
	ENABLE	Polarity - Fixed Active Low in S6961/2
	PASWRD	Password setup for operator/administrator access

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Select POS to Reset the Current Position to Zero

POS is a quick way to reset the motor's current position to (absolute) zero - a very useful setup and debugging tool.

1. Press EDIT > POS (F3). You will be queried as shown.
2. Press YES (F1) or NO (F3)

```
Reset Position?
YES                NO
```

Select LIST to View Program Memory Usage

LIST provides a way to view your program memory usage. Standard program storage in your IDC SmartDrive is 6K bytes (maximum single program is 1,024 bytes), and will store up to 199 programs. The 30K memory option will store up to 400 programs.
Note: one byte equals one character in a program and on the keypad display.

1. Press EDIT > ↓ > LIST to display the number of programs stored in your Smart Drive.

```
DIRECTORY ↑MORE↓
PROGRAMS: 18
```

2. Press↓ to display the total amount of memory your programs have used.

```
DIRECTORY ↑MORE↓
BYTES USED:  1186
```

3. Press ↓ to display the number of bytes of memory you still have available.

```
DIRECTORY ↑MORE↓
BYTES FREE: 4958
```

4. Pressing ↓ continuously will take you through the list of programs, displaying the number of bytes being used by each program.

```
DIRECTORY↑MORE↓
5  <untitled>: 56 bytes
```

TUNING Necessary only on brushless-servo Smart Drives

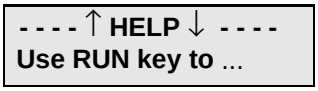
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Using HELP

If you have a question while using the keypad, pressing HELP will display a help message related to the currently active menu. Help messages are often several lines, which you can scroll through using the ↑ and ↓ keys. When you are finished reading a help message, press ESC to return to the menu.

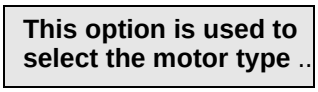
Pressing HELP in the Main Menu

HELP explains the functions available when you press any of the non-numeric keys.



Pressing HELP in Menus and Sub-Menus

HELP explains the selections available from your current menu location.



Pressing HELP In the Program Edit function

HELP provides a brief, alphabetical list of commands. Command syntaxes and details on using commands are available in the Chapter 6 - *Programming Commands*, or from HELP in the Application Developer editor.

Note: A program must be selected to view the COMMAND SUMMARY.

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Using COPY

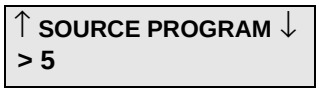
Copying programs from one name (or number) to another, and downloading between keypads or between keypad and PC can save a significant amount of time when programming with a keypad.

Pressing the COPY key brings up three choices that can be accessed by pressing the function keys.



PROG

PROG allows you to copy any existing program to a new program name.



To copy one program to another:

1. Press PROG.
2. Enter the source program number. Or, if you wish, you can scroll through your list of program names by using the ↑↓ keys.
3. Press ENTER.

Then you are asked to enter the new program. If the target program already exists, you will have to delete it first (see DEL).

1. Enter the target program number.
2. Press ENTER.



Remember to change the name of the copied programs to avoid subroutine call conflicts.

Note regarding keypad and SmartDrive memory: standard memory on both the keypad and SmartDrive is 6K. The keypad cannot copy more than 6K of programs from a SmartDrive equipped with the 30K memory option.

TO PAD

Allows you to copy programs from the SmartDrive to the keypad or from a PC to the keypad.



To copy programs from the SmartDrive to the keypad:

1. Press F2 (TO PAD). The two messages to the right will appear sequentially on the keypad display.

   When the messages disappear, the programs have been downloaded to the keypad.





To copy programs from a PC to the keypad:

1. Connect keypad to Computer using RS232 cable (IDC P/N PCS-5004).
2. In *Application Developer* **Communications** menu, click on **Send All** and choose **To Keypad**. The keypad will display the message “Receiving From PC” and a few more messages will quickly appear, then disappear from the screen.

   When the keypad display goes completely blank, the PC-to-keypad download is complete.

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FROM

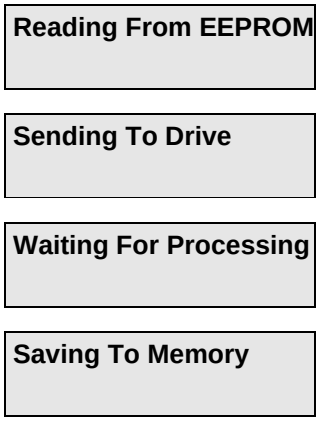
Provides a means of copying (sending) programs *from* the keypad to a SmartDrive or *from* the keypad to a PC.

To copy programs from keypad to SmartDrive

1. Press FROM (F3).

   The four messages to the right will appear sequentially on the keypad display.

   When the messages disappear, the download is complete.



To copy programs from the keypad to a PC

1. Connect keypad to Computer using RS232 cable (IDC P/N PCS-5004).
2. In *Application Developer* **Communications** menu, click on **Retrieve All** and choose **From Keypad**. The keypad will display the message “Sending to PC” and a few more messages will quickly appear, then disappear from the screen.

   When the keypad display goes blank, the keypad-to-PC upload is complete.

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Using DELETE (DEL)

The DEL key allows you to delete any motion program currently in your SmartDrive.

To delete a program

1. Press DEL.
2. Enter the number of the program to delete. Or, if you wish, you can scroll through a list of existing program names by using the ↑↓ keys.
3. Press ENTER.

```
↑ DELETE PROGRAM ↓
> _
```

To Delete a single entry (letter or number)

1. Move the cursor over the entry you wish to delete (move with ← or →).
2. Press DEL.

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Chapter 5 - Configuring Your System

This chapter presents a straightforward procedure for configuring your system to your specific equipment and application requirements. The task of configuring your S6961 or S6962 SmartDrive system can be divided into two sections: the first is the **Hardware Setup** of your SmartDrive, which includes motor and encoder connections, current, inductance, and anti-resonance settings. The second section covers the **Software Configuration** of the control. This includes distance, acceleration and velocity scaling as well as I/O configuration.

The software configuration is presented from a keypad user's perspective, via the keypad menu structure and step-by-step keypad instructions. All of the software configuration can be done via the keypad, or via RS232 using *Application Developer.* Details on how to use IDC's *Application Developer* can be found in the Chapter 8.

Application Developer and RS-232C users should to refer to this chapter for detailed explanations of configuration parameters. For RS-232C terminal users, non-Windows PC users, or PLC users, the equivalent 2-character ASCII configuration commands are detailed in the Chapter 8, but the examples presented here are valid for all users. The 2-character ASCII command appears in brackets next to the appropriate keypad menu choice in this chapter. *Application Developer* users will find that the Windows dialog boxes follow the keypad menu structure very closely.

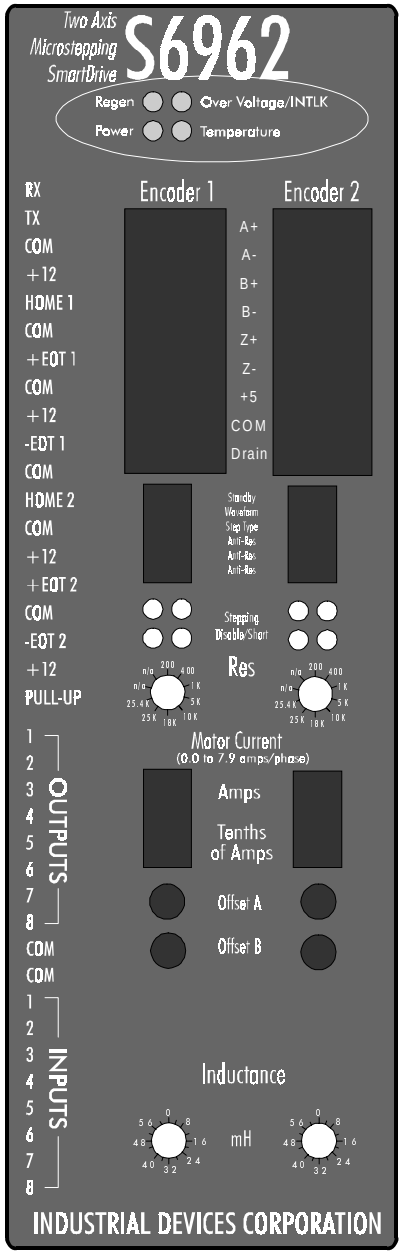
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Section 1 - Hardware Setup

LED Diagnostic Indicators

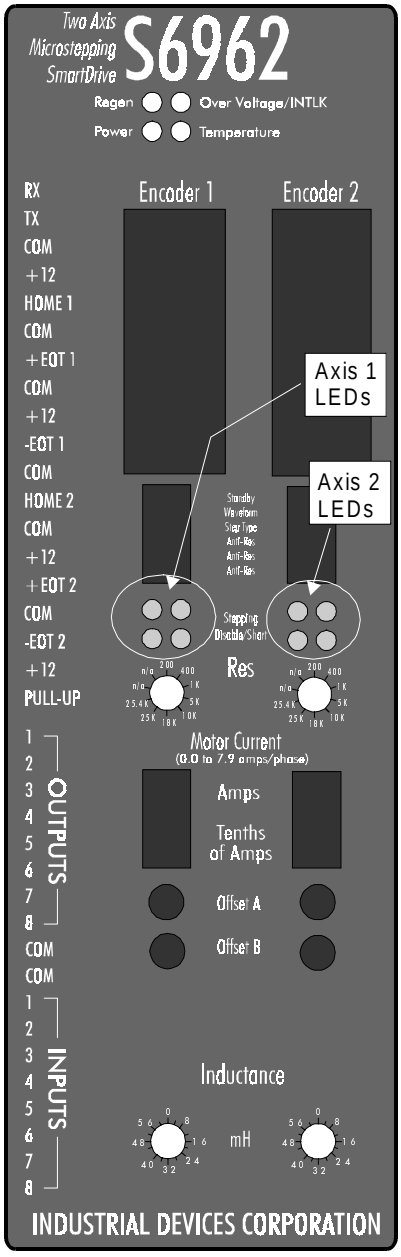
Before making connections and applying power to your system, you should become familiar with the Light Emitting Diode (LED) diagnostic indicators on your S6961/2. The following descriptions of indicators apply to both the S6961 and S6962 although only the S6962 side panel is shown.

LED	Functional Description
Power	The green **Power** LED indicates that the internally regulated logic supplies are operating. If 120 VAC power is applied at the line/neutral terminals and the Power LED does not illuminate immediately, the drive is defective. For several seconds after power is applied to the drive, various LED indicators will illuminate and flicker. This is a normal initialization sequence. Once complete, only the Power LED should remain illuminated.
Regen	The yellow **Regen** LED illuminates whenever the internal power dump circuitry is shunting energy from the High Voltage DC Supply to a regen resistor. This occurs when the regenerative energy transferred from the motor surpasses a level set by the drive. If the Regen activity is modest, the indicator may flicker very briefly.
Over Voltage/ INTLK	The red dual-function Over Voltage/INTLK LED illuminates when either of the two following fault conditions occur: 1 - Overvoltage on the internal high voltage power bus due to regen activity that overwhelms the power dump capacity. This latched condition is indicated by continuous illumination and is cleared by recycling power to the drive. 2 - Loss of continuity in the Interlock circuit. A missing Interlock jumper at either motor connector will invoke this latched condition which flashes the indicator. This condition is cleared by cycling power.
Temperature	The red **Temperature** LED illuminates when the drive has faulted due to an over-temperature condition (approximately 70°C/ 158°F on the heatsink). The fault is latched and must be cleared by recycling power. If over-temperature occurs once, it will probably occur again unless steps are taken to increase cooling or reduce throughput. Lowering the ambient temperature, circulating air past the heatsink, installing a fan kit (-FK1), or using the Standby current setting all help to lower the temperature of the heatsink.



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LED	Functional Description
Stepping	The two green **Stepping** LEDs indicate that the control is sending CW (right LED) or CCW (left LED) step pulses to the amplifier board. The LEDs are driven by digital one-shots to clearly indicate the receipt of even a single step pulse. Above several steps per second the LED becomes continuously illuminated.
Disable/ Short	The yellow **Disable** LED is illuminated when the Shutdown input is activated by an external controller. The Shutdown signal also activates the Short output, but does not turn on the Short LED (see description of Short LED below). The red **Short** LED indicates that a Short Circuit or Undervoltage condition has occurred. A short circuit problem can occur because of shorted or miswired motor leads, or because of an internal drive defect. This fault is cleared by recycling power. If the cause persists, repeated faults may occur. To isolate the problem, disconnect and insulate the motor leads from the drive connector, but leave the Interlock jumper installed. Apply power and step pulses. If the drive does not invoke the short circuit fault, then it is likely that the defect is in the motor, its cabling, or the connections at the drive. **NOTE:** Though similarly named, the Fault LED and Fault Output do NOT activate the same. The Fault Output indicates that one of several fault conditions has occurred (Overvoltage, Undervoltage, Interlock, Over temperature, Shutdown or Short Circuit Fault), and the front panel LEDs provide a means of resolving the source of the fault.



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Motor Wiring

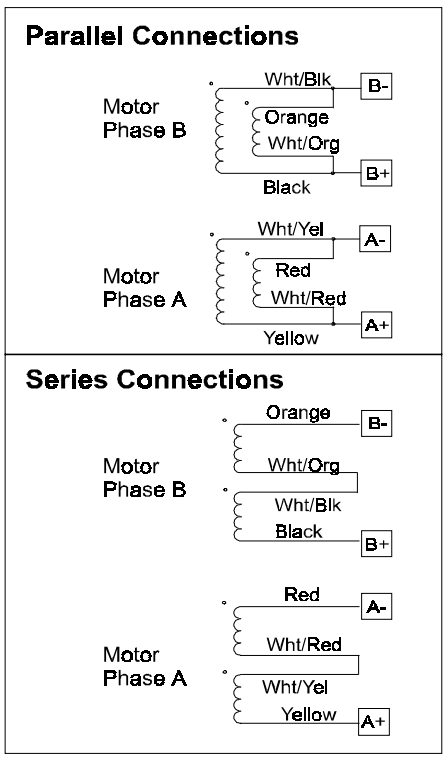
The **A+, A-, B+** and **B-** phase outputs power the motor windings.

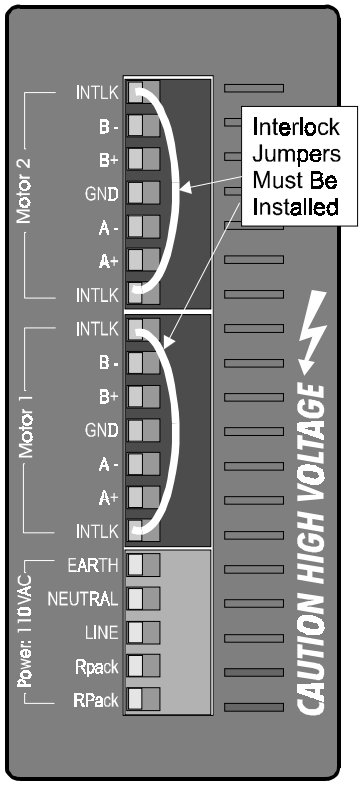
The two **INTLK** pins must be jumpered together at each motor connector for the drive to apply power to the motor. If the interlock wire breaks, or the connector is removed, the current to the motor is immediately stopped, the drive faults (latched) and flashes the dual function LED labeled Over Voltage/INTLK. Extending the interlock wire beyond about 5 inches can lead to noise generated shutdowns.

GND is internally connected to the Earth pin on the Power connector. This provides a convenient terminal for grounding the motor frame and a motor cable shield.

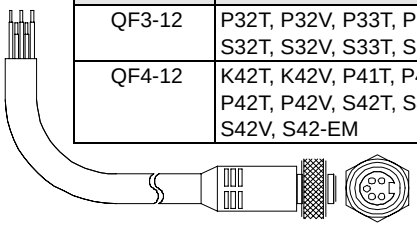
IDC Motors

The figure below illustrates the drive connections to IDC motors with eight flying leads.





Wire Color on Quick Disconnect Cables	S6961/2 Connection
Red w/ Black	B-
Red w/ White	B+
Green	*GND
Red w/ Yellow	A-
Red	A+
*Gray-colored Quick Disconnect Cables are shielded - connect shield to GND.	

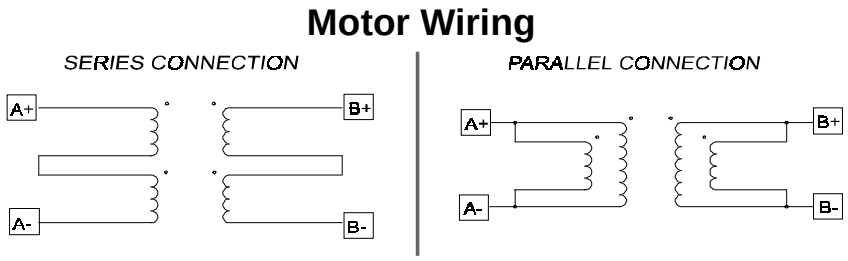


IDC Quick Disconnect Cables	
IDC P/N	**IDC Motor Applicability**
QF3-12	P32T, P32V, P33T, P33V, P33V-EQ, S32T, S32V, S33T, S33V
QF4-12	K42T, K42V, P41T, P41V P42T, P42V, S42T, S42T-EM, S42V, S42-EM

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Non-IDC Motors

Bi-filar wound, 8-lead, non-IDC motors can be wired in series or parallel as shown in the drawing (though the color code will probably be different). When using a 6-lead unipolar motor, the center taps are left unconnected from the drive and insulated from each other and from ground.



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Encoder Wiring

An optional encoder port is available for each axis to allow for stall detection and position maintenance. Encoders are also used to position to the actual load position rather than a motor position. IDC recommends at least a 4:1 motor step to encoder step ratio to prevent the possibility of end of move dither caused by trying to position to an encoder position that falls between to motor step positions. The color codes shown to the side apply to IDC supplied encoders only. Use the signal names to connect other manufacturers encoders.

Encoder Wiring Color Code

Encoder Connector on S6961/2	Standard Encoder	-EQ Cable for P & K Motors	
	Color	Pin-Out	Color
A+	Red	B	Red
A-	Pink or Purple	C	Pink or Purple
B+	Green	N	Green
B-	Blue	P	Blue
Z+	Yellow	M	Yellow
Z-	Orange	U	Orange
+5V	White	K	White
Com	Black	T	Black
Drain	Shield	---	---
			Brown (N/C)

Side Panel Settings

The operation and purpose of the side panel rotary and DIP switch settings are described in detail in this section. The side panel adjustments fall into two categories. The first are the motor dependent settings such as current and inductance. These settings should be made before power is applied to the drive. The second group of settings are application dependent. These include the anti-resonance and current waveform settings. They should be optimized while the drive and motor are loaded and running.

Before Applying Power

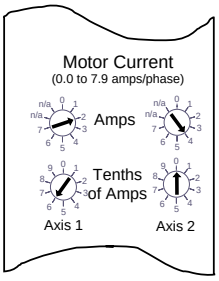
Prior to applying power to your S6961/2 drive, the motor current, inductance, step type and resolution settings must be made. The other settings (waveform, standby current, anti-resonance, and phase offset adjustments can be made while the drive is powered and the motor is moving.

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Motor Current

The S6961/2 has a **Motor Current** range of 0.0-6.0 Amps (peak) per motor phase per axis. The S6961/2-8A option has 0.0-7.9 Amps available. The total current of an S6962-8A should not exceed 12.0 Amps. Each axis has two, 10-position rotary switches for setting the current independently in each motor. The top switch sets the integer current value, and the bottom switch sets the tenths of amps value.

The example shows the current set to 2.6 Amps on Axis 1 and 4.0 Amps on Axis 2.



WARNING!
Setting the current too high can destroy the motor.

IDC Motor Current

The following table shows the S6961/2 current settings for IDC step motors. When using step motor wired in parallel at speeds above 5 revs per seconds, the duty cycle of the motor must be limited to 60% to prevent the motor from overheating.

IDC Motor	Series (T) Current	Parallel (V) Current
S12	1.1A	2.2A
S21	1.2A	2.4A
S22	1.5A	3.0A
S23	1.7A	3.5A
S32	2.8A	5.6A
S33	3.5A	7.0A*
S42	6.0A	7.9A*
P21	Series Current N/A on P21 - K43	1.3A
P22		2.0A
P31		2.9
P32	*Motor current settings greater than 6.0 Amps require the -8A version of the S6961/2 SmartDrive.	3.3
P33		4.0
P41		5.7
P42	Contact IDC for ordering the -8A version. This option includes a fan-kit	*6.6
P43		*6.6
K31		2.9
K32		3.4
K33		3.3
K41		5.7
K42		*6.4
K43		*6.6

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Non-IDC Motor Current

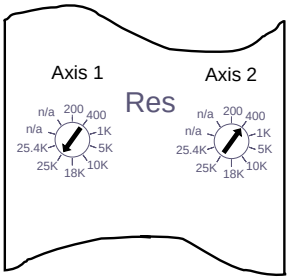
IDC's S Series motors have custom windings to provide optimum dynamic performance with our S6961/2 drives. If you need to use another manufacturer's motor, it should meet the following guidelines:

- If possible, use the manufacturer's 160 VDC, bipolar current rating. With **4-lead motors**, the manufacturer's (bipolar) current rating translates directly to the S6961/2 current setting.
- For the proper current setting for **6-lead (unipolar) motors**, use 70% of the manufacturer's rating.
- For **8-lead motors**, you have the choice of wiring the motor in series or parallel (see Motor Wiring). In series, set the current to the manufacturer's bipolar rating. In parallel, double the bipolar current rating.

Motor Resolution

Your S6961/2 drive has eight selectable motor resolutions (200, 400, 1,000, 5,000, 10,000, 18,000, 25,000 and 25,400 steps per motor revolution.)

Motor Resolution may be selected using the switches on the side panel of the S6961/2 (shown right) or configured with the keypad (see "Configuring Your Software" later in this chapter).



The motor resolution setting, labeled **Resolution** (S6961) or **RES** (S6962) on your drive, will determine the number of incoming step pulses per revolution of your motor. This resolution setting assumes you are using a step motor with 1.8° per full step. The example shows Axis 1 set to 25k steps/rev and Axis 2 set to 400 steps/rev.

Motor resolution is most often set to the maximum your indexer can handle (i.e. the maximum step rate of the indexer provides the maximum motor speed you require). In other applications, you may want to choose your motor resolution to achieve a desired number of steps per engineering unit (per inch, degree, mm, etc.). Resolution also has an affect on velocity smoothness. Above 10,000 steps per revolution you will notice little improvement in smoothness, unless you are moving only a few steps per second.

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Motor Inductance

IDC Motor Inductance

The S6961/2 drive has a dial-in **Motor Inductance** range of 2-60 mH per phase, with 16 settings over that range. The 16-position rotary inductance-setting switch has inductance settings from 0 to 60 mH, in multiples of 4 mH. To get the proper inductance setting from the motor inductance rating, round to the nearest multiple of 4 mH. (When using motors with an inductance less than 4 mH, always set the **Motor Inductance** switch to 4mH.) For example: when using an IDC model S33 wired in series, the inductance rating is 10 mH. Rounding to the nearest inductance setting gives 8mH.

The following table shows motor inductance rating for IDC step motors. The “Meter Reading” column shows the inductance that a typical digital multi-meter would read if you measured the inductance of the motor. The "S6961/2 Setting" column shows the actual S6961/2 drive setting.

IDC Motor	Series/T Inductance (mH)		Parallel/V Inductance (mH)	
	Meter Reading	S6961/2 Setting	Meter Reading	S6961/2 Setting
S12	10	8	2.5	4
S21	18	16	4.5	4
S22	18	16	4.5	4
S23	18	16	4.5	4
S32	10	8	2.5	4
S33	10	8	2.5	4
S42	7	4	1.8	4
P21	Series Inductance N/A on P21 - K43 **Note:** If you are installing and configuring an S6961/2 that shipped from IDC before 08/01/96 (the serial number is date-coded) you will need to set the inductance switch to 2 *times* (2X) the value shown in this table to get catalog-specified performance from your system.		20	20
P22			16	16
P31			14	12
P32			30	28
P33			25	24
P41			15	12
P42			21	20
P43			28	28
K31			14	12
K32			30	28
K33			30	28
K41			15	12
K42			15	12
K43			28	28

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Non-IDC Motor Inductance

The S6961/2 will operate motors with inductance up to 100 mH per phase, but dynamic performance with high inductance motors will be limited. If you are not using an IDC step motor, look for the motor manufacturer's inductance rating.

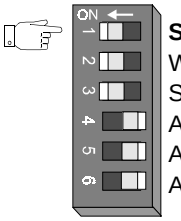
If the exact inductance of the motor is not known, initially set the inductance to 32 mH. The inductance switch is more of an adjustment than a setting. Because of the variety of ways that manufacturer's specify motor inductance, it is difficult to relate a spec. sheet number to an actual drive setting, so some adjustment may be needed. If the S6961/2 Inductance is set too low, the motor will not output its rated torque and speed. Setting the Inductance switch too low will cause motor stalls. Setting the Inductance switch too high will produce an audible hum from the motor, and increase motor heating. Between these two extremes, there are generally 2 or 3 correct inductance settings.

With 4-lead motors, the manufacturer's inductance rating usually translates directly to the S6961/2 inductance setting. To determine the 6-lead unipolar motor inductance setting, we normally use 4X the manufacturer's rating. For 8-lead (bi-filar wound) motors in series, set the inductance to 4X the manufacturer's rating. In parallel, use the manufacturer's rating. Again, please check with the motor manufacturer for the correct inductance settings.

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Standby Current

The automatic **Standby** current function allows your motor and drive to operate cooler if the motor is not required to move a significant percentage of the time. Drive losses, which produce heat in the drive, are directly proportional to motor current. Reducing current in the motor has a slight cooling effect.



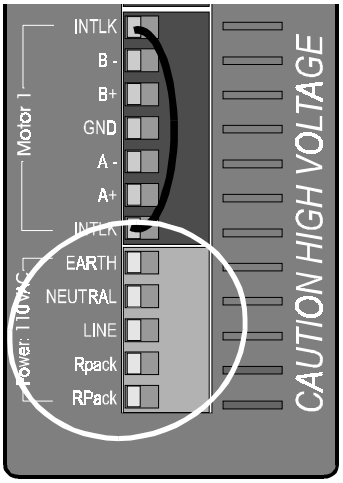
Standby
Waveform
Step Type
Anti-Resonance
Anti-Resonance
Anti-Resonance

Setting the **Standby** current DIP switch to ON reduces motor current by 30% when the drive has not received a step pulse for 250 msec. Full current is restored when the next step pulse is received. Each drive can also be set to standby via software command with the EA2 command.

A 30% reduction in motor current during **Standby** correlates with an approximate 30% reduction in motor holding torque. You will not be able to use **Standby** mode in applications where you need more than 70% of the motor's torque to hold a load stationary (e.g. holding a vertical load against gravity with a ball screw). **Standby** should not be used in applications where an encoder is used to perform end-of-move position maintenance.

AC Power

AC power is supplied via the **Earth, Line,** and **Neutral** terminals on the bottom of the drive. **Line** and **Neutral** are internally fused. Input voltage must be in the range 85-132 VAC rms, 50/60Hz. Low voltage will fault the drive. High voltage will fault the drive and possibly blow the internal fuse.



The **Earth** terminal should be connected to ground. For safety and best grounding results, use a 14-gauge, braided wire to provide a low impedance path to earth ground.

The drive can draw up to 1200 VA per axis (current setting, and duty-cycle dependent).

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After Applying Power

After you have applied power to your S6961/2 drive and have established a valid step command source, the following side panel adjustments can be made to "fine tune" the performance of your motor/drive system.

Phase Offset

Microstepping a step motor requires producing sinusoidal currents in the two-phase windings of the motor. Motor to motor manufacturing variances can result in a DC offset in either or both windings that produce a small torque ripple which can result in two problems:

1. A small cyclic step error arises which repeats itself every 7.2 degrees of rotation.
2. At a particular speed, the torque ripple occurs at the resonant frequency of the motor and results in noticeable velocity ripple.

The S6961/2 drive provides phase **Offset A** and **Offset B** potentiometers on the side panel to adjust DC offset in each of the windings for optimum velocity smoothness and step-to-step accuracy of each motor/drive system.

Here is a simple balancing procedure:

1. Run the motor continuously, unloaded, at the speed “V” given in the chart below.
2. This should produce a noticeable amount of velocity ripple which may be audible and can be felt by lightly touching the motor case or shaft.
3. Alternately adjust Offset pots A and B off center for best smoothness.

IDC Motor	V (RPS)
S12	5.4
S21	4.6
S22	3.9
S23	3.6
S32	3.0
S33	2.8
S42	2.1
P21	3.8
P22	4.1
P31	3.5
P32	3.5
P33	3.4
P41	2.8
P42	2.8
P43	2.7
K31	2.3
K32	5.5
K33	4.0
K41	3.2
K42	3.1
K43	3.0

The required speed “V” depends on the motor torque and total system inertia. We use an unloaded motor because you can then accurately find the torque and inertia from the motor data sheets. If you are using another manufacturer’s motor, the speed may be calculated from this formula:

$$V = 0.0225\sqrt{\frac{Tm}{J}}$$

Where: V = speed (RPS)
T_m = holding (stall) torque (N m)
J = rotor moment of inertia (kg m^2)

This formula will yield a value between 2 and 5 RPS depending on the type of motor.

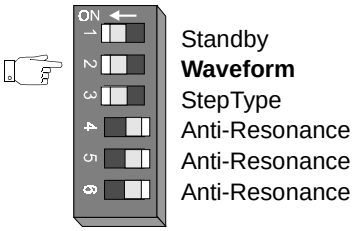
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Current Waveform

Depending on motor design and the current level at which the motor is being driven, it may be advantageous to distort the sinusoidal waveform to achieve better low speed smoothness and step-to-step accuracy. The S6961/2 allows you to select between a -4% 3rd harmonic distortion (Waveform DIP switch OFF) and a pure sine wave (Waveform DIP switch ON). The motor designs used by IDC run best with the Waveform switch OFF.

To determine the best setting for your motor:

1. Operate the unloaded motor continuously at speed "V/4" as shown in the chart to the right.
2. While touching the shaft lightly, flip the Waveform switch back and forth to determine which setting produces the smoothest motion.



You will not have to repeat this test unless you change motor type or motor manufacturer. Pure sine wave will usually produce the best results with skewed rotors or 50-48 tooth geometry.

IDC Motor	V/4 (RPS)
S12	1.35
S21	1.15
S22	0.98
S23	0.90
S32	0.75
S33	0.70
S42	0.53
P21	0.95
P22	1.0
P31	0.88
P32	0.87
P33	0.84
P41	0.71
P42	0.69
P43	0.68
K31	0.58
K32	1.4
K33	1.0
K41	0.79
K42	.78
K43	.75

Step Type

Step Type is not configurable in the S6961/2. Changing the position of the Step Type switch (switch #3) should not affect the performance of your SmartDrive.

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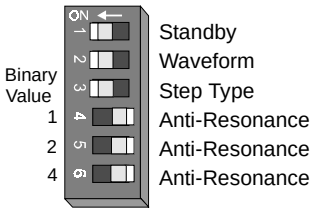
Anti-Resonance Compensation

The S6961/2's anti-resonance compensation eliminates motor stalling caused by mid-range instability effects in the motor, and reduces the amount of transient ringing that occurs at the end of a move, which effectively produces faster move times.

Anti-Resonance Settings for an Unloaded IDC Motor

The three **Anti-Resonance** switches adjust the gain of the resonance compensation circuit in the S6961/2. The table below shows the proper setting for an unloaded IDC motor.

Unloaded IDC Motor	Series (T)Gain Setting			Parallel (V) Gain Setting		
	SW4	SW5	SW6	SW4	SW5	SW6
S12	ON	ON	ON	ON	ON	ON
S21	ON	ON	ON	ON	OFF	ON
S22	ON	ON	ON	ON	ON	OFF
S23	OFF	OFF	ON	OFF	ON	OFF
S32	OFF	ON	OFF	ON	OFF	OFF
S33	OFF	ON	OFF	ON	OFF	OFF
S42	ON	OFF	OFF	OFF	OFF	OFF
P21	Series Gain N/A on P21 - K43			OFF	ON	ON
P22				ON	OFF	ON
P31				OFF	ON	OFF
P32				ON	OFF	OFF
P33				ON	OFF	OFF
P41				ON	OFF	OFF
P42				ON	OFF	OFF
P43				OFF	OFF	OFF
K31				ON	OFF	OFF
K32				ON	OFF	OFF
K33				ON	OFF	OFF
K41				ON	OFF	OFF
K42				ON	OFF	OFF
K43				OFF	OFF	OFF



The above example (OFF-OFF-OFF) shows a setting of N=0

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Setting Anti-Resonance for a Loaded Motor

The gain required for a loaded motor is a function of the motor winding and load inertia (gain will be inversely proportional to load inertia). The value of **N** for a moderately loaded step motor system will normally fall between 0 and 10. To get the proper anti-res setting, round to the nearest available value (0-7) and set the corresponding binary-weighted DIP switches.

Use the following formula to calculate the gain setting (**N**) to use in a loaded motor situation:

$$N = \frac{0.45}{V\sqrt{T(J_L + J_M)}}$$

Where: J_M = Rotor moment of inertia (kg m^2)

J_L = Load moment of inertia (kg m^2)

T = Motor stall torque (N-m) less 10%

V = Motor speed (rps) at which torque has fallen off 10% from its stall value. This speed/torque point is located just beyond the “knee” of the motor’s speed torque curve.

NOTE: The **Resolution** and **Step Type** settings are read only at power up. Subsequent adjustments have no effect until power is cycled. The other adjustments (**Current, Waveform, Standby, Inductance, Anti-Resonance**, and **Phase Offsets**) can be changed while the motor is energized and moving.

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Section 2 - Configuring Your Software

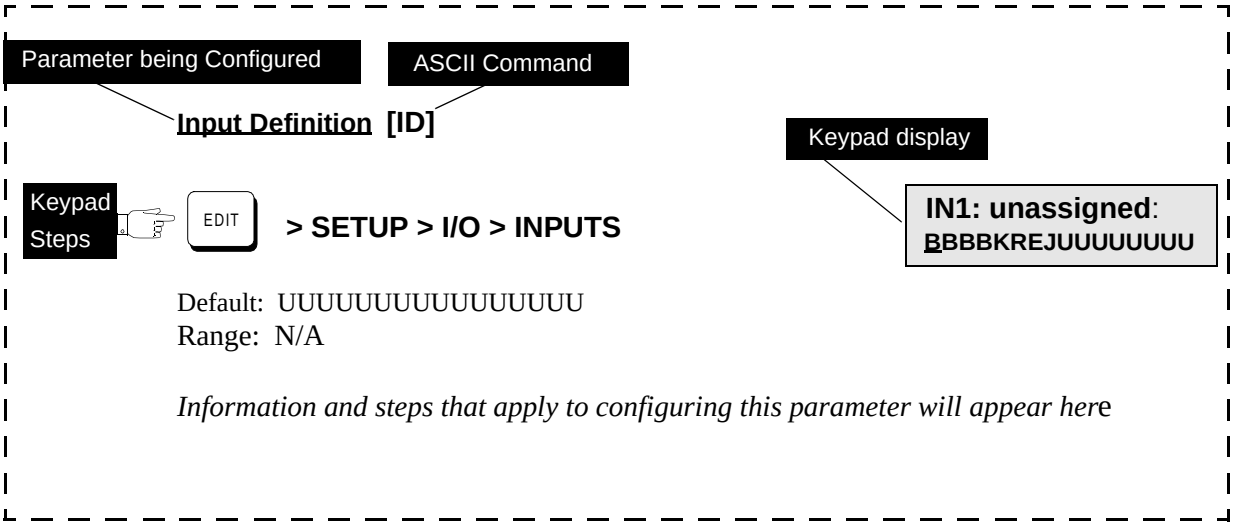
This section contains detailed, step-by-step directions for customizing the S6961 or S6962 to your specific application and mechanical requirements. IDC recommends that even experienced users follow this procedure in its entirety. Following all the SETUP steps will ensure that the most crucial parameters are configured. This section is presented from the point of view of the keypad user. The directions that follow will take you through each of the SETUP menus in the keypad, and give you details about each of the choices you will be asked to make.

Application Developer and RS-232C users will want to refer to this chapter for detailed explanations of configuration parameters. Details on how to use IDC's *Application Developer* can be found in the Chapter 8. For RS-232C terminal users, non-Windows™ PC users, or PLC users, the equivalent 2-character ASCII configuration commands are detailed in the *RS-232 Command Reference* section Chapter 8, but the examples presented here are valid for all users. The 2-character ASCII command appears in brackets next to the appropriate keypad menu choice in this chapter. *Application Developer* users will find that the Windows dialog boxes under the Setup menu follow the keypad menu structure very closely.

Users who plan to create and download their own ASCII setup file will also find this section useful. ASCII commands relating to the parameter being set are shown in brackets. RS-232 command syntax details may be found in Chapter 8.

The task of configuring your S6961 or S6962 SmartDrive system to a specific application consists of customizing a number of software parameters to match the mechanics of the system. These parameters include distance, acceleration and velocity scaling as well as I/O configuration.

Each SETUP step follows the format of the example below:



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Using the SETUP Parameters to Configure Your System

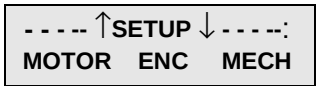
Press the EDIT key, then the SETUP (F2) key to reveal three parameters as shown at top right.



Press ↑↓ keys to access the remaining six parameters.



Configuring your system with the keypad begins below:



Configuring Your Stepper Motor

Configuring Motor Type [MT11]

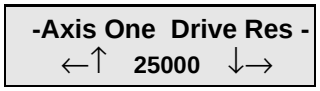
Note: Motor type is not configurable with the S6961/2. Motor type is fixed at STEPPER. When you select MOTOR > TYPE, you will see three motor choice; STEPER, R-SRVO, and L-SRVO. Pressing STEPER (F1) and the arrow keys will only verify that the keypad display is working properly.

EDIT **> SETUP > MOTOR > TYPE > STEPER**



Configuring Drive Resolution [MRi]

EDIT **> SETUP > MOTOR > D-RES**



Default: 25000 steps/rev
Range: n/a

Your application will dictate the choice of D-RES. For example: if you want moves in 0.1 degree increments, a D-RES of 18,000 will allow 50 motor steps per degree and prevent any resolution-induced rounding errors. Setting the drive resolution automatically adjusts the pulse-width.

1. Use ← → keys to select an axis.
2. Use the ↑↓ keys and ENTER key to select from a list of drive resolutions: 200; 400; 1000; 2000; 5000; 8000; 10000; 18,000; 25000; or 25400.

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Configuring Motor Direction [MDi]

EDIT **> SETUP > MOTOR > DIR**

Axis One Motor Dir-
←↑ **POSITIVE** ↓→

Default: POSITIVE
Range: n/a

This option provides a convenient way to change which direction the motor moves when you program a positive distance command.

When POSITIVE is selected as the motor direction, the EOT+ limit switch should be wired so that moves in the plus direction (as shown on the keypad display, or via the PA command) will activate the switch. When NEGATIVE is selected, the EOT+ limit switch should be wired so that moves in the negative direction (as shown on the keypad display, or via the PA command) will activate the switch.

1. Use ← → keys to select an axis.
2. Use the ↑ ↓ and ENTER keys to select a direction

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Configuring Your Encoder

If you are not using an encoder, only the encoder mode must be configured. **Ensure that OPEN LOOP is selected if you are not using an encoder,** and skip to **Configuring Your Mechanics.**

Configuring Encoder Mode [EMi]

EDIT **> SETUP > ENC > MODE**

```
- Axis One Enc Mode-
←↑  OPEN LOOP  ↓→
```

Default: OPEN LOOP
Range: n/a

This option sets the encoder mode. Encoder feedback is strictly optional with the SmartDrive. Use ← → keys to select an axis.

1. Use ← → keys to select an axis.
2. Use the ↑↓ and ENTER keys to select the encoder mode:

OPEN LOOP	The OPEN LOOP position will be displayed on the keypad.
OPEN-STALL	The OPEN LOOP position will be displayed on the keypad, and the encoder will be used for stall detection. (See Following Error)
CLOSED LOOP	The actual encoder position is displayed on the screen. All subsequent moves are calculated from this actual position. All moves are based on encoder pulses. Stall detection is enabled. Positioning resolution will equal the resolution of your encoder.
SERVO-CLOSED LOOP	Displays actual encoder position, but moves are based only on commanded OPEN LOOP position. Stalls are detected in this mode.
CLOSED LOOP-PM	Functionally identical to CLOSED LOOP, with the addition of post-move position maintenance of the last commanded position. Provides “pseudo-servoing” to stepper systems. Use PM GAIN, PM VMAX, and IN-RANGE WINDOW setup parameters to specify position maintenance tuning parameters. Application Notes: Following-error is still active while in CLOSED LOOP-PM mode. A following-error will occur when the number of correction steps exceeds the following error value. This allows the unit to signal a fault when the displacement cannot be corrected, i.e. an obstruction. CLOSED LOOP-PM will not attempt to correct position while navigating menus with the keypad.

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Configuring Encoder Resolution [ERi]

EDIT **> SETUP > ENC > E-RES**

```
- Axis One Encoder Res-
←↑      2000      ↓→
```

Default: 2,000 counts/rev.
Range: n/a

This option is used to set the encoder resolution. The resolution is specified in encoder pulses per revolution of the motor, post-quadrature. To prevent end-of-move dither with a SmartDrive, we recommend an encoder resolution of 8000 counts/rev or less.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter the encoder resolution.

Configuring Following Error Limit [FEi]

EDIT **> SETUP > ENC > FOL-ERR**

```
- - Axis One Fol Error --
←↑   750  steps   ↓→
```

Default: 750 motor steps
Range: 0-999,999 motor-step counts, 0 = OFF

This option defines the maximum position following error allowed during motion. A fault occurs when the error between the commanded and feedback signal exceeds the Following Error value.

1. Use ← or → keys to select an axis.
2. Using numerical keys, enter desired motor steps.
3. Press ENTER to save your entry.

If a Following Error occurs, the control will enter a fault state where:

- Any motion or program being executed is immediately terminated.
- The LCD Display will indicate "Following Error", along with an explanation.
- A fault output will be generated if defined as a "Stall" or Fault output.
- The fault must be cleared before motion can occur. A Stop or Kill, via programmable inputs or serial command, the ESC key or a RESET will clear a Following Error fault
- Bit 9 of SS response is set to 1
- Bit 1 of SD response is set to 1

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Configuring Position Maintenance Deadband [IRi]

EDIT **> SETUP > ENC > IN-RNGE > WINDOW**

```
- IN-RANGE SETUP- -
WINDOW  TIME
```

Default: 25 encoder steps
Range: 0-99,999

In-Range Window specifies the position maintenance deadband or region surrounding the set-point position. The "window" is specified in post-quadrature (4 x # of lines) encoder steps.

The "window" is the region surrounding the commanded position in which the motor shaft can reside and not be considered "out of position." In Position Maintenance mode the control will try to correct the position if the motor is outside this window.

1. Select WINDOW (F1) in the IN-RANGE SETUP menu.
2. Use ← or → keys to select an axis.
3. Enter the desired number of encoder steps (must be a positive number).
4. Press ENTER.

Configuring Position Maintenance Gain [PGi]

EDIT **> SETUP > ENC > PMGAIN**

```
- Axis One PM Gain- -
←        10        →
```

Default: 10
Range: 1-32,767

PM Gain specifies a gain value used to determine correction velocity. The correction velocity is calculated as "displacement* correction gain" in units of steps/sec. Therefore, the larger the displacement, the faster position maintenance will attempt to correct position. For example, if the correction gain is set to 3 and an active displacement of 3200 steps occurs, the correction velocity will be (3 * 3200) = 9600 steps/sec.

Configuring Position Maintenance Max Velocity [PVi]

EDIT **> SETUP > ENC > PMMAX**

```
- Axis One PM MaxVel-
←      1.0 rps      →
```

Default: 1.0 rps
Range: 0.005-9,999,999

PMMAX limits the velocity of a position maintenance correction. Regardless of the magnitude of displacement of correction gain, the correction velocity will never exceed the maximum velocity setting.

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Configuring Your Mechanics

Through the MECH SETUP menu, your SmartDrive allows you to program distance, velocity, and acceleration units convenient for your application. Once configured, your keypad will use these units in all display and position reporting modes. This menu also allows you to set a maximum allowable speed for each axis.



Pressing MECH displays three menu choices:



Pressing ↓ or↑ reveals four additional menu choices:



Configuring the Distance Unit [DUi]

EDIT **> SETUP > MECH > DIST**



Default: revs
Range: n/a

DIST is used along with RATIO to select your distance units and unit label. All distance values specified in the system will be expressed in the units selected here. The relationship between motor revolutions, system mechanics, and the distance label chosen here is defined with the RATIO command defined below.

1. Use ← or → keys to select an axis.
2. Use the↑ ↓ keys to select distance units from the following list:

mils	arcmin	inch	degrees	µm
feet	radians	yards	grads	
steps	cm	%	meter	
arcsec	revs	mm	index	

Notes:

- You can change DIST or RATIO at any time. Changing them will not change the associated DI or DA values in a program. (i.e. DI100 will command a 100 inch move instead of a 100 step move if the DIST units are changed from Steps to Inches.)
- Make certain that your Gear Ratio (GR) option is set to accurately reflect the Distance Unit.
- If *steps* is chosen, the control automatically fixes the RATIO (see following).

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Configuring the Gear Ratio [GRi:i]

EDIT **> SETUP > MECH > RATIO**

```
- - - Axis One Ratio - - -
←↑     1  to  1     ↓→
```

Default: 1 to 1
Range: n/a

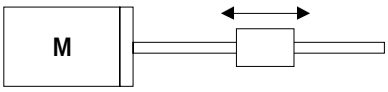
The RATIO option is used to scale DI and DA moves to your preferred distance units. RATIO sets the ratio of *motor revolutions per DIST unit*. Up to 5 digits on either side of the ratio can be entered to properly scale your DIST units. Make certain that the RATIO accurately represents the Distance Unit (DU).

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter a ratio expressed as two integers. Ex: when entering output shaft revolutions of a 5:1 gearbox, enter "5 to 1" rather than "1 to 0.2"

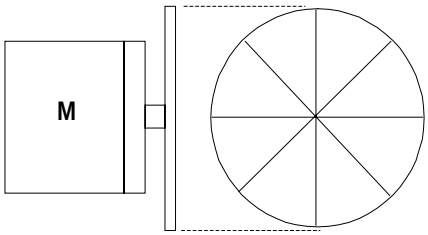
Notes:
You can change DIST or RATIO at any time. Changing them will not change the associated DI or DA values in a program, so all moves will change by the same factor that RATIO was changed.

If using an IDC supplied actuator, the proper Gear Ratios for entering units of *Inches* and *mm* can be found in Appendix A.

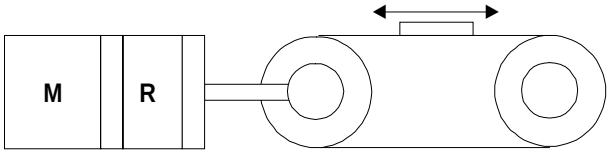
Units Example - Lead Screw System
- Desired distance units: inches
- Leadscrew: 4 revs/inch
- DIST = inch
- RATIO = 4 to 1



Units Example - Rotary Index Table
- Desired distance units: 1/8 of a revolution
- DIST = index
- RATIO = 1 to 8



Units Example - Gear Reduced Tangential Drive System
- Desired distance units: mm
- Reducer: 5:1 reduction
- Drive pulley: 6 inch circumference
- DIST = mm
- RATIO = 50 to 1524



5 revolutions of motor travel results in 152.4 mm of linear load travel. This ratio must be expressed as an integer to be used in the Gear Ratio command. Multiply each side by 10 to get a Gear Ratio of 50 to 1524.

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Configuring the Units of Velocity [VUi]

EDIT **> SETUP > MECH > VEL**

```
- Axis One Vel. Units -
←↑     mm/sec     ↓→
```

Default: rps (motor revolutions per second)
Range: n/a

Use this option to select your velocity units. All velocity values specified in the system will be expressed in these units.

1. Use ← or → keys to select an axis.
2. Use the ↑↓ and ENTER keys to select velocity units from the list:
   - rps
   - rpm
   - (DIST units)/sec (see SETUP>MECH>DIST)
   - (DIST units)/min (see SETUP>MECH>DIST)

Configuring Maximum Velocity [MVr]

EDIT **> SETUP > MECH > VMAX**

```
- - Axis One Max Vel. -
←↑  50.0  inch/sec  ↓→
```

Default: 50 {velocity units}
Range: n/a

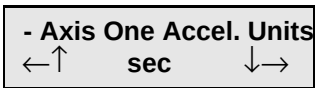
This parameter limits the top speed of your motor. Depending on the application, you may want to limit the speed of your control to prevent accidental damage to your mechanics. For example, in a leadscrew driven system, exceeding the “critical speed” will damage the leadscrew.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to set the maximum velocity in VEL units.

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Configuring Acceleration Units [AUi]

EDIT **> SETUP > MECH > ACCEL**



Default: sec
Range: n/a

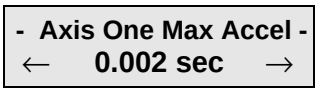
This option is used to select acceleration (and deceleration) units. All acceleration and deceleration values specified in the system will be expressed in these units. You can specify acceleration as a rate, or in time-to-accelerate to full speed.

1. Use ← or → keys to select an axis.
2. Use the ↑ ↓ and ENTER keys to select acceleration units from the list at below:

   - sec (time to reach top speed)
   - (DIST units)/sec^2
   - rps^2 (motor revolutions/sec^2)

Configuring Acceleration Maximum [AMr]

EDIT **> SETUP > MECH > AMAX**



Default: 0.002 seconds or 999999 units/sec^2
Range: n/a

Acceleration Maximum command sets a maximum acceleration and deceleration limit for programmed move profiles in the current acceleration units. Programmed accelerations and decelerations for moves will be limited by this parameter (analogous to VMAX for velocity).

1. Use ← or → keys to select an axis.
2. Enter the desired Acceleration Maximum
3. Press ENTER.

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Configuring Your Inputs & Outputs

Your SmartDrive has eight discrete optically-isolated inputs, and eight discrete optically-isolated outputs. It also supports up to eight Opto I/O modules (G4/G5 footprint), which is like having a G4PB8 board and cable built in, and it has the capability of supporting a mix of analog and digital modules. Every input and output can be configured to a specific machine control function.

The eight OPTO positions can be inputs or outputs, logic or AC/DC power, digital or analog, or even used as thermocouple (Type K or J) inputs. The control is completely protected from damage that might be caused by accidentally interchanging modules. Simply insert the modules and configure each position in the OPTO menu as either an input or an output. If a module is located incorrectly, the control will not respond correctly, but no damage will occur.

Your SmartDrive is compatible with almost any manufacturer's G4 or G5 *digital* opto modules (OPTO 22, Grayhill, Gordos, etc.). However, at the time of this printing, only Grayhill's *analog* modules are compatible with our control. Other manufacturers' *analog* opto modules do not fit into a G4 footprint.

For more information on how to use your SmartDrive's inputs and outputs in an application, refer to Chapter 7 - *Programming Your Application*, and Chapter 6 - *Programming Commands.*

The function of each input and output in your system is easily configured with I/O SETUP menus. Once you have defined your inputs and outputs, it is a good idea to document your configuration scheme for later reference when developing future motion programs.

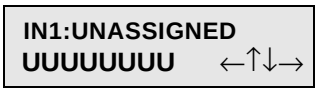


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Configuring Your Inputs

Configuring Input Definition [IDaaaaaaaa]

EDIT **> SETUP > I/O > INPUTS**



Default: UUUUUUUUUUUUUUUU
Range: n/a

The function of each input is easily configured using the keypad as described below. The function for each input channel is indicated by a letter along the bottom of the display.

1. Use ← and → keys to select an Input. The function of the highlighted input will be displayed on the top line.
2. Once your cursor is on the desired input, use ↑↓ to select from the following list of dedicated functions for each input:

Input Characters and Keypad Display	
Character	**Keypad Display**
B	Bin Program
C	Bcd Program
c	Clear Command Buffer
D	Lock Keypad
E, e	Extend Jog 1, Extend Jog 2
***F, f**	Set Force 1, Set Force 2
I	Interrupt (Run98)
J, j	Jog Speed 1, Jog Speed 2
K	Kill
M, m	Shutdown 1, Shutdown 2
N	Analog Input
P	Pause/Continue
R, r	Retract Jog 1, Retract Jog 2
G	Registration (1 For Axis 1, 2 For Axis 2)
S	Stop
U	Unassigned
V	Data Valid
W	Warm Boot

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Input Character Descriptions

B Binary Program Select
Allows programs to be run remotely using a PLC, switches, or outputs from a computer. Up to 199 programs may be selected with standard 6K memory (up to 255 programs with 30K option). The lowest numbered input becomes the least significant selection bit (i.e., input #1 is less significant than input #2). The act of configuring an input as a program select input also enables binary program select mode.

C BCD Program Select
Allows programs to be run remotely using a TM99 Thumbwheel module, PLC, switches, or outputs from a computer. Up to *99* programs may be selected using BCD inputs. The lowest numbered input becomes the least significant selection bit (i.e., input #1 is less significant than input #2).

The act of configuring an input as a program select input also enables the BCD program select mode.

c Clear Command Buffer
Clears the terminal input buffer and buffered command buffer

D Lock (Disable) Keypad
When activated, the keypad is disabled allowing NO user access. The keypad resumes normal operation, subject to the dipswitch pattern, when the input is released.

E, e Extend Jog (E specifies axis 1, e specifies axis 2)
When activated, the motor will Jog in the Extend (+) direction. When the input is released, motion stops at the Jog Accel rate. If an End of Travel limit is hit while jogging, the motor will stop at the Stop Rate (see Edit-Setup-Misc.). Before the motor can be moved back off the limit, a Stop or Kill input must be activated to clear the fault generated by hitting an End of Limit switch. Alternatively, an S or K command sent over RS-232C will also clear the fault.

The velocity is determined by the Jog Speed Input and the Jog Low and High setup parameters. When the input is off, the speed is low, and vice versa. If none of the inputs are configured for Jog Speed, the motor will jog at the Jog Low setting.

G Registration
For the Registration (RG) command to function, Input #1 must be configured as a Registration input on axis 1, and Input #2 must be configured as a Registration input on axis 2 (S6962) - no other inputs will work. See the RG command for more details.

I Interrupt (Run 98)
When activated, motion on all axes is stopped at the stop-rate (see Edit-Setup-Misc-Stop-Rate). The current program is stopped, and processing continues with the first command in program 98. If no program is running when the input is activated, program 98 will run. This input is ignored while the keypad is in Edit mode. This is a positive edge sensitive input, rather than a level sensitive input. If multiple inputs are configured as Interrupts, only the first edge of the first activated input will be seen. If subsequent Interrupt inputs go active while the first Interrupt input is active, no additional interrupts will be seen.

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Advanced Interrupt handling can be achieved using the (INT98CTRL) and (ARM INT98) variables. The (INT98CTRL) variable determines whether Interrupts can be disabled or not. The (ARM INT98) variable allows you to arm and disarm the Interrupt as desired. When the SmartDrive powers up (INT98CTRL) is initialized to 0. In this mode, every interrupt results in an immediate jump to program 98, even if you just entered program 98. This state is backwards compatible with earlier revision IDC SmartDrives. The value of (ARM INT98) is ignored.

When (INT98CTRL)=1 you can enable and disable Interrupts at will with the (ARM INT98) variable. Setting (INT98CTRL)=1 also initializes (ARM INT98) to 1. This means the control is watching for interrupts. When (INT98CTRL) is set to 1 an interrupt causes the program to jump to program 98 **AND** sets (ARM INT98)=0, disabling any further interrupts until you re-enable them by setting (ARM INT98)=1. This allows you to control when you want to re-enable Interrupts in your interrupt service routine (program 98).

To summarize, when (INT98CTRL)=1:

If (ARM INT98)=0
Interrupts are ignored. (ARM INT98) is internally set to 0 on the first edge if the previous (ARM INT98) value was 1. Interrupt processing will be suspended until (ARM INT98) is reset to 1. This allows for input debouncing and controlling the ability of program 98 to interrupt itself.

If (ARM INT98)=1
The system is awaiting the first INT98 input assert edge. Once the interrupt is seen the control will go to program 98. Subsequent interrupts are ignored until (ARM INT98) is set to 1.

(INT98CTRL) and (ARM INT98) are reset to default values on power-up. Note: There is a space between M and I in (ARM INT98).
When activated, any executing program or functional operation is terminated and program I98 (interrupt program) is immediately executed. If a move is executing when the interrupt is activated, the move is terminated (decelerated at a rate determined by the Stop Deceleration rate setup parameter). The unit will enter Run mode once program I98 is completed

J, j **Jog Speed** (J specifies axis 1, j specifies axis 2)
This input works along with the Extend Jog and Retract Jog. When a jog input is activated, the control checks the state of this input to determine the jog speed. If the input is OFF, the system will jog at the Jog Low speed. If the input is ON it will jog at the Jog High speed. If the input is not configured the jog inputs will induce motion at the low speed.

K **Kill Motion**
Causes the control to abruptly stop commanding further motion and terminates program execution. No deceleration ramp is used. Caution: instantaneous deceleration could cause damage to mechanics. The **Stop** input provides a more controlled halt.

M, m **Motor Shutdown** (M specifies axis 1, m specifies axis 2)
May be activated when the control is not running a program and the motor is idle. Selecting shutdown (M, m) will disconnect power to the motor, which removes current (torque) and allows the motor to spin freely.

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N aNalog
Only the OPTO I/O may be configured as analog inputs. To use an analog or temperature I/O module the I/O position must be configured as an analog input signal. This tells the SmartDrive that the input is no longer a discrete input and prevents the input signal from being misinterpreted.

Analog signals are read into input variables (AI9) through (AI16) corresponding to OPTO positions 9 through 16. See Chapter 7 - *Programming Your Application* for details on using analog I/O.

P Pause/Continue
When this input is grounded, program execution is stopped. Moves are not interrupted when the **Pause** input goes active. Command execution will **Pause** at the end of the move, and **Continue** when the input goes high. See the **ST** and **RG** commands in Chapter 3 for interrupting moves in progress.

R, r Retract Jog (R specifies axis 1, r specifies axis 2)
When activated, the motor will Jog in the Retract (minus) direction. When the input is released, motion stops at the Jog Accel rate. If an End of Travel limit is hit while jogging, the motor will stop at the Stop Rate. (see Edit-Setup-Misc.) Before the motor can be moved back off the limit, a Stop or Kill input must be activated to clear the fault generated by hitting an End of Limit switch. Alternatively, an **S** or **K** command sent over serial communication will also clear the fault.

The velocity is determined by the **Jog Speed (J)** input and the Jog Low and Jog High setup parameters. When the input is OFF the speed is low, and vice versa. If none of the inputs are configured for Jog Speed, the motor will jog at the Jog Low setting.

S Stop
When activated, any program execution or functional operation is immediately stopped. This includes any motion, time delays, loops, and faults. Moves *will* be decelerated at the stop deceleration rate. New programs will not execute until the stop input goes inactive.

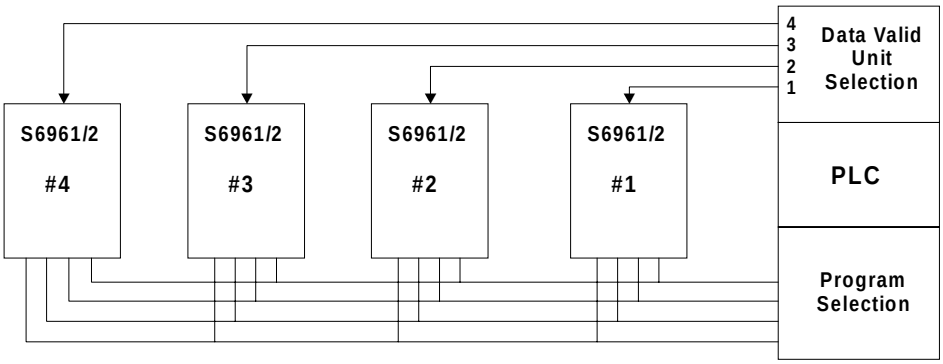
See the **SCAN** setup parameter for more information on stopping program execution. See the **ST** command in Chapter 3 for more information on stopping moves without halting command execution.

U Unassigned
An **Unassigned** input functions as a programmable input, and can be used in IF and WT statements just like any of the dedicated function inputs.

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V Data Valid

When this input is configured, it determines if the Binary/BCD program select lines are processed or ignored. If the input is active, program select lines are processed, otherwise they are ignored. This allows applications to be wired in a pseudo-bus architecture fashion with each unit sharing the same program select lines, and the data valid inputs determining which units should listen. Configuring this output can greatly reduce panel wiring.
In the example shown below, using the Data Valid input reduced the number of wires by one-half.



W Warm Boot—System Reset

Resets the SmartDrive, clearing the RAM Buffer, and resetting the control to its power-up state. Programs and setup parameters are not erased. This is typically used to restart system when a fault condition occurs. The power-up program, if defined, will be run.

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Configuring Your Outputs

Configuring Output Definition [ODaaaaaaaa]

EDIT **> SETUP > I/O > OUTPUTS**

OUT1: PROGRAMMABLE
PPPPPPPP--------←↑↓→

Default: PPPPPPPP--------
Range: n/a

The function for each output channel is indicated by a letter along the bottom of the display. The first 8 letters are for the dedicated Outputs.

1. Use ← and → keys to select an Output channel. The function of the highlighted output will be displayed on the top line.
2. Once your cursor is on the desired output, use ↑↓ to select from a list of function configurations for each channel. See below

Output Characters and Keypad Display	
Character	**Keypad Display**
A	Amp Fault
B, b	Brake 1, Brake 2
C	Over Current
D, d	Direction 1, Direction 2
F	Fault
H, h	At Home 1, At Home 2
***K, k**	At Cl Limit 1, Limit 2
L	Limit Error
M, m	Move Done 1, Move Done 2
P	Programmable
S	Stall
T**	Torque Mode

*B8961/2 only

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Output Character Descriptions

A Amplifier Fault
Output goes low on any amplifier fault. An amplifier fault may be due to temperature, motor short-circuits, excessive following error, over-voltage and excessive regeneration conditions. Note: This is not an all-inclusive fault output. Use F-Fault for this.

B, b Brake (B specifies axis 1, b specifies axis 2)

> **CAUTION**
> IDC offers brakes for the actuator screw, or as an integral part of some motors. Though both types of brakes are highly effective, there are specific trade-offs that the user should be aware of regarding each type of brake. Please discuss the issue of brakes with an IDC Applications Engineer or with your distributor.

It is often advisable that applications using a ballscrew type actuator with a vertical load use a brake to prevent the load from falling in the event of a fault. The **Brake** output is normally disengaged, which is actually an ON condition. When a fault occurs, power to the brake is removed and the brake is engaged. This is a "fail-safe" type of brake, controlled by an OPTO module, and it requires a customer supplied, 120VAC power supply, or 24 VDC with B Motors.

D, d Direction (D specifies axis 1, d specifies axis 2)
The Direction Output indicates the direction of motion for a given axis. The output remains set until motion is commanded in the reverse direction.

F Fault
The fault output acts as an all-inclusive fail-safe output. Under normal operation the output is grounded (ON) and goes high(OFF) when any type of fault occurs. A fault can occur from any amplifier fault condition as well as for the following general faults:

- BMA (Board Monitor Alarm) time-out
- Error finding Home - both limits were hit.

The exact cause of the fault can be determined a number of ways:

- Shown on keypad's display
- Over RS-232C using the **SS**, **SD**, and **SA** status commands (see Chapter 8)
- Other outputs can be configured to show more specific fault states

H, h At Home (H specifies axis 1, specifies axis 2)
The output is on as long as an axis is at home.

L Limit Error
The output goes low if a limit switch is hit during a normal move, or if both limits are hit during a Go Home move.

M, m Move Complete (M specifies axis 1, m specifies axis 2)
The output goes high as soon as an axis move is started and goes low when a move is completed.

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P Programmable
Unassigned outputs default to **Programmable** and can be used in **OT** commands.

N aNalog
Only the OPTO I/Os may be configured as analog outputs. To use an analog output module the position must be configured as an analog output. This tells the SmartDrive that the output is no longer a discrete output and ensures that the output signal is sent properly. Analog signals are set by assigning a value to reserved variables (AO9)-(AO16) corresponding to OPTO positions 9 through 16. See Chapter 7 for more details on using analog I/O modules.

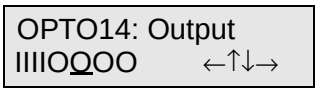
S Stall
The output goes low if the control detects a motor stall.

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Configuring Your Optional OPTO Modules

Opto Definition [OP]

EDIT **> SETUP > I/O > OPTOS**



Default: IIIIIIII
Range: n/a

The OPTOS menu allows you to configure each OPTO I/O position as either an input or an output. The hardware is protected against damage if you mistakenly configure an input as an output.

1. Use ← and → keys to select an OPTO channel. The top line of the display indicates whether the channel is currently configured as an input or an output.
2. Once your cursor is on the desired channel, use ↑↓ to select INPUT or OUTPUT.

Your SmartDrive is compatible with almost any manufacturer's G4 or G5 *digital* Opto modules (OPTO-22, Grayhill, Gordos, etc.). However, at the time of this printing only Grayhill's *analog* modules are compatible with our control. Other manufacturer's *analog* modules do not fit into a G4 footprint.

IDC stocks the following Opto modules which may be specified when ordering an S6961/2:

Order Code (p/n)	I/O Module Description	Opto-22 P/N	Grayhill P/N
A (PCB-1210)	10-32 VAC/VDC Input	G4IDC5	70G-IDC5NP
B (PCB-1211)	TTL Input	G4IDC5K	
C (PCB-1212)	35-60V DC Input	G4IDC5G	70G-IDC5G
D (PCB-1213)	90-140 VAC Input	G4IAC5	70G-IAC5
F (PCB-1215)	5-60 VDC, 3 Amps Output	G4ODC5	70G-ODC5
G (PCB-1216)	12-140 VAC, 3 Amps Output	G4OAC5	70G-OAC5
I (PCB-1218)	Input Test Switch	G4SWIN	
J (PCB-1219)	0-10 Volt Analog Input		73G-IV10
K (PCB-1220)	4-20 mA Analog Input		73G-II420
L (PCB-1221)	0-10 Volt Analog Output		73G-OV10
M (PCB-1222)	4-20 mA Analog Output		73G-OI420
N (PCB-1223)	J Type Thermocouple Input, 0 to 700(C		73G-ITCJ
O (PCB-1319)	K Thermocouple Input -100 to 924(C		73G-ITCK
P (PCB-1224)	RTD Thermocouple Input, 100 Ohm		73G-ITR100

More information on available OPTO modules is available from the Opto module manufacturer or your local distributor.

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Configuring Your Output States

Configuring Output States on Power Up [OEP]

EDIT **> SETUP > I/O > OUTSTS > PWR-UP**



Default: OFF
Range: n/a

This option sets the desired states of the outputs on power up.

1. Use ← and → keys to scroll through outputs #1- #8 and any OPTO positions configured as outputs.
2. Use the ↑ and ↓ keys to set the output state as OFF or ON and press ESC to save.

Configuring Output States on Fault [OEF]

EDIT **> SETUP > I/O > OUTSTS > FAULT**



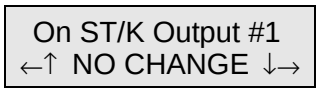
Default: NO CHANGE
Range: n/a

This option sets the desired states of the outputs on a fault.

1. Use ← and → keys to scroll through outputs #1- #8 and any OPTO positions configured as outputs.
2. Use the ↑ and ↓ keys to set the output state as OFF, ON or NO CHANGE and press ESC to save.

Configuring Output States on Stop / Kill [OES]

EDIT **> SETUP > I/O > OUTSTS > ST/K**



Default: NO CHANGE
Range: n/a

This option sets the desired states of the outputs on a Stop or Kill.

1. Use ← and → keys to scroll through outputs #1- #8 and any OPTO positions configured as outputs.
2. Use the ↑ and ↓ keys to set the output state as OFF, ON or NO CHANGE and press ESC to save.

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Configuring End of Travel Switch Polarity [ET]

EDIT **> SETUP > I/O > LIMITS**

```
--- ↓ I/O SETUP ↑ ---
OUTSTS  LIMITS
```

Default: NORM CLOSED
Range: n/a

This option allows configuration of the EOT switch polarity as NORM OPEN or NORM CLOSED to accommodate the use of either type of switch.

1. Use ← and → keys to select an axis.
2. Use the ↑ and ↓ keys to select NORM OPEN or NORM CLOSED and press ESC to save.

```
 --Axis one EOT Pol--
←↑ NORM CLOSED ↓→
```


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Configuring Your Jog Parameters

Your SmartDrives's keypad gives the programmer (and the machine operator if desired) a convenient way to jog the motor.

```
↑ JOG SETUP ↓
ACCEL  LO-VEL  HI-VEL
```

The parameters which control your jog operation are configured using the JOG SETUP menu:

```
↑ JOG SETUP ↓
ENABLE
```

Note: The Units used by the Jog parameters are configured from the SETUP > MECH menu.

Configuring Jog Acceleration [JAr]

EDIT **> SETUP > JOG > ACCEL**

```
-Axis One Jog Accel
←     0.3   sec     →
```

Default: 0.3 {Accel Units}
Range: n/a

This option sets the acceleration and deceleration used during a jog move.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter a new Jog Accel/Decel value in the same units you selected in the SETUP > MECH > ACCEL menu.

Configuring Jog Low Velocity [JLr]

EDIT **> SETUP > JOG > LO-VEL**

```
- Axis One Jog Lo-Vel -
←     0.5  in/sec     →
```

Default: 0.5 {Velocity Units}
Range: n/a

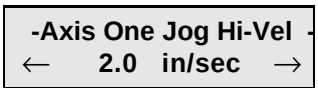
This option sets the low speed jog velocity used during a jog move.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter new low jog velocity value in the same units you selected in the SETUP > MECH > VEL menu.

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Configuring Jog High Velocity [JHr]

EDIT **> SETUP > JOG > HI-VEL**



Default: 2.0 {Velocity Units}
Range: n/a

This option sets the high speed jog velocity used during a jog move.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter new high jog velocity value in the same units you selected in the SETUP > MECH > VEL menu.

Configuring Jog Enable [JEi]

EDIT **> SETUP > JOG > ENABLE**



Default: Enabled
Range: n/a

This option enables or disables the jogging features of the control. When disabled, an error message is displayed when the jog buttons are pressed. Jogging functions are often disabled once a machine is installed to prevent an operator from accessing them.

1. Use ← or → keys to select an axis.
2. Use ↑↓ keys to enable and disable the function.

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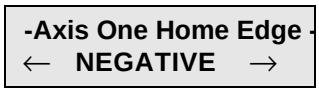
Configuring Your HOME Parameters

Your SmartDrive has a built-in homing function which combines the flexibility of a customized homing routine with the ease of use of calling a "canned" program. Also see the GH command in the IDeal Command Reference chapter for more details on homing.



Configuring Home Edge [HEi]

EDIT **> SETUP > HOME > EDGE**



Default: NEGATIVE
Range: n/a

This option selects which side (positive or negative) of the home switch active region the SmartDrive must find before searching for the index channel of the encoder.

1. Use ← or → keys to select an axis.
2. Use ↑↓ keys to select the positive or negative side of the home switch.

Configuring Home Switch [HSi]

EDIT **> SETUP > HOME > SWITCH**



Default: Norm Open
Range: n/a

This option selects the type of switch used for the home input for each axis. A Normally Open switch connects to ground when activated. A Normally Closed switch is pulled high when activated.

1. Use ← or → keys to select an axis.
2. Use ↑↓ keys to select the switch type. (NORM OPEN or NORM CLOSED)

NOTE: To conserve inventory (part #s), you may want to use only N.C. switches.

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Configuring Home Offset [HOr]

EDIT **> SETUP > HOME > OFFSET**

```
Axis One Home Offset-
← 0.0 rev →
```

Default: 0.0 {Distance Units}
Range: n/a

This option sets the home offset. After a successful homing move, the home position (the default home position is +0.0000) is set to the offset value.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter a new home offset value in DIST units.

A home offset allows you to have separate systems with identical programs in them. All you have to change is the home offset value for each machine. It helps reduce start up time, since your home limit switch can now be almost anywhere. It also reduces the time necessary to get a system back up and running should your home switch ever get damaged or moved.

Example: Home Offset = 1.0000
When the control finds the home position, it sets the position counter to 1.0000 distance unit. The absolute zero position counter is now referenced 1 unit behind the mechanical home position. All absolute moves will be referenced from the absolute zero position.

Configuring Home Final Direction [HFi]

EDIT **> SETUP > HOME > FINAL**

```
--Axis One Final Dir- -
← POSITIVE →
```

Default: POSITIVE
Range: n/a

Specify the final approach direction of your Go Home (GH) move with this option. This is the direction used to search for the encoder index mark (Z channel) after the appropriate home switch edge is found.

1. Use ← or → keys to select an axis.
2. Use ↑↓ keys to select the final approach direction.

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Configuring Homing Mode [HMi]

EDIT **> SETUP > HOME > MODE**

--Axis One Home Mode
←↑ **Switch Only** ↓→

Default: Switch Only
Range: n/a

The Homing Mode parameter establishes how a Go Home (GH) command will execute homing routines. There are three modes of operation:

Switch Only	The control will only search for the appropriate edge of a switch.
***Switch Then Z Channel**	The control first looks for a home switch, aligns to the edge, and then slowly moves until an encoder Z pulse is found.
***Z Channel Only**	The control does not search for a home switch, instead it rotates at a slow speed until an encoder Z pulse is found, regardless of the home switch state. The magnitude of GH velocity parameter is ignored. The sign of the velocity parameter determines the low speed direction.

*Requires an encoder

1. Use ← or → keys to select an axis.
2. Use ↑↓ keys to select the homing mode.

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Configuring Your PROGRAM SETUP Parameters

The Program Setup menu allows selection of (1) a program to be immediately run when the SmartDrive is powered-up and (2) scanning conditions for the BCD or binary program select inputs.

```
- PROGRAM SETUP -
PWR-UP  SCAN   DELAY
```

Configuring Power-Up Program [PUi]

EDIT **> SETUP > PROG > PWR-UP**

```
-Power Up Program -
PROGRAM: 0
```

Range: n = 0 to 199 (400 with 30K option)
Default: 0

This option selects a power-up program. The selected program is executed (run) when your SmartDrive is powered-up or reset. If a value of 0 is entered in this menu, or if the specified program does not exist, no program is run.

1. Use ← or → keys to select an axis.
2. Use numeric keys to enter a program number.

Configuring Scan Conditions [SNaaaaaaaa]

EDIT **> SETUP > PROG > SCAN**

```
- - -Stop Scan After- - -
←↑YYYYYYY ESC ↓→
```

Default: YYYYYYY
Range: n/a

The SCAN menu allows you to select which events will cause the control to stop scanning program-select configured inputs. It is used to enable or disable stop-scan events. If a given stop-scan event is enabled, the system will stop scanning the inputs for program numbers when that condition occurs. The SmartDrive must be reset via a Warm Boot input or by cycling power to start program scanning after an active Stop Scan event. This option has no effect if the inputs have not been configured as program select inputs (either BCD or Binary). Each event is represented by one of seven Y/N positions on the bottom display line.

1. Use ← or → keys to select an axis.
2. Use ← and → keys to select a stop-scan condition. The selected event will be listed to the right of these 7 characters: ESCape, STOP, LIMIT+, LIMIT-, KILL, FAULT or INTerrupt.
3. Use ↑↓ keys to enable (Y) or disable (N) the selected event.

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Configuring Scan Delay [DYi]

EDIT **> SETUP > PROG > DELAY**

```
 - - -Scan Debounce-- -
DELAY(ms): _
```

Default: 100 ms
Range: n/a

The DELAY time sets the amount of time the control requires the program select inputs (BCD or Binary) to remain stable before the control will recognize and run a program. The minimum time is 2 ms. If program select inputs are not stable for a time equal to or greater than the specified delay, the program will not be executed.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter a value in ms.

Note: See Data Valid Input Configuration for an alternate approach.

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Configuring Your Serial Communications

If you plan to use the serial communications port on your SmartDrive, you can use your keypad to turn the auto-echo on and off and set the unit's daisy chain address. The baud rate of 9600 is fixed on the SmartDrive.

```
- - RS-232C SETUP-- -
ECHO   UNIT#
```

Fixed RS-232C parameters:

- Baud rate: 9600
- Data bits: 8
- Stop bits: 1
- Parity: none

Configuring Echo Enable [ECi]

EDIT **> SETUP > RS232 > ECHO**

```
- -  RS-232C Echo --
↑       ENABLED       ↓
```

Default: ENABLED
Range: n/a

This option is used to enable or disable the RS-232C ECHO. If ECHO is disabled, characters received by the control's serial port will not be re-transmitted. ECHO must be enabled in daisy-chaining applications.

1. Use ← or → keys to select an axis.
2. Use the ↑↓ keys to enable or disable ECHO.

Configuring Unit Number [UNi]

EDIT **> SETUP > RS232 > UNIT#**

```
   ↑ Unit Number ↓
NUMBER: _
```

Default: 1
Range: 1-99

This option is used to set the unit address. Each unit in an RS-232C serial daisy chain of multiple units must have a unique Unit Address. Refer to the section on daisy chain operation in the RS-232 Operation chapter more information on this type of application.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter the unit address.

Note: See AA Command in *Programming with RS-232C* for Auto-Addressing.

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Configuring Your Miscellaneous Setup Parameters

The miscellaneous setup (MISC SETUP) parameters include auto-formatting of the keypad display, and setting the deceleration rate (used with a stop input or with the ESC key while an axis is moving).

↑ **MISC SETUP** ↓
DISP STOP-RATE TEST

Configuring Display Format [DF]

EDIT **> SETUP > MISC > DISP**

↑ **MISC SETUP** ↓
DISP STOP-RATE TEST

Default: Quad #1: POS1
Quad #2: POS2 (S6962)
BLANK (S6961)
Quad #3: INPUTS
Quad #4: OUTPUTS
Range: n/a

Display format allows the user to customize the data displayed on the keypad run time screen. The run time screen has been divided into 4, 10-character configurable quadrants. The DISP menu displays labels for the 4 quadrants with carets (< >) denoting the selected quadrant.

1. Use ← → ↑ and ↓ keys to move quadrant selection delimiters (< >).
2. Press ENTER to edit quadrant.

Once a quadrant is selected, there are 16 possible data types that can be displayed in that quadrant.

Data Type	Quadrant Display
BLANK	No display
POS1	Axis #1 position
POS2	Axis #2 position
POS1+UNIT	Axis #1 position with axis units
POS2+UNIT	Axis #2 position with axis units
VEL1	Axis #1 commanded velocity
VEL2	Axis #2 commanded velocity
CUR1	Axis #1 current in Amps (B896X only)
CUR2	Axis #2 current in Amps (B896X only)
INPUTS	Discreet input status (0 off, 1 on)
OUTPUTS	Discreet output status (0 off, 1 on)
OPTOS	OPTO input and output status (0 off, 1 on) as configured
SA_STATUS1	Displays SA serial command response for axis #1
SA_STATUS2	Displays SA serial command response for axis #2
SS_STATUS	Displays SS serial command response
TEXT	Display user defined text in a quadrant

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3. Use the ↑ and ↓ key to scroll through the data types and press ESC to save all data types except TEXT (see step 4).
4. In order to define a text field, scroll to the TEXT data type and then press the ALPHA key or a number key. A cursor will appear allowing up to 10 characters to be entered. Type the desired text, press the ENTER key and then press ESC to register.

Configuring Stop Decel Rate [SRi]

EDIT **> SETUP > MISC > STOP-RATE**

```
--Axis One Stop Decel -
←   0.1     (rps²)   →
```

Default: 100 rps^2 (units fixed at motor rps^2)
Range: n/a

This option is used to set the deceleration rate whenever a configurable stop input is activated, or when the ESC key is pressed while moving. This is usually set to the fastest controllable deceleration rate possible with mechanics in your application.

1. Use ← or → keys to select an axis.
2. Use the numeric keys to enter a stop deceleration.

Configuring Enable Line Polarity [EL0]

Default: FIXED ACTIVE LOW

```
- Axis One EnablePol -
ACTIVE LOW
```

This parameter is not configurable on the S6961/2.

Configuring Fault Line Polarity [FL1]

Default: FIXED ACTIVE LOW

```
- Axis One  FaultPol -
ACTIVE LOW
```

This parameter is not configurable on the S6961/2.

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Configuring Passwords [PWaaaa,aaaa]

EDIT **> SETUP > MISC > PASWRD**

```
- -PASSWORD SETUP--
OPRATR ADMIN CLEAR
```

Default: None
Range: n/a

In addition to the keypad DIP switches, user-definable passwords also enable you to restrict access to the RUN, EDIT, COPY and DEL menus.

1. Enter your desired password, using the same keypad entry techniques described in Chapter 4. Use ←→ and DEL keys to edit the password.

2. Press ENTER to register the password.

The SmartDrive allows up to two types of passwords: **OPRATR** (Operator) and **ADMIN**.

Passwords and Menu Accessibility

This Password	Will Give You Access to These Menus
OPRATR only	RUN, EDIT, COPY, DEL
ADMIN only	RUN, EDIT, COPY, DEL
OPRATR + ADMIN	ADMIN = RUN, EDIT, COPY, DEL OPRATR = RUN only (All RUN functions except TEST)

General Password Rules:

- Passwords can be a maximum of 4 characters consisting of 0-9, upper and lower case letters A-Z, or a combination of numbers and letters.
- If no password is entered, there is no restriction.
- Entering the wrong password, or pressing ESC at the password prompt will return the keypad to the standard run-time display.
- Select EDIT > SETUP > MISC > PASWRD > CLEAR to delete all passwords.

NOTE: Subsequent attempts to RUN or EDIT a program do not require the password to be entered each time. You will be prompted to: **Use Last (F1)**, or **Reset (F3).** Select **Use Last** to run or edit another program. Select **Reset** to require the next user to enter a password.

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Chapter 6 - Programming Commands

This chapter defines, in alphabetical order, all of IDC's IDeal™ commands that can be used in a program. Please refer to *Chapter 4, Using the Keypad,* for more information on entering these commands with the keypad.

Some IDeal™ commands are supported only in serial communication mode. These commands are listed and defined in *Chapter 8, Programming with Serial Communication,* and they can also be found in the *Summary of Commands* immediately inside the back cover of this manual.

The commands in this chapter are defined according to the following example:

DI

Distance Incremental ..... syntax - DI±r,±r

Units: selected from the EDIT > SETUP > MECH menu
Range: unit scaling dependent
Default: *If the command has a default, it will be listed here (n/a if there is no default)*

DI specifies a move distance relative to the current position. Such moves are called incremental moves, as opposed to the absolute zero reference used in DA. Incremental moves are typically used in applications where there is no concern for origin, such as feed-to-length applications. Incremental moves are also often used inside a loop to shorten a program. Incremental and absolute moves may be mixed - the control always keeps track of the absolute position.

Example: Move 2 units in the + (positive) direction. Move 1 more unit in the + direction. Move 4 units in the - (negative) direction.

Program: AC.1 VE60 **DI2** GO **DI1** GO **DI-4** GO

Note: Additional programming examples are found in the next chapter.

Summary of IDeal™ Commands

Command	Description	Command	Description	Command	Description
AC	Acceleration	**GI**	Go Immediate	**MS**	Message to Display
BR	Break	**GO**	Go (Start a Move)	**ON**	On Command
DA	Distance Absolute	**GP**	Go Point	**OT**	Output
DC	Distance to a Change	**GS**	Gosub	**"__"**	"Message to Serial Port"
DE	Deceleration	**GT**	Go To	**RG**	Registration Move
DI	Distance Incremental	**IF**	If Then	**SP**	Set Position
EA	Enable Amplifier	**IV**	Input Variable	**SQ**	Square Root
EB	End of Block	**LP**	Loop	**ST**	Stop on Input
EN	End of Routine	**LU**	Loop Until	**TD**	Time Delay
FK	Function Key	**LW**	Loop While	**VE**	Velocity
GH	Go Home	**MC**	Move Continuous	**WT**	Wait

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IDeal™ Commands



Acceleration.....syntax - ACr,r

Units: sec, rps^2 or unit/s^2 (selected from the EDIT > SETUP > MECH menu)
Range: unit scaling dependent
Default: n/a

AC sets the acceleration and deceleration ramp on all velocity changes. The deceleration value (DE) will be the same as the acceleration value unless it is specifically set after the AC command., The value of DE must be reset every time AC is changed. Use *only* AC if you want a symmetrical move profile. Use DE if you want a different deceleration rate. Subsequent moves will use the last DE or AC value specified.

Examples:	AC2 VE12 DA3 GO	Sets acceleration and deceleration to 2.
	DE.5 VE12 DA6 GO	Accel stays at 2, decel changes to 0.5.
	VE20 DA0 GO	Acceleration and deceleration remain at 2 and 0.5.
	AC4 DA2 GO	Acceleration and deceleration become 4.
	DE3 AC1 DI3 GO	DE reset to 1 by AC1 before the move is made.



Break .....syntax - BR

Units: selected from the EDIT > SETUP > MECH menu
Range: unit scaling dependent
Default: n/a

The Break command instantly “breaks” a loop block in which it is defined and continues program execution from the loop’s terminating EB command. This allows for more complex loop conditioning than LU or LW commands.

Example:

```
(A)=0                       {Define variable A}
(B)=0                       {Define variable B}
LP                          {Define loop block}
  IF(A)>10                  {Check if A is greater than 10}
    IF2,0                   {Check if input #2 is off}
      BR                    {Break loop}
    EB
  EB
(A)++                       {Increment variable A by 1}
EB                          {BR command jumps here}
MS1,”A is greater than 10”  {Display message}
```


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Distance Absolute.....syntax - DA±r,±r

Units: selected from the EDIT > SETUP > MECH menu
Range: unit scaling dependent
Default: n/a

DA sets the next move position, referenced from absolute zero. The absolute zero position is established after a Go Home move (GH) and/or with the Set Position (SP) command. Absolute positioning is typically used in applications where you are moving to a number of known locations, or if your physical work area is restricted.

Incremental (DI) and absolute moves may be mixed; the control always keeps track of the absolute position.

Examples:	AC2 DE.5 VE12 DA3	GO Moves to absolute position 3 units.
	DA3 GO DA3	GO Moves *once* to absolute position 3 units.

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Distance to a Change.....syntax - DC±r,±r

Units: selected from the EDIT > SETUP > MECH menu
Range: unit scaling dependent
Default: n/a

DC is used to define complex, multiple velocity move profiles, or to change an Output at a specific point during the move. It defines the distance at which a change will occur, "on the fly", while the motor is still moving. At the specified distance you can change the velocity, acceleration, deceleration, or change the state of one or more outputs.

The DC command must follow the DA or DI commands which specify the total move distance. The DC distance is interpreted as an absolute position when used with DA and an incremental position when used with DI. When used with DI, the value of DC must be specified as a positive number. When multiple DC's are specified within an incremental move (DI), the incremental distance specified by the DC command is taken from the last DC command, not from the beginning of the move. See the incremental move examples below for more clarification. The *standard* software supports a maximum of 20 DC commands within a move profile.

Examples:
AC.05 DE.05 VE10 DA4 DC1 OT100 DC2 OT010 DC3 OT001 GO
While moving to an absolute position of 4 units turn on output 1 at 1 unit, output 2 at 2 units and output 3 at 3 units.

AC.05 DE.09 VE30 DA6 DC3 VE15 GO
Move to absolute position 6 units with a starting speed of 30. At 3 units, reduce speed to 15 (change-on-fly) and complete move.

AC1 DE.5 VE20 DI-8 DC1 OT10 DC3 OT01 GO
Move an incremental distance of *negative* 8 units. After 1 unit, turn on output 1, and after 3 *additional* units of motion, turn off output 1 and turn on output 2.

AC.05 DE.15 VE50 DI15 DC5 VE10 DC5 VE5 GO
At a starting speed of 50, begin moving an incremental distance of 15 units. After 5 units, ramp down to 10 speed. After an *additional* 5 distance units, ramp down to 5 speed and continue until the final position is reached.

AC.1,.1 VE10,20 DI10,10 DC5,5 VE20,10 GO
Move an incremental distance of 10 units on axis 1 and 2. After 5 units on axis 1, ramp up to a speed 20; after 5 units on axis 2, ramp down to speed 10. Note that these velocity changes both take place after 5 distance units, but they do not take place at the same time.

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DE

Deceleration.....syntax - DEr,r

Units: sec, rps^2 or unit/s^2
Range: unit scaling dependent
Default: n/a

Sets the deceleration ramp on all negative velocity changes. The deceleration value will be the same as the acceleration value unless a deceleration is specified. The value set will be used on subsequent moves unless it is re-specified by *either* an acceleration (AC) or deceleration (DE) command.

Examples:		
	AC2 VE12 DA3 GO	Sets acceleration and deceleration to 2.
	DE.5 VE12 DA6 GO	Accel stays at 2 and decel changes to 0.5.
	VE20 DA0 GO	Acceleration and deceleration remain at 2 and 0.5.
	AC4 DA2 GO	Both acceleration and deceleration become 4.
	DE3 AC1 DI3 GO	AC1 sets *both* the accel and decel to 1.

DI

Distance Incremental..... syntax - DI±r,±r

Units: selected from the EDIT > SETUP > MECH menu
Range: unit scaling dependent
Default: n/a

DI specifies a move distance relative to the current position. Such moves are called incremental moves, as opposed to the absolute zero reference used in DA. Incremental moves are typically used in applications where there is no concern for origin, such as feed-to-length applications. Incremental moves are also often used inside a loop to shorten a program. Incremental and absolute moves may be mixed - the control always keeps track of the absolute position.

Example: AC.1 VE60 DI2 GO DI1 GO DI-4 GO
Move 2 units in the + direction. Move 1 more unit in the positive direction. Move 4 units in the negative direction. The final absolute position is -1.0000.

EA

Enable/Disable Amplifier..... syntax - EAi,i

Units: n/a
Range: 0 (disable), 1 (enable), 2 (standby)
Default: n/a

EA sets the state of the amplifier enable signal. The polarity can be changed in EDIT > SETUP > MISC > ENABLE.

Example:		
	EA0	Disables the amplifiers on axis one and two.

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EB — End of Block ..... syntax - EB

Units: n/a
Range: n/a
Default: n/a

The EB command designates the **E**nd of a **B**lock of loop or IF commands. Every LP, LW, LU, and IF statement must have an EB associated with it.

Examples:	LP2 DI3 GO EB	Performs the move twice
	IF1,1 DI5 GO DI10 GO EB GH3	If input 1 is On, make 2 moves before homing. If input 1 is Off, jump to the GH command.

EN — End of Routine..... syntax - EN

Units: n/a
Range: n/a
Default: n/a

EN marks the end of a program or subroutine. It is optional at the end of a program. If EN marks the end of a subroutine, command execution continues from the command following the gosub (GS) command which called the subroutine. If the routine was not called from another program, the EN command simply stops command execution. The control continues to monitor the program select inputs (if defined).

The EN command can be used anywhere in a program to stop command execution.

Example:	IF2,1 EN EB DI2 GO	If input #2 is on, stop the program, or return to the calling program. If not, move 2 units.

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FK

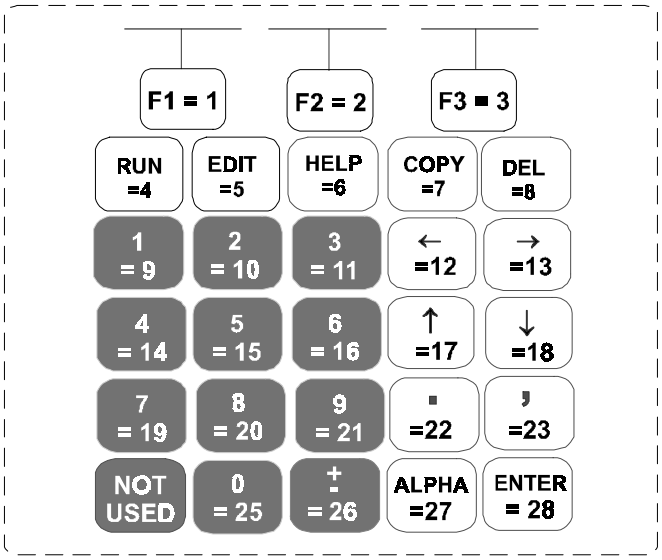
Function Key .....syntax - FKi,i,..,i

Units: n/a
Range: i = 1-28
Default: n/a

Note: 24, the ESC key, cannot be assigned since it stops a program
The FK command allows you to redefine what a keypad key function within your program. The FK command pauses processing until any of the buttons you have "armed" are pressed. The number of the button pushed is assigned to the system variable, (FKEY). You can then manipulate or directly use this variable to branch to other routines or make other decisions. FK allows the programmer to redefine the keypad function keys as operator menu selection buttons. You can even write your program with menus that look and feel like our setup menus.

Example: FK1,2,3,4
GS(FKEY)
Pauses command execution until F1, F2, F3, or RUN is pressed on the keypad. (FKEY) is assigned a value of 1-4. Subroutine 1-4 is called with the GS (gosub) command.

See the illustration below for the value of (FKEY) returned for each key:



The following example shows how to use the keypad function keys as an operator interface:

1. Write a menu message (MS) on the keypad display above the corresponding function keys.
2. Use the FK command to pause command processing until the operator selects a valid function key. Only keys explicitly defined in the FK statement are considered valid.
3. Gosub to the appropriate program.

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Example of a 3-screen menu program:

```
Program 20:
[SCREEN 1]                          Name the main program
MS1,""                              Clears keypad screen
MS3,"Select a Part"                 Writes a Message
MS21,"Part A  Part B  Part C"       Writes a message above function keys
FK1,2,3,17,18                       Wait for selected key press
GT(FKEY)                            Jumps to prog # 1, #2, or #3
                                    if F1,F2, or F3 is pressed
                                    Jumps to prog #17, or #18
                                    if the up or down arrow keys are pressed.
EN                                  End of Routine

Program 18:
[SCREEN 2]
MS21,"Part D  Part E  Part F"       Writes a message above F1, F2, F3.
FK1,2,3,17,18                       Wait for selected key press
IF(FKEY)=17 GT[SCREEN 1] EB         If Up arrow goto screen 1
IF(FKEY)=18 GT[SCREEN 3] EB         If Down arrow goto screen 3
(FKEY)=(FKEY)+3                     Add offset to FKEY variable to goto
                                    correct part subroutine.
GT(FKEY)                            Jumps to part D, E, F in program#4, 5, or 6
EN                                  End of Routine

Program 17:
[SCREEN 3]
MS21,"Part G  Part H  Part J"       Writes a message above function keys.
FK1,2,3,17,18                       Wait for selected key press
IF(FKEY)=17 GT[SCREEN 2] EB         If Up arrow goto screen 2
IF(FKEY)=18 GT[SCREEN 1] EB         If Down arrow goto screen 1
(FKEY)=(FKEY)+6                     Add offset to FKEY variable to goto
                                    correct part subroutine
GT(FKEY)                            Jumps to part G, H, J in program #7,8 or 9
EN                                  End of Routine
```

The programs to make Parts A, B, C, D, etc. are in program numbers 1-9. To continuously cycle through put a GT[SCREEN 1] at the end of each part program.

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GH

Go Home ..... syntax - GH±r,±r

Units: velocity units selected from the EDIT > SETUP > MECH menu
Range: unit scaling dependent
Direction: positive (+) direction established in EDIT > SETUP > MOTOR menu
Default: n/a

The GH command initiates a homing routine (seeks the home switch) to establish a home reference position. When it reaches home, the position counter is set to zero or to the Home Offset value selected in the EDIT > SETUP > HOME menu.

The motor will move at the GH velocity (n) and direction (±) specified until it either finds a home limit switch or determines that it can not find one between the two end-of-travel limit switches. The Go Home move uses the last acceleration and deceleration specified.

The exact homing routine used, and the ultimate end position of your system's home reference, depends upon the values of your EDIT > SETUP > HOME parameters (edge, level, final approach direction, and offset,) and whether or not you have specified open or closed loop moves in the EDIT > SETUP > ENCODER menu.

The control will reverse direction when the first End of Travel limit switch is encountered while searching for a Home switch. If the second End of Travel switch is encountered, the unit will abort the Go Home move and generate a fault.

Assuming the presence of an operational home switch, the control will ultimately seek a home position according to the home setup parameters you specified (edge, level, final approach direction, and offset).

Closed loop systems will normally home with more accuracy than open loop systems because encoders come with a Z marker pulse (1/8000 of a revolution on our B Series.) In a typical Go Home routine, the control will first sense the edge of the switch defined in the Go Home SETUP menu. It will then decelerate the motor to a stop at the last defined deceleration rate. The final homing motion will now be determined by the Go Home options selected in the SETUP menu.

The final homing direction dictates the direction from which the final approach to the switch is made. The edge selected will determine which side of the home switch this final approach will be based from. In a "closed loop" mode Go Home routine, the control will additionally slow to a creep speed and stop when it sees the encoder's "Z" Marker Pulse after seeing the reference edge of the switch. If a marker pulse is not seen within one motor revolution after the reference edge of the switch is seen, the final homing routine will be aborted.

Note: Homing Mode directly affects or reconfigures the function of the GH command (see "Configuring Your Home Parameters" in Chapter 5).

Examples:

AC.5 DE.5 GH-20 Go Home in the negative direction at a speed of 20

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AC.5 DE.5 GH20	Axis one Go Home in the positive direction at a speed of 20. Axis two Go Home in the positive direction at a speed of 18.



Go Immediate ..... syntax -GI or GIi

Units: n/a
Range: n/a
Default: n/a

The GI command begins a defined move profile in the same manner as the GO command. Unlike the GO command, where program execution waits until all defined moves have terminated, GI allows program execution to continue once the move has begun. This allows for other program defined processes to take place while an axis is moving, such as independent multi-axis moves, OT commands, and conditional IF blocks. One axis is not required to wait for another axis to finish a move before beginning its own move.

Following is an example of a program using the GI command:

VE1 DI20 GI MS1, "Axis #1 is moving" TD2

In this example, once the DI20 move begins, program execution immediately displays the "Axis #1 is moving" message for 2 seconds. Once the TD2 command has executed, the program will terminate; however, axis #1 will continue to move until the DI20 distance is reached. A Stop, Kill, or press of the ESC key will halt a GI based move either inside or outside program execution.

The GI command can cause program execution and moves to be asynchronous. In order to re-synchronize the end of a GI move with program execution, use the Wait (WT) command and its new syntax, i.e. WT#1 will wait for only axis #1.
If a program error occurs during a GI move, the move will stop at the Stop Decel Rate.

USING THE GI COMMAND - EXAMPLES
The following examples are provided to help further explain the use of the command:

A. If a GI move is in progress and an additional move is commanded on the same axis, the additional move will not begin until the GI move has completed. For example:

VE1 DA100 GI OT1,1 DA0 GI IF1,1 MS1,"All moves done" TD5 EB

In this program, one may expect to see the message "All moves done" immediately after the DA100 move begins. In reality, the program will wait at the DA0 GI until the DA100 move has completed before continuing. More simply stated, a move cannot be commanded to begin on an axis that is already moving.

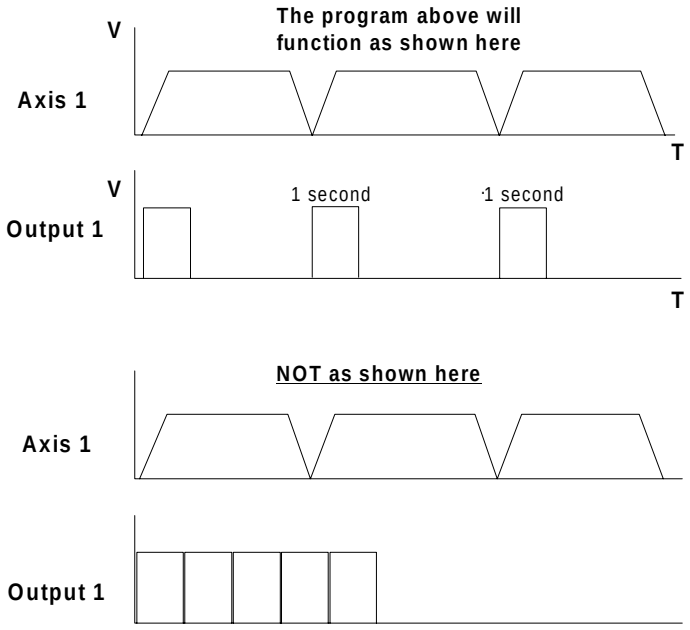
B. For multi-axis systems, GI allows moves within a move. For example:

VE1 DA100 GI LP5 VE,10 DI,5 GO EB

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C. Since GI allows program execution to continue, there can be programming issues when using GI. For example, in the following program fragment:

LP VE2 DI10 GI OT1 TD1 OT0 EB

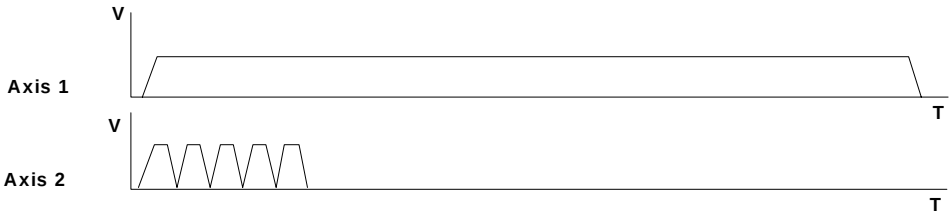


After the first pass through, the loop command (LP) will wait at the GI command since subsequent GI moves must wait for the present move to finish.

D. Another issue is programming conditional GI moves within IF blocks, for example:

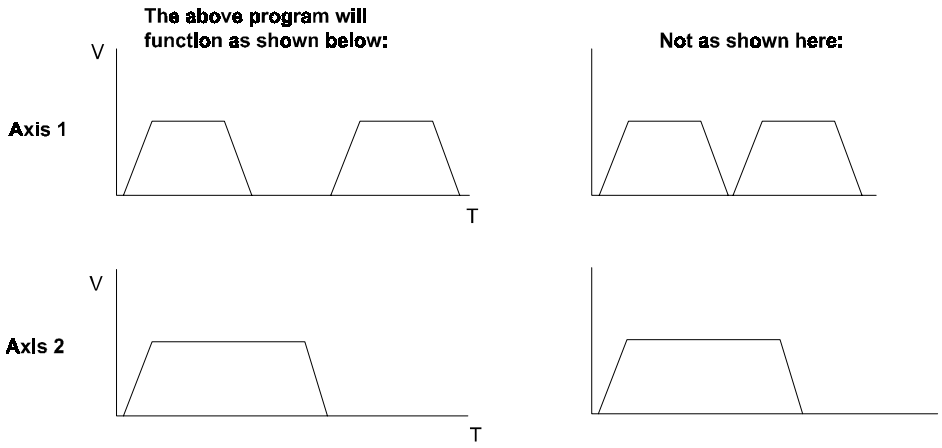
LP IF1,1 VE5 DI20 GI OTXX100 EB IF2,1 MC,+ VE,10 GO EB IF3,1 VE,0 GO EB EB

In this program, when input #1 is asserted, the GI move will be commanded, however, since the program will continue executing, input #1 may still be asserted on the next loop iteration. This will cause a second GI move to be commanded which may be undesirable. To avoid this situation, the addition of a WT1,0 after the IF1,1 will ensure that input #1 is only seen once since it has to be deactivated to allow the program to continue.

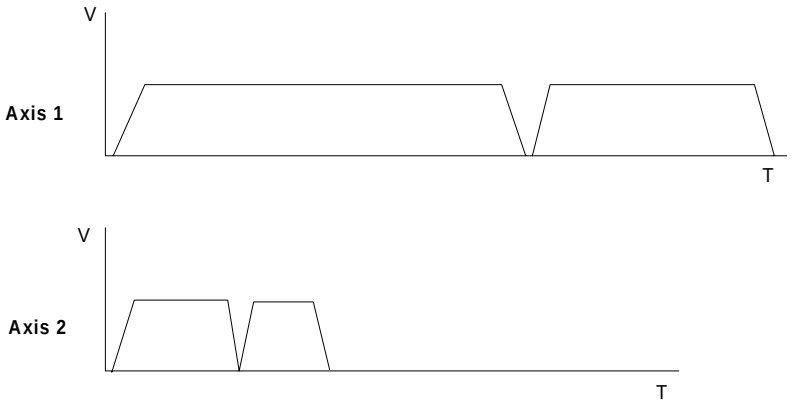


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E. **DI1 GI DI,5 GO DI1 GI**



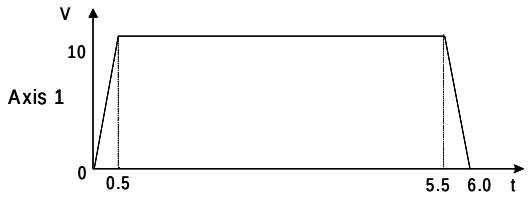
F. **DI10 GI DI,2 GO DI,2 GO DI10 GI**

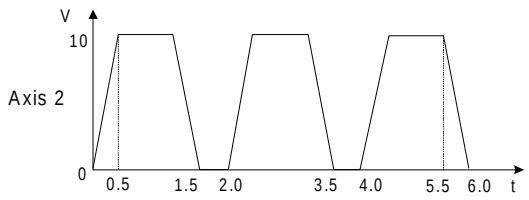


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G.

```
(VAR1)=10                  {Initialize Variable}
LP                         {Beginning of Loop Block}
    DI55,10                {Define Two Axis Move}
    VE10,10
    AC.5,.5
    GI                     {Start Go Immediate Move Both Axes}
    MS1,''''               {Clear Screen}
    MS1,(AI9)              {Write Analog Input 9 to the Screen While
                           Moving}
    WT,#2                  {Wait for Axis 2 to Stop Moving}
    TD.5                   {Time Delay of 0.5 seconds}
    DI,10                  {Define Axis 2 Move of 10 units}
    GI                     {Start Axis 2 GO Immediate Move}
    IF8,1                  {If Input 8 is on}
    OT10,1                 {Turn on Output 10}
    TD.1                   {Time Delay of 0.1 seconds}
    OT10,0                 {Turn off Output 10}
    EB                     {End of If Block}
    WT,#2                  {Wait for Axis 2 to Stop Moving}
    TD.5                   {Time Delay of 0.5 seconds}
    DI,10
    GI                     {Start Axis 2 Go Immediate Move}
    (DIST)=(VAR1)*1000     {Do Variable Math while Moving}
    (TERM)=(DIST)          {Send Value of DIST Variable out of Serial Port}
    WT,#2                  {Wait for Axis 2 to Stop moving}
    OT2,1                  {Turn On Output 2}
    WT#1                   {Wait for Axis 1 to Stop Moving}
    OT1,1                  {Turn On Output 1}
    DA0,0
    GO                     {Move Both Axes Back to Starting Position}
EB                         {End of Loop Block, Restart Loop}
EN                         {End of Program}
```





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Go (Start a Move) .....syntax - GO or GOi,i

Units: n/a
Range: i = 1-16
Default: n/a

GO executes a move profile defined by some combination of AC,VE, DE, DI, DA, DC, or MC commands. Actual motion of a new profile will occur after a short calculation of the motion trajectory.

GOi pre-calculates the move and waits for Input number "i" to activate before executing. This variation is sometimes useful for applications needing very short, repeatable move calculation delays. It is more often used simply to shorten code, since it functions like the combination of Wait on Input and Go (WTi GO) yet it pre-calculates the move. Like other commands using I/O, GOi does not restrict you from using an input even if it has been configured for some predefined function.

Example:	AC.05 DE.05 VE50 DI5 GO	GO initiates calculation of a move profile using buffered parameters (.05 unit Accel and Decel Ramp, speed 50, 5 unit incremental move) and then executes it.
	AC.05 DE.05 VE50 DI5 GO2	When input 2 is activated, immediate execution of the motion calculation already in the buffer is performed.

NOTE: If you have a multi-axis control refer to the section on multi-axis moves in *Programming Your Application*. It contains important information on multi-axis syntax and synchronization.

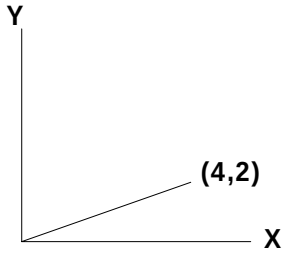
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GP

Go Point (Linear Interpolation).....syntax - GP or GPi

Units: n/a
Range: n/a
Default: n/a

The GP command allows the SmartDrive to execute a linear interpolated move. An example of the GP move is as follows:



The units and values for path velocity, acceleration and deceleration in GP moves are specified by the parameters traditionally defined for an axis #1-based move. As in regular moves, velocity, acceleration, and deceleration only need to be defined once. Each sequential GP move thereafter will use these values until new values are specified. The endpoint of the move is specified by a two-axis DA or DI command which corresponds to the appropriate X and Y coordinates. The following program would execute the move in the illustration above: VE2 AC.1 DA4,2 GP
The path velocity is 2 user units/sec, path acceleration is 0.1 sec., and the X,Y position would be (4,2).

The GPi syntax is identical to the GOi command. GPi pre-calculates the move and waits for Input number “i” to activate before executing. For example, GP4 would pre-calculate the move and wait for input 4 to be active before executing.

Although both axis move during a GP defined move, all GP parameters refer to the path movement rather than to the individual axis movements.

NOTES ON GP:

GP will work with any velocity and acceleration unit.

The largest possible GP moves are restricted to $X^2 + Y^2 <= (2^{31} - 1)^2$ in units of steps. For example, the longest simultaneous X,Y point move is:
Steps: DA1518500249,1518500249
User units with resolution 8000: DA189,812.5311,189,812.5311
User units with resolution 25000: DA60,740.0099,60,740.0099
Commanding moves larger than $X^2 + Y^2 <= (2^{31} - 1)^2$ will produce unpredictable results.

The DC command does not recognize an interpolated move as a ‘single’ move and will treat the axes independently. Therefore, using a DC during a GP move will cause unpredictable results unless the user has calculated the necessary values to preserve the vector move.

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GS

Gosub ..... syntax - GSi and GS[name]

Units: n/a
Range: i = 1-199 (1-400 with 30K memory option), [name] = any legal program name
Default: n/a

Jumps to program number or name and returns to the calling program when command processing reaches the EN command in the sub-routine. After the return, execution continues at the command immediately following the GS. Subroutines may be nested in the *standard* firmware up to 16 levels deep. A Goto (GT) will clear the subroutine stack, preventing future Gosubs from overflowing the stack or returning to the wrong location.

Example:	DI10 GS[Part A] GO	Run program “Part A”, return and make a 10 unit incremental move.

GT

Go to Program ..... syntax - GTi or GT[name]

Units: n/a
Range: i = 1-199 (1-400 with 30K memory option), [name] = any legal program name
Default: n/a

GT branches to the program number or name specified. All subsequent commands in the calling program are ignored. Nested loops and subroutines calls are cleared by a GT command.

Example:	IF10 GT[PART A] EB	IF input 1 is on and input 2 is off, jump to program “Part A”
	IF01 GT20 GT30 EB EN	IF input 1 is off and input 2 is on, run program 20. Program 30 will never run. Use the GS command if you want to return to this program and *goto* program 30.

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If ..... syntax - IF (See Below)

Units: n/a
Range: see below
Default: n/a

Syntax(s): IFi,xx...
IFxx... (assumes first input is input 1)
IF (mathematical expression) or expressions (2)
Range: i = starting input number, 1-8
x = 0; input high
x = 1; input low (grounded)
x = *anything else* (input level don't care)
expression = any valid expression (defined in math and variables section).

Allows the conditional execution of a block of commands based on the evaluation of an expression or input state. If the expression or input state is TRUE, the commands between the IF and the EB are executed. If FALSE, execution continues with the command following the EB. An IF statement should not be confused with a WT statement. An IF statement evaluates, true or false, based on the conditions that the SmartDrive sees at the instant the command is processed. A WT statement pauses command processing until the condition is true.

Note: An End of Block (EB) command must be used with every IF command.
IF blocks can be nested up to 16 levels deep.

To increase flexibility (primarily with programmable logic controllers or PLCs) the IF command allows you to use configured inputs in the command. To help prevent this added flexibility from causing programming confusion, you can specify any character as an input (x). This allows you to self-document your IF statements. For example, assume you configured input #3 as a "JOG SPEED" input. Programming such as "IF01J10" can help remind you that you are already using input #3 as "JOG SPEED".

Example:

IF14,1 GO EB	If input 14 equals 1 Go
IF12,010 GO EB	If inputs 12-14 equal 010 Go
IF110 GO OT3,1 EB	If inputs 1-3 equal 110 Go and turn on Output #3
IF(A19)<5500 OT11 GO EB	If analog input 9 is less than 5500, turn on output 1 and 2, then GO
IF(TEMP)>50 OT1 EB	If temperature variable >50 turn on Output 1
IF(PARTS)=25 GS20 EB	If PARTS variable = 25 Gosub to Program 20

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Input Variable .....syntax - IVi,(variable),*min,max*

Units: n/a
Range: i = 1-40 display position in characters
variable = any legal variable name
min= the minimum range value (optional)
max= the maximum range value (optional)
Default: n/a

This command allows an operator to input variable information under program control. It is typically used with the message command, MS, to prompt for operator input of the variable specified in IV. The cursor is placed on the display at character position "i". The program waits until a number is entered before continuing execution. The command will not allow you to type past the end of either line on the display. Variables will store 4 digits to the right of the decimal place.

When minimum and/or maximum range values are specified, the IV command will not accept inputs from outside this range. When a value outside the range is entered, one of the following messages is displayed on the keypad:

- "Input below minimum, Press ESC to resume"
- "Input above maximum, Press ESC to resume"

These variables can then be used in a math equation, conditional expression, or to set any command parameters (Example: DA, DC, VE, AC, LP, IF, TD, etc.). A variable can be used anywhere in a program where a real number or integer could be used.

Due to the nature of converting decimal numbers to binary and back, care must be taken in performing math on variables used in LP statements. LP will truncate the non-integer portion of the variable. For example: (COUNT)=25*.2 LP(COUNT) will only loop 4 times because (COUNT)=4.9999. A small offset can be added to variables used in LP statements to avoid this problem. (COUNT)=(COUNT)+.1 will guarantee that (COUNT) will be greater than 5, so the program will loop 5 times.

Example:

MS1,””	Clears the Display
MS1, "How many?: ”	Writes string beginning at character 1, top line
IV12,(PIECES),1,15	Waits at 12th character for the # of pieces in the range 1-15.
MS1,””	Clears the Display
MS1,”How long?: ”	Writes string beginning at character 1, top line
IV12,(LENGTH)	Waits at 12th character for the # of pieces.
LP(PIECES)	Loops the number of pieces entered
DI(LENGTH)	Defines the desired move length/distance.
GO	Moves the length commanded
EB	Ends the loop.

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LP

Loop ..... syntax - LPi

Units: n/a
Range: n/a
Default: 0

LP will cause all commands between LP and EB to be repeated "i" times. If LP is followed by a 0 or no number, the loop will repeat continuously.

Note: An End of Block (EB) command must be used with every LP command.

The *standard* software allows up to 16 nested loops (one inside the other). Each LP command must have a corresponding EB command to end the block (loop). A GT command within a loop will terminate the loop, clear the loop stack, and jump to a new program.

Example: AC.09 DE.09 LP3 VE30 DI1 GO EB VE7 DI-3 GO EN
The motor will perform an incremental 1 unit move at speed 30 three times and then a 3 unit move at speed 7 in the other direction.

LU

Loop Until Condition True**..... syntax - LU (See Below)**

Units: n/a
Range: n/a
Default: n/a

The Loop Until (LU) command defines a loop block in which loop iterations are based on a conditional result. The syntax for LU, which is identical to the IF command, is as follows:

Syntax: LUi,xx…
LUxx…
LU(Mathematical expression) or expressions (2)
where,
i = starting input number, 1-8 (SmartStep), 1-16 (SmartDrive)
x = 0, (Input Off)
x = 1 (Input On)
x = *anything else* (Input level Don't Care)
Mathematical expression = Any valid conditional or logical expression

Note: An End of Block (EB) command must be used with every LU command.

The LU loop will continue to iterate until the specified conditional result is true. LU checks the conditional at the end of the loop block, therefore, the block is always executed at least

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once, even if the condition is true on the first iteration. Loop While (LW) defines loops where the conditional is checked at the *beginning* of the loop.

The *standard* software allows up to 16 nested loops (one inside the other). A GT command within a LU loop will terminate the loop, clear the loop stack and jump to the new program. Following are examples of programs using LU:

Example #1: (A)=0 LU(A)=10 DI10 GO (A)=(A)+1 EB
In this example, the loop is executed *10* times with a final position 110 distance units.

Example #2:(A)=10 LU(A)<20 DI10 GO EB
In this example, the loop is executed once since the (A)<20 condition is true on the first iteration.

Example #3:LUXX1X1 MS1,"Inputs 3 & 5 are off" EB GT[Inputs On]
In this example, the loop will continue to execute as long as inputs #3 and #5 are off.

Example #4:LU4,1 MS1,"Input 4 is off" EB GT[Input On]
In this example, the loop will continue to execute as long as input #4 is off.



Loop While Condition True **.....syntax - LW (See Below)**

Units: n/a
Range: n/a
Default: n/a

The Loop While (LW) command defines a loop block in which loop iterations are based on a conditional result. The syntax for LW, which is identical to the IF command, is as follows:

Syntax: LUi,xx…
LUxx…
LU(Mathematical expression) or expressions (2)
where,
i = starting input number, 1-8 (SmartStep), 1-16 (SmartDrive)
x = 0, (Input Off)
x = 1 (Input On)
x = *anything else* (Input level Don't Care)
Mathematical expression = Any valid conditional or logical expression

Note: An End of Block (EB) command must be used with every LW command.

LW will continue to iterate while the specified condition is true. LW checks the condition at the beginning of the loop block, therefore if the condition is false on the first iteration, the block is immediately skipped. Loop Until (LU) defines loops where the condition is checked at the *end* of the loop block.

The *standard* software allows up to 16 nested loops (one inside the other). A GT command within an LW loop will terminate the loop, clear the loop stack, and jump to the new

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program. Following are examples of programs using LW:

Example #1:(A)=0 LW(A)<=10 DI10 GO (A)=(A)+1 EB
In this example, the loop is executed *11* times with a final position 110 distance units.

Example #2:(A)=10 LW(A)>20 DI10 GO EB
In this example, the loop is immediately skipped since the (A)>20 condition is false.

Example #3:LWXX1X1 MS1,"Inputs 3 & 5 are on" EB GT[Inputs Off]
In this example, the loop will continue to execute as long as inputs #3 and #5 are on.

Example #4:LW4,1 MS1,"Input 4 is on" EB GT[Input Off]
In this example, the loop will continue to execute as long as input #4 is on



Move Continuous .....syntax - MC+,+

Units: n/a
Range: n/a
Default: n/a

MC sets move profiles to "continuous move", utilizing AC and VE parameters. Move Continuous is enabled on an axis with the "+" sign. MC+ enables the mode for axis one; MC,+ enables the command on axis two; and MC+,+ enables both axes. DI, DA and DC commands reset the mode to distance.

Each Move Continuous segment must contain a GO command. Accelerations and velocities may be changed in any segment. If no change is specified to one of these parameters, the last value will be used. It is <u>not</u> valid to issue positional commands (DI, DA, DC, GH, SP) to an axis while it is in a Move Continuous mode. However, you may make distance-based moves on the other axis while running one axis continuously. Any command is valid within an MC segment except Distance Commands (DA, DC, & DI).

The direction of the move is specified by the sign of the VE parameter. If the sign of the VE parameter changes between two segments, the control will automatically stop the motor (at the programmed rate) and change directions to the new speed. This makes changing directions based on variable inputs very easy to program using a scaled variable as the VE parameter.

Once a Move Continuous segment is started, it will continue to move at the speed specified by VE until either another VE is commanded, the ESC Key is pressed, or an End Of Travel, Kill Motion, Interrupt, or Stop Input is activated. A commanded velocity of zero (VE0) stops an MC move. Motion will also stop if you enter the Edit, Help, Copy, or Delete menus.

After a continuous move segment has started, command processing will continue when constant velocity is reached. Other commands are then processed sequentially.

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This allows you to:

- Have asynchronous inputs change the speed of an axis
- Make motion profile changes based on time delays or input states
- Manipulate I/O while moving as a function of time, distance, or input states
- Change speed based on analog inputs or variables
- Have an operator update the speed of an axis through the keypad
- Servo to an analog input
- Make a one or two-axis joystick using analog inputs
- Start a continuous move on one axis, and make distance based moves on another

If a motor is making a move when it comes to the end of a program, the motor will continue moving, even after the program ends. This allows you to:

- Put different MC moves in different programs and select different speeds by running different programs.
- Change speeds based on Binary or BCD program select lines
- Call MC moves as subroutines
- Run from “hosted” RS-232C mode, where the computer commands speed changes
- Run another program from the keypad that does not violate MC syntax. So you could run another program from the keypad to change speeds, move the other axis, manipulate I/O, interface with an operator or calculate arithmetic.

Example 1: Basic Move Continuous syntax. Demonstrates how to change speed and stop MC moves based on time delays and input conditions.

MC+	Enable Move Continuous on axis 1
AC.1	Set the acceleration rate
VE50	Set top speed to 50
GO	Start the Move Continuous move, command processing will continue when axis 1 reaches constant velocity
TD2	Delay for 2 seconds at speed
VE25 GO	Decel to 25
WT111	Wait for inputs 1,2, and 3 to go active
VE0 GO	Stop the move

Example 2: Demonstrates how to prompt an operator for speed changes on a single-axis SmartDrive. The move is started after the initial velocity prompt. The velocity only changes when the operator enters a new value via the keypad. The move can be stopped by entering a velocity of zero, or when any of the stop conditions defined above exist.

[One Axis MC]	
MS1,"Enter the Velocity"	Prompt the operator
IV23,(V)	Put the operator input in variable (V)
MC+ AC1	
VE(V)	Use operator-entered variable (V) as new speed
GO	Change velocity of axis 1 to the new speed
GT[One Axis MC]	Repeat

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Example 3: Demonstrates how to prompt an operator for speed changes on a two-axis SmartDrive.

```
[Two Axis MC]
MS1,"Enter the X Velocity"  Prompt the operator
IV23,(V1)                   Put the operator input in variable V1
MC+ AC1                     Enable MC and set acceleration on axis 1
VE(V1)                      Use operator inputted variable (V1) as new speed
GO                          Change velocity of axis 1 to the new speed
MS1,"Enter the Y Velocity"  Prompt the operator
IV23,(V2)                   Put the operator input in variable V2
MC,+  AC,1                  Enable MC and set acceleration on axis 2
VE,(V2)                     Use operator inputted variable (V2) as new speed
GO                          Change velocity of axis 2 to the new speed
GT[Two Axis MC]Repeat
```

Example 4: Demonstrates the use of WT, OT and TD commands in continuous move.

```
MC+ AC3 VE3 GO          Start first segment
WT8,1 AC.1 VE10 GO      Wait for input 8 and change speed
TD5 AC.3 VE.2 GO        Wait for 5 seconds and change speed
WT3,1 VE-10 GO          Wait for input 3 and change speed and direction
OT11                    Turn on outputs 1 and 2
TD10 VE0 GO             Wait 10 seconds and stop the move
```

Example 5: Demonstrates two-axis joystick control with a Smart Drive. The control must be equipped with two analog inputs (in this case we assume AI9 and AI10) and be connected to an external, user supplied joystick.

```
[Joystick]              Main Program, X=Axis 1, Y=Axis 2
GS[Get Speeds]          Call a routine that scales the analog input voltage to
                        X and Y speeds
MC+,+  AC.2,.2          Enable continuous mode, set accelerations
VE(VX),(VY)             Set speeds for X and Y axis
GO                      Start motion
GT[Joystick]            When the axes reach constant speed, run [Joy stick] and
                        update the velocity based on the current analog input voltage.

[Get Speeds]            Converts two analog inputs to X and Y speeds
                        Returns variables (VX) and (VY), the X and Y velocities
(Deadband)=.15          Set desired zero speed deadband of joystick
(Neg Deadband)=-.15
(Max RPS)=5             Set desired full deflection speed
(Scale)=(Max RPS)/28137 Scale factor based on Max RPS
(Offset X)=47685        X axis offset for analog in
(Offset Y)=50990        Y axis offset for analog in

(VX)=(AI9)-(Offset X)   Convert the analog input to a speed for X and Y
(VX)=(VX)*(Scale)
```


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```
(VY)=(AI10)-(Offset Y)
(VY)=(VY)*(Scale)

IF(VX)<(Deadband)          If the speed is within the deadband, set the speed to zero
IF(VX)>(Neg Deadband)
(VX)=0
EB
EB
IF(VY)<(Deadband)          If the speed is within the deadband, set the speed to zero
IF(VY)>(Neg Deadband)
(VY)=0
EB
EB
EP                         Return to {Joy Stick} and update the speeds of X and Y.
```


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MS

Message to Display..... syntax - see below

Units: n/a
Range: n = 1-40 display position in characters; Characters 1-20 on top line, 21-40 on the bottom display line.
Default: n/a

Syntax: MS,"" returns to the default runtime display
MSn,""
MSn,"user text"
MSn,(variable)

MS allows you to put messages on the keypad's display. Messages are typically used to prompt for operator input, display function key prompts, or as a diagnostic tool.

MSn,"" clears the display from the n^{th} character on. MSn,"user text" prints user text beginning at the n^{th} character. MSn,(variable) writes the value of the variable on the display beginning at the n^{th} character. The above variations to MS will disable the default position and I/O display until program execution stops. MS,"" can be used to restore the default axis position and I/O display during program execution.

Examples:

MS1,""	Clears the Display.
MS3, "Part Count"	Writes string beginning at character 3, top line.
MS27,(COUNT)	Displays the value of the variable (COUNT), beginning at position number 27 (7th character, 2nd line).

Below is an example of one segment of the Keypad Programming Template which can be found immediately inside the back cover of this manual. The template is provided to allow you to write MS programs by hand exactly as they will appear on the 40-character keypad display. Please feel free to make copies of the template for writing your programs.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
M	S	2	7	,	(	C	O	U	N	T	)								
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
			FK1							FK2							FK3		

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ON Command (On Event)..... syntax - ONn,GTx, ONn,GSx, ONn,0

Units: n/a
Range: n/a
Default: n/a

The ON command allows the user to define conditional program execution based on the occurrence of a certain event. When the programmable event occurs, the current program and move are interrupted and program execution begins at the predefined interrupt program. The interrupt program can be defined as a GT or a GS. Defining the interrupt as a GS allows program execution to return to the exact point in the original program where the interrupt occurred. The ON command currently supports EOT as an event conditional.

The syntax for defining an event and interrupt program number and type is ONn,GTx or ONn,GSx where n is the event type and x is the interrupt program number or name:

n: L On End of Travel Limit

The syntax for clearing a previously defined event conditional is ONn,0 where n is the event type as listed above and 0 (zero) is the clear event designator.

Once an ON event has been defined, it is active in *all* user programs and need not be redefined unless the user wishes to change the interrupt program type, number or name, or clear the event condition.

Example: Using ON to handle an EOT event

```
[POWERUP]
ONL,GT[ON EOT]          {Goto [ON EOT]on an end of travel input}
GT[HOME]                {Home the machine}

[MAIN]
LP                      {Loop infinitely}
  VE5 DA20 GO           {Define move}
  DA0 GO                {Define move}
EB

[ON EOT]
IF(SA1)&256             {Check if EOT- switch was hit (bit #9 in SA)}
  VE1 DA0.5 GO          {Move off EOT- switch}
  GT[HOME]              {Home the machine}
EB
VE1 DA-0.5 GO           {Move off EOT+ switch}
GT[HOME]                {Home the machine}

[HOME]
GH3                     {Home}
GT[MAIN]                {Jump to main loop}
```


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OT

Output ..... syntax - see below

Units: n/a
Range: i = starting output number, 1-16
x = 0; output high (OFF)
x = 1; output low (ON)
x = *anything but a 1 or 0*; the state of the output remains unchanged
Default: n/a

Syntax: OTi,xx...
OTxx...(assumes first output is # 1)

Sets both discrete and digital Opto output states. Once an output is turned on, it will remain set until changed by another output command, a reset input (software warm-boot), or power is cycled. All outputs are turned off upon power up or during a reset.

To increase flexibility, the OT command allows you to use configured outputs anytime. To help prevent this added flexibility from causing programming confusion, you can use any character in the "don't change" section of your output statement. This allows you to self-document your OT statements. For example, assume you configured output #3 as a "FAULT" output. Programming like "OT01F10" can help remind you that you are already using output # 3.

Example:

OT4,1	Turn on Output 4
OT2,0D1	Turn Outputs 2 off, leave 3 as is, and turn 4 on
OT110	Turn Outputs 1 and 2 on, and 3 off

" "

Quote..... syntax -"*Any ASCII character*"

Units: n/a
Range: n/a
Default: n/a

The " " command transmits a string out the serial communications interface. A "" without any string will transmit a carriage return character (ASCII 13).

Example:

"Move Complete"	Transmits string *only* out serial interface.
""	Transmits a carriage return *only.*

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RG

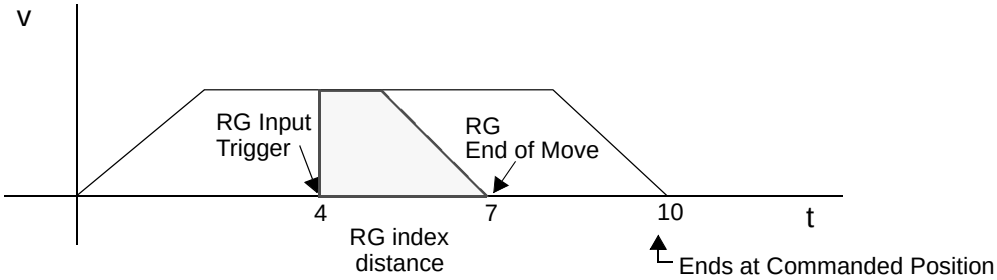
Registration ..... syntax - RGr,r

Units: n/a
Range: n/a
Default: n/a

The Registration Command (RG) specifies a distance to be indexed from the current position - as commanded by a specific input trigger. For example, in the following program of 10 user-units on axis #1, the input trigger is received at user-unit 4, to move 3 user-units from the point where the input trigger was received.

VE2 AC.1 DA10 RG3 GO

In the program above, assume the input was an optical sensor which triggered on a registration mark at a position of 4 user-units. The figure below shows the commanded move related to the registration move.



Accompanying the programmable Registration Command is the configurable Registration Input: G (also G in Serial Setup Commands). To configure a Registration input from the keypad, choose EDIT > SETUP > I/O > INPUTS. An input configured as a Registration Input will be designated by a G on the keypad input status display. The RG Command will only function if the corresponding input has been configured as a Registration Input (see note).

Note: Registration Input is only configurable on input #1 for axis #1, and on input #2 for axis #2.

System Performance when Using the RG (Registration) Command

The input capture delay is 5µs. Worst case position error is 9 steps at 50 rps.

There is a Capture Window (Position Lag) associated with the RG Command, which is a function of move velocity and the Position Capture Delay (reaction time) and can be calculated with the following equation:

Capture Window = RG Position Capture Delay * Velocity (Steps/Sec)

The Capture Window value is the number of steps accumulated between the falling edge of the Registration input and the time the current position is captured. Depending on the FPGA hardware version of your Indexer this RG Position Capture Delay will either be 164 µs or 5 µs.

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The Registration Command is only available on firmware version 4.0 & higher. If you have FPGA version 5.9 or earlier, the Capture Delay will be 164 µs. If you have FPGA 6.7 or higher, the position is captured in hardware, and the only Capture Delay is the input's opto-isolator (5 µs). Use the keypad's HELP key to determine your FPGA version.

Regardless of the FPGA version used, we have found both Capture Delays to be extremely repeatable. This leads to a very repeatable Capture Window (distance lag from when the registration input is made) that can be accounted for by decreasing your commanded registration distance by the Capture Window. For example, a motor traveling 240,000 steps/sec (30 rps with 8000 step/rev drive resolution) has a capture window of 39 steps for a 164 µs Capture Delay and 1 step for a 5 µs Capture Delay. Assuming the desired registration distance was 3 user units (assuming 1 user unit is 8000 motor steps), an RG2.9795 would result in the motor traveling exactly 3 user units for a unit with a 164 µs Capture Delay.



Set Position ..... syntax - SP±r,±r

Units: selected in EDIT > SETUP > MECH menu
Range: varies based upon Distance Units
Default: 0

SP sets the current absolute position to "n". This command is typically used to readjust or shift a coordinate system. It is often done after a series of incremental moves to reset the absolute coordinate frame.

Example:

MC+ GO WT1,1 VE0 GO SP10.5	After the move is complete, sets the current position of axis 1 to 10.5.



Square Root..... syntax - SQr,(var)

Units: n/a
Range: 0.0001 to 214748.3645
Default: n/a

The **SQ** command calculates the square root of a number and returns the result in a user defined variable. The n parameter in the syntax can be a number or a variable parameter, however, the second parameter must be a previously defined variable for which the square root result is stored. If the second parameter is not a defined variable, you will get a **Bad Variable Name** error. Following mathematical convention, SQ will produce an **Invalid Parameter** error for negative "r" values. The return value is accurate to the 0.01 place.

Example:The following example program calculates the square root of 27.96 and stores the value in the user defined variable (SQRESULT).

Program: (SQRESULT)=0 SQ27,(SQRESULT)
The returned value in (SQRESULT) would be 5.28.

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ST Stop On Input ..... syntax - STn,n or ST#n,#n

Units: n/a
Range: 0-16 (Inputs)
#1, #2 (Axes)
Default: n/a

Syntaxes:
ST stops move execution upon activating the input specified by n.
ST0 disables (turns off) the STn command.
ST#1 stops move execution on axis #1.
ST,#2 stops move execution on axis #2.
ST#1,#2 stops move execution on both axes.

ST#n functions identically to the STn command without the use of an input allowing program command conditional motion termination.

After the ST command is executed, the specified input is monitored during every "move profile." If the imput is activated, the current "move in progress" is terminated, stoping all motion until the input is deactivated or a ST0 is processed. the drive will process and calculate commands, but it will wait at the next GO command until the ST input changes.

The motor is stopped at the deceleration rate specified in the Stop Decel Rate setup parameter. Once issued, Stop on Input remains active until it is turned off by the ST0 command, a reset is issued, or power is cycled.

Example: Move to absolute position of 6 distance units. If (A)>10, motion is stopped.

```
AC,1 VE25,25 DA6,6 GI        {Move to 6 absolute distance units and Go Immediate}
IF(A)>10                     {Check value of A (assume A was previously defined}
ST#1 TD1 ST,#2               {Stop motion on axis #1 wait 1 sec. then stop axis #2}
EB
ST#1,#2                      {Stop motion on both axes}
```

TD Time Delay ..... syntax - TDr

Units: seconds
Range: r = .01 to 99999.99 seconds
Default: n/a

Delay r seconds before executing the next command.

Example: VE50 DI4 GO OT11 TD.5 OT00

Move 4 units, turn outputs 1 and 2 on, delay .5 seconds, and turn outputs 1 and 2 off.
See also: System variable (TIME), in *Chapter 7, Programming Your Application*.

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VE

Velocity .....syntax - VEr,r

Units: selected from the EDIT > SETUP > MECH menu
Range: .002 - 50 rps. Range is scaled to velocity units
Default: 1 motor rev per sec (rps)

VE sets the maximum velocity during a move profile. If the acceleration rate is not high enough or the move distance is not long enough the motor may end up making a triangular (velocity vs. time) move and the motor may never reach the specified speed. Once VE is specified, the value is used in all subsequent moves until re-defined.

Example:

AC.1 DE.2 VE50 DA4 GO	Move to absolute position 4 units with a top speed of 50 units/sec.

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Wait..... syntax - see below

Units: n/a
Range: i = starting input number, 1-16
x = 0; input high
x = 1; input low (grounded)
x = *anything but 1 or 0*; ignore the input level
expression = any valid expression as defined in the math and variables section.
Default: n/a

Syntax: WTi,xx...
WTxx... (assumes first input is input 1)
WT,expression
WT#1, used with GI moves

This command waits for the specified condition to be true before continuing execution of a program. Either digital or analog input conditions may be used.

To increase flexibility the WT command allows you to use configured inputs in the expression. To help prevent this added flexibility from causing programming confusion, you can specify any character as an input (x). This allows you to self document your WT statements. For example, assume you configured input #3 as a "JOG SPEED" input. Programming like "WT01J10" can help remind you that you are already using input # 3.

Example:

WT4,1 GO	Wait for input 4 to equal 1 before moving
WT2,010 GO	Wait for inputs 2-4 to equal 010 before moving
WT110 GO	Wait for inputs 1-3 to equal 110 before moving
WT#1	Causes program execution to halt until GI move is complete

Note: In order to synchronize program execution with the end of a GI move, there is new syntax associated with the WT command: WT#1,#2 will halt program execution until the respective axis has completed its move. WT#1 will wait for only axis #1; WT,#2 will wait only for axis #2; WT#1,#2 will wait until both axes have stopped.

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Summary of Operators, Functions, and Expressions	
[ ]	Name Program
( )	Name Variable
&&	Logical AND
||	Logical OR
!	Logical NOT
!=	Not Equal
+	Add
-	Subtract
*	Multiply
/	Divide
=	Equal
>	Greater Than
<	Less Than
>=	Greater Than or Equal to
<=	Less Than or Equal to
&	Bitwise Boolean AND
|	Bitwise Boolean OR
++	Increment Variable
+=	Increment by n
--	Decrement Variable
-=	Decrement by n
<<	Shift Left
>>	Shift Right

Refer to Chapter 7, Programming Your Application, for more details and examples of how to use the above operators, functions, and expressions.

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Chapter 7 - Programming Your Application

The purpose of this chapter is to provide information that will help programmers begin developing applications with the SmartDrive. There are also several practical examples that can be copied and modified. Other program examples are available from the *Application Developer* disk set (see DEMOS.idc).

SmartDrive Programming Overview

Before beginning to develop a machine control program with a SmartDrive, the user must decide how the SmartDrive fits into the overall machine control hierarchy. There are three basic ways SmartDrives are used. They can be used in a stand-alone mode where the SmartDrive controls all the I/O and motion on a machine. They can also be used with a PLC, where the PLC runs the machine and just calls on the SmartDrive, via program select lines, for motion. Thirdly, they can be used in a “hosted” mode with a PC. In this mode no programs are stored in the SmartDrive, the PC downloads a string of commands at execution time.

The information in this chapter applies to all three modes of machine control. The SmartDrive uses a sequential, interpretive, command processor. This means that commands in a program are executed one at a time, and that the action called for in one command must complete before the next command is processed.

Example: [move] VE4 DI10 OT01 GO OT10

In the program [move], the maximum move velocity is set to 4, the command incremental distance is set to 10, output 1 and output 2 are turned off and on simultaneously, axis one then moves 10 units. After axis one stops moving, output 1 is turned on and output 2 is turned off. The state changes on outputs 1 and 2 happen at the same time.

The programmer can control the flow of the program with WT (wait for an event or condition to occur), TD (wait for a pre-set amount of time to elapse), and IF (if a certain condition is true at this instant, then execute a block of commands) statements. External controllers such as PLC and computers can be coordinated via digital outputs and ASCII strings sent out the serial port.

Creating or Editing Programs with the Keypad

IDC’s IDeal Command language is easy to remember and powerful. Command descriptions are also available on-line using the HELP key within the *Application Developer* program editor.

If you need help with basic keypad operation, please refer to Chapter 4 - *Using the Keypad*, and Chapter 5 - *Configuring Your System.*

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Command Summary

The chart below lists all the IDeal commands that can be stored and executed as a part of a program. In Chapter 8, *Programming with Serial Communication*, there is more information on serial commands, such as Setup, Immediate Status, Supervisory Commands, and “Commands Not Available in Hosted Mode.”

Command	Description	Command	Description
AC	Acceleration	**IV**	Input Variable
BR	Break	**LP**	Loop
DA	Distance Absolute	**LU**	Loop Until
DC	Distance to a Change	**LW**	Loop While
DE	Deceleration	**MC**	Move Continuous
DI	Distance Incremental	**MS**	Message to Display
EA	Enable Amplifier	**ON**	On Command
EB	End of Block	**OT**	Output
EN	End of Routine	**RG**	Registration Move
FK	Function Key	**SP**	Set Position
GH	Go Home	**SQ**	Square Root
GI	Go Immediate	**ST**	Stop on Input
GO	Go (Start a Move)	**TD**	Time Delay
GP	Go Point	**VE**	Velocity
GS	Gosub	**WT**	Wait
GT	Go to	**" "**	"Message to Serial Port"
IF	If Then		

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Variables and Arithmetic

Variables

The SmartDrive will accept a variable in a command instead of a constant. Variables may be used in:

- Arithmetic
- Conditional Expressions
- Loop Counts
- Distance and velocity commands
- Set values
- Set command values or parameters
- Set analog signals
- Read analog or temperature input
- Display information such as position or velocity
- Any place that a number can be used, a variable can be used

Legal Variable Names

The SmartDrive allows you to create descriptive variable names, as opposed to V1, V2, etc. Variables can be up to 14 characters, but the first 10 characters must be unique. They may contain other printable ASCII characters, such as numbers, underscores, exclamation points, even spaces. Upper and lower case characters are supported within variable names, and these variable names are case sensitive. ASCII control characters such as LF and CR are not supported. All variables must be enclosed in parentheses, (variable name). Parentheses are not legal variable characters.

The standard software allows for up to 100 variables. All variables are stored as fixed-point numbers. All variables are global. All standard variables are volatile, though non-volatile variables are available as well.

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Built-In Variables

The following variable names are predefined in the control. They can be used throughout your programs in expressions, to set voltages, to test conditions, or even to display information on the keypad screen or some other external serial device.

Variable Name	Description	Type
(AI9) thru (AI16)	Analog Input 9 thru 16	Read Only
(AO9) thru (AO16)	Analog Output 9 thru 16	Write Only
(AROWREL)	Current status of any of the four arrow keys	Read Only
(CPOS1), (CPOS2)	Commanded Position of axis 1, 2	Read Only
(EPOS1), (EPOS2)	Encoder Position of axis 1, 2	Read Only
(POS1), (POS2)	Current Position of axis 1, 2	Read Only
(VEL1), (VEL2)	Commanded Velocity of axis 1, 2	Read Only
(EE1) thru (EE20)	Non-volatile, limited use, user system variables	Read/ limited Write
(FKEY)	Value of Function Key pressed	Read Only
(LASTKEY)	Value of last Function key pressed	Read/Write
(TERM)	Sends variable out RS-232 port	Write Only
(1TW)	Scans inputs 1-4 for BCD Digit	Read Only
(2TW)	Scans inputs 1-8 for BCD Digit	Read Only
(TIME)	Elapsed Time (ms) since power up or since reset	Read Only
(CRCS)	Value of the EEPROM setup checksum	Read Only
(CRCP)	Value of the EEPROM program checksum	Read Only
(SA1), (SA2)	Integer value of the status of axis 1-2 (See RS232 command SA)	Read Only
(SD1), (SD2)	Integer value of the drive status of axis 1-2 (See RS232 command SD)	Read Only
(SS)	Integer value of the system status (See RS232 command SS)	Read Only
(INT98CTRL)	Enables/disables (ARM INT98) trigger option - Refer to Ch. 5, Configuring Your Inputs, Input Descriptions, Input I.	Read/Write
(ARM INT98)	Enables/disables INT98 input if (INT98CTRL) is enabled	Read/Write

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Examples of Built-in Variables:

• (PIECES)=10	Assigns 10 to variable
• (SPEED)=(AI12)*(VEL SCALE)	Speed = analog input times a scalar
• MS21,"Enter Length" IV32,(LENGTH)	Prompts user and gets feed length
• VE(SPEED)	Sets velocity to value in variable
• MS1,(POS2)	Displays current position of axis 2 on keypad screen
• (TERM)=(POS1)	Sends the current position of axis 1 out the RS-232 port of the SmartDrive
• (TEMPERATURE)=(AI9)	Reads in temperature from an analog input
• (AO15)=4012	Sets the analog output to 4012

Using the Built-In Variable (AROWREL)

(AROWREL) is a built-in Boolean read only variable which determines the status of any of the 4 arrow keys. When used in conjunction with (FKEY), the user can detect whether or not an arrow key is being held down. (AROWREL) will return one of the following values:

(AROWREL) = 0 One of the arrow keys is being held down.
(AROWREL) = 1 The arrow key has been released.

(AROWREL) will return key status for the 4 arrow keys only. If any other key is pressed, (AROWREL) will return zero regardless if the key is held down or not. The following is an example jog application using (AROWREL) and (FKEY):

```
[MAIN]                {Program #1}
FK12,13               {Wait for a Left or Right arrow key}
GT(FKEY)              {Jump to arrow key program #12 or #13}

[LEFTARROW]{Program #12}
MC+                   {Enable MC mode}
AC.1                  {Start MC move}
VE1                   {Move in positive direction}
GO
LP
  IF(AROWREL)=1{Check status of arrow key}
    VE0               {Stop MC move on key release}
    GO
    GT1               {Return to main program}
  EB
EB                    {End loop block}

[RIGHTARROW]{Program #13}
MC+                   {Enable MC mode}
AC.1                  {Start MC move}
```


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```
VE-1                {Move in negative direction}
GO
LP
  IF(AROWREL)=1{Check status of arrow key}
    VE0             {Stop MC move on key release}
    GO
    GT1             {Return to main program}
  EB
EB                  {End loop block}
```

Non-Volatile Variables

The non-volatile variables (EE1)-(EE20) are twenty user accessible variables that retain their values through power cycles, warm boots, and system resets. Standard user variables are reset at power down or reset. Each time one of these variables is changed (i.e. used on the left side of an equal (=) sign, the new value is written to and stored in the user non-volatile EEPROM.

CAUTION

Caution must be observed when using these variables. Since EE have a limited read/ write lifetime (100,000 writes before failure), variable values that change frequently should not be stored as EE system variables. Examples include loop-count variables, and POS1 and POS 2 variables. The SmartDrive will allow only 1,000 EE writes between power cycles. This limit has been set to prevent a simple programming mistake or misunderstanding from permanently damaging the SmartDrive's non-volatile memory. When this write limit has been exceeded, all programs will stop running, an error message will be displayed, and the appropriate status bits will be set.

The EE system variables were originally developed for use in batch manufacturing applications where a number of variable setup parameters must be entered at the start of each part run. These same setup parameters can then be used through any number of power cycles, or machine resets.

Example: A program called [Set-up] is run at the start of each part run to initialize a number of variable part parameters. During production the program called [PARTS] is run. This program *reads* from the EE variables, but does not generate any *writes* to the EE, so the lifetime of the EE is not compromised.

```
[Set-up]
MS1,"Feed length?: "    Writes string beginning at character 1, top line
IV12,(LENGTH),1,15      Loads the part length into volatile user variable (LENGTH)
MS1,"Feed Speed?: "     Writes string beginning at character 1, top line
IV12,(SPEED),.05, 5     Loads the speed into volatile user variable (SPEED)
(EE1)=(LENGTH)          Loads the length into non-volatile system variable (EE1)
(EE2)=(SPEED)           Loads the speed into non-volatile system variable (EE2)
EN
```


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[PARTS]	[PARTS] runs on power up, unless new parameters are entered.
(LENGTH)=(EE1)	Load the part specific variable from the non-volatile variables.
(SPEED)=(EE2)	
LP(NUMBER)	Loop (NUMBER) of times
DI(LENGTH)	Move (LENGTH)
VE(SPEED)	at (SPEED) velocity
GO	
OT1 TD.1 OT0	Toggle output to indicate part done
EB	End the loop Block

Arithmetic Operands and Equations

The SmartDrive supports addition (+), subtraction (-), multiplication (*), and division (/). Expressions may only contain *one* operand. Complex equations require multiple statements. Variables and fixed point numbers may be mixed in arithmetic equations. All user arithmetic and variable storage uses 32-bit integer and fractional representation.

The + and - symbols have a dedicated button on the keypad. Pressing the button will toggle between the two.

The *, /, and = are accessed from the Alpha+0+… keystrokes.

Examples:

- (X)=(Y)*10
- (AO15)=(VOLTAGE)+(ERROR)

Do not enter:

• (X)=1+2-3	This statement is not legal because it has more than one operand.
• (Length)=(Total)*.03125	The SmartDrive fixed-point variable storage only supports 4 places to the right of the decimal place (32 bit storage of fractional decimal number).

Instead enter:

- (X)=1
  (X)=(X)+2 or (X)+=2
  (X)=(X)-3 or (X)-=3

and

• (Length)=(Total)*3.125	Multiply by the significant figures.
• (Length)=(Length)*.01	Then move the decimal place.
• or (Length)=(Total)/32	The SmartDrive fixed-point variable storage supports 4 characters to the right of the decimal place (32 bit storage of fractional decimal number).

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Boolean Operators - & (And), | (Or)

The operators & and | will perform the respective bitwise Boolean functions on immediate or variable parameters.

An application example of the Boolean operators would be: isolating a specific bit from an SD (Tell Drive Status) response. Suppose you want to determine if axis #1 drive was enabled from a program. This corresponds to a bit #5 (10000) Binary, (16) integer in the SD response. The program segment would look as follows:

(DRIVE STAT)=(SD1)&16 IF(DRIVE STAT)=16 MS,1"Drive Enabled" EB

The 16 corresponds to an integer weight of bit #5 (10000) since you wish to "mask" out the enable bit.

Logical Operations on Expressions (&&,||)

Conditional commands (IF,WT, LU, LW) support logical operations of AND (&&) and OR (||). Two expressions may be logically AND'd or OR'd within one conditional command. For example:

(A)=5 (B)=2.5 IF(A)>2&&(B)=2.5 MS1, "True Statement" EB

In the above program, the message "True Statement" would appear since BOTH conditional statements are true, thus making the entire IF conditional true.

AND			OR		
Expression A	**Expression B**	**A & B**	**Expression A**	**Expression B**	**A || B**
False	False	False	False	False	False
False	True	False	False	True	True
True	False	False	True	False	True
True	True	True	True	True	True

Incrementing and Decrementing Variables (++, =+, --, -=)

There are four syntaxes supported by variables: ++ (single increment), += (value increment), -- (single decrement), -= (value decrement). These operators will initialize any uninitialized variable to zero before incrementing or decrementing it for the first time.

(Variable Name)++	Increments a variable value by 1
(Variable Name)+=n	Increments a variable value by n
(Variable Name)--	Decrements a variable value by 1
(Variable Name)-=n	Decrements a variable value by n

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Expressions

The SmartDrive supports five conditional expressions: less than (<), equal to (=), greater than (>), less than or equal to (<=), and greater than or equal to (>=). The IF and WT commands can use these expressions to direct program flow or wait for an analog input to meet a condition. The > and < symbols are entered into the keypad editor with the ALPHA+↑+↑....↑

Examples:

IF (X)>10 GS20 EB	If X is greater than 10 gosub to program #20
WT(AI12)<(MAX TEMP)	Wait for the temperature to go below the maximum before continuing command processing.

Summary of Operators, Functions, and Expressions

[ ]	Name Program
( )	Name Variable
&&	Logical AND
||	Logical OR
!	Logical NOT
!=	Not Equal
+	Add
-	Subtract
*	Multiply
/	Divide
=	Equal
>	Greater Than
<	Less Than
>=	Greater Than or Equal to
<=	Less Than or Equal to
&	Bitwise Boolean AND
|	Bitwise Boolean OR
++	Increment Variable
+=	Increment by n
--	Decrement Variable
-=	Decrement by n
<<	Shift Left
>>	Shift Right

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Multi-axis Operation

IDC's IDeal command language is intuitive, yet powerful enough for difficult applications. The SmartDrives allow you to make multi-axis, synchronized, moves or multiple independent moves that start at the same time.

Simple GO commands

The most intuitive and simple programs utilize the GO commands. Motion parameters for each axis are separated by commas. Motion parameters consist of the AC, DE, VE and either DI or DA command. These four parameters completely define the commanded motion profile. The last parameter used by an axis is stored in a table. The GO command uses the last DI or DA command processed to determine which axes move and how far they move. For example:

AC2,5	Set acceleration of both axes
VE10,3	Set velocity of both
DI9,-3.1	Set distance of each axis
GO	Start both together
DI9	Moves only axis 1 because the last D command
GO	only had a parameter for axis 1
DI,2	Moves only axis 2 because the last D command
GO	only had a parameter for axis 2

In the first move in the example, the GO command is used to start multiple axes at the same time. The move profiles for each axis are independent. While axes start at the same time, the moves are independent and will follow their respective accelerations and velocities, though the axes may not stop moving at the same time.

The Go Interpolated (GI) command allows you to move two axes along a linear path that starts and stops at the same time. The control uses the most recent value in axis 1, the first parameter, to specify the AC, VE, and DE values along the path (see example 1 below). In most cases, your program will be easier to understand if you *re*define these parameters as a single value for the path (see example 2 below). GI uses the last distance value for each axis to determine the end points of the linear move. The two examples below result in identical GI moves.

Example 1:	Example 2:
AC2,3	AC2
VE4,10	VE4
DE.5	DE.5
DI5,6	DI5
GI	DI,6
	GI

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GO and GI commands support additional parameters providing more advanced features. The additional parameters allow you to:

1. Start each axis based on different conditions.
2. Start one axis with an input while another is moving.
3. Start one or more axis moving based on one input.
4. Start different axis based on different inputs.
5. Reduce the size of some programs by using fewer “move” commands.

GO supports an extended syntax to allow these other move specifications.

GO*i,i* or GIi,i
i=0-16, integers only

The extended syntax always explicitly defines which axes will move. Only those axes which have an active input defined by **i** will move, and the last move parameters will define the shape and length of the move profile.

An axis will start moving when the input defined by *i* turns on. You can start different axes at different times by using different integers (*i*) for each axis.

Setting i=0 will explicitly define which axis will move when a GO command is processed. (See the examples below for more clarification)

The last move parameters used to define a move profile are saved. This saves program space in applications where sections of code repeat the same moves. The DI or DA command is the only motion parameter that needs to be repeated. A stair-step pattern is one example of this.

Using different i’s for each axis allows you to start one axis and wait for an input on another, or start both based on different inputs. See the examples below for more clarification.

Examples:

GO	Moves all the axes defined in the last DA or DI command
DI3 GO	Move only axis 1
DI3,4 GO	Move axes 1 and 2
DI2,2 GO,0	Move *only* axis 2, even if the last DA or DI command defined both axes

DA(Part 1), (Part 2)

GO4,5	Move axis 1 once input 4 is activated, axis 2 once input 5 is activated.
GO4,4	Move axis 1 and 2 once input 4 is activated

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Typical Programming Examples

The following program examples will show how the IDeal command language can be used to perform simple tasks. There are more extensive and elaborate example programs in the DEMOS.idc file that came with your Application Developer disk set.

To aid your program documentation, comments can be placed in brackets {comment}. These comments are stripped out of the program as it is downloaded to help conserve memory in the control. Files should be saved BEFORE downloading for documentation purposes.

```
Example: DI10,2 GO     {Moves to load position}
         DI15,15 GO    {Moves to unload position}
```

To create a Message and input a Variable

```
[GET PARTS]                 Name of subroutine
MS1,""                      Clears the Display
MS1,"How many?: "           Writes string beginning at character 1, top line
IV12,(PIECES)               Waits at 12th character for the # of pieces.
MS1,""                      Clears the Display
MS1,"How long?: "           Writes string beginning at character 1, top line
IV12,(LENGTH)               Waits at 12th character for the length.
LP(PIECES)                  Loops the number of pieces entered
DI(LENGTH)                  Moves the length entered.
GO EB
```

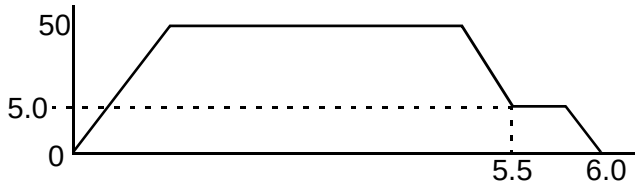
Creating an Operator Menu (see the FK command description for details)

```
MS1,""                          Clears keypad screen
MS21,"PART1  PART2  PART3"      Writes a message above function keys.
FK1,2,3                         Waits for a Function Key to be pressed
(FKEY)=(FKEY)+50                Add an offset to FKEY
GT(FKEY)                        Goto program #51, 52, or 53.   (50 + 1, 2, or 3)
```


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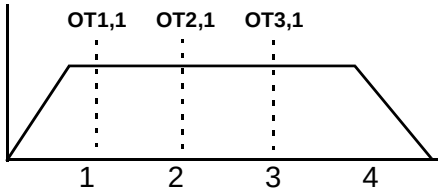
Fast In, Slow Feed Move (Using the Distance to Change (**DC**) command)

AC.05	Set acceleration
DE.09	Set deceleration
VE50	Set first velocity
DA6	Set *total* move distance
DC5.5	Set point where you want to change speed
VE5	Set second speed
GO	Start the move profile



Turning On an Output on-the-fly

AC.05	Set acceleration
VE10	Set velocity
DA4	Set *total* move distance
DC1	Set point to turn on...
OT1	Output 1
DC2	Set point to turn on...
OT2,1	Output 2
DC3	Set point to turn on...
OT3,1	Output 3
GO	



To input a 4 Digit BCD number reading 2 Digits at a time

[GET 4 BCDS]	Returns value of 4 digit BCD number
OT01	Connect ground of first two BCD digits
(4 DIGIT BCD)=(2TW)*100	Make value of first two digits the MSB
OT10	Connect ground of 2nd two BCD digits
(4 DIGIT BCD)=(4 DIGIT BCD)+(2TW)	Add value of 2nd two to 1st two * 100

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Reading an Analog Input

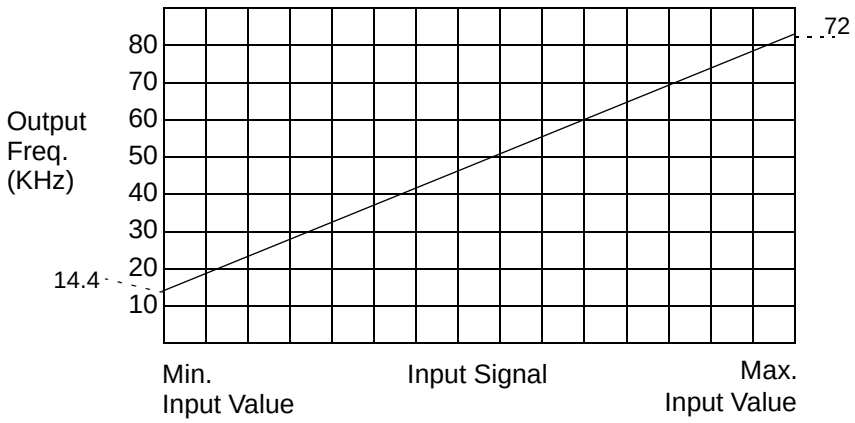
The value of the analog system variables (AI9-16) are scaled from 14,400 to 72,000 Hz. This value is actually a scaled frequency read by the SmartDrive. These input values are updated every 16 milliseconds . If your program needs to display this value in units such as VOLTS, you will need to scale the value to VOLTS in your program. The scale number you use will depend on which analog input you are using. For example: a "J" thermocouple uses a different factor than a "K" thermocouple.

Example: Using a 0-10 VDC analog input. 0V=14,400; 10V=72,000 or 5,760 Hz/volt.

(VOLT)=(AI12)	Read the value of analog input 12 into variable volts
(VOLT)=(VOLT)-14400	Remove frequency offset
(VOLT)=(VOLT)*1.736	Scaling factor multiplied. by 10,000
(VOLT=(VOLT)*.0001	Scaling back to volts

The variable (VOLT) is now in units of volts. If you are waiting for a condition to occur or doing a comparison, (see below) there is no need to go through the conversion process.

(TEMP)=(AI9)	Read in temperature from analog input
WT(AI12)<45000 GO	Wait for analog input 12 <45000 (<5.3 VDC using the previous example) before moving
IF(AI12)<45000 GO EB	Go if analog input 12 < 45000



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Configuring an Analog Output

The analog outputs of SmartDrives are 12-bit outputs. The value of the analog output is scaled to this 12-bit (0-4095) resolution. If you have a 4-20 mA output you will have an output resolution of .004 mA.
The output value is set with the system variable (AO*n*). *n*=9-16
The value of n corresponds to the OPTO position of the analog output.

To configure an OPTO position as an analog output:

1. Configure the position as an output using EDIT > SETUP > I/O > OPTOS.
2. Configure the output position as analog using EDIT > SETUP > I/O > OUTPUT.

The analog system output variable has a range of 0-4095 (12 bits). 0 is the minimum output and 4095 is the maximum value of the analog module you are using.

Example:
4-20mA output module, 0= 4mA, 4095=20mA,

(AO15)=256 Sets the analog output to 5 mA

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Chapter 8 - Programming with Serial Communication

Overview

Any RS-232C terminal, PC, computer serial RS-232C card, or RS-232C-equipped PLC can be used to configure, program, and operate IDC's SmartDrive controls. IDC provides and strongly recommends using our Windows-based *Application Developer* for configuration and programming. If you choose not to use this tool, all of the *IDeal*™ RS-232C programming and setup commands are listed alphabetically later in this chapter.

Application Developer provides a graphical control configuration environment, a program development editor, and a terminal communication package. *Application Developer* also provides application upload and download utilities, and an on-line software reference help utility.

This chapter is divided into 4 main sections. Section 1 covers common RS-232C details including baud rate settings as well as hardware and daisy chaining information. All RS-232 users will need this information. Section 2 covers the installation of *Application Developer.* Section 3 covers *Using Application Developer* to setup and program SmartDrive systems. Section 4 provides details on all of the RS-232C setup commands that *Application Developer* employs. This section will be useful to users who are not using Windows, or who plan to run the SmartDrive in a "hosted" environment. (i.e. the host streams down individual commands for immediate execution, or calls previously defined programs.) The host could be a PC, RS-232C equipped PLC, or some other type of intelligent device. IDC recommends that even users whose final application will be run in hosted mode use *Application Developer* to initially configure their system.

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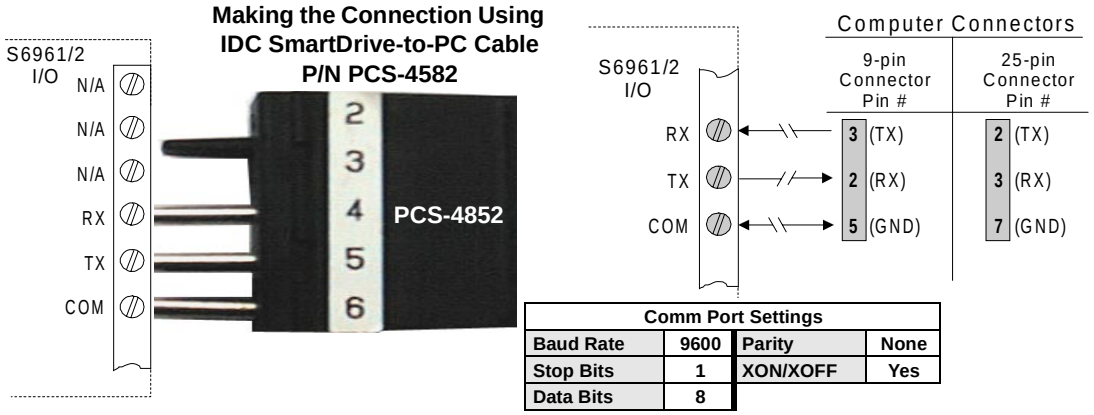
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Section 1: RS-232C Protocol

IDC's SmartDrive series controls use a 3-wire implementation of RS-232C. The RX, TX, and COM lines are the serial signals supported. No hardware handshaking is required. Note that some RS-232C devices require handshaking, such as RTS and CTS. It is the responsibility of the user to disable this handshaking via software or hardware.

Making RS-232C Connections to the S6961/2

Make your RS-232C connection as shown below. The SmartDrive-to-PC Cable (IDC P/N PCS-4852) is an ideal choice for making trouble-free connections.



Comm Port Settings			
Baud Rate	9600	Parity	None
Stop Bits	1	XON/XOFF	Yes
Data Bits	8		

Troubleshooting Serial Communication Problems

If communications between computer and SmartDrive are unsuccessful, one or more of the following procedures will usually solve the problem:

1. Test your terminal or terminal emulation software. Unhook the drive and transmit a character. An echoed character should not be received. If an echoed character is received, you are in half duplex mode. Jumper your host's TX and RX connections, and transmit another character. If you do not receive the echoed character, consult the manufacturer of the host's serial interface for proper pin-outs.
2. Host transmit (TX) must be connected to receive (RX) of the drive unit, and receive (RX) of the host must be connected to transmit (TX) of the drive. If communication fails, try switching connections on either the host or the drive.
3. Many serial ports require handshaking. Jumper RTS to CTS, and DSR to DTR (see table).
4. Configure the host to the identical baud rate, number of data bits, number of stop bits, and parity.
5. Receiving double characters (XX) when entering single characters (X), indicates your computer is set to the half duplex mode. Change to the full duplex mode.
6. Check your grounds. Use DC common or signal ground as your reference. Do not use earth ground or shield.
7. Check your cable length. If any cable is over 50 ft. long, you should be using a line driver, optical coupler, or shield. Shields must be connected to earth ground at one end only.

Jumpers	9 pin D	25 pin D
RTS to CTS	7 to 8	4 to 5
DSR to DTR	4 to 6	6 to 20

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Daisy Chaining SmartDrives

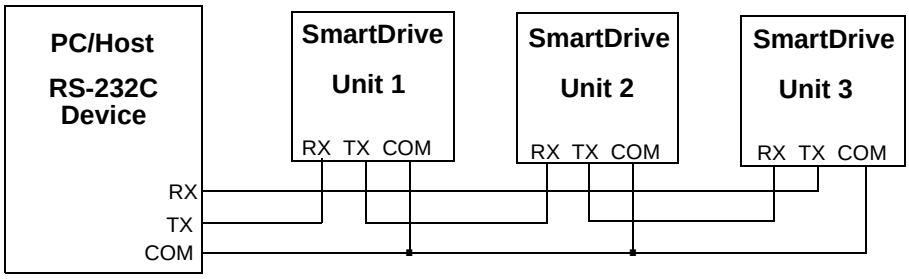
Your SmartDrive also supports daisy chaining. The unit address (range 1-99) can be set via the keypad, through Application Developer, or with a terminal program using the Unit Number (UN) command, or the entire chain may be addressed at once using the Auto-Address (AA) command.

Rules for Daisy Chain Operation

1. Units on a daisy chain must be "device addressed' (numbered) in ascending order away from the host device/controller in order for the Load All (LA - EX) commands to work properly. The unit addresses are not required to be numerically sequential, but must be in ascending order.
   Example: 1, 2, 4, 6, 8 is valid addressing. 6, 3, 10, 8, 2 is not valid.
2. Do not duplicate unit numbers or addresses.
3. RS-232C Echo should be enabled for each unit on the daisy chain. Disabling RS-232C Echo will prevent the daisy chain from functioning properly.
4. Any loose RS-232C connections or miswiring along the daisy chain will cause communication to fail. Please double check wiring if communication problems arise.
5. "Device Addressing" RS-232C commands (using the specific unit number in front of the command) is necessary if the user wants only one specific unit to perform an operation.
6. Status commands require addressing.

Please call IDC if you need to daisy chain more than 99 drives.

The hardware configuration below shows how to connect the daisy chain.



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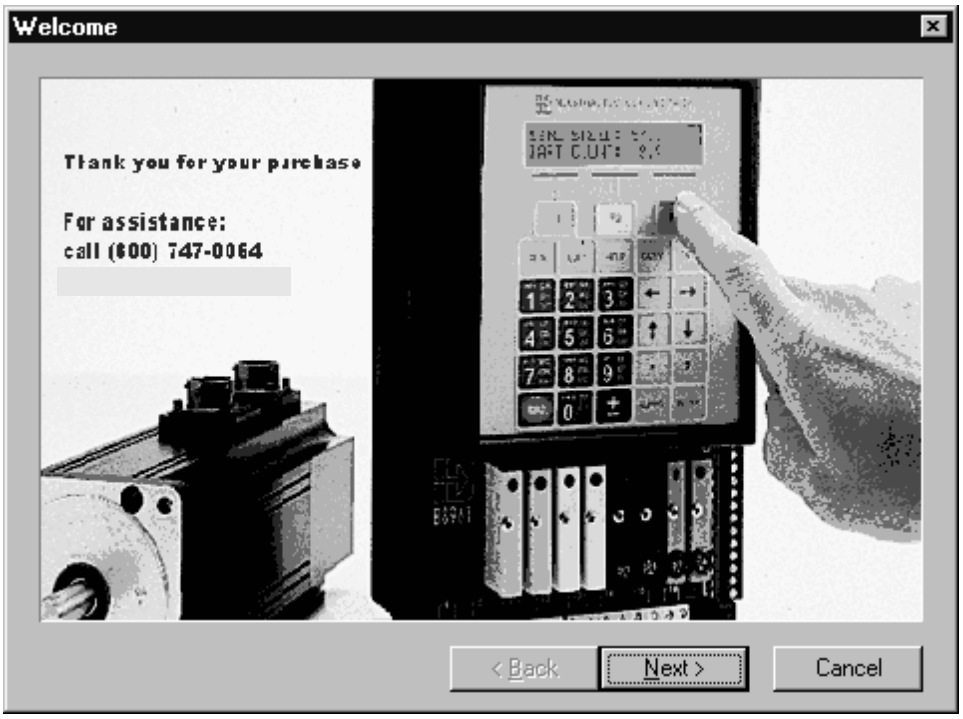
Section 2: Application Developer Software

All of IDC's SmartDrives come with *Application Developer* software. The programs and data files are automatically installed with a setup utility included on the disk.

Installing Application Developer in Windows 95, 98, or NT

1. Insert *Application Developer* Disk 1 in your floppy disk drive.
2. Click on Start.
3. Click on Run.
4. If there is no drive specified in the Command Line box, type the drive letter, followed by a colon (:), then a backslash (\), and the word **setup.**
   For example: **a:\setup**
5. Click OK.

The installation program will display the Welcome screen shown below. Throughout the installation process, the program will prompt you to enter information. Click on the **Next** button to continue the installation. At any point during the installation, you can click on **Cancel** to abort the process.



The Setup program will take you through a series of screens to verify user information and destination directories.

When you reach the window that says "Click the type of Setup you prefer, then click next", select **Typical** unless a partial installation is required. Selecting Custom allows you to select/de-select applications and various IDCMotion support files. Application Developer and Servo Tuner may not run properly if these support files are not installed.

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The Setup program will then prompt you to select a program group (or program folder in Win'95) to install the program icons. The Setup program will also create a series of sub-directories containing Application Developer, and an icon list. Also included in the Application Developer directory is a readme.txt file, a PowerPoint training presentation, and a terminal program for use in troubleshooting daisy-chains.

Common Installation Errors and Remedies

There are no known installation problems with Application Developer. Please call the IDC Applications Department at (800) 747-0064 or (707) 789-1000 (from outside U.S.) if you need assistance installing this software.

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Section 3: Using Application Developer

Application Developer's graphical environment helps you setup and program your SmartDrive from your computer. It guides you through configuring your control, following the same steps and menus as the keypad configuration. Complete details on setup menus and choices can be found in Chapter 5 - *Configuring Your System*. Applications (programs and configuration files) may be created, saved, edited and downloaded (sent) to your control. *Application Developer* will also upload (receive) an entire setup and program memory from a control.

Setup Wizard

The Setup Wizard allows the quickest and most accurate initial selection of drive, encoder, mechanics, and motion units. This chapter contains information to help you get started using Application Developer.

Open an Existing File

The window shown below appears immediately after starting the Application Developer program. If you "Open an Existing Project", Application Developer will bypass the Setup Wizard and allow you to select a file in the Open File window (see below). After you have opened an existing file it is still possible to use the Setup Wizard at any time by simply clicking on the Wizard tool bar button.



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New Project - Using the Setup Wizard

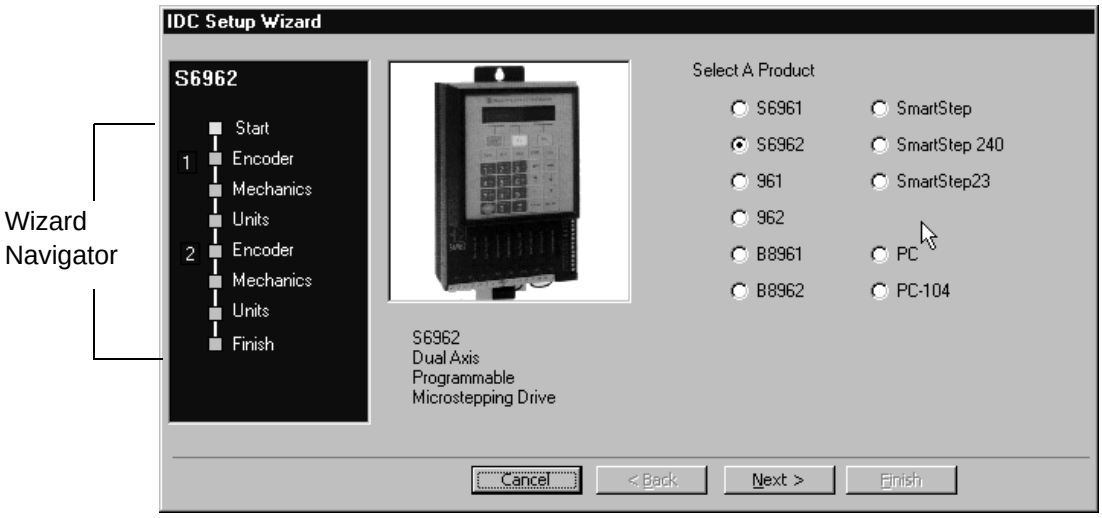
1. Click on the **New Project** button to start the Setup Wizard.



2. Select the product you are configuring, **S6962** in this case, and click on the **Next** button.

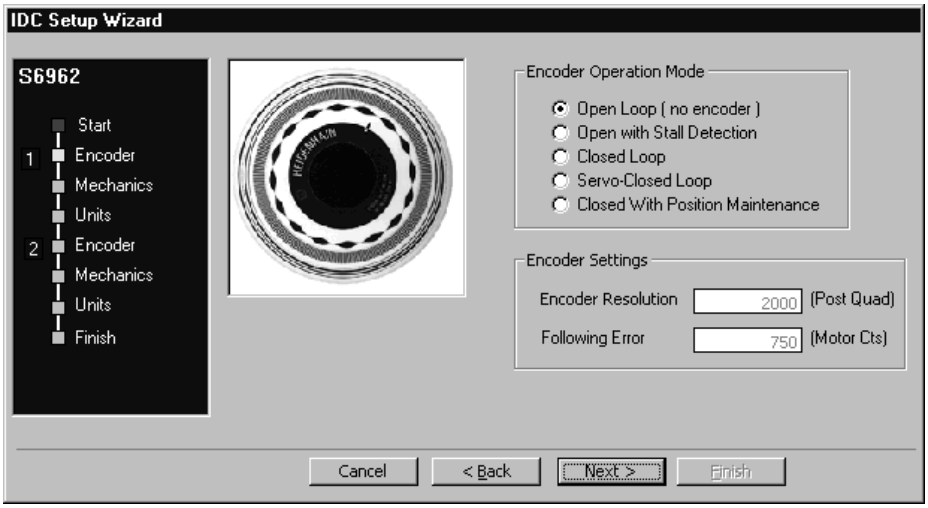
   Note: an S6962 will be configured in this example of using the Setup Wizard. If you are configuring an S6961, you will only be configuring one axis.

   The **Wizard Navigator** (left of photo) allows you to quickly locate your current position at any time during the setup process. The column of boxes represents the axes to be configured. A box's color represents its configuration status, i.e. **gray** indicates a parameter that has not been configured, **yellow** indicates the current position of the Wizard (parameter being configured), and **black** indicates that the parameter has been configured.



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3. Click on the Next button and the Encoder setup window will appear.



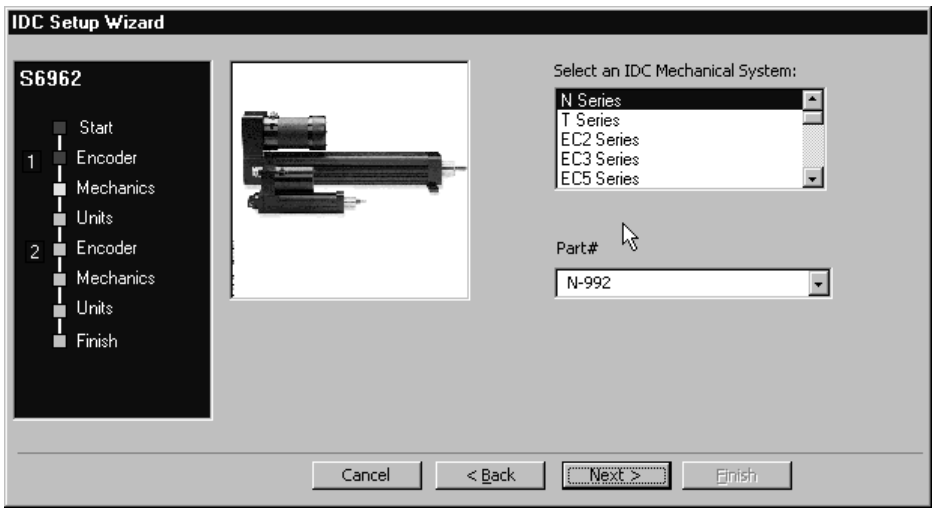
4. If you will be connecting an encoder, select one of the Encoder Operation Modes. Encoder modes are described in Chapter 5.

5. If you have made a selection other than Open Loop (no encoder), you may wish to edit the Encoder Resolution and Following Error parameters at this time.

   Note: It may be necessary to edit these parameters because servo systems usually require a larger following error than stepper systems.

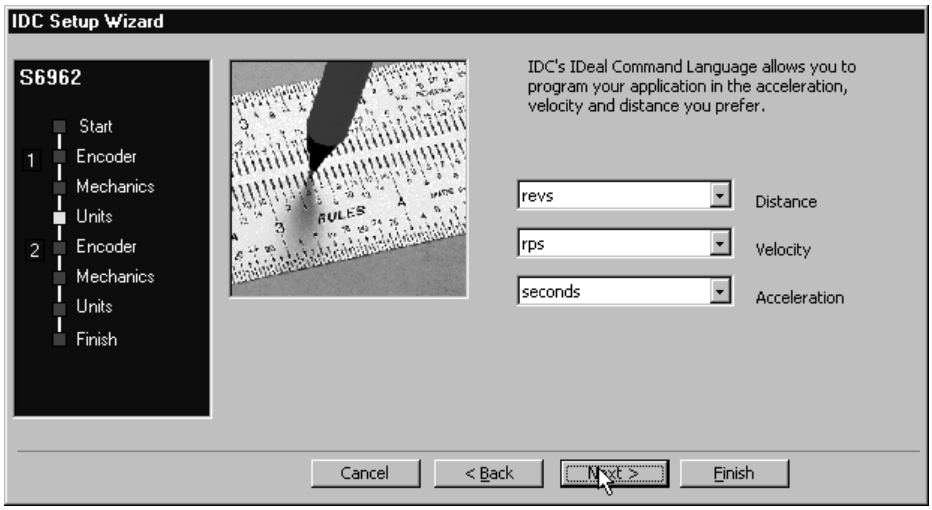
6. Click **Next** and you will be in the Mechanics setup window. Mechanical System setup is particulary easy if you are using IDC systems.

   Select the IDC Mechanical System and Part # you intend to control with this axis, and the Wizard will calculate the rest. Select Other if you are using a non-IDC system.



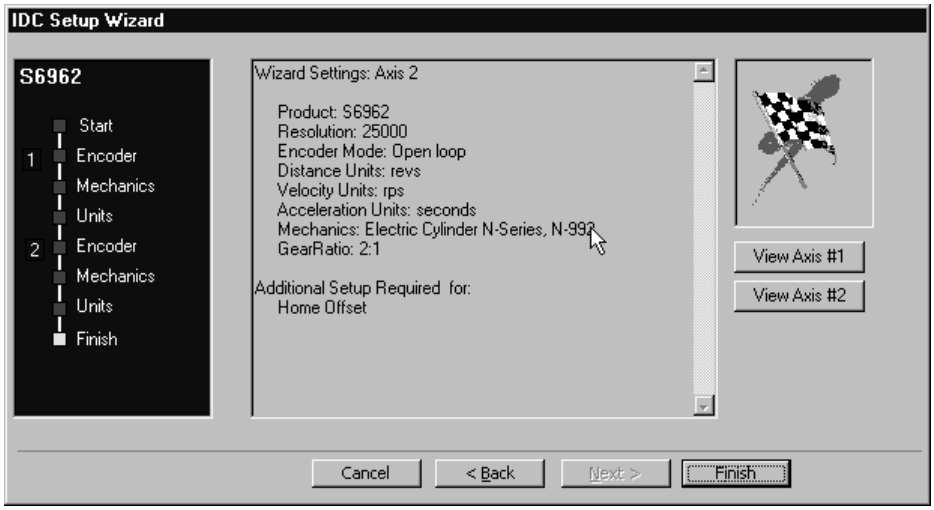
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7. Clicking on the **Next** button will bring up the **Units** setup window. The SmartDrive lets you program the control in the units that work best for your application.



8. Select your preferences from the pulldown menus and click on **Next**.

9. When all axes have been configured, the following window will appear. This display gives you the opportunity to review the settings you have made for each axis, and to return (using the Back button) to any parameter you may wish to change at this time.



10. When you are satisfied with the setup of your system, click on **Finish**. Note that the Wizard Navigator now indicates that all axes and parameters have been configured.

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After Using the Setup Wizard

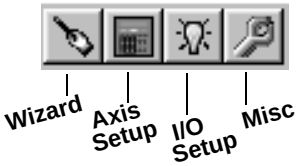
Your basic system setup parameters have been configured by the Setup Wizard, and though the system is functional, your application will probably require further configuration and fine-tuning.

The remainder of this chapter provides the same setup information as configured by the Setup Wizard plus more detailed information on each parameter to allow more control of your system and greater capacity for applications.

The Setup Wizard remains available at any time by clicking on the **Wizard** button. The **Axis Setup**, **I/O Setup**, and **Misc** toolbar buttons provide access to the setup parameters that will be explained throughout the remainder of this chapter.

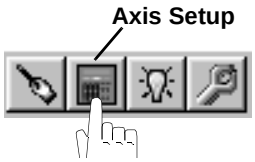
Setup Tool Bar Buttons

To access the setup windows and menus, simply click on the desired toolbar buttons as shown here:



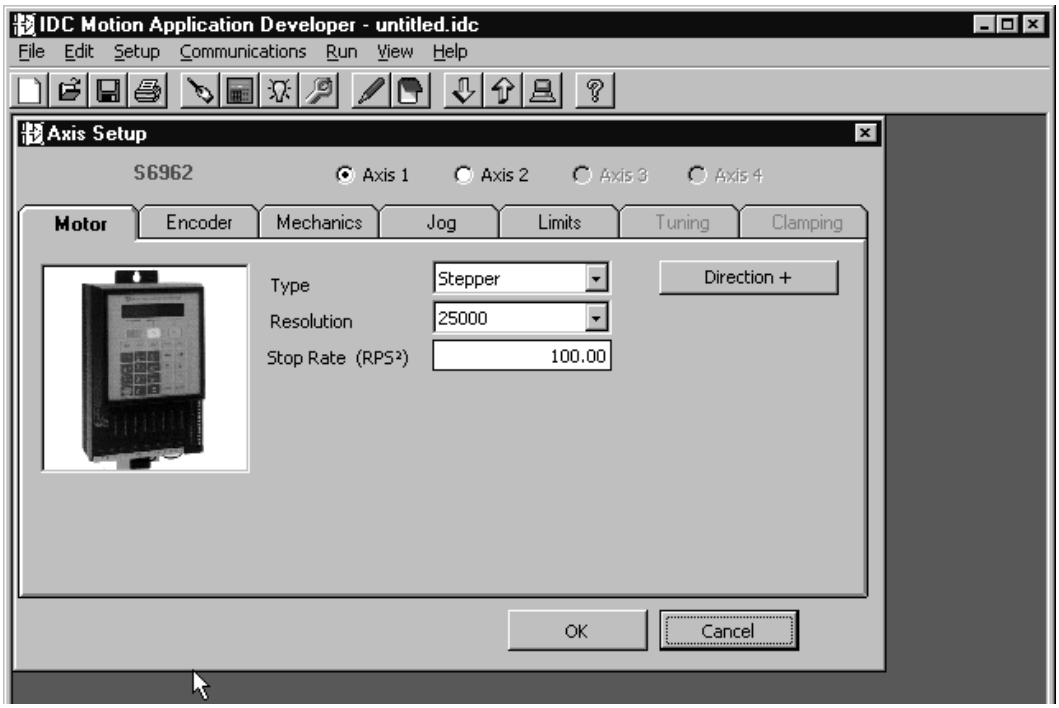
Axis Setup

Click on the Axis Setup button.



The first menu to appear will be the Motor menu, as shown below:

Note: please refer to Chapter 5 for detailed descriptions of setup parameters.



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Axis



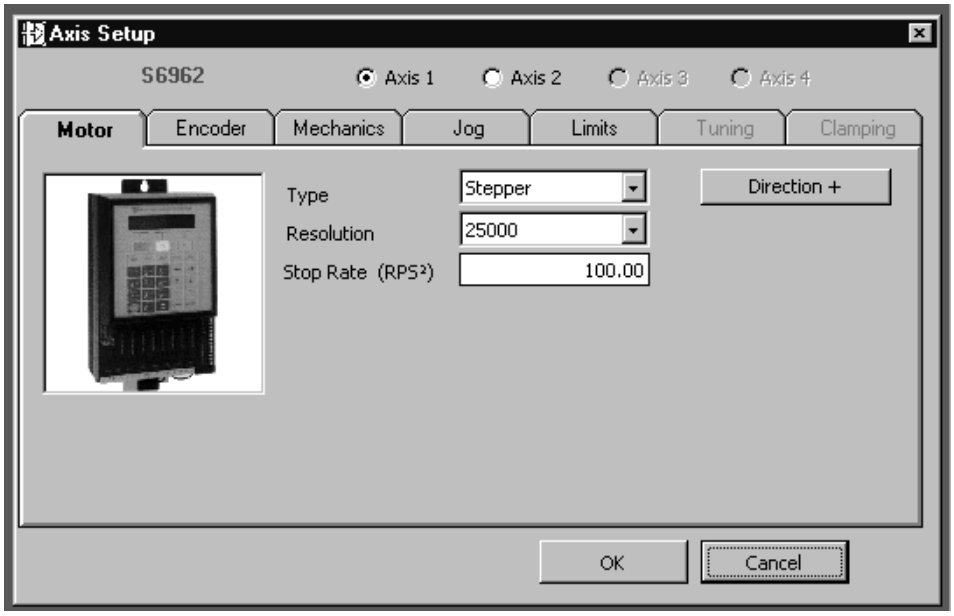
Each axis of your system must be configured separately.

1. Select the axis to be configured.

2. Configure parameters for each axis as it applies to your application (Motor, Encoder, Mechanics, Jog, Limits).

Motor Menu

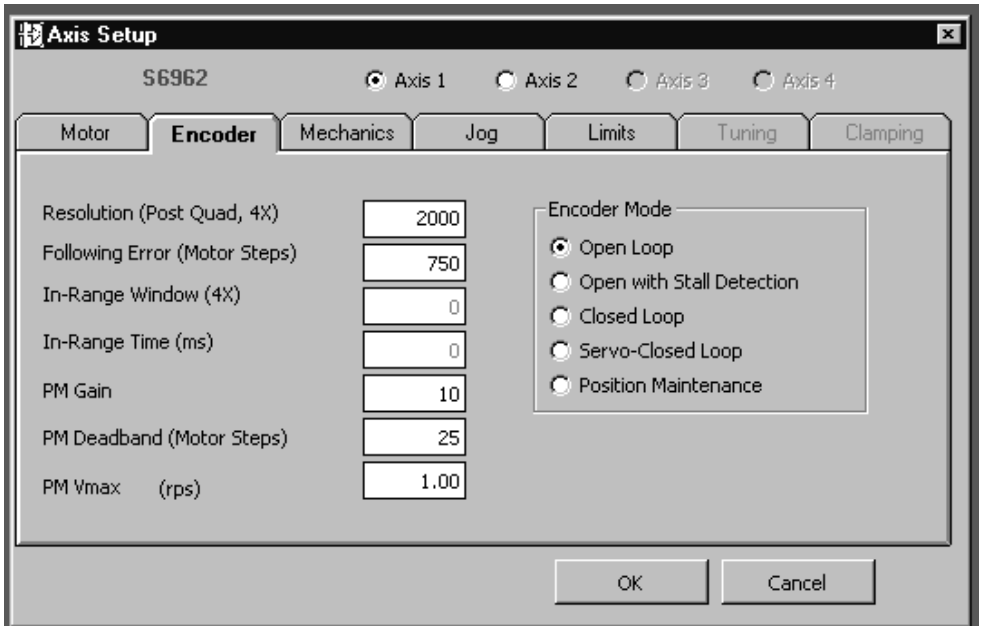
Settings for Drive Type, Resolution, Stop Decel Rate, and motor Directions are selected in the **Motor** menu.
Motor **Type** automatically defaults to Indexer. There are no other options.



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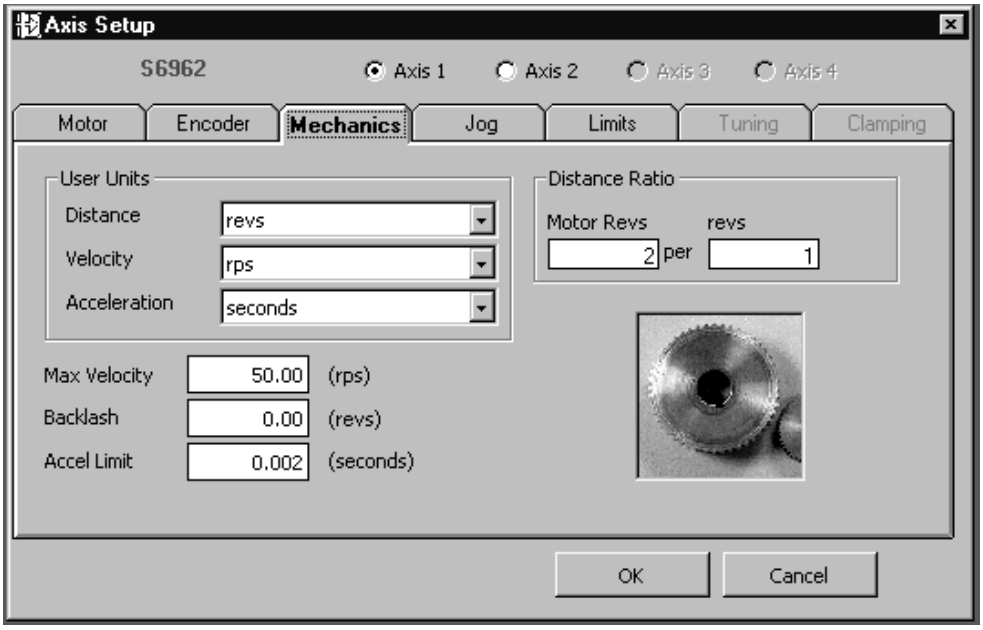
Encoder Menu

If you are not using an encoder, only the Encoder Mode must be configured. **Ensure that OPEN LOOP is selected if you are not using an encoder,** and skip to **Configuring Your Mechanics**



Mechanics Menu

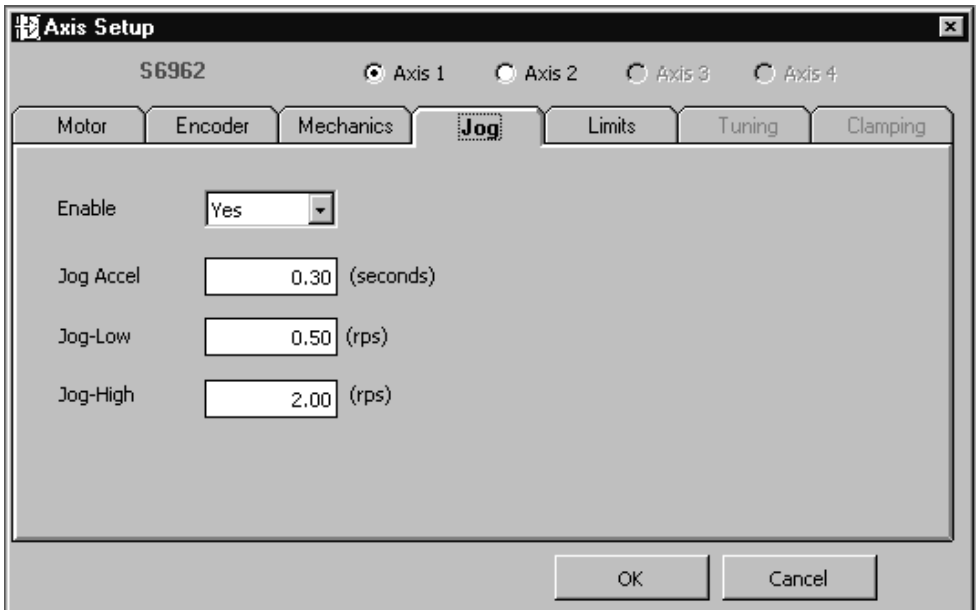
The Mechanics menu allows you to program distance, velocity, and acceleration units convenient for your application. This menu also allows you to set a maximum allowable speed and acceleration for each axis.



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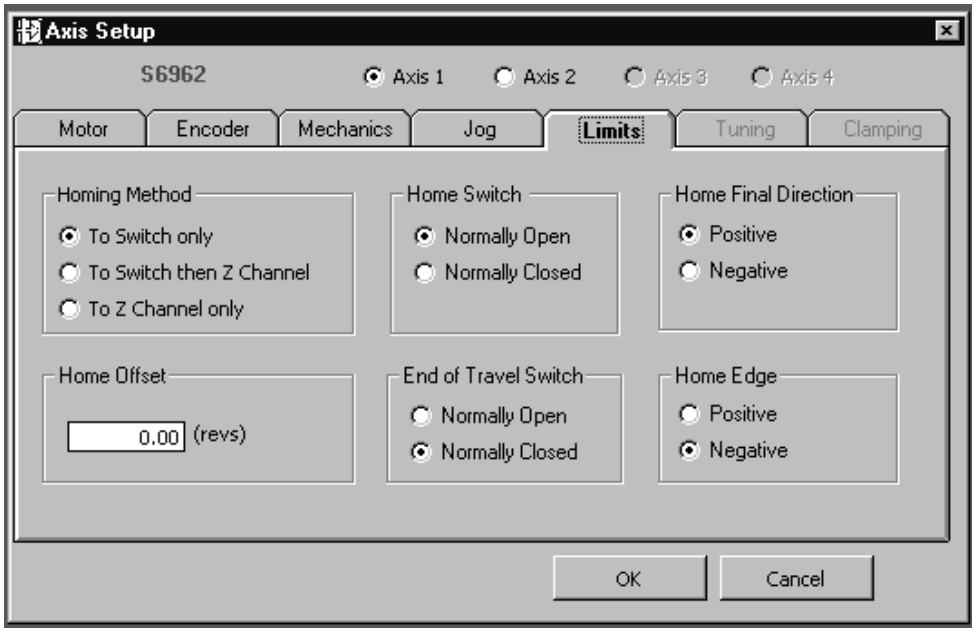
Jog Menu

The parameters which control your jog operation are configured using the Jog menu shown below.



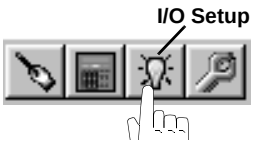
Limits Menu

Your S6961/2 has a built-in homing function which combines the flexibility of a customized homing routine with the ease of use of calling a “canned” program. Also see the GH command in the IDeal Command Reference chapter for more details on homing.



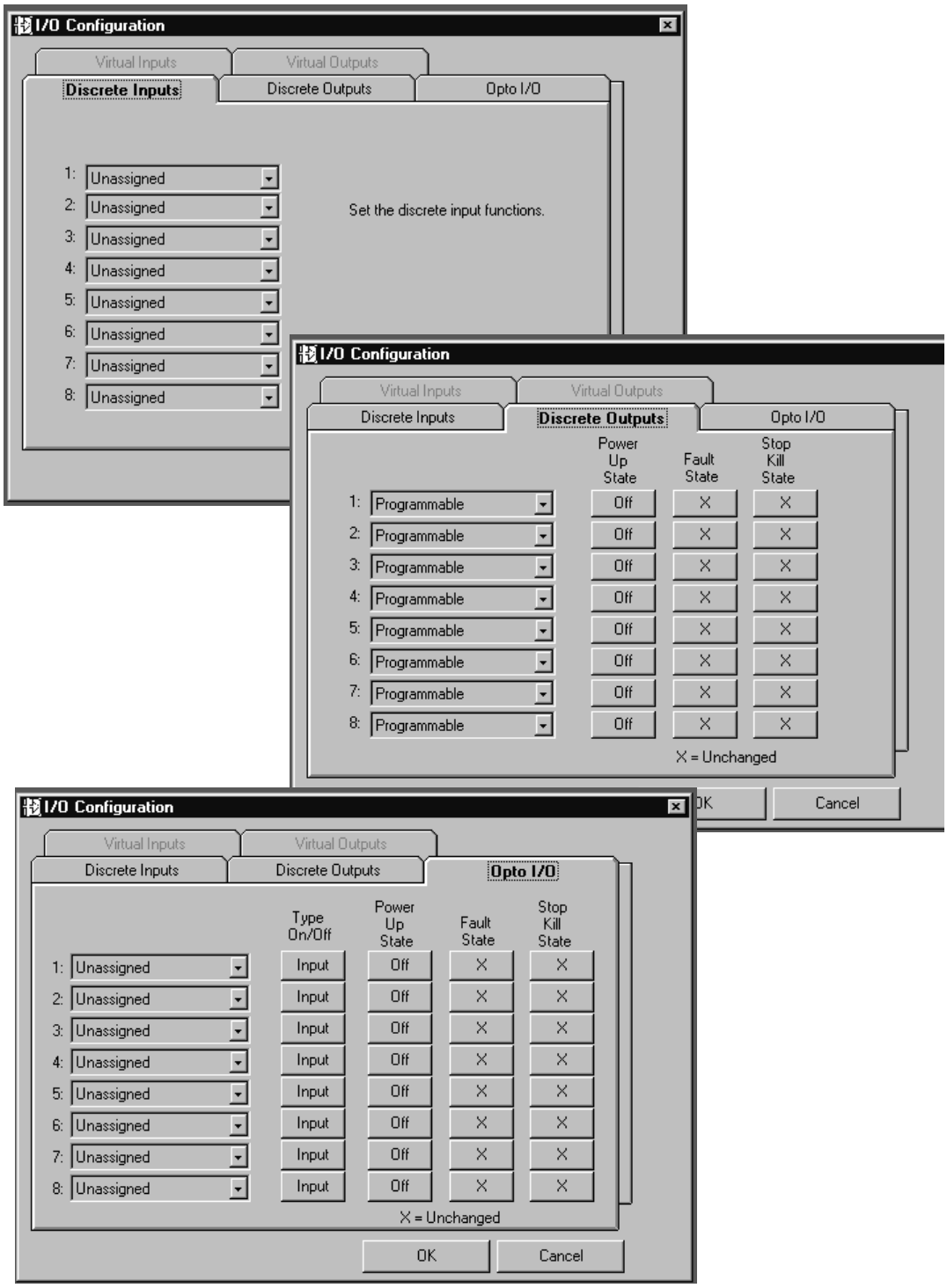
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I/O Setup



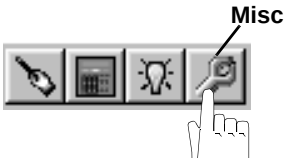
Click on the I/O Setup button.

To define a dedicated function for each input and output, scroll through the pulldown lsits and select from the available choices.



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Miscellaneous (Misc) Setup

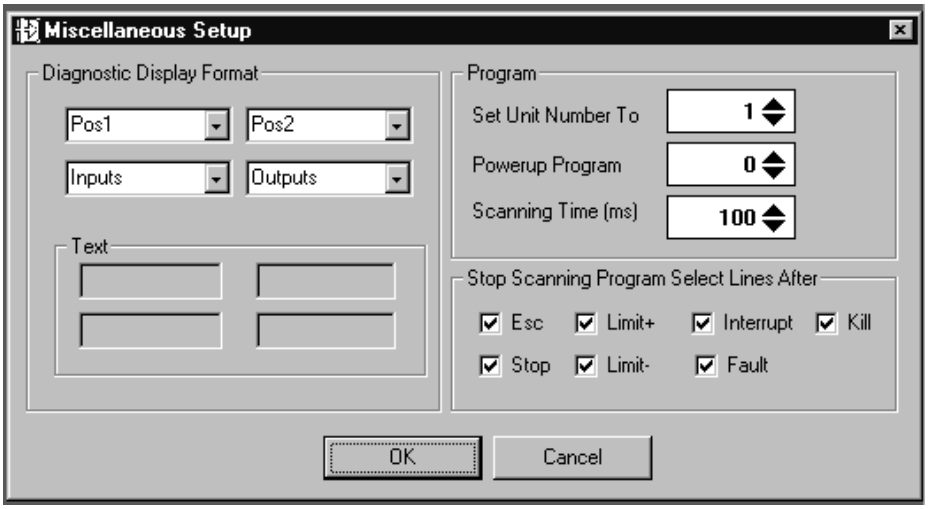


Click on the Misc (Miscellaneous) button.

Misc Setup contains two configuration categories that include options available in the PROGRAM SETUP and RS-232C SETUP menus detailed in Chapter 5.

Program

a. Sets the SmartDrives address.
b. Sets the program to run on power-up. No program will run if set to 0.
c. Sets the debounce (scan time) time of the program select inputs.



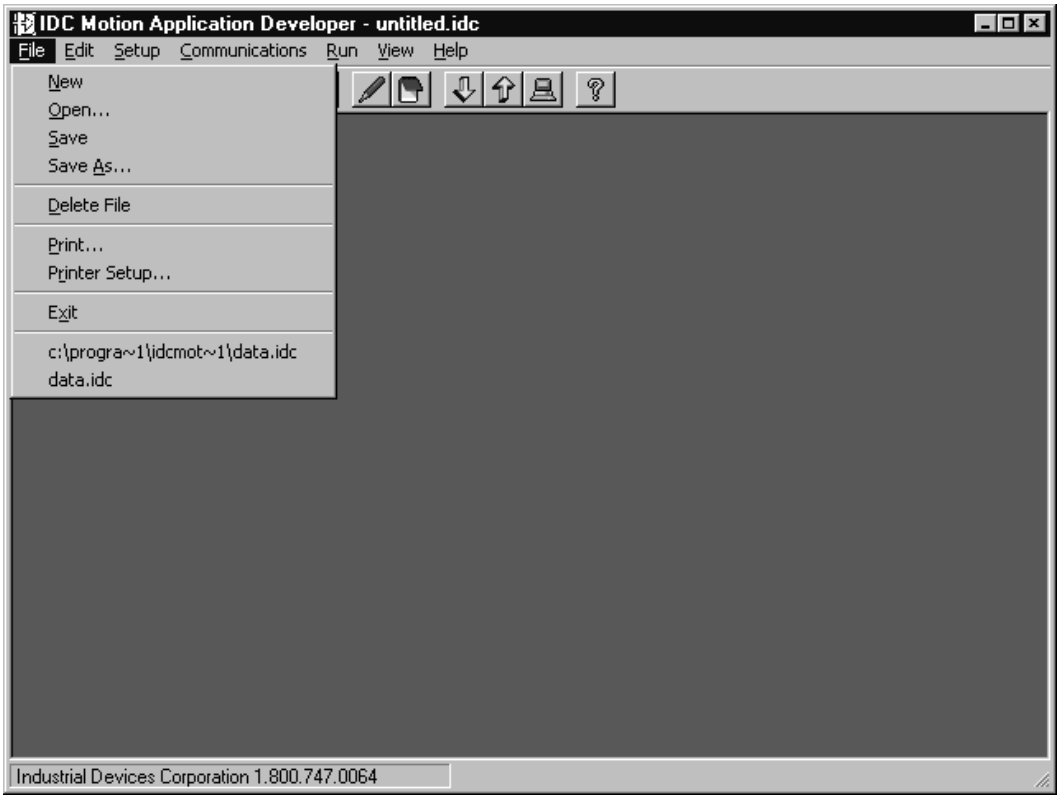
Stop Scanning Program Select Lines After...

Allows you to select the conditions under which program scanning stops.

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File Menu

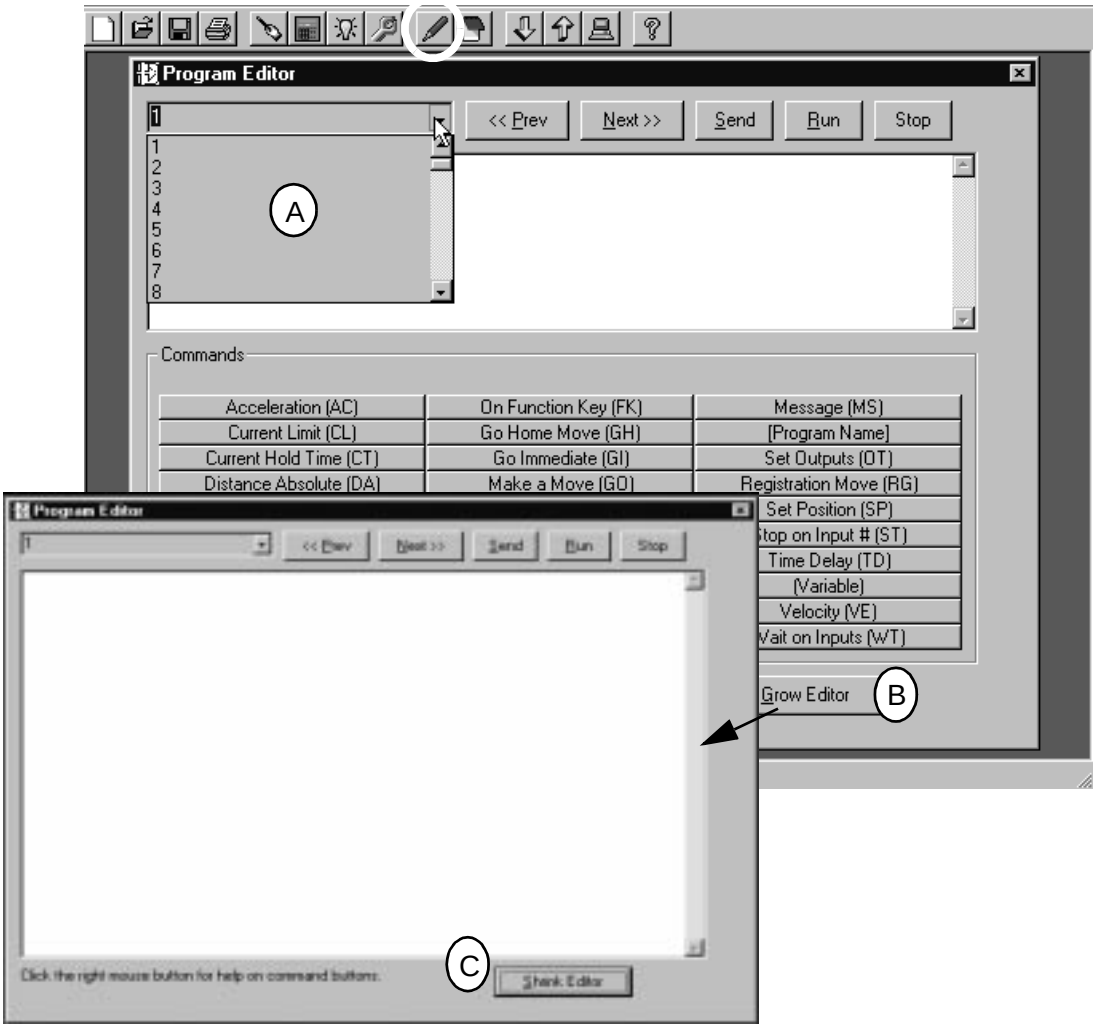
Applications (programs and configuration files) may be stored on disk as DOS files. The default suffix is *.idc. The other selections under File are generic to all “Windows” applications.



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Program Editor

The **Program Editor** features the standard windows editing features, Cut, Copy, and Paste, plus Grow Editor and Delete Current Program options. Undo, Delete and Select All are available by pressing the right mouse button, and an online HELP file may be reached via the F1 key.



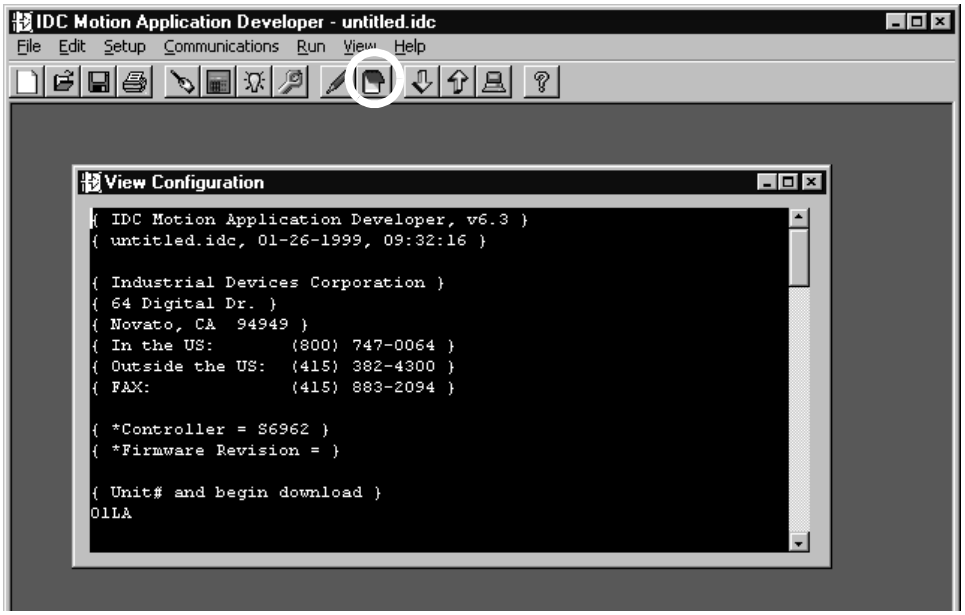
The drop down menu box (A) in the upper left hand corner shows the number and name of the currently active program, plus a list of up to 399 more programs. When the entire file is downloaded to the SmartDrive, these program numbers correspond to the program numbers the controller uses for binary and BCD program selections.
Use **Edit > Grow Editor** (B) to increase the working text area and eliminate the command prompts. Use **Edit > Shrink Editor** (C) to return to the normal Program Editor.

Program comments are placed between brackets {comments}. These comments are not downloaded to the SmartDrive Total program length, not including comments, is limited to 1k. Total program length with comments is 8k.

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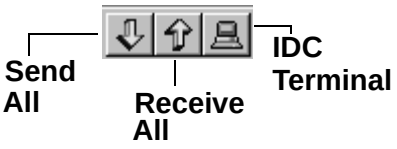
View Configuration

Click on the View Configuration button at any time to see your system configuration status. All configuration parameters are listed and may be viewed by scrolling the list.



Communications

All Communications functions may be accessed from the main menu bar. Send All, Receive All and IDC Terminal are selectable on the Toolbar as shown here:



Send All

Use *Send All* to download the application you have developed. In addition to motion programs, your application file will include the setup commands derived from the choices you made in the Setup dialog boxes. *Send All* completely configures the SmartDrive control, and will overwrite any existing programs or configurations in the control. The feature allows easy configuration of repeat machines. Program comments will be stripped off before being sent to the SmartDrive. IDC recommends saving the commented version of your application before downloading.

Retrieve All

Use *Retrieve All* to upload the entire contents of a SmartDrive control to a new file that can then be edited, downloaded to another SmartDrive, or saved to a PC file for documentation purposes. This file contains the complete contents of the SmartDrive including all the programs defined, I/O definition, and mechanical scaling parameters.

Please note that this version of your application does not contain any comments, as they are stripped off during download to conserve memory in the SmartDrive.

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Change Unit Number

Change Unit Number is used to set the device address of the control that *Send/Receive Program* uploads and downloads to on a single RS-232C daisy chain. Each unit must have its own unique software address. The Unit number of each control should be set *BEFORE* the units are connected in a daisy chain (the default address is one). *Send Program* only sends information to the unit selected here. A new unit number must be set to download to the next unit on the daisy chain. See *RS-232C Protocol*, earlier in this chapter, for hardware information on daisy-chain wiring.

Setup Comm Port

Comm Port is used to select a Comm Port when your PC has multiple serial ports. This dialog box also has a comm port test utility to verify proper RS-232C operation.

IDC Terminal

Terminal is a standard terminal emulator used for on-line communication with a SmartDrive control. It is very useful for troubleshooting interactive host/control communications.

Run Menu

Run > *Program* is used to run a specific program from *Application Developer*. Programs can also be initiated via dedicated program select inputs, through the keypad, or via any terminal using the RN command.

Run is only accessible from the main menu bar.

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Section 4: RS-232C IDeal™ Command Reference

Overview

Though we strongly recommend taking advantage of the capabilities and convenience of *Application Developer*, you can configure, program, and run a SmartDrive from any RS-232C terminal or computer. If you do not intend to use the Windows software tools we provide, you will need to use the IDeal™ RS-232C command listings that follow.

"Hosted" or "interactive" motion control from a PLC or PC is also a common mode of operation. You can write your control programs in your language of choice (BASIC, C, ladder, etc.).

RS-232C SmartDrive operation is divided into four categories of commands. The first category is ***Serial Setup Commands***. These are the commands that IDC's *Application Developer* program uses to configure the SmartDrive according to the choices made in the SETUP dialog boxes. These ***Serial Setup Commands*** include the syntax of the command, but the full command definitions and examples are found in *Chapter 5 - Configuring Your System*.

The second category is ***Serial Programming Commands***. These are commands that can be executed over RS-232C or downloaded to the SmartDrive's non-volatile memory for later execution. This category of commands is identical in syntax and functionality to the equivalent keypad command. These run-time RS-232C commands are listed in the RS-232C Command Reference, but the full definition and examples are listed in *Chapter 6 - Programming Commands*.

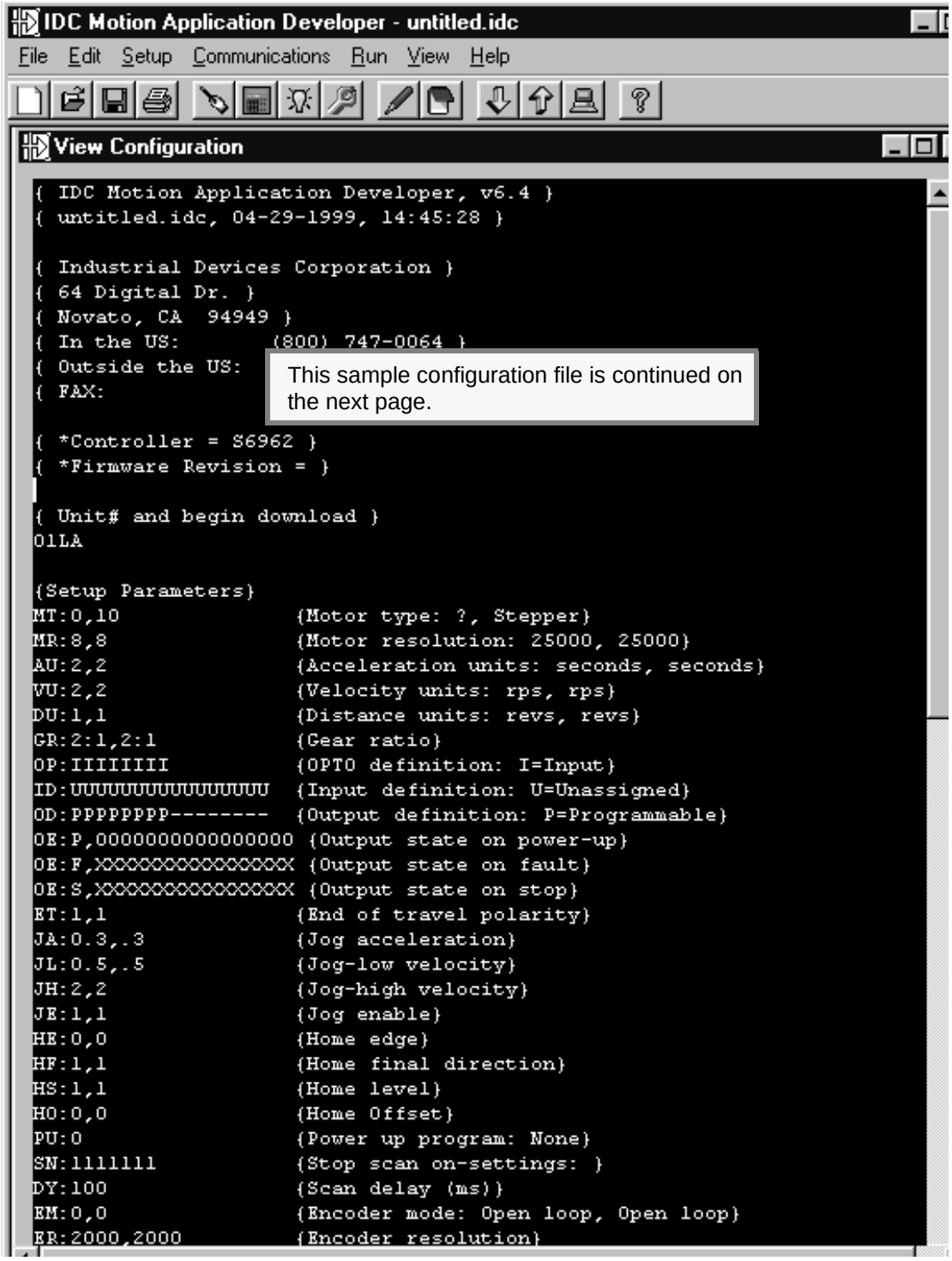
The third category of Serial commands is ***Serial Immediate Status Commands***. These commands bypass the normal command buffer and are executed immediately, regardless of what else the SmartDrive has been asked to do. These commands include instantaneous position reporting, drive status, and emergency kill and stop commands.

The final category is ***Serial Supervisory Commands***. These are the actual uploading and downloading of the setup and program parameters. Once an application with setup parameters and command has been created, these commands are used to download and upload the file to and from the SmartDrive.

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Sample *.idc File

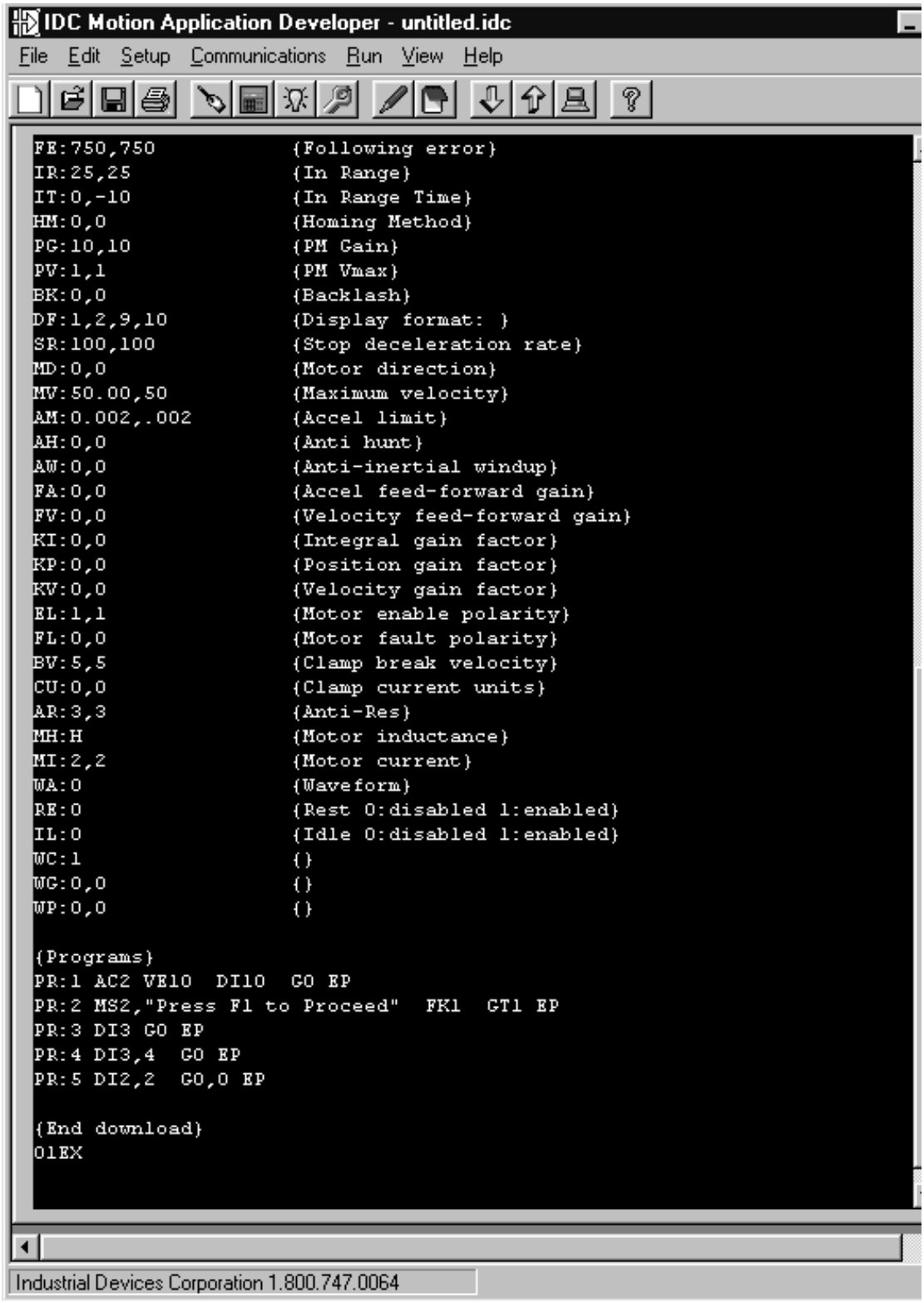
To familiarize yourself with *IDeal™* RS-232C commands, review the following example of a typical file created in *Application Developer* for download to an S6962. You will need to generate a similar file to configure your SmartDrive. Individual programs can be downloaded in such a configuration file, or downloaded separately at run-time. The SmartDrive can also execute run-time commands in an “immediate” mode outside of any program. See the *Command Syntax* section of this chapter for more details.



This sample configuration file is continued on the next page.

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Sample configuration file continued:



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Command Syntax

All *IDeal*™ commands use two letter UPPER CASE ASCII characters. Command delimiters can be a carriage return (<cr>) or space (<sp>) character.

The commands that follow define IDC's command syntax. A brief command description is given here, but the full command definition is found in Chapter 5. This listing is intended only to help programmers with command syntax. *IDeal* programming commands are defined in Chapter 6.

The table below describes the abbreviations and format used in our command syntax definitions:

Letter or Symbol	Description
<n>	Unit address number is optional with RS-232C, and the command is sent to all units if no address is specified. All Status commands require an address. *Example:* <n>**AUi,i**
,	Field separator.
a	Alphabetic character.
h	Hexadecimal number.
i	Decimal integer number.
r	Decimal real number (up to 4 places to the right of the decimal).
:	A colon (:) is a neutral character. It can be used in a command to make it more readable to the programmer. For example OP:OOOOIIII is easier to understand than OPOOOOIIII. **Note**: The colon is required in GR command and is not neutral. (Unit Ratio). *Example:* **GR4:1**

Some *IDeal*™ commands request a response from the control. Responses will always be preceded by an asterisk (*) which notifies the other controls on a daisy chain to ignore the subsequent response characters preceding the next command delimiter. For example, the Input State (IS) command might return *AF09<cr> Your computer program will need to mask the asterisk before decoding the value returned.

You can document your programs by placing comments between brackets. For example: {this is a comment}. To maximize program storage space, the control "strips off" these comments when a program file is downloaded.

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Serial Setup Commands

These are the commands that IDC's *Application Developer* program uses to configure the SmartDrive according to the choices made in the SETUP dialog boxes.

<table>
<tr><th>Command</th><th>Command Description and Application Examples</th><th>Syntax</th></tr>
<tr><td>AM</td><td>Acceleration Maximum</td><td><n>AMr,r</td></tr>
<tr><td>AU</td><td>Acceleration Units
i=0 units/s^2 (where "units" is a string defined by the DU command)
1 rps^2
2 seconds
Example: AU0 (units/s^2 on axis one)</td><td><n>AUi,i</td></tr>
<tr><td>DF</td><td>Display Format
Configures the 4 keypad run time display quadrants. DF takes 4 parameters where i is an integer representing a display data type per quadrant. User defined text is limited to 10 characters per field.

<table>
<tr><td>i = 0</td><td>Blank</td><td>i = 8</td><td>*CUR2</td></tr>
<tr><td>i = 1</td><td>POS1</td><td>i = 9</td><td>INPUTS</td></tr>
<tr><td>i = 2</td><td>POS2</td><td>i = 10</td><td>OUTPUTS</td></tr>
<tr><td>i = 3</td><td>POS1 + UNIT</td><td>i = 11</td><td>OPTOS</td></tr>
<tr><td>i = 4</td><td>POS2 + UNIT</td><td>i = 12</td><td>SA_STATUS1</td></tr>
<tr><td>i = 5</td><td>VEL1</td><td>i = 13</td><td>SA_STATUS2</td></tr>
<tr><td>i = 6</td><td>VEL2</td><td>i = 14</td><td>SS_STATUS</td></tr>
<tr><td>i = 7</td><td>*CUR1</td><td>" "</td><td>User defined text in quotes</td></tr>
</table>
*Not available</td><td><n>DFi,i,i,i
<n>DF"Text",i,i,i</td></tr>
<tr><td>DU</td><td>Distance Unit Label
i = 0 steps (fixes GR @ 1:1
<table>
<tr><td>1=rev</td><td>5=cm</td><td>9=deg</td><td>13=arcmin</td></tr>
<tr><td>2=inch</td><td>6=mm</td><td>10=radian</td><td>14=%</td></tr>
<tr><td>3= mil</td><td>7=yard</td><td>11=grad</td><td>15=index</td></tr>
<tr><td>4=meter</td><td>8=foot</td><td>12=arcsec</td><td>16=µm</td></tr>
</table></td><td><n>DUi,i</td></tr>
<tr><td>DY</td><td>Scan Delay
Where i is the number of ms
Example: DY500 (500 ms) Default is 100ms</td><td><n>DYi</td></tr>
<tr><td>EL</td><td>Enable Line Polarity
Fixed in SmartDrive</td><td><n>EL1,1</td></tr>
<tr><td>EM</td><td>Encoder Mode
0 = Open Loop,
1 = Open Loop with stall detect
2 = Closed Loop
3 = Servo Closed Loop
4 = Closed Loop-Position maintenance
Example: EM2 (closed loop)</td><td><n>EMi,i</td></tr>
</table>

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Serial Setup Commands

These are the commands that IDC's *Application Developer* program uses to configure the SmartDrive according to the choices made in the SETUP dialog boxes.

Command	Command Description and Application Examples	Syntax
ER	**Encoder Resolution** Where i is an even integer Example: ER2000 (2000 counts/rev)	**<n>ERi,i**
ET	**End of Travel Switch Polarity** Selects the polarity of the EOT (End of Travel) switches. i = 0 NORM OPEN i = 1 NORM CLOSED	**<n>ETi,i**
FE	**Following Error Limit** Example: FE1000 (axis one 1000 counts)	**<n>FEi,i**
FL	**Fault Line Polarity** Fixed in SmartDrive.	**<n>FL0, 0**
GR	**Units Ratio** Example: GR4:1 (4 motor revolutions per distance (DU) unit)	**<n>GRi:i, i:i**
HE	**Home Edge** 0 = Negative Edge, 1 = Positive Edge. Example: HE0 (positive)	**<n>HEi,i**
HF	**Home Final Direction** 0 = Negative direction, 1 = Positive direction. Example: HF1 (one positive)	**<n>HFi,i**
HM	**Homing Mode** i=0 Switch Only i=1 Switch Then Z Channel i=2 Z Channel Only	**<n>HMi,i**
HO	**Home Offset** Example: HO1.0 (axis one 1.0 distance unit)	**<n>HO±r,±r**
HS	**Home Switch** 0 = Normally Closed, 1 = Normally Open Example: HS1 (uses a normally open home switch-this is the default setting)	**<n>HSi,i**
ID	**Input Definition** Example: ID:UUUUUUUU The first 8 inputs are unassigned. All 8 input states must be specified. See also: OD Note: The G (Registration) Command is only valid for Input 1.	**<n>IDaaaaaaaaaaaaaaaa**
IR	**Position Maintenance Deadband** Sets position maintenance deadband in motor steps Valid as a program command using an immediate parameter only (No variables).	**<n>IRi,i**
JA	**Jog Acceleration** Example: JA.01 (.01 - Units selected by AU command.)	**<n>JAr,r**
JE	**Jog Enable** 0 = Jog Disabled, 1 = Jog Enabled Example: JE1 (enabled)	**<n>JEi,i**
JH	**Jog High Velocity** Example: JH5.0 (5 in units selected by VU command.)	**<n>JHr,r**
JL	**Jog Low Velocity** Example: JL1.5 (1.5 in units selected by VU command.)	**<n>JLr,r**

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Serial Setup Commands

These are the commands that IDC's *Application Developer* program uses to configure the SmartDrive according to the choices made in the SETUP dialog boxes.

<table>
<tr><th>Command</th><th>Command Description and Application Examples</th><th>Syntax</th></tr>
<tr><td>MD</td><td>Motor Direction Reference
0 = Positive direction, 1 = Negative direction
Example: MD0 (one positive</td><td><n>MDi,i</td></tr>
<tr><td>MR</td><td>Motor Resolution
Default: 25,000 steps/rev
<table><tr><td>i = 0</td><td>200 steps/rev</td><td>i = 6</td><td>10000 steps/rev</td></tr><tr><td>i = 1</td><td>400 steps/rev</td><td>i = 7</td><td>18000 steps/rev</td></tr><tr><td>i = 2</td><td>1000 steps/rev</td><td>i = 8</td><td>25000 steps/rev</td></tr><tr><td>i = 3</td><td>2000 steps/rev</td><td>i = 9</td><td>25400 steps/rev</td></tr><tr><td>i = 4</td><td>5000 steps/rev</td><td>i = 10</td><td>36000 steps/rev</td></tr><tr><td>i = 5</td><td>8000 steps/rev</td><td></td><td></td></tr></table></td><td><n>MRi,i</td></tr>
<tr><td>MT</td><td>Motor Type
MT10 (fixed at MT10 on S6961/2)
Selects a built-in motor type.</td><td><n>MT10,10</td></tr>
<tr><td>MV</td><td>Maximum Velocity
Example: MV50.0 (axis one 50 in units selected by VU command.)</td><td><n>MVr,r</td></tr>
<tr><td>OD</td><td>Output Definition
Example: OD:PPPPPPPP All 8 outputs defined as Programmable outputs.
All 8 output states must be specified. See also: ID</td><td><n>ODaaaaaaaaaaaaaaaa</td></tr>
<tr><td>OE</td><td>Output States on Event
Configures output states on an event specified by a. OPTO positions 9-16 are only definable if configured as an output using OP command.

a = P (Power-Up)
F (Fault)
S (Stop / Kill)

i = 0 Off
1 On
X No Change

Example: OEF,0001XX01XXXXXXXX</td><td><n>OEa,iiiiiiiiiiiiiii</td></tr>
<tr><td>OP</td><td>OPTO Configuration
i = Input, O = Output
Example: OP:IIIIOOOO First four configured as inputs, last four as outputs</td><td><n>OPIIIIOOOO</td></tr>
<tr><td>PG</td><td>Position Maintenance Gain
Sets position maintenance correction gain.
i=1 to 32,767</td><td><n>PGi,i</td></tr>
<tr><td>PU</td><td>Power-Up Program
Example: PU105 (Runs program number 105 on power-up.)</td><td><n>PUi</td></tr>
<tr><td>PV</td><td>Position Maintenance Max. Velocity
Sets position maintenance maximum correction velocity
(Units specified by VU command).</td><td><n>PVi,i</td></tr>
</table>

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Serial Setup Commands

These are the commands that IDC's *Application Developer* program uses to configure the SmartDrive according to the choices made in the SETUP dialog boxes.

<table>
<tr><th>Command</th><th>Command Description and Application Examples</th><th>Syntax</th></tr>
<tr><td>PW</td><td>Password
Up to 4 characters: a-z, A-Z, 0-9
Entering a dash (-) will clear the password. Skipping a parameter will leave the password unchanged (see examples below).

Examples using PW:
Example 1: PW4FT,Q12h
Set the OPRATR password to 4FT and the ADMIN password to Q12h
Example 2: PW,New
Changes ADMIN password to New; leaves OPRATR password unchanged
Example 3: PW-,-
Clears both the OPRATR and ADMIN passwords</td><td><n>PWaaaa, aaaa</td></tr>
<tr><td>SN</td><td>Scan Conditions
Conditions stopping program select line scanning are represented by “i”
<table><tr><td></td><td>ESC</td><td>Stop</td><td>Limit +</td><td>Limit -</td><td>Kill</td><td>Fault</td><td>Interrupt</td></tr><tr><td>SN</td><td>i</td><td>i</td><td>i</td><td>i</td><td>i</td><td>i</td><td>i</td></tr></table>0 = Continue program select scanning,
1 = Stop program select scanning on this condition
Example: SN:0111111 (all input conditions, except pressing the ESC key stop program select line scanning)</td><td><n>SNiiiiiiii</td></tr>
<tr><td>SR</td><td>Stop Deceleration Rate
Example: SR100 (100 rps^2)
Note: Stop Deceleration Rate units are always in rps^2 and are not user selected</td><td><n>SRr,r</td></tr>
<tr><td>UN</td><td>Unit Number
Example: UN5 (sets unit address to 5)</td><td><n>UNi</td></tr>
<tr><td>VU</td><td>Velocity Units
<table><tr><td>0</td><td>units/sec (where “units” is a string defined by the DU command)</td></tr><tr><td>1</td><td>units/min (where “units” is a string defined by the DU command)</td></tr><tr><td>2</td><td>rps</td></tr><tr><td>3</td><td>rpm</td></tr></table>Example: VU2 (axis one set to rps)</td><td><n>VUi,i</td></tr>
</table>

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Serial Programming Commands

The commands in this category may be sent to the SmartDrive's buffer and executed on a first-in first-out (FIFO) basis. This execution does not require you to create or download any program to the SmartDrive's volatile memory. See *Chapter 6, Programming Commands* for complete definitions.

Command	Command Description and Application Examples	Syntax
AC	**Acceleration** Example: AC10	**ACr,r**
DA	**Distance Absolute** Example: DA15	**DAr,r**
DC	**Distance to a Change** Example: DC20	**DC±r,±r**
DE	**Deceleration** Example: DE.2	**DE±r,±r**
DI	**Distance Incremental** Example: DI 3.42	**DI±r,±r**
EA	**Enable Axis** i=0 (disable drive), i=1 (enable drive), i = 2 (standby) Example: EA0 disables axis	**EAi,i**
GH	**Go Home** Example: GH10	**GH±r**
GI	**Go Immediate**	**GI, GIi,i**
GO	**Begin Move**	**GO, GOi,i**
MC	**Move Continuous**	**MC+,+**
OT	**Set Outputs** Example: OT5,101 (turns on outputs 5 and 7, turns off output 6)	**OTi,iii...** **OTiii...**
" "	**Send String Over Serial Port** Example: GO "End of Move" (sends "End of Move" out serial port after move)	**"user text"**
RG	**Registration** Example: RG3.5	**RGr,r**
SP	**Set Position** Example: SP15.0 (set axis position to 15.0)	**SPr,r**
SQ	**Square Root** Example: SQ16, (x)	**SQr,(var)**
ST	**Stop on Input** Example: ST4 DI50 GO (motor will decelerate to a stop or remain stopped if input 4 is activated). ST0 disables the input	**STi,i**
TD	**Time Delay** Example: OT1,1 TD.12 OT1,0 Turn Output 1 on for 120 msec.	**TDr**
VE	**Velocity** Example: VE50 (sets speed for the next move to 50, in units set by the VU command)	**VEr,r**

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Serial Programming Commands The commands in this category may be sent to the SmartDrive's buffer and executed on a first-in first-out (FIFO) basis. This execution does not require you to create or download any program to the SmartDrive's volatile memory. See *Chapter 6, Programming Commands* for complete definitions.		
Command	**Command Description and Application Examples**	**Syntax**
WT	**Wait On Input Condition** Example: WT1,0 GO (wait for input 1 to turn off before starting move) #1 = axis to "wait on"	**WTi,ii...** **nWTiii...** **<n>WT expression** **<n>WT#i**

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Commands Not Available In Hosted Mode The following set of commands can only be executed if they are part of, or within, a program:	
Command	**Command Name**
BR	**Break**
EB	**End Block**
GS	**Go Sub**
GT	**Go To**
IF	**If**
IV	**Input Variable**
LP	**Loop**
MS	**Display Message**
EN	**End Routine**
FK	**Function Key**
LU	**Loop Until**
LW	**Loop While**
WT	**Wait**

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Serial Immediate Status Commands

Serial Immediate Status commands are processed immediately upon receipt, rather than waiting in the buffer for previous commands to finish. They can be issued while a program is running, or while motion is in progress. They can't be stored within a program.

Using Immediate Status Commands

Serial Immediate Status commands are provided for two purposes. One is to allow a host control to query the SmartDrive, in real time, for system, position, and I/O status. The second is to provide a means to do in-depth troubleshooting via RS-232C. These commands will interrupt the SmartDrive and generate a return. They do not affect operation of the SmartDrive.

In a typical hosted-mode application, all machine operations and decisions are performed by a high level device. Motion commands are generated, and downloaded to the SmartDrive by this host device, such as a computer or PLC. The following commands are provided so that the host can verify the status of the SmartDrive before commanding motion. The System Status (SS) command returns overall system information, and indicates general faults. The Axis and Drive (SAi and SDi) commands can then be used to provide more detailed, axis specific information.

These commands are also an invaluable system troubleshooting aid. Since they are immediate commands, they will generate a response from the SmartDrive even if it is in the middle of move, waiting for an input condition to become true, etc. Checking the System Status, and the I/O Status will give you enough information to explain what the SmartDrive is doing. If a fault is indicated, the Drive and Axis Status commands can give detailed, axis specific information.

Summary of Immediate Status Commands

Command	Syntax	Purpose
Clear Command Buffer	<n>CB	Clears the terminal input buffer and buffered command buffer
Input States	<n>IS	Real-time status of discrete and OPTO inputs
Kill	<n>K	Issues immediate halt to current and programmed motion
Model Number	<n>MN	Returns unit model number over RS-232C
Output States	<n>OS	Real-time status of discrete and OPTO outputs
Current Position	<n>PA1, <n>PA2	Real-time position, in user units, of axis 1, axis2
Stop	<n>S	Issues program terminaiton, decelerates to a halt
Axis Status	<n>SA1, <n>SA2	Returns axis specific status (i.e. limit and home states) of axis 1, axis 2
Drive Status	<n>SD1, <n>SD2	Returns drive specific status (i.e. type of amp fault) of axis 1, axis 2
System Status	<n>SS	Returns general system status and operation

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Serial Immediate Status Commands

Note: All but the S and K commands require an address

CB — Clear Command Buffer

Syntax: <n>CB

Clears the terminal input buffer and buffered command buffer

IS — Tell Input States

Syntax: <n>IS

Returns the current state (on or off) of the 8 inputs. The status is returned as a four digit hexadecimal number, preceded by an asterisk. The least significant digit represents the binary value of inputs 4-1.

Example: IS returns *00F6<cr> with the input conditions shown in this table.

n/a								Inputs							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
off	off	off	off	off	off	off	off	on	on	on	on	off	on	on	off
0				0				F				6			

Your computer program will have to decode the hexadecimal number to determine the state of any each input.

K — Kill

Syntax: <n>K

Issuing the K command causes the control to abruptly stop commanding further motion and terminates program execution. No deceleration ramp is used with this command. Caution should be used in issuing this command because of the damage instantaneous deceleration could cause to mechanics The Stop commands provides a more controlled halt.

MN — Model Number

Syntax: <n>MN

Returns the unit model number.
MN command responses are: *S6961 *S6962

OS — Tell Output States

Syntax: <n>OS

Returns the current state (on or off) of the 8 Outputs and any of the Optos that are configured as digital Outputs. The status is returned as a four digit hexadecimal number, preceded by an asterisk.

Example: OS returns *00F6<cr> with the Output conditions shown in this table.

n/a								Inputs							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
off	off	off	off	off	off	off	off	on	on	on	on	off	on	on	off
0				0				F				6			

Your computer program will have to decode the hexadecimal number to determine the state of any output.

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Serial Immediate Status Commands Note: All but the S and K commands require an address		
Command	**Command Description and Application Examples**	**Syntax**
PA	**Tell Absolute Position** Reports current position in user units based on encoder mode selected. Can report specifically commanded or encoder position when PAa,n is used. a = C (Commanded Position) E (Encoder Position) i = 1-2 axis Examples: PA2 Returns axis #2 encoder mode position PAC,1 Returns axis #1 commanded position	**<n>PAn** **<n>PAa,i**
RS	**Reset System** Re-initializes, or warm boots, the control software to its power-up state. The initialization process takes about 10 seconds to complete. Programs and configuration settings are not erased. This command is the equivalent of cycling power.	**<n>RS**
S	**Stop** Terminates program execution and immediately decelerates each motor to a halt (at a rate set by the SR command). Functions the same as the pressing ESC key on the IDC keypad or activating an input defined as a Stop input.	**<n>S**

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Serial Immediate Status Commands

Note: All but the S and K commands require an address

Command	Command Description and Application Examples	Syntax
SA	**Tell Axis Status** Returns the current axis status as a four digit hexadecimal number, preceded by an asterisk. Your controller program will decode the hexadecimal number to determine the axis status. Example: SA1 returns *002A<cr>. This means Axis 1 is not moving, the last move completed successfully, and the home switch is on.	**<n>SA1**

Status															
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
off	off	off	off	off	off	off	off	off	off	on	off	on	off	on	off
0				0				2				A			

Description	bit #	Parameter Definition
Not Moving/Moving	1	1=Steps being sent to the amplifier 0= No steps being sent
At Velocity	2	1= Stepping at a constant rate (includes zero velocity) 0= Step rate is changing
In Range	3	B8961/2 only
Move Command Complete (Same as Move Done Output)	4	1=The correct number of steps were sent without an amp fault, following error, or hitting an End of Travel limit. 0=Reset to zero at the beginning of each move.
Home Successful	5	1= The last homing move was successful 0= At power up, reset to zero at the start of the next jog, GO, or GH.
Home Switch Status	6	Hardware status of home switch. 0=off, 1= on
- Limit Switch Status	7	Hardware status of limit switch 0=off, 1= on, limits require a NC switch
+ Limit Switch Status	8	Hardware status of limit switch 0=off, 1= on, limits require a NC switch
- Limit Switch Latched	9	1= Set when a move is terminated by a limit in the - direction. Cleared at the start of a move in the + direction. 0= At power up or reset, even if on the - limit.
+ Limit Switch Latched	10	1= Set when a move is terminated by a limit in the + direction. Cleared at the start of a move in the - direction. 0= At power up or reset, even if on the + limit
RESERVED	11	State undefined, should be masked
RESERVED	12	State undefined, should be masked
RESERVED	13	State undefined, should be masked
RESERVED	14	State undefined, should be masked
RESERVED	15	State undefined, should be masked
RESERVED	16	State undefined, should be masked

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Serial Immediate Status Commands

Note: All but the S and K commands require an address

Command	Command Description and Application Examples	Syntax
SD	**Tell Drive Status** Returns the current drive status as a four digit hexadecimal number, preceded by an asterisk. Your controller program decodes the hexadecimal number to determine the drive status. Example: SD1 returns *0010<cr>. This means Axis 1 is enabled, in position mode, and is not faulted.	**<n>SD1**

Status															
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
off	off	off	off	off	off	off	off	off	off	off	on	off	off	off	off
0				0				1				0			

Description	bit #	Parameter Definition
Following Error	1	1= Following error occurred 0=At power up and reset. Set to zero at the start of the next move.
Over-current	2	1= Over Current (requires reset to clear) 0= At power up and after reset.
Thermal Fault	3	1= Thermal fault in the motor or drive (requires reset to clear) 0= At power up and after reset.
RMS Over-current *B8961/2 only*	4	1= RMS current limit exceeded. (requires reset to clear) 0= At power up and after reset
Drive Enabled	5	1= Enable Drive (see also EA1) 0= Disable Drive (see also EA0)
RESERVED	6	State undefined, should be masked
RESERVED	7	State undefined, should be masked
Torque/Position *B8961/2 only*	8	1= Amplifier in torque mode (TM1, call factory for details) 0= Amplifier in position mode. (factory default)
Amplifier Fault	9	1= The amplifier is faulted. Requires a power cycle to reset. 0= At power up or reset
RESERVED	10	State undefined, should be masked
RESERVED	11	State undefined, should be masked
RESERVED	12	State undefined, should be masked
RESERVED	13	State undefined, should be masked
RESERVED	14	State undefined, should be masked
RESERVED	15	State undefined, should be masked
RESERVED	16	State undefined, should be masked

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Serial Immediate Status Commands

Note: All but the S and K commands require an address

Command: SS

Syntax: <n>SS

Tell System Status

Returns the current system status as a four-digit hexadecimal number, preceded by an asterisk. Your controller program decodes the hexadecimal number to determine the system status.

Example: SS returns *0001<cr> means there are no amplifier faults, and no programs running - SmartDrive is ready to process any buffered RS-232C command.

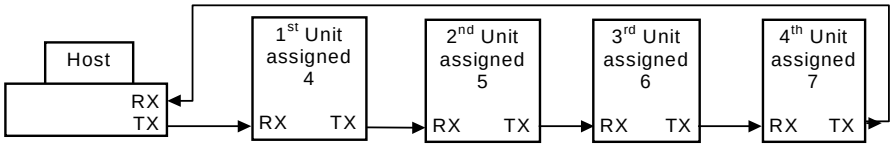
Status															
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
off	off	off	off	off	off	off	off	off	off	off	on	off	off	off	on
0				0				0				1			

Description	bit #	Parameter Definition
Ready to Buffer RS-232C Commands	1	1= Ready to buffer RS-232C commands 0= Initializing from a power-up or reset, or unchecked errors exist. Any buffered commands sent will be discarded.
FLASH Error	2	1= Non-volatile memory checksum error, all programs were deleted on power up. 0= Non-volatile memory checksum OK
Program Running	3	1= Running a program 0= Not running a pre-defined program.
FK Active	4	1= Paused waiting for a function key. 0= Not waiting at a FK command.
WT Active	5	1= Paused waiting for a input condition. 0= Not waiting at a WT command
TD Active	6	1= Paused at a time delay. 0= Not waiting at a TD command
Waiting for IV	7	1= Paused, waiting a variable input. 0= Not waiting at a IV command
Buffer Full	8	1= RS-232C buffer 75% full Total Capacity: 2k 0= RS-232C buffer less than 60% full.
Axis #1 Fault	9	1= Amp fault, following error, move stopped by limit switch (see SAi and SDi for more detailed fault information) 0= No faults
Axis #2 Fault	10	1= Amp fault, following error, move stopped by limit switch (see SAi and SDi for more detailed fault information) 0= No faults
RESERVED	11	State undefined, should be masked
Program Select Scanning	12	1=BCD and Binary program select scanning enabled. 0=A Stop Scan condition has occurred or no inputs are configured as program select lines.
Data Download Status	13	1=Data Transfer failed (program memory overflow) 0=Data successfully received
RESERVED	14-16	State undefined, should be masked

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Serial Supervisory Commands

The following commands control program uploading, downloading, deleting, execution, etc. All of these commands are fully defined in this section.

Command	Command Description and Application Examples	Syntax
AA	**Auto Address** The AA command automatically addresses SmartDrive units in a daisy chain. It assigns an address to each unit on the daisy chain. This allows the units to be wired in a daisy chain without setting each unit's address manually. The AA command parameter n indicates the value in which the addressing sequence will begin.  In the example above, the Host issues an **AA4** and the units are addressed 4, 5, 6, 7. This offers the convenience of adding a new unit anywhere in the daisy chain without manually re-addressing all the other units. Just connect the new unit, issue an AA command from the new unit with the address of the new unit as the AA parameter, i.e. AA*i*.	**<n>AA or AAi**
DP	**Delete Program** Erases a program from memory, where i is the program number. This is equivalent to pressing the delete key on the keypad and entering the program number. Range: 1-199 (1-400 with 30K memory option) Example: DP99 (deletes program number 99).	**<n>DPi**
DR	**Download Program to RAM** Begins downloading a program from the host to the control's RAM, rather than non-volatile memory. (Also see the PR command description) These programs will be lost after a reset or power cycle. The program string must end in EP. The commands between DR and EP do not need a device address. The DR command is typically used when the control is operated exclusively via a host controller which constantly downloads and executes programs. This increases the usable life of the FLASH. Range: 1-199 (1-400 with 30K memory option) Example: 1DR50 AC4 DE4 VE30 LP6 DI10.5 GO EN 1EP RN50 Downloads program #50 to Unit #1's RAM, then runs program #50	**<n>DRi**
EC	**RS-232C Echo Enable/Disable** 0 = echo Disabled, 1 = echo Enabled. Example: EC0 (echo off) The RS-232C Echo must be enabled for daisy chain operation	**<n>ECi**
EP	**End Program Definition** Denotes the end of a program definition. All program definitions must begin with nPRi or nDRi and end with EP. Example: PR15 [part A] AC4 VE30 DI10.5 GO EP	**<n>EP**

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Serial Supervisory Commands

The following commands control program uploading, downloading, deleting, execution, etc. All of these commands are fully defined in this section.

Command	Command Description and Application Examples	Syntax
EX	**Ends Upload All or Load All** Singles the end of a upload all (UA) or load all (LA) sequence. EX is sent by the SmartDrive to the host after completing a UA. EX is sent by the host to the SmartDrive to terminate a LA.	**<n>EX**
LA	**Load All** Sent to the SmartDrive before downloading a long list of setup parameters and programs. This command will disable the non-addressed units so that each setup parameter doesn't need an address. Must be followed by an EX to reestablish the daisy chain communications.	**<n>LA**
LS	**List Programs** Lists number of programs, memory usage, and the current available memory of the SmartDrive. Just like **Edit/List** from the keypad.	**<n>LS**
OC	**Original Configuration** Returns the FLASH to its original factory-default state. The command buffer is cleared, all programs are erased, and all configuration settings are returned to their default values	**<n>OC**
PR	**Define Program** Starts a program definition. Just like the DR command, but writes the Smart-Drives non-volatile EEPROM memory. Example: PR25 AC.1 VE5 DI10 GO EP (uses only a program number). Example: PR25 [P/N 170-001] AC.1 VE5 DI10 GO EP (uses optional program name).	**<n>PRi**
RN	**Run Program** This commands any program, by number only. The RN command does not support the optional program names. Example: RN25	**<n>RNi**
SW	**Software/Firmware Version** SW returns firmware version SW1 returns DSP, FPGA, and firmware versions	**<n>SW**
UA	**Upload All** Uploads all setup parameters and programs from unit n. SmartDrive sends an EX to terminate upload.	**<n>UA**
UL	**Upload Program** Range: i=1-199 (program #) (up to 400 programs with 30K option) Uploads program number i to the host - SmartDrive adds brackets. Example: 1UL2 Uploads program 2 from unit #1. Response: { [part A] AC4 VE30 DI10.5 GO }	**<n>ULi**

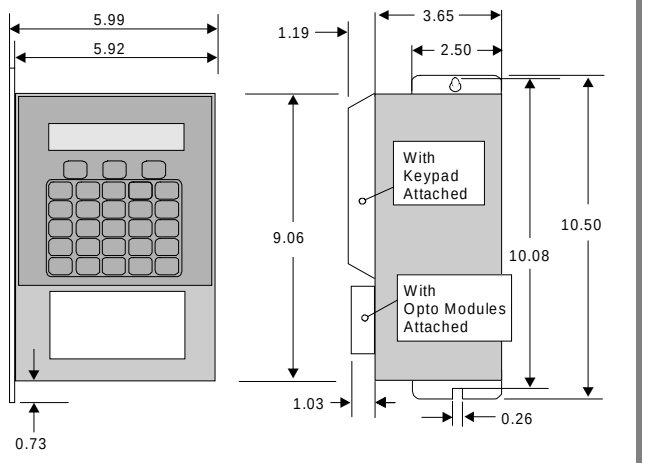
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Chapter 9 - Hardware Reference

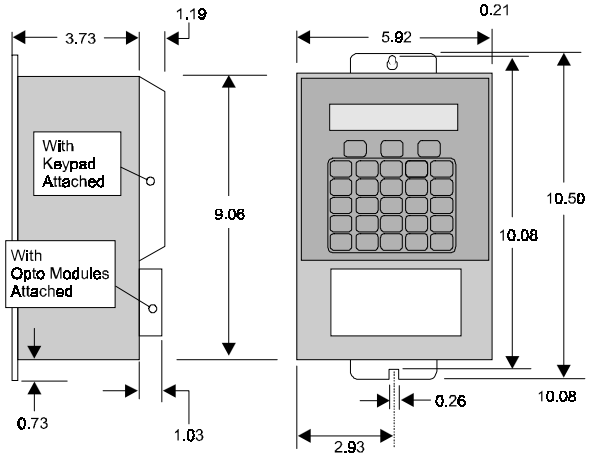
Mounting Your S6961/2

Your S6961/6962 SmartDrive arrived ready for a minimum depth cabinet mounting. By moving the mounting bracket to the narrow side of the heatsink, you can mount the SmartDrive in a minimum width configuration.

Minimum Width Mounting Dimensions



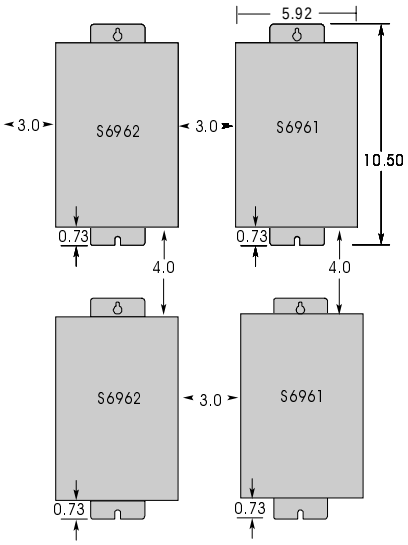
Minimum Depth Mounting Dimensions



The S6961/2 depends on air flow for cooling. In all but the least demanding applications, the following mounting guidelines should be observed:

- Allow approximately one inch clearance for a fan kit (-FK1) if the available air flow appears marginal. The fan-kit adds 1.05 in to the depth of the drive if mounted in the Minimum Depth Configuration. It adds 1.05 in to the width if mounted in the Minimum Width Configuration.
- The heat sink fins should be oriented vertically for convection currents to flow along the fins.
- The vertical clearance between an S6961/2 drive and other equipment or surfaces of the enclosure should be a minimum of 4.0 inches. Horizontal clearance should be a minimum of 3.0 inches. See drawing.
- High heat-generating equipment should not be mounted directly below this drive.

Minimum Panel Mounting Separation (in.)



Forced air cooling may be necessary if air flow is extremely poor, if the ambient temperature is excessive (above 35(C). See *-FK1 Fan Kit.*

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Mounting S6961/2 in an Enclosure - Proper Ventilation

Adequate ventilation is critical for optimum performance and prevention of damage to components when mounting your S6961/2 in an enclosure. The cooler this or any other electronic equipment is maintained, the longer its life expectancy.

Heat produced by the drive will be introduced into the enclosed environment, increasing ambient temperature. If the drive is enclosed, this hot air must be exhausted from the enclosure to maintain as low an ambient temperature as possible.

In still air the heatsink temperature will rise 0.9°C per watt above the ambient temperature. If air flow is maintained across the heatsink, the thermal resistance may decrease to about 0.4°C per watt. The FK1 Fan Kit, described below, achieves 0.3°C/W decrease in thermal resistance.

Calculating Heat Dissipation

In order to determine how to best provide ventilation, it may be necessary to calculate the amount of heat dissipation or thermal loss by your S6961/2. To estimate the thermal loss for the S6961/2, use the following formula:

$$P_{Th} = 5.7 + 2.67(I_1 + I_2) + .2(I_1^2 + I_2^2) \text{ watts}$$

where I_1 and I_2 are the commanded current settings in axis 1 and 2. To estimate the dissipation from an S6961/2, add 5 watts to the dissipation calculated.

Example:
For a one-axis drive (S6961) with I_1 = 5 amps:

$$P_{Th} = 5.7 + 2.67 \times 5 + 0.2 \times (5^2) = 24 \text{ watts}$$

The power loss in the drive is NOT related to motor load or the work the motor is performing. If regen occurs regularly, then the regen energy adds to the drive losses because it is turned into heat in the internal power dump resistor. At high speed where the torque falls off, the current is also lowered by the same proportion and consequently the drive losses are lowered accordingly. If standby current is invoked, the current becomes 0.7 of the set value, and the drive losses fall as determined by the above formula. The safest estimate is to simply assume that the current is always at the set value. Operation at high speed or standby at rest gives some headroom by creating somewhat less heat.

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FK1 Fan Kit

The FK1 Fan Kit Option may be necessary if air flow across the S6961/2 drive heat sink is extremely poor, or if the ambient temperature is excessive. FK1 is required by IDC for all applications where the total drive current (axis one current plus axis two current in the case of the S6962) exceeds 6.0 Amps. A fan kit is automatically provided when the 8 amp version of the Smart Drive (S696n-8A) is ordered.

If your S6961/2 drive shuts down repeatedly due to an over temperature condition, you will have to take steps to increase cooling. The FK1 fan kit can be purchased as a field retrofit kit (part number FANKIT-1). The 115 VAC power for the fan is supplied by the S6961/2 drive. Please consult IDC for more information.

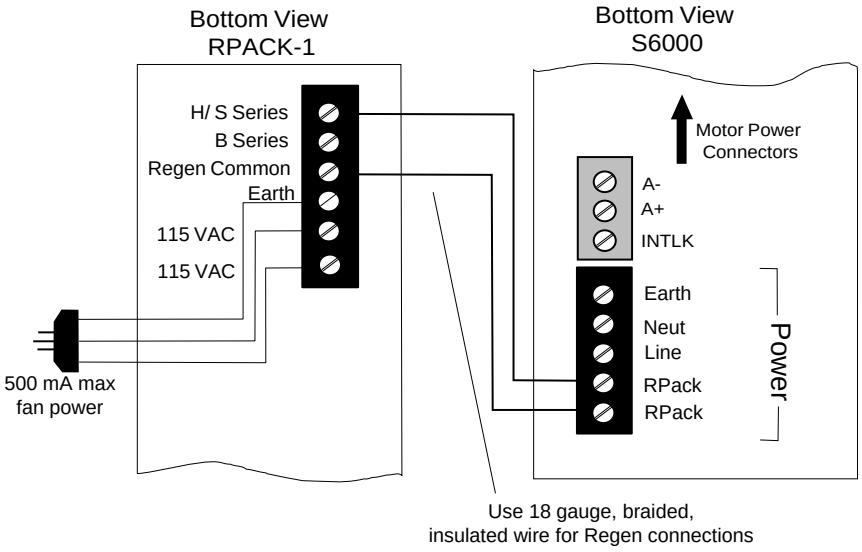
See the latest IDC catalog for additional information on the fan kit, including mounting dimensions.

RPACK-1 Mounting and Installation

The RPACK-1 is a packaged power dump device consisting of high voltage power resistors, a heatsink and a cooling fan. It is an accessory to IDC's S, H and B Series controls.

The RPACK-1 is typically used when it is necessary to very rapidly decelerate heavy vertical loads or large inertial loads. The RPACK-1 dissipates the kinetic and potential energy that would otherwise cause the drive to shutdown due to an Over-Voltage or Regen fault. Using an RPACK-1 can help reduce overall cycle time by allowing a higher deceleration rate than would be possible without it.

The RPACK-1 mounting dimensions are the same as the S6961/2 mounting dimensions. Electrical connections should be made according to the diagram below.



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Remote Mounting Your FP220 Keypad

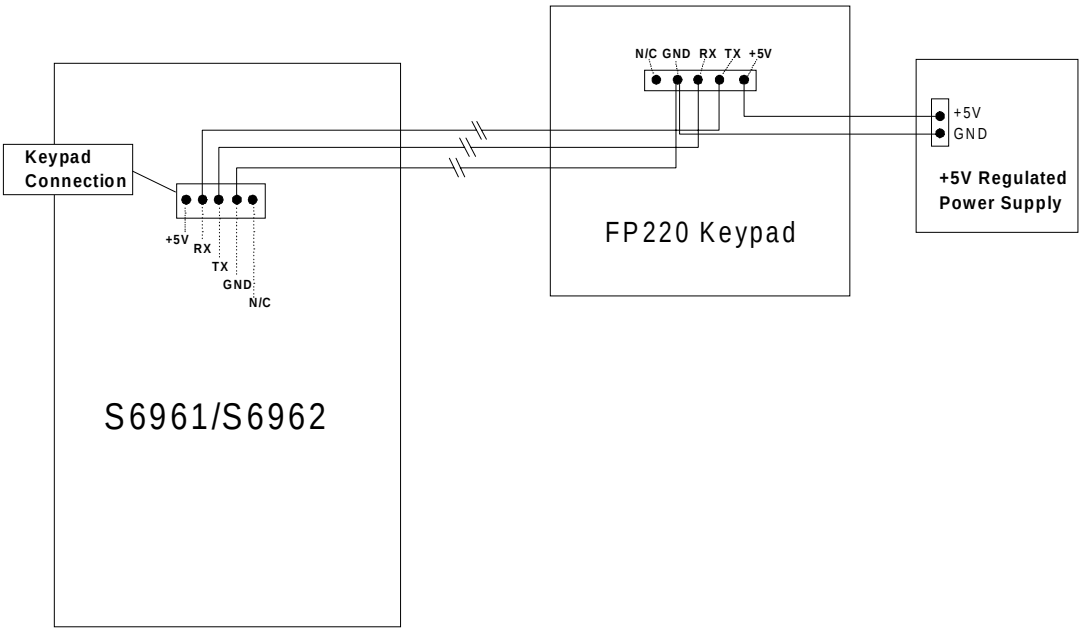
The keypad can easily be mounted and sealed to NEMA 4 specifications by using the included mounting gasket and 6-foot communication cable. **Warning: Do not attach the gasket to the keypad.** Attach the gasket with the adhesive side toward the mounting enclosure. A pressure-seal is formed between the gasket and the keypad, while the adhesive maintains the seal between the enclosure and the gasket.

The keypad communicates with the SmartDrive via RS-232C and this cable may be extended if necessary. For distances greater than the standard remote cable length, a separate +5VDC supply may be required to power the keypad. See drawing below for power supply connections.

An FP220 Keypad Mounting Template is included with every keypad. Please pay particular attention to the **CAUTION** on the template.

Extending the Cable Length to Your Keypad

The keypad requires a stable +5VDC to operate its electronics. Since voltage drop may occur at long cable lengths, it may be necessary to connect an independent power supply as shown below:



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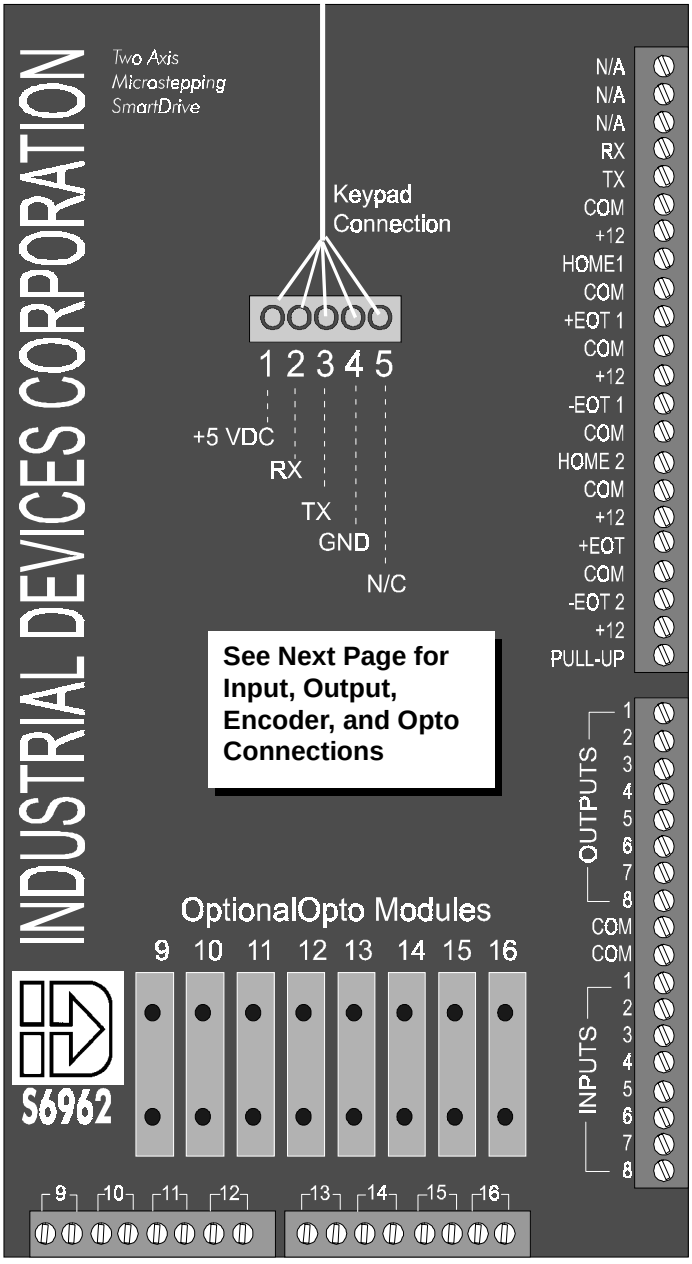
S6961/S6962 Smart Drive Hardware Specifications

AC Power	105-132 VAC single phase, 50/60 Hz	
	S6961	500 VA maximum
	S6962	1000 VA maximum
Motor Output	Voltage	160 VDC bus, with 115 VAC input
	Current	Switch selectable. 0.1-6.0 Amps/phase (0.1-7.9 Amps/phase with -8A option)
	Waveform	Switch selectable. Pure sine or -4% 3rd harmonic distortion
	Resolution	Switch selectable. 200, 400, 1000, 5000, 10000, 18000, 25000, 25400
	Stand-by	Switch selectable. Reduces motor current to 70% if no step pulses are received for 250 ms. Full current restored upon next step pulse
	Protection	Shuts down due to short circuits (phase to phase and phase to ground), Open circuits, Brownout, and Over temperature
	Anti-Res Compensation	Switch selectable (0-7) gain setting for motor resonance compensation
Step Motor Specifications	IDC's S Series motors have custom windings to provide optimum dynamic performance with our S6000 drives. If you need to use another manufacturer's motors, they should meet the following guidelines: • 2 phase, hybrid, permanent magnet step motor • 4, 6, or 8 lead motor • Series or parallel inductance rating between 2-60 mH. Higher inductance motors will not damage the drive, but they will have limited dynamic performance. • A minimum high-pot test rating of 500 VDC	
Command Interface	Type	RS-232C serial type, 3 wire implementation (TX, RX, & COM)
	Parameters	9600 Baud, 8 data bits, 1 stop bit, no parity, XON/OFF
	Configuration	Up to 99 units can be supported over RS-232C on a daisy chain
Inputs	Programmable Inputs	8 optically isolated programmable inputs, Limits, Home. All inputs are active low, optically isolated inputs. Min current:12 mA, Max: 35 mA 250 mA max. current available from on board 12Vdc supply
	Encoder	Differential quadrature incremental (TTL). Max freq. of 1.5MHz Power +5 VDC @ 200 mA output power for each external encoder
Outputs	Programmable Outputs	8 optically isolated, open collector, programmable outputs
	Isolated Pull-Up	5-24 VDC, 100 mA max. current per output. 250 mA max. current available from 12 VDC supply.
	OPTO compatible I/O	8 OPTO compatible: Any G4 I/O module; analog & temperature
Controller Performance	Positioning Range	± 2,147,483,647 steps; absolute and incremental
	Velocity Range	0 to 1,250,000 steps/sec (motor and voltage dependent)
	Acceleration Range	0.002 seconds to 2.0 hours
Environmental	Drive Temp.	Thermal Shutdown occurs if the drive heatsink temp. exceeds 70°C
	Motor Temp.	Max winding temp 135°C(thermostat protected)
	Humidity	0 - 90% non-condensing

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S6961 and S6962 Hardware Connections

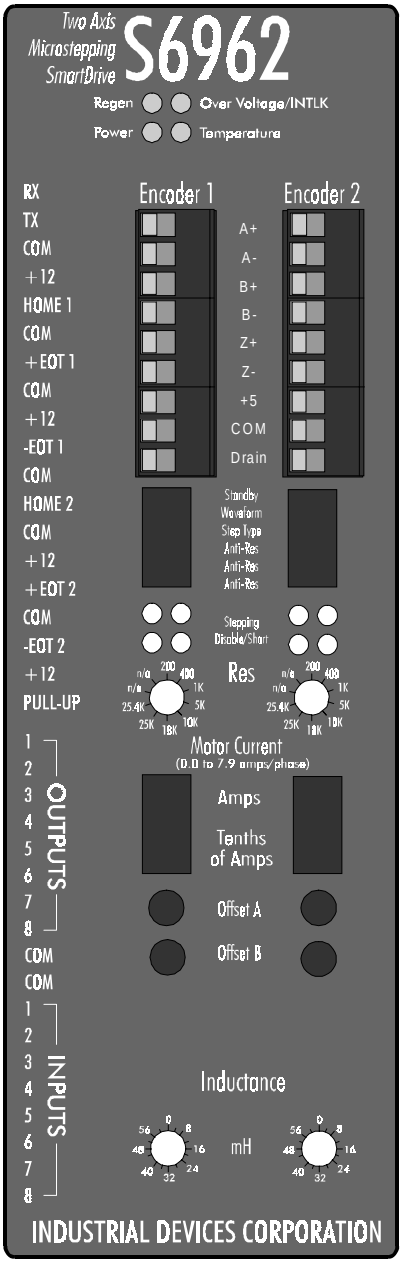
S6962 shown here. S6961 has same features for single axis.

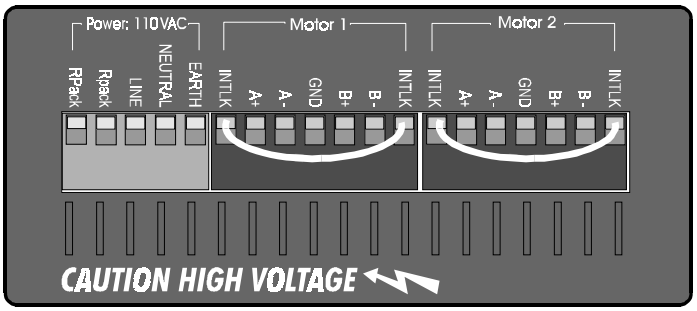


See Next Page for Input, Output, Encoder, and Opto Connections

OPTO Connections

Side Panel



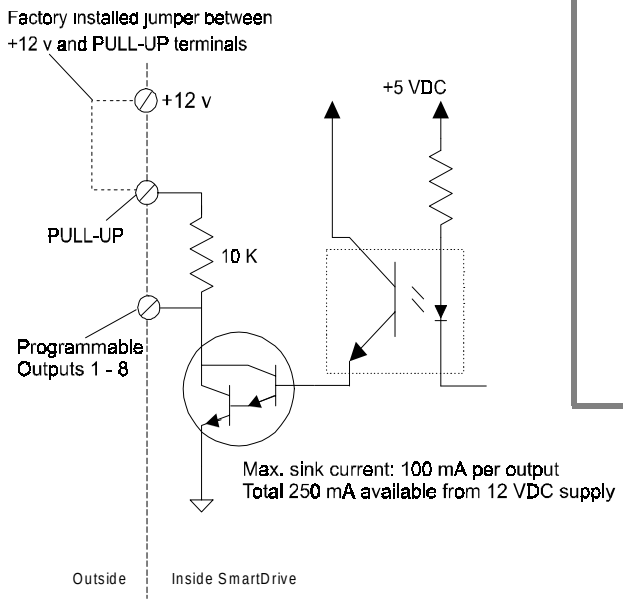


See Chapter 5 for Motor and Power Connections

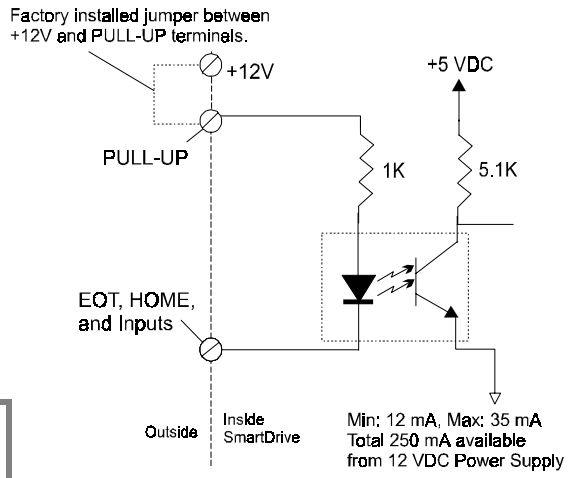
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S6961 and S6962 Input and Output Schematics

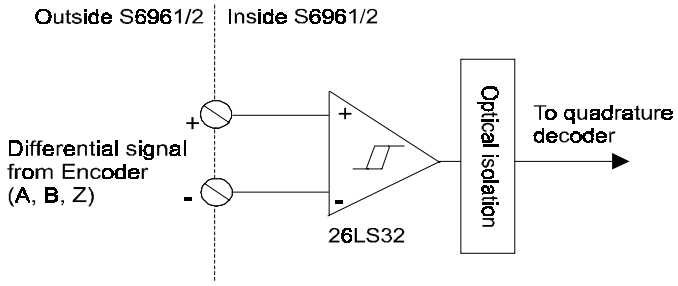
Programmable Output Schematic



Programmable Input Schematic



Encoder Input Schematic

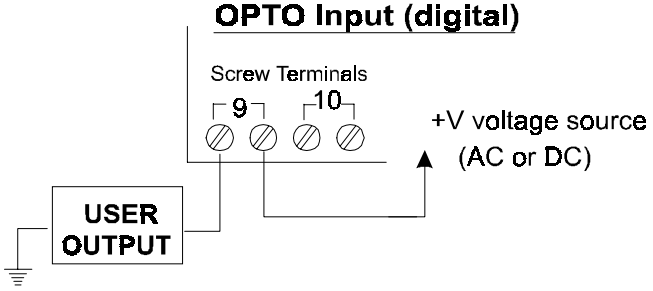


Connecting an Encoder to an S6961/2

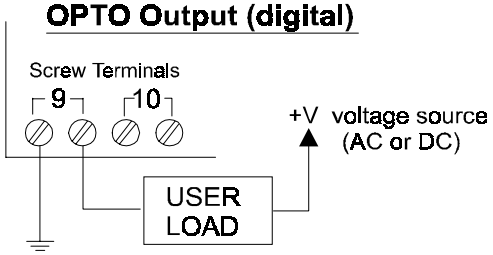
(Color codes are for IDC encoders only. Use signal names for other manufacturer's encoders)

Encoder Wiring Color Code			
Encoder Connector on S6961/2	**Standard Encoder**	**-EQ Cable for P & K Motors**	
	Color	**Pin-Out**	**Color**
A+	Red	B	Red
A-	Pink or Purple	C	Pink or Purple
B+	Green	N	Green
B-	Blue	P	Blue
Z+	Yellow	M	Yellow
Z-	Orange	U	Orange
+5V	White	K	White
Com	Black	T	Black
Drain	Shield	---	---
			Brown (N/C)

OPTO Input (digital)

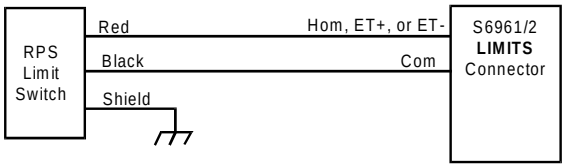
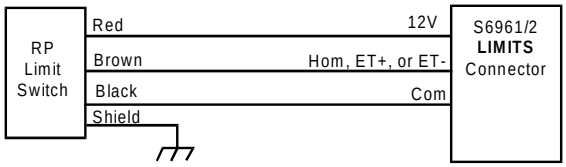
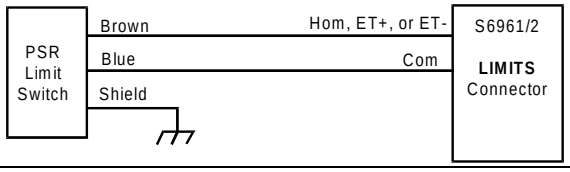
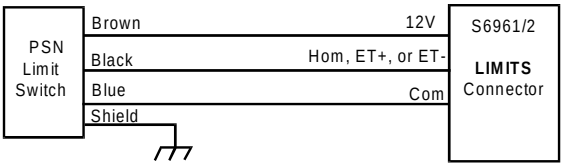


OPTO Output (digital)



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Connecting IDC Limit Switches to the S6961/2

IDC Limit Switches			
Switch	Type	Comments	Connections
RPS-1 RPS-2	Normally Open Home only Normally Closed	Reed Switch - has less wiring and lower cost Mounts to N, T, R2, R3, and R4 Actuators	
RP-1 RP-2	Normally Open Home only Normally Closed	Hall Effect Switch - has longer life, and uses LEDs Mounts to N, T, R2, R3, and R4 Actuators	
PSR-1 PSR-1Q PSR-2 PSR-2Q	Normally Open Home Only Normally Closed	Reed Switch - “Q” indicates Quick Disconnect Mounts to EC, NV	
PSN-1 PSN-1Q PSN-2 PSN-2Q	Normally Open Home Only Normally Closed	NPN Hall Effect - “Q” indicates Quick Disconnect Mounts to EC, NV	
PSP-1 PSP-1Q PSP-2 PSP-2Q	Normally Open Normally Closed	PNP Hall Effect Used on Controls requiring PNP Mounts to EC, NV	Will Not Work with IDC Controls

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OPTO Modules (optional)

IDC stocks the following Opto modules, which may be specified when ordering an S6961 or S6962:

Order Code (p/n)	I/O Module Description	Opto-22 P/N	Grayhill P/N
A (PCB-1210)	10-32 VAC/VDC Input	G4IDC5	70G-IDC5NP
B (PCB-1211)	TTL Input	G4IDC5K	
C (PCB-1212)	35-60V DC Input	G4IDC5G	70G-IDC5G
D (PCB-1213)	90-140 VAC Input	G4IAC5	70G-IAC5
E (PCB-1214)	180-240 VAC Input	G4IAC5A	70G-IAC5A
F (PCB-1215)	5-60 VDC, 3 Amps Output	G4ODC5	70G-ODC5
G (PCB-1216)	12-140 VAC, 3 Amps Output	G4OAC5	70G-OAC5
H (PCB-1217)	Output 24-280 VAC, 3 Amps	G4OAC5A	70G-OAC5A
I (PCB-1218)	Input Test Switch	G4SWIN	
J (PCB-1219)	0-10 Volt Analog Input		73G-IV10
K (PCB-1220)	4-20 mA Analog Input		73G-II420
L (PCB-1221)	0-10 Volt Analog Output		73G-OV10
M (PCB-1222)	4-20 mA Analog Output		73G-OI420
N (PCB-1223)	J Type Thermocouple Input, 0 to 700(C		73G-ITCJ
O (PCB-1319)	K Thermocouple Input -100 to 924(C		73G-ITCK
P (PCB-1224)	RTD Thermocouple Input, 100 Ohm		73G-ITR100

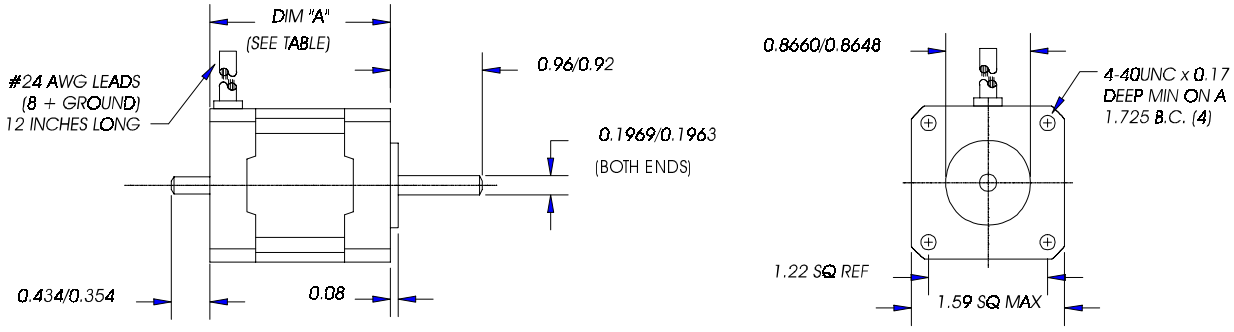
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Accessories for the S6961 and S6962

S6961/S6962 Accessories		
Accessory (P/N)		**Description**
PCS-4852		SmartDrive-to-PC Cable
PCS-5004		PC-Keypad Cable for copying programs between keypad and PC
RPACK-1		External Regenerative Power Dissipation Module
FK1 Fan Kit		Fan Kit for High Performance Applications

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S12 Hybrid Step Motor Specifications



T=Series V=Parallel

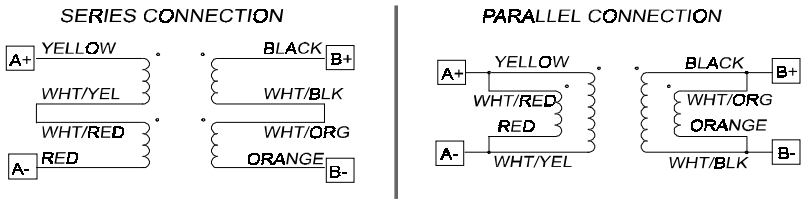
Electrical Specs.		S12T	S12V
Continuous Stall Torque	oz-in [N-m]	35 [0.25]	
Recommended Current/Phase	Amps	1.0	2.0
Winding Resistance @ Ambient	Ohms	5.52	1.38
Inductance	mH	8.8	2.2
Max. Winding Temperature	°F [°C]	212 [100]	
Mechanical Specs.		**S12T**	**S12V**
Rotor Inertia	oz-in-s^2 [kg-m^2]	5.1x10^{-4}	
Axial Shaft Load	lbs [N]	10 [45]	
Radial Shaft Load @ 0.5 inches	lbs [N]	5 [22]	
Motor Weight	lbs [kg]	0.66 [0.3]	
Step Angle (full step)	degrees	1.8	

Notes:
- Parallel (V) wiring: 50% duty cycle max. above 5 rps (300 rpm).
- Always use at least 30% torque safety margin when applying step motors.

Drive Settings

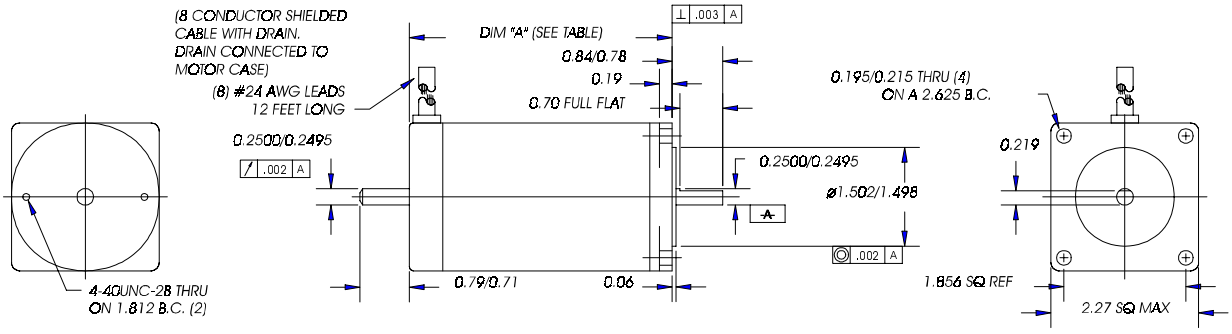
S12T - Series		S12V - Parallel	
Current	Inductance	Current	Inductance
1.0 Amps	**8 mH**	**2.0 Amps**	**4 mH**

Motor Wiring



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S21/S22/S23 Hybrid Step Motor Specifications



T=Series V=Parallel

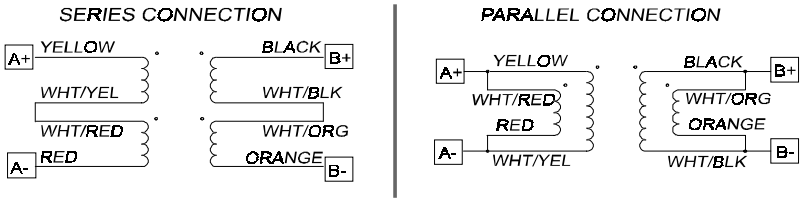
Electrical Specs.		S21T	S21V	S22T	S22V	S23T	S23V
Continuous Stall Torque	oz-in [N-m]	65 [0.46]		100 [0.71]		125 [0.88]	
Recommended Current/Phase	Amps	1.2	2.4	1.5	3.0	1.75	3.5
Winding Resistance @ Ambient	Ohms	5.4	1.35	4.8	1.2	4.4	1.1
Inductance	mH	18	4.5	18	4.5	18	4.5
Max. Winding Temperature	°F [°C]	212 [100]		212 [100]		212 [100]	
Mechanical Specs.		**S21T**	**S21V**	**S22T**	**S22V**	**S23T**	**S23V**
Rotor Inertia	oz-in-s^2 [kg-m^2]	1.66x10^{-3}[1.17x10^{-5}]		3.31x10^{-3}[2.34x10^{-5}]		4.97x10^{-3}[3.51x10^{-5}]	
Axial Shaft Load	lbs [N]	25 [111]		25 [111]		25 [111]	
Radial Shaft Load @ 0.5 inches	lbs [N]	5.6 [25]		5.6 [25]		5.6 [25]	
Motor Weight	lbs [kg]	1.6 [0.73]		2.4 [1.1]		3.2 [1.5]	
Step Angle (full step)	degrees	1.8		1.8		1.8	

Drive Settings

S21T - Series		S21V - Parallel	
Current	Inductance	Current	Inductance
1.2 Amps	**16 mH**	**2.4 Amps**	**4 mH**
S22T - Series		**S22V - Parallel**	
Current	Inductance	Current	Inductance
1.5 Amps	**16 mH**	**3.0 Amps**	**4 mH**
S23T - Series		**S23V - Parallel**	
Current	Inductance	Current	Inductance
1.7 Amps	**16 mH**	**3.5 Amps**	**4 mH**

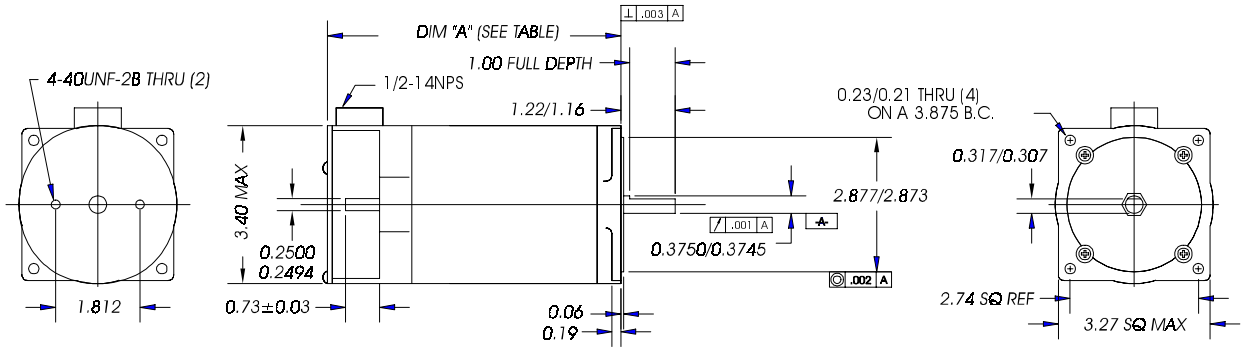
Notes:
- Parallel (V) wiring: 50% duty cycle max. above 5 rps (300 rpm).
- Always use at least 30% torque safety margin when applying step motors.

Motor Wiring



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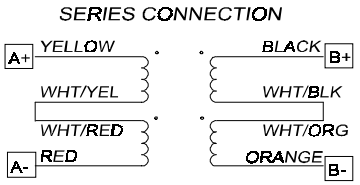
S32/S33 Hybrid Step Motor Specifications

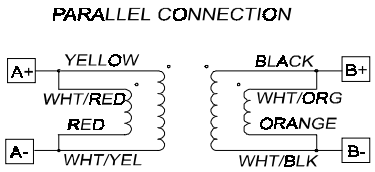


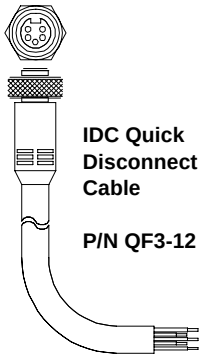
		T=Series		V=Parallel	
Electrical Specs.		**S32T**	**S32V**	**S33T**	**S33V**
Continuous Stall Torque	oz-in [N-m]	300 [7.1]		400 [5.3]	
Recommended Current/Phase	Amps	2.8	5.6	3.5	7.0
Winding Resistance @ Ambient	Ohms	1.03	.26	.96	.24
Inductance	mH	10	2.5	10	2.5
Max. Winding Temperature	°F [°C]	212 [100]		212 [100]	
Mechanical Specs.		**S32T**	**S32V**	**S33T**	**S33V**
Rotor Inertia	oz-in-s^2 [kg-m^2]	0.017 [3.51x10^{-5}]		0.0265 [3.51x10^{-5}]	
Axial Shaft Load	lbs [N]	50 [222]		50 [222]	
Radial Shaft Load @ 0.5 inches	lbs [N]	14.5 [64.4]		14.5 [64.4]	
Motor Weight	lbs [kg]	5.1 [2.3]		8.3 [3.8]	
Step Angle (full step)	degrees	1.8		1.8	

Notes:
- Parallel (V) wiring: 50% duty cycle max. above 5 rps (300 rpm).
- Always use at least 30% torque safety margin when applying step motors.

Motor Wiring







IDC Quick Disconnect Cable

P/N QF3-12

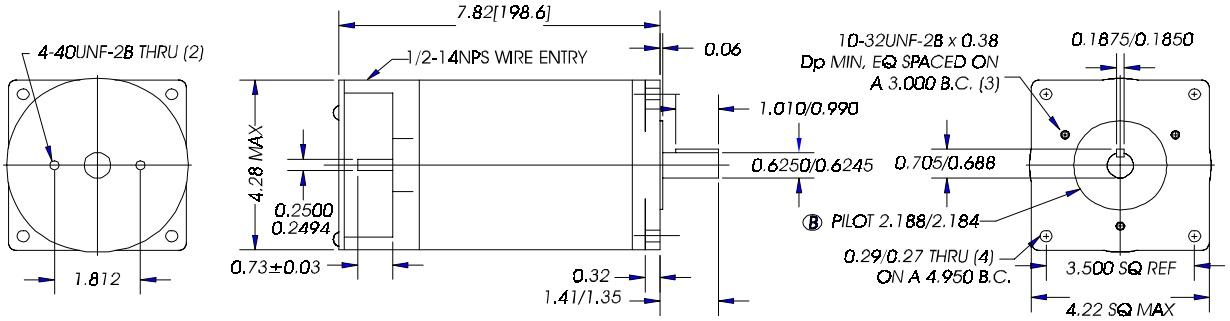
Wire Color on Quick Disconnect Cables	S6961/2 Connection
Red w/ Black	B-
Red w/ White	B+
Green	*GND
Red w/ Yellow	A-
Red	A+
*Gray-colored Quick Disconnect Cables are shielded - connect shield to GND.	

Drive Settings

S32T - Series		S32V - Parallel	
Current	Inductance	Current	Inductance
2.8 Amps	**8 mH**	**5.6 Amps**	**4 mH**
S33T - Series		**S33V - Parallel**	
Current	Inductance	Current	Inductance
3.5 Amps	**8 mH**	**7.0 Amps**	**4 mH**

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S42 Hybrid Step Motor Specifications

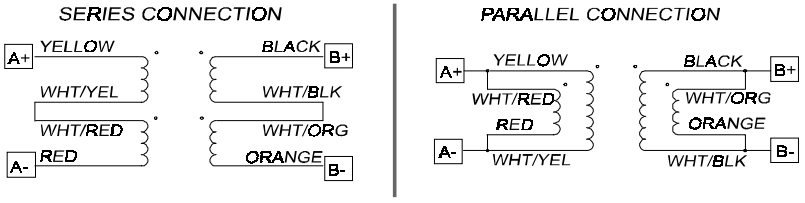


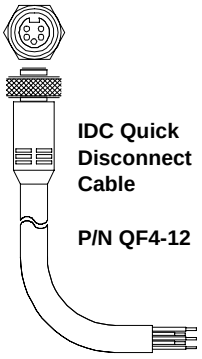
T=Series V=Parallel

Electrical Specs.		S42T	S42V
Continuous Stall Torque	oz-in [N-m]	1000 [7.1]	725 [5.1]
Recommended Current/Phase	Amps	6.0	7.9
Winding Resistance @ Ambient	Ohms	.36	.09
Inductance	mH	7	1.75
Max. Winding Temperature	°F [°C]	212 [100]	
Mechanical Specs.		**S42T**	**S42V**
Rotor Inertia	oz-in-s^2 [kg-m^2]	114x10^{-3}[80.5x10^{-5}]	
Axial Shaft Load	lbs [N]	65 [289]	
Radial Shaft Load @ 0.5 inches	lbs [N]	23.6 [105]	
Motor Weight	lbs [kg]	19.1 [8.66]	
Step Angle (full step)	degrees	1.8	

Notes:
- Parallel (V) wiring: 50% duty cycle max. above 5 rps (300 rpm).
- Always use at least 30% torque safety margin when applying step motors.

Motor Wiring





IDC Quick Disconnect Cable

P/N QF4-12

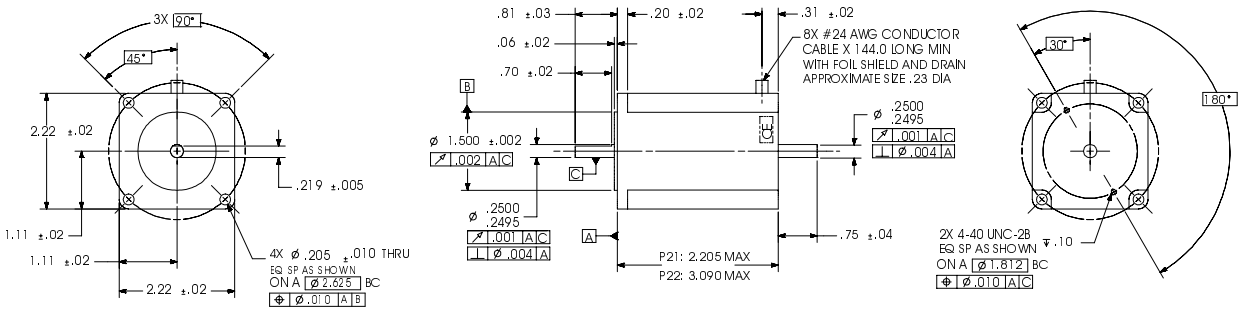
Wire Color on Quick Disconnect Cables	S6961/2 Connection
Red w/ Black	B-
Red w/ White	B+
Green	*GND
Red w/ Yellow	A-
Red	A+
*Gray-colored Quick Disconnect Cables are shielded - connect shield to GND.	

Drive Settings

S42T- Series		S42V - Parallel	
Current	Inductance	Current	Inductance
6.0 Amps	**8 mH**	**7.9 Amps**	**4 mH**

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P21/P22 Hybrid Step Motor Specifications



Note: Specs. apply to parallel (120 VAC) connections.

Electrical Specs.	**P21**	**P22**
Continuous Stall Torque oz-in [N-m]	100	200
Recommended Current/Phase Amps	1.3	2.0
Winding Resistance @ Ambient Ohms	4.7	3.7
Inductance mH	20	16
Max. Winding Temperature °F [°C]	248 [120]	
Mechanical Specs.	**P21**	**P22**
Rotor Inertia oz-in-s^2 [kg-m^2]	0.0035 [2.48 x 10^{-5}]	0.0061 [4.32 x 10^{-5}]
Axial Shaft Load lbs [kg]	10 [44]	
Radial Shaft Load @ 0.75 inches [19mm] lbs [kg]	15 [66]	
Motor Weight lbs [kg]	1.9 [0.86]	2.7 [1.23]
Step Angle (full step) degrees	1.8	

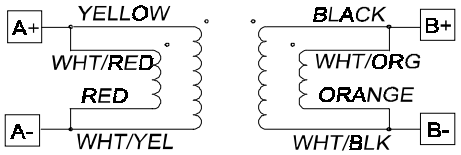
Note:
- Always use at least 30% torque safety margin when applying step motors.

Drive Settings

P21		P22	
Current	Inductance	Current	Inductance
1.3 Amps	**20 mH**	**2.0 Amps**	**16 mH**

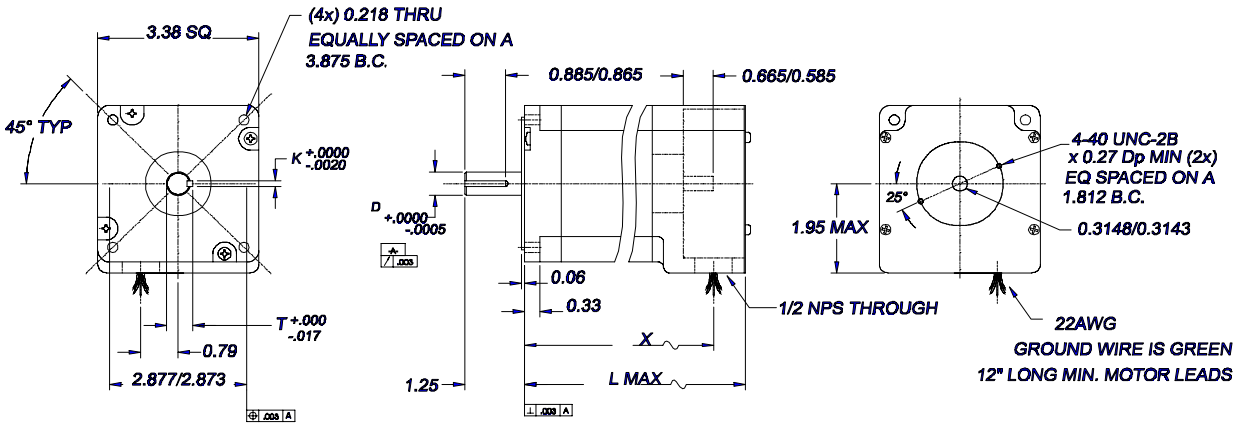
Motor Wiring (parallel only for S6961/2)

PARALLEL CONNECTION



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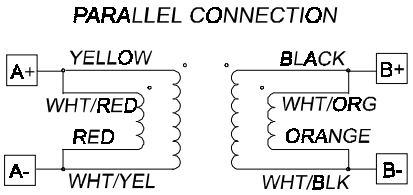
P/K 31, 32, 33 Step Motor Specifications



Motor Dimensions

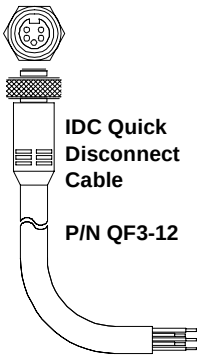
MOTOR	D	K	T	X	LMAX.
P31/K31	.5000	.1250	.555	(3.70)	4.44
P32/K32	.5000	.1250	.555	(5.22)	5.96
P33/K33	.6250	.1875	.705	(6.74)	7.48

Motor Wiring (parallel only for S6961/2)



Note: Specs. apply to parallel (120 VAC) connections.

Electrical Specs.		P31	P32	P33	K31	K32	K33
Continuous Stall Torque	oz-in [N-m]	450 [3.2]	920 [6.5]	1260 [8.9]	580 [4.1]	1200 [8.5]	1600 [11.3]
Recommended Current/Phase	Amps	2.9	3.3	4.0	2.9	3.3	3.3
Inductance	mH	14	30	25	14	30	30
Max. Winding Temperature	°F [°C]	212 [100]	212 [100]	212 [100]	212 [100]	212 [100]	212 [100]
Mechanical Specs.		**P31**	**P32**	**P33**	**K31**	**K32**	**K33**
Rotor Inertia	oz-in-s^2 [kg-m^2]	.0202	.038	.0567	.0202	.038	.0567
Axial Shaft Load	lbs [N]	305 [1350]	305 [1350]	305 [1350]	305 [1350]	305 [1350]	305 [1350]
Radial Shaft Load @ 0.5 inches	lbs [N]	65 [285]	65 [285]	110 [489]	65 [285]	65 [285]	110 [489]
Motor Weight	lbs [kg]	5	8.4	11.9	5	8.4	11.9
Step Angle (full step)	degrees	1.8	1.8	1.8	1.8	1.8	1.8

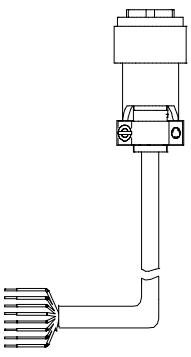


IDC Quick Disconnect Cable

P/N QF3-12

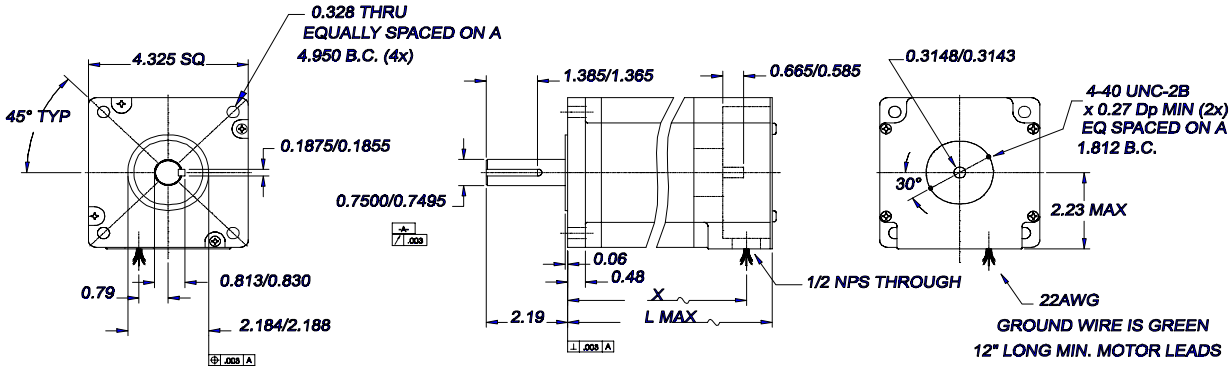
Wire Color on Quick Disconnect Cables	S6961/2 Connection
Red w/ Black	B-
Red w/ White	B+
Green	*GND
Red w/ Yellow	A-
Red	A+
*Gray-colored Quick Disconnect Cables are shielded - connect shield to GND.	

Encoder Color Code & Pin-out for P&K Motors		
Signal	**Pin**	**Color**
A+	B	Red
A-	C	Pink or Purple
B+	N	Green
B-	P	Blue
Z+	M	Yellow
Z-	U	Orange
+5V	K	White
COM	T	Black
Shld	---	---
		Brown (NC)



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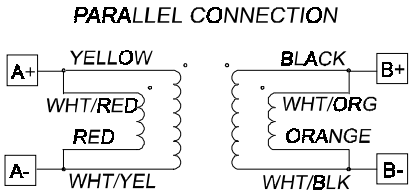
P/K 41, 42, 43 Step Motor Specifications



Motor Dimensions

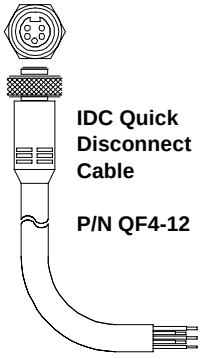
MOTOR	X	LMAX.
P41/K41	4.46	5.20
P42/K42	6.48	7.22
P43/K43	8.49	9.23

Motor Wiring (parallel only for S6961/2)



Note: Specs. apply to parallel (120 VAC) connections.

Electrical Specs.		P41	P42	P43	K41	K42	K43
Continuous Stall Torque	oz-in [N-m]	1250 [8.8]	2300 [16.2]	3250 [22.9]	TBD	3000 [21.2]	TBD
Recommended Current/Phase	Amps	5.7	6.6	6.6	5.7	6.4	6.6
Inductance	mH	15	21	28	15	15	28
Max. Winding Temperature	°F [°C]	212 [100]	212 [100]	212 [100]	212	212 [100]	212
Mechanical Specs.		**P41**	**P42**	**P43**	**K41**	**K42**	**K43**
Rotor Inertia	oz-in-sec	.0783	.1546	.2293	.0783	.1546	.2293
Axial Shaft Load	lbs [N]	404 [1790]	404 [1790]	404 [1790]	404	404 [1790]	404
Radial Shaft Load @ 0.5 inches	lbs [N]	125 [550]	110 [489]	110 [489]	125	110 [489]	110
Motor Weight	lbs [kg]	11	18.4	25.7	11	18.7	25.7
Step Angle (full step)	degrees	1.8	1.8	1.8	1.8	1.8	1.8

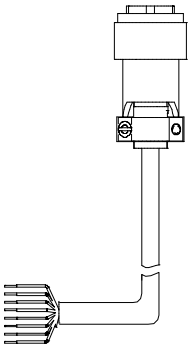


IDC Quick Disconnect Cable

P/N QF4-12

Wire Color on Quick Disconnect Cables	S6961/2 Connection
Red w/ Black	B-
Red w/ White	B+
Green	*GND
Red w/ Yellow	A-
Red	A+
*Gray-colored Quick Disconnect Cables are shielded - connect shield to GND.	

Encoder Color Code & Pin-out for P&K Motors		
Signal	**Pin**	**Color**
A+	B	Red
A-	C	Pink or Purple
B+	N	Green
B-	P	Blue
Z+	M	Yellow
Z-	U	Orange
+5V	K	White
COM	T	Black
Shld	---	---
		Brown (NC)



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Chapter 10 - Troubleshooting

The following table will help you isolate some of the more common application problems with S6961/2 systems. For detailed descriptions of the fault LEDs, see "LED Diagnostic Indicators" in Chapter 5, *Configuring Your System*.

Symptom	Possible Causes	Possible Remedies
Troubleshooting the Keypad		
The keypad is blank and the backlight is off.	The keypad is not receiving a good +5VDC signal.	Check wiring, verify that the +5VDC is between 4.8 and 5.2V.
	Keypad cable miswired.	Ensure signals are connected to correct pins. See Chapter 4.
It is difficult to read the display	The contrast needs adjustment	Adjust the contrast potentiometer on the back of the keypad.
Controller doesn't respond to keypad inputs (keypad is inoperable).	The keypad is disabled.	Dip switch settings on back of keypad may be set to disable the keypad. Change settings, recycle power and try again.
Troubleshooting RS-232C		
Cannot communicate over RS-232C.	Various possible causes.	See Troubleshooting RS-232C in Chapter 8.
Keypad Message Faults		
"Hit A Limit"	An EOT+/- switch has been activated or has not been connected.	Either the motion commanded was not correct, or the EOT switch is incorrectly positioned on your system. If you are not using EOT switches, jumper EOT+ and EOT- to COMMON.
	EOT wiring incorrect.	Change limit polarity.
"Amplifier Fault"	A drive fault has occurred.	Check the fault LEDs for a specific fault.

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Symptom	Possible Causes	Possible Remedies
“Over Temperature Fault”	The drive has a fan kit and the fan is not turning.	With power off confirm the internal fan connection. If connected the fan bearings have probably worn. Contact IDC to obtain a replacement fan.
	Heatsink temperature has reached or exceeded 65°C	1 - Enable Standby mode to reduce current by 30% when the motor is at rest. Verify your motor will have enough holding torque prior to enabling Standby mode. 2 - Provide forced air cooling to your cabinet to reduce heatsink temperature. 3 - Purchase an IDC Fan Kit. See your IDC distributor and order part number: FANKIT-1.
“Over Current Fault”	The motor is miswired or internally shorted. The SmartDrive is protected against such shorts, but you will need to correct the problem to clear the fault.	With power off recheck connections. Check SmartDrive current setting to make sure you did not accidentally damage a winding by using more current than the motor is rated for. Check to see the motor phases are not shorted to one another or to the case of the motor. The resistance in each phase should be approximately the same - only a few ohms. If any phases are open or have large resistance, the motor is probably damaged and should be replaced.
“Over Voltage Fault”	Too high a bus voltage is present. This is usually caused by a regeneration event that overwhelms our internal power dump circuit. It can also be caused by high line voltage, or voltage spikes.	Reduce the regen event by reducing the load or make the move less aggressively by reducing the commanded acceleration or velocity. Check your AC line voltage to verify it is within SmartDrive limits.
“Interlock Fault”	Motor connector does not contain an interlock jumper, motor has been disconnected, or connector is loose.	Verify the motor connector is properly seated and Interlock jumper is installed on motor connector.

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Symptom	Possible Causes	Possible Remedies
“Following Error”	Motor stalled.	Confirm proper motor configuration (current, AR, mH). Make a less aggressive move. Verify there is not an obstruction preventing motor movement.
	Wrong motor or encoder resolution set.	Setting the encoder resolution incorrectly will cause a following error to occur. Confirm the settings are correct.
“Encoder Wired Backwards”	Encoder position is moving opposite of commanded position.	Check motor and encoder wiring. Swap A and B channels of the encoder.
“Encoder Fault”	Attempted motion in a closed loop mode, and encoder position remained unchanged.	Check encoder wiring, and if the encoder is connected and powered properly.
	Wrong encoder mode selected.	If you are not using an encoder, OPEN LOOP must be selected as the Encoder Mode. See Chapter 5.
“Error Finding Home”	Both EOT switches were activated without finding a home switch.	Ensure home switch is connected. Ensure home switch is properly configured as NORM OPEN or NORM CLOSED.
“Invalid Program”	Attempted to access an empty program (i.e. GT, GS).	Verify program number, or define program called.
“Program Too Large”	Program exceeds 1024 bytes in length.	Split program into smaller programs or reduce program size.
“Insufficient Memory”	All stored user programs exceed 30K.	Reduce program size, or delete programs.
“Invalid Program #”	Program number value exceeds 199 (400 with 30K memory option), or program name does not exist.	Verify program name and number.
“Unknown Command”	A command not in the IDeal programming set has been issued.	Check program for data entry errors.
“Command Is Too Long”	Command and parameter string exceeds 80 characters.	Reduce command string size.
“Too Many Parameters”	Parameter list exceeds amount supported by command.	Reduce parameter list size.
“Invalid Parameter”	Parameter type is invalid with command.	Verify parameter with command syntax.
“Bad Command Syntax”	Command and parameter list has invalid syntax.	Check program for data entry errors.

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Symptom	Possible Causes	Possible Remedies
“Too Many Nested LPs”	Program exceeds 16 nested loops.	Reduce nested loops.
“Too Many Nested GSs”	Program exceeds 16 nested gosubs.	Reduce nested gosubs.
“Too Many Nested EBs”	Program exceeds 16 nested IF blocks.	Reduce number of nested IF blocks.
“Bad Variable Name”	A variable used as a command parameter is undefined or mis-spelled.	Verify variable name, or define variable with an initial value.
“No Free Variables”	Attempted to define more than 100 user variables.	Reduce number of user vari-ables.
“B8961/2 Command Only”	Command is available on servo SmartDrives only.	Delete the command or pur-chase a B8961/2.

Fault LED Illuminated on the S6961/2

Fault LED is on	Miswired motor, or short circuit in motor	Remove power from system. Isolate problem by disconnect-ing motor leads from the motor connector, but leave interlock jumper installed. Apply power and step pulses. If fault does not occur, the motor or its wir-ing is defective.
	AC voltage below 85 Volts	Verify AC line voltage well above 85 volts
	Defective amplifier board	If fault still occurs, the product is defective. Return to IDC for repair.
Temperature LED is on	Heatsink temperature in-creased above 65°C.	Increase cooling: circulate more air past heatsink, add -FK1 fan kit, use Standby mode, or reduce duty cycle.
Regen. LED is fully illuminated	Means regen. circuit is active. This alone is NOT a problem. Higher deceleration or load may cause a problem	Adding an RPACK-1 may re-duce drive heating
Over Volt./Interlock LED is on, and Regen LED was fully illu-minated before fault occurred	Excessive Regen.	Use an RPACK and/or reduce Decel.
Over Volt./Interlock LED is flashing.	The interlock jumper is missing.	Install interlock jumper (INTLK to INTLK on motor connector).
	Motor connector disconnected, opened, or not seated correct-ly.	Check the connection. Recon-nect wires if necessary. Re-seat the connector.

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Symptom	Possible Causes	Possible Remedies
Little or no holding torque on the motor, the power LED is on and the Fault LED is off.	Drive is disabled. Disable LED should be on	Enable the amplifier from the RUN/TEST/SHUTDOWN menu from the keypad, OR with the EA1 command from RS232.
	Motor not wired to drive.	Check motor wiring
	Current is set too low.	Check current setting rotary switches.

Troubleshooting Motor Performance Problems

Motor stalls between 12-18 rps.	Wrong Anti-Resonance setting Too high an acceleration.	See Anti-Resonance settings Reduce load or acceleration.
Motor runs rough at low speeds (1-5 RPS).	You're running at 200 or 400 steps per rev. Considered normal.	Increase resolution setting on the side of the drive *and* in the EDIT/SETUP/MOTOR/DRES menu. Both settings must be indentical.
	Phase Offsets or Waveform may need to be adjusted.	See Side Panel Settings in Chapter 5.
	Motor current is set too high.	Check motor current setting.
	Step pulses are erratic.	Check for constant step pulse rate with an oscilloscope.
Motor moves the wrong distance.	Drive and control resolution don't match.	Make settings indentical.
	Incorrect gear ratio and/or unit setting.	Check the distance units and the Gear Ratio setting in the EDIT/SETUP/MECH menu.
Motor stalls at high speeds.	Commanded velocity is too high for system capability.	Check motor current setting. May have to reduce velocity. Also see "Anti-resonance settings."
Motor stalls during acceleration.	Motor current is incorrect. Acceleration rate is too high for the system capability.	Check motor current setting. Reduce your acceleration, or use a motor with higher torque.
	Anti-Resonance set incorrectly.	Modify Anti-res. setting.
Motor moves in the wrong direction.	The system's sense of direction is reversed.	Change control's direction in the EDIT/SETUP/MOTOR/DIR menu, or, with AC power off, change motor direction by swapping A+ with A-. on the motor connector.
	The motor phases are miswired.	
Motor has torque, steps are being received (Stepping LED is on) but motor doesn't turn.	Motor is stalled, or load is jammed mechanically.	Reduce the load, acceleration, or the speed of the move. Remove obstruction from machine.

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Symptom	Possible Causes	Possible Remedies
Motor seems to “whine.”	The inductance or anti-resonance setting may require adjustment.	Change/confirm the inductance setting. If this does not help, try adjusting the anti-resonance setting.
No motion occurs when programs are run.	Current set too low.	Check current settings.

Motor Safety

Motor runs very hot.	Motor current set too high.	Check current setting.
	Motor running beyond recommended duty cycle.	Lower duty cycle.
	Motor housings can reach temperatures up to 100°C - may not be a problem.	Use Standby mode if your application allows it. Reduce cycle rate.

I/O Troubleshooting

Controller does not recognize OPTO outputs.	OPTO positions default to inputs.	Configure as output from the EDIT/SETUP/I/O/OPTO menu.

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Product Support

Factory Authorized Distributors

IDC has more than 45 factory-trained and authorized automation technology distributors located throughout North America, Western Europe, and the Pacific Rim. Each has been selected for their technical expertise, their local market knowledge, and exemplary business practices. They are ready to assist you in applying Industrial Devices' systems, as well as other complementary equipment. Contact us at (800) 747-0064 or (707) 789-1000 (from outside the U.S.) for the name of the distributor in your area.

Regional Offices

IDC Distributors are supported by local, direct IDC Regional Managers. There are currently 4 IDC regional offices in North America. IDC Regional Managers are available to assist with unusually demanding applications, present on site customer seminars, determine custom product needs, or respond to high volume requirements.

Toll Free Technical Support

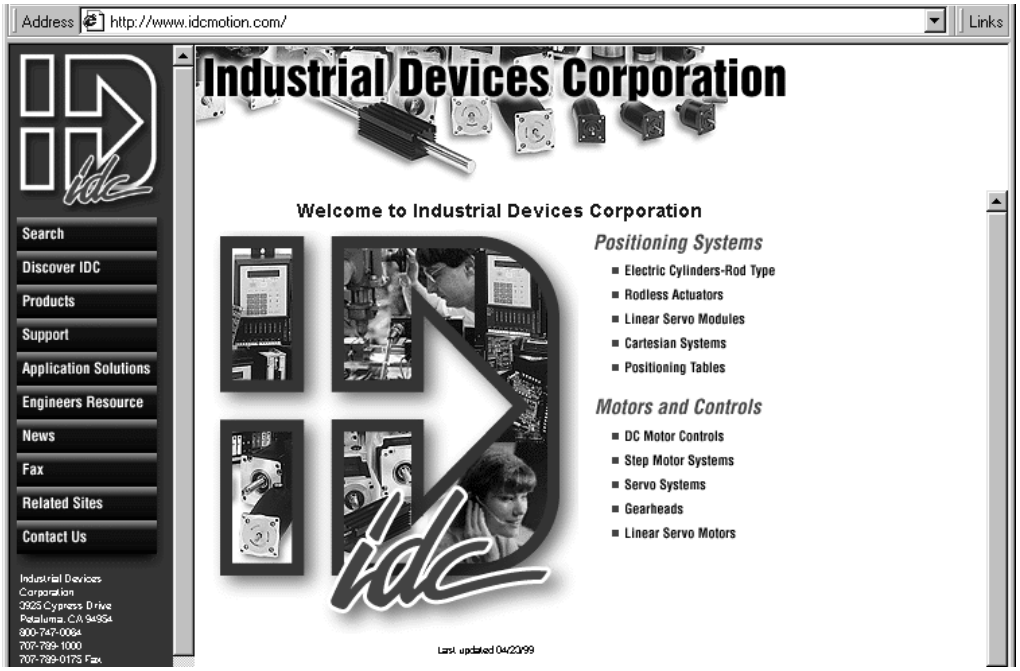
Industrial Devices employs a large staff of mechanical and electrical engineers, whose full time responsibility is to help you select the proper system, install it correctly, and get it up and operating to your satisfaction. The Applications Engineering department is open from 6am to 5pm Pacific Time, Monday through Friday. The toll free number is (800) 747-0064. Outside of the United States call (707) 789-1000. The technical support fax number is (707) 789-0175. Email should be directed to: support@idcmotion.com.

CAD Library

IDC actuator, motor, and gear-motor CAD drawings (in .dxf format) are available to save you valuable design time and prevent transcription errors. Low volume requests are complimentary. Check the web site for CAD drawings that may be downloaded.

Web Site

Check us out at **www.idcmotion.com** for information on our products and support.



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Warranty & Repairs

Industrial Devices Corporation (IDC) warrants this product to be free of defects in material and workmanship for a period of two (2) years from the date of shipment to the end user. Products that have been improperly used or damaged, in the opinion of IDC, are not subject to the terms of this warranty.

IDC maintains a repair facility at its factory in Petaluma, California for products manufactured by IDC. Prior approval by IDC is required before returning any product for any reason. All returned packages must be accompanied by an RMA# (Return Material Authorization number).

To obtain return authorization, contact your local IDC distributor or IDC. Please note the following procedure:

1. Obtain the model and serial number of the defective unit.
2. Prepare a purchase order for possible repair cost, in the event that the unit is not warranted.
3. Contact your IDC distributor or IDC (1-800-747-0064) for an RMA#.
4. Provide information describing the nature of the failure. The better the information, the faster we'll have your problem resolved.
5. Ship unit prepaid to the address below (be sure to include your RMA # on the shipping label):

Attn: Repair Department
RMA# _ _-_ _ _
Industrial Devices Corporation, LLC
3925 Cypress Drive
Petaluma, CA 94954

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Appendix A - IDC Actuator Ratios

Configuring *inch* & *mm* Units on SmartDrives Used With IDC Actuators

One of the first steps in setting up an IDC SmartDrive with an IDC linear actuator is to configure the distance, velocity, and acceleration to use meaningful units, probably *inches* or *millimeters*. This is done via the RATIO (GR) command. The RATIO is the number of *motor revs* per *distance unit*. The Distance Unit used is selected via the SETUP > MECH menu from the keypad or Application Developer.
Example: GR5:1 means 5 motors revs per 1 distance unit. Several other examples are available in the *Configuring Your System* chapter of this manual.

The RATIO is also used to scale the velocity and acceleration numbers when *user units/sec* or *units/sec*^{2} have been selected from the velocity or acceleration menus.

Until now, since each actuator has its own "revs per inch" ratio, data from the model number had to be interpreted and then a ratio calculated. The following pages reduce that procedure to looking up the inch or mm ratio from a table sorted by actuator model number. Instructions are also included to calculate a ratio for other distance units. Increased positional accuracy is often achieved when using these values, because some ratios aren't exact ("3.5:1" is really 50:14, or 3.571428…).

Shown below are the three different ways to change the RATIO in an SmartDrive. Please note that some ratios cannot be entered via the keypad or Application Developer. The keypad and Application Developer screens only support up to 5 digits in each RATIO number. Via RS-232C, up to 8 digits can be entered for each number. The rounding error caused by only being able to enter 5 digits is very minimal for most actuators and stroke lengths, and is often much less than the positional uncertainty caused by mechanical backlash and windup.

Methods For Configuring Ratio

There are three methods for entering the ratio information. The keypad is the quickest method, if your system includes that option.

1. SmartDrive Keypad [EDIT-SETUP-MECH-RATIO Menu]
2. IDC Motion™ (Application Developer) [*Setup, Axis* Menu]
3. Direct RS-232C connection [GR Command]

Using the Keypad to Enter Ratio Information

Press:

EDIT **> SETUP > MECH > RATIO**

Keypad Display

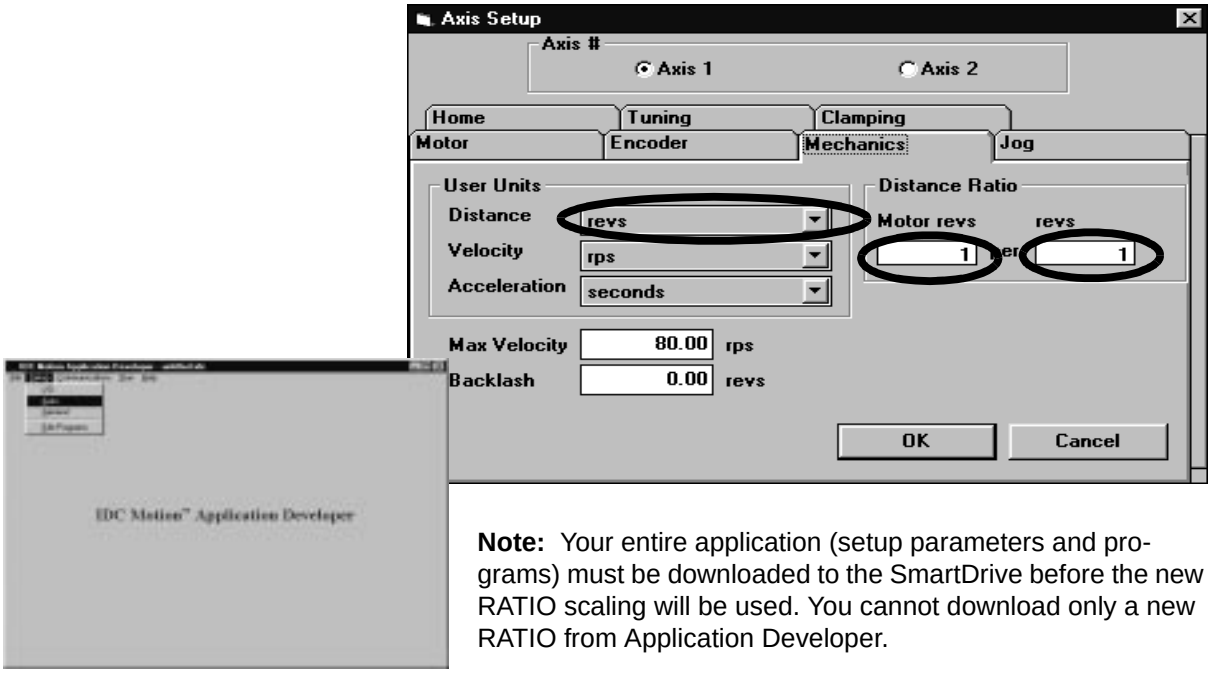
```
- - - Axis One Ratio - - -
←↑     1  to  1     ↓→
```

Default: 1 to 1

These two integer values set the number of ***motor rev's*** per ***distance unit*** (i.e. inch, mm, cm, etc.)

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Application Developer

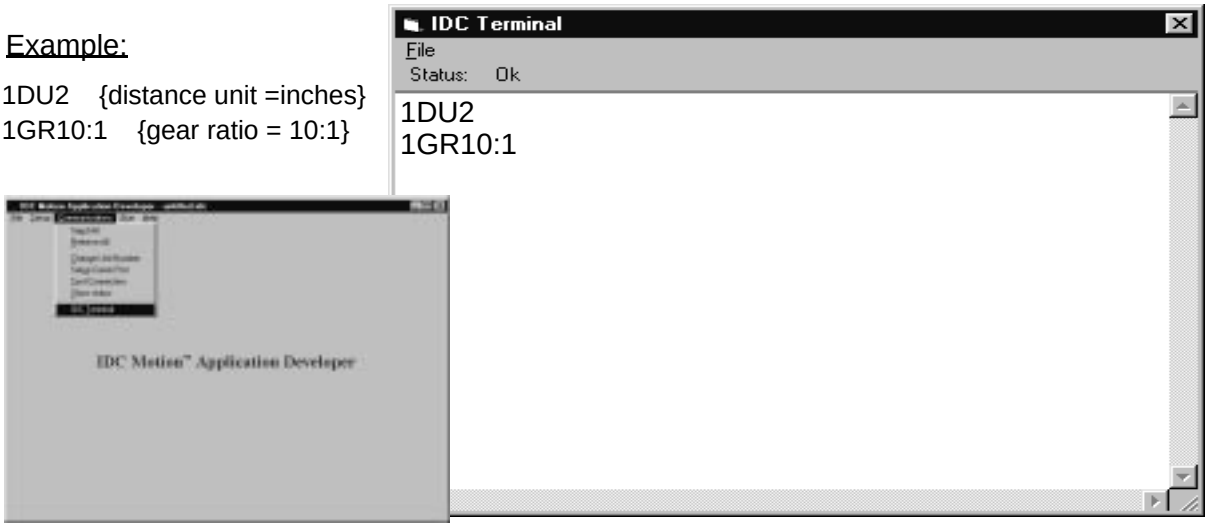


Note: Your entire application (setup parameters and programs) must be downloaded to the SmartDrive before the new RATIO scaling will be used. You cannot download only a new RATIO from Application Developer.

RS-232C Terminal

Example:

1DU2 {distance unit =inches}
1GR10:1 {gear ratio = 10:1}



Gear Ratio Notes:

- You can change DIST or RATIO at any time. Changing them will not change the associated DI or DA values in a program, so all moves will change by the same factor that RATIO was changed.

- If using an IDC supplied actuator, the proper Gear Ratios for entering units of *Inches* and *mm* can be found in the following actuator ration tables.

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IDC Actuator Ratios

N, T, R2, R3, R4, NM, RM, NV, EC2, EC3, EC5 Series

N Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
N-992	1	2	2	2 to 1	20 to 254
N-102	1	2	2	2 to 1	20 to 254
N-152	1.5	2	3	3 to 1	30 to 254
N-202	2	2	4	4 to 1	40 to 254
N-252	2.5	2	5	5 to 1	50 to 254
N-312	3.125	2	6.25	625 to 100	6250 to 25400
N-352	3.571	2	7.14286	100 to 14	1000 to 3556
N-602	6	2	12	12 to 1	120 to 254
N-1202	12	2	24	24 to 1	240 to 254
N-995	1	5	5	5 to 1	50 to 254
N-105	1	5	5	5 to 1	50 to 254
N-155	1.5	5	7.5	75 to 10	750 to 2540
N-205	2	5	10	10 to 1	100 to 254
N-255	2.5	5	12.5	125 to 10	1250 to 2540
N-315	3.125	5	15.625	250 to 16	2500 to 4064
N-355	3.571	5	17.85714	250 to 14	2500 to 3556
N-605	6	5	30	30 to 1	300 to 254
N-1205	12	5	60	60 to 1	600 to 254
N-998	1	8	8	8 to 1	80 to 254
N-108	1	8	8	8 to 1	80 to 254
N-158	1.5	8	12	12 to 1	120 to 254
N-208	2	8	16	16 to 1	160 to 254
N-258	2.5	8	20	20 to 1	200 to 254
N-318	3.125	8	25	25 to 1	250 to 254
N-358	3.571	8	28.57143	400 to 14	4000 to 3556
N-608	6	8	48	48 to 1	480 to 254
N-1208	12	8	96	96 to 1	960 to 254
N-9910	1	10	10	10 to 1	100 to 254
N-1010	1	10	10	10 to 1	100 to 254
N-1510	1.5	10	15	15 to 1	150 to 254
N-2010	2	10	20	20 to 1	200 to 254
N-2510	2.5	10	25	25 to 1	250 to 254
N-3110	3.125	10	31.25	500 to 16	5000 to 4064
N-3510	3.571	10	35.71429	500 to 14	5000 to 3556
N-6010	6	10	60	60 to 1	600 to 254
N-12010	12	10	120	120 to 1	1200 to 254

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T Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
T-101	1	1	1	1 to 1	10 to 254
T-151	1.5	1	1.5	1.5 to 1	15 to 254
T-201	2	1	2	2 to 1	20 to 254
T-501	5.110	1	5.110442	42432 to 8303	4243 to 21090
T-1001	10.007	1	10.00729	68640 to 6859	6864 to 17422
T-104	1	4	4	4 to 1	40 to 254
T-154	1.5	4	6	6 to 1	60 to 254
T-204	2	4	8	8 to 1	80 to 254
T-504	5.110	4	20.44177	169728 to 8303	16973 to 21090
T-1004	10.007	4	40.02916	274560 to 6859	27456 to 17422
T-106	1	6	6	6 to 1	60 to 254
T-156	1.5	6	9	9 to 1	90 to 254
T-206	2	6	12	12 to 1	120 to 254
T-506	5.110	6	30.66265	254592 to 8303	25459 to 21090
T-1006	10.007	6	60.04374	411840 to 6859	41184 to 17422

R2 Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
R2-10T	1	0.33333	0.33333	1 to 3	10 to 762
R2-15T	1.5	0.33333	0.5	1 to 2	10 to 508
R2-20T	2	0.33333	0.66667	2 to 3	20 to 762
R2-31T	3.125	0.33333	1.04167	50 to 48	500 to 12192
R2-35T	3.571	0.33333	1.19048	50 to 42	500 to 10668
R2-120T	12	0.33333	4	4 to 1	40 to 254
R2-102	1	2	2	2 to 1	20 to 254
R2-152	1.5	2	3	3 to 1	30 to 254
R2-202	2	2	4	4 to 1	40 to 254
R2-312	3.125	2	6.25	50 to 8	500 to 2032
R2-352	3.571	2	7.14286	50 to 7	500 to 1778
R2-1202	12	2	24	24 to 1	240 to 254
R2-105	1	5	5	5 to 1	50 to 254
R2-155	1.5	5	7.5	7.5 to 1	75 to 254
R2-205	2	5	10	10 to 1	100 to 254
R2-315	3.125	5	15.625	250 to 16	2500 to 4064
R2-355	3.571	5	17.8571	250 to 14	2500 to 3556
R2-1205	12	5	60	60 to 1	600 to 254
R2-108	1	8	8	8 to 1	80 to 254
R2-158	1.5	8	12	12 to 1	120 to 254
R2-208	2	8	16	16 to 1	160 to 254
R2-318	3.125	8	25	25 to 1	250 to 254
R2-358	3.571	8	28.5714	200 to 7	2000 to 1778
R2-1208	12	8	96	96 to 1	960 to 254

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R3 Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
R3-10T	1	0.1666667	0.16667	1 to 6	10 to 1524
R3-15T	1.5	0.1666667	0.25	15 to 60	150 to 15240
R3-20T	2	0.1666667	0.33333	1 to 3	10 to 762
R3-30T	3.000	0.1666667	0.5	3 to 6	30 to 1524
R3-50T	5.037	0.1666667	0.83951	3536 to 4212	354 to 10699
R3-100T	10.000	0.1666667	1.66667	10 to 6	100 to 1524
R3-102	1	2	2	2 to 1	20 to 254
R3-152	1.5	2	3	3 to 1	30 to 254
R3-202	2	2	4	4 to 1	40 to 254
R3-502	5.037	2	10.07401	212160 to 21060	21216 to 53492
R3-1002	10.000	2	20	20 to 1	200 to 254
R3-105	1	5	5	5 to 1	50 to 254
R3-155	1.5	5	7.5	75 to 10	750 to 2540
R3-205	2	5	10	10 to 1	100 to 254
R3-505	5.037	5	25.18519	106080 to 4212	10608 to 10699
R3-1005	10.000	5	50	50 to 1	500 to 254
R3-108	1	8	8	8 to 1	80 to 254
R3-158	1.5	8	12	12 to 1	120 to 254
R3-208	2	8	16	16 to 1	160 to 254
R3-508	5.037	8	40.2963	212160 to 5265	21216 to 13373
R3-1008	10.000	8	80	80 to 1	800 to 254

R4 Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
R4-10T	1	0.1333333	0.13333	8 to 60	8 to 1524
R4-15T	1.5	0.1333333	0.2	12 to 60	12 to 1524
R4-20T	2	0.1333333	0.26667	16 to 60	16 to 1524
R4-30T	3.000	0.1333333	0.4	24 to 60	24 to 1524
R4-50T	5.110	0.1333333	0.68139	28288 to 41515	2829 to 105448
R4-100T	10.007	0.1333333	1.33430	27456 to 20577	2746 to 52266
R4-101	1	1	1	1 to 1	10 to 254
R4-151	1.5	1	1.5	15 to 10	15 to 254
R4-201	2	1	2	2 to 1	20 to 254
R4-501	5.110	1	5.11044	42432 to 8303	4243 to 21090
R4-1001	10.007	1	10.00729	68640 to 6859	6864 to 17422
R4-104	1	4	4	4 to 1	40 to 254
R4-154	1.5	4	6	6 to 1	60 to 254
R4-204	2	4	8	8 to 1	80 to 254
R4-504	5.110	4	20.44177	169728 to 8303	16973 to 21090
R4-1004	10.007	4	40.02916	274560 to 6859	27456 to 17422
R4-106	1	6	6	6 to 1	60 to 254
R4-156	1.5	6	9	9 to 1	90 to 254
R4-206	2	6	12	12 to 1	120 to 254
R4-506	5.110	6	30.66265	254592 to 8303	25459 to 21090
R4-1006	10.007	6	60.04374	411840 to 6859	41184 to 17422

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NM / RM	Motor Reduction	Screw Pitch	Overall Ratio (mtr. turns/inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for inches	Ratio for mm
M-992	1	2	2	2 to 1	20 to 254
M-995	1	5	5	5 to 1	50 to 254
M-998	1	8	8	8 to 1	80 to 254
M-9910	1	10	10	10 to 1	100 to 254

NV Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
NV-105	1	5	5	5 to 1	50 to 254
NV-155	1.5	5	7.5	75 to 10	750 to 2540
NV-205	2		10	10 to 1	100 to 254
NV-108	1	8	8	8 to 1	80 to 254
NV-158	1.5	8	12	12 to 1	120 to 254
NV-208	2	8	16	16 to 1	160 to 254

EC2 Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
EC2-10-16B	1	1.5875	1.59	254 to 160	1 to 16
EC2-15-16B	1.471	1.5875	2.33	6350 to 2720	25 to 272
EC2-20-16B	2	1.5875	3.18	508 to 160	2 to 16
EC2-50-16B	5.022	1.5875	7.97	242341 to 30400	9541 to 30400
EC2-100-16B	10.005	1.5875	15.88	183487 to 11552	72239 to 115520
EC2-10-05B	1	5.08	5.08	254 to 50	1 to 5
EC2-15-05B	1.471	5.08	7.47	6350 to 850	25 to 85
EC2-20-05B	2	5.08	10.16	508 to 50	2 to 5
EC2-50-05B	5.022	5.08	25.51	242341 to 9500	9541 to 9500
EC2-100-05B	10.005	5.08	50.83	183487 to 3610	72239 to 36100
EC2-10-04A	1	6.35	6.35	254 to 40	1 to 4
EC2-15-04A	1.471	6.35	9.34	6350 to 680	25 to 68
EC2-20-04A	2	6.35	12.70	508 to 40	2 to 4
EC2-50-04A	5.022	6.35	31.89	242341 to 7600	9541 to 7600
EC2-100-04A	10.005	6.35	63.53	183487 to 2888	72239 to 28880

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EC3 Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
EC3-10-16B	1.000	1.5875	1.59	254 to 160	1 to 16
EC3-15-16B	1.500	1.5875	2.38	3810 to 1600	15 to 160
EC3-20-16B	2.063	1.5875	3.27	8382 to 2560	33 to 256
EC3-50-16B	5.038	1.5875	8.00	284988 to 35635	112200 to 356352
EC3-70-16B	7.000	1.5875	11.11	327736 to 29491	129030 to 294912
EC3-10-10B	1.000	2.54	2.54	254 to 100	1 to 10
EC3-15-10B	1.500	2.54	3.81	3810 to 1000	15 to 100
EC3-20-10B	2.063	2.54	5.24	8382 to 1600	33 to 160
EC3-50-10B	5.038	2.54	12.80	284988 to 22272	112200 to 222720
EC3-70-10B	7.000	2.54	17.78	327736 to 18432	129030 to 184320
EC3-10-05B	1.000	5.08	5.08	254 to 50	1 to 5
EC3-15-05B	1.500	5.08	7.62	3810 to 500	15 to 50
EC3-20-05B	2.063	5.08	10.48	8382 to 800	33 to 80
EC3-50-05B	5.038	5.08	25.59	284988 to 11136	112200 to 111360
EC3-70-05B	7.000	5.08	35.56	327736 to 9216	129030 to 92160
EC3-10-04A	1.000	6.35	6.35	254 to 40	1 to 4
EC3-15-04A	1.500	6.35	9.53	3810 to 400	15 to 40
EC3-20-04A	2.063	6.35	13.10	8382 to 640	33 to 64
EC3-50-04A	5.038	6.35	31.99	284988 to 8909	112200 to 89088
EC3-70-04A	7.000	6.35	44.45	327736 to 7373	129030 to 73728

EC5 Series	Motor Reduction	Screw Pitch	Overall Ratio (Mtr Turns/Inch)	*Smart Drive* Mechanical Ratio Setting [EDIT]-[SETUP]-[MECH]-[RATIO] menu	
				Ratio for Inches	Ratio for mm
EC5-10-32B	1.000	0.79375	0.79	254 to 320	1 to 32
EC5-15-32B	1.500	0.79375	1.19	3810 to 3200	15 to 320
EC5-20-32B	2.000	0.79375	1.59	508 to 320	2 to 32
EC5-50-32B	5.110	0.79375	4.06	107777 to 26570	42432 to 265696
EC5-100-32B	10.007	0.79375	7.94	174346 to 21949	68640 to 219488
EC5-10-25B	1.000	1.016	1.02	254 to 250	1 to 25
EC5-15-25B	1.500	1.016	1.52	3810 to 2500	15 to 250
EC5-20-25B	2.000	1.016	2.03	508 to 250	2 to 25
EC5-50-25B	5.110	1.016	5.19	107777 to 20757	42432 to 207575
EC5-100-25B	10.007	1.016	10.17	174346 to 17148	68640 to 171475
EC5-10-10B	1.000	2.54	2.54	254 to 100	1 to 10
EC5-15-10B	1.500	2.54	3.81	3810 to 1000	15 to 100
EC5-20-10B	2.000	2.54	5.08	508 to 100	2 to 10
EC5-50-10B	5.110	2.54	12.98	107777 to 8303	42432 to 83030
EC5-100-10B	10.007	2.54	25.42	174346 to 6859	68640 to 68590
EC5-10-06A	1.000	4.23333333	4.23	254 to 60	1 to 6
EC5-15-06A	1.500	4.23333333	6.35	3810 to 600	15 to 60
EC5-20-06A	2.000	4.23333333	8.47	508 to 60	2 to 6
EC5-50-06A	5.110	4.23333333	21.63	107777 to 4982	42432 to 49818
EC5-100-06A	10.007	4.23333333	42.36	174346 to 4115	68640 to 41154

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Steps for Entering Custom Distance Units (when ratio for *inches* is known)

Instruction	Example
1. **Select User Units** Select a preferred unit-of-measure for linear distance. This will be used for programming distance, and can be used for velocity and acceleration as well.	*centimeters*
2. **Determine Overall Mechanical Ratio** Look up actuator mechanical "inch" ratio. Units must be "motor turns/inch."	*6.25* *motor turns/inch*
3. **Convert Ratio to *Turns/User Unit*** Convert "turns/inch" ratio by multiplying or dividing by the same factor you would to convert inches to your preferred user unit.	*6.25 ÷ (2.54 cm/in) = 2.4606*
4. **Convert Decimal Ratio to *Ratio of Two Integers*** A. Multiply by the power of ten required to move decimal point to the far right. Note that a maximum of six digits can be entered into the Smart Drive - it might be necessary to round of the number from step 3) above. *This is the numerator of the integer ratio.* B. The power of ten becomes the denominator.	*2.4606 x 10^4 = 24606* *10^4 = 10000*
5. **Enter Ratio into Smart Drive** A. Press [EDIT], [SETUP], [MECH], [RATIO] to get to the Mechanical Ratio menu. The numbers from step 4 can now be entered. B. Press [Enter] after entering the ratio numerator, then [(] to move right and enter the ratio denominator. Press [Enter] after entering the denominator, then [ESC] to move back one menu.	*24606 to 10000* *(24606 revs = 10000 cm)*
6. **Program Smart Drive** The Smart Drive is now ready to program in your own User Units. Distances will match the units configured above.	*DI10.0 GO* *(moves 10.0 cm)*

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IDeal™ Programming Commands

AC	Acceleration	**FK**	Function Key	**LP**	Loop	**SP**	Set Position
BR	Break	**GH**	Go Home	**LU**	Loop Until	**SQ**	Square Root
DA	Distance Absolute	**GI**	Go Immediate	**LW**	Loop While	**ST**	Stop Move
DC	Distance to Change	**GO**	Start Move	**MC**	Move Continuous	**TD**	Time Delay
DE	Deceleration	**GP**	Go Point	**MS**	Message	**VE**	Velocity
DI	Distance Incremental	**GS**	Go to Subroutine	**ON**	On Condition	**WT**	Wait
EA	Enable Amplifier	**GT**	Go to Program	**OT**	Outputs ON/OFF		
EB	End Block	**IF**	If Conditional	**“ “**	Quote		
EN	End Routine	**IV**	Input Variable	**RG**	Registration		

Serial Setup Commands

AM	Acceleration Max.	**FL**	Fault Line Polarity	**JE**	Jog Enable	**PG**	Pos. Maint. Gain
AU	Acceleration Units	**GR**	Units Ratio	**JH**	Jog High Velocity	**PU**	Power-Up Program
DF	Display Format	**HE**	Home Edge	**JL**	Jog Low Velocity	**PV**	Pos. Maint. Max. Vel.
DU	Distance Unit Label	**HF**	Home Final Direction	**MD**	Motor Dir. Reference	**PW**	Password
DY	Scan Delay	**HM**	Homing Mode	**MR**	Motor Resolution	**SN**	Scan Conditions
EL	Enable Line Polarity	**HO**	Home Offset	**MT**	Motor Type	**SR**	Stop Decel. Rate
EM	Encoder Mode	**HS**	Home Switch	**MV**	Maximum Velocity	**UN**	Unit Number
ER	Encoder Resolution	**ID**	Input Definition	**OD**	Output Definition	**VU**	Velocity Units
ET	E-O-T Switch Polarity	**IR**	Pos. Maint. Deadband	**OE**	Ouput States on Event		
FE	Following Error Limit	**JA**	Jog Acceleration	**OP**	OPTO Configuration		

Serial Immediate Status Commands

CB	Clear Comnd. Buffer	**MN**	Model Number	**RS**	Reset System	**SD**	Tell Drive Status
IS	Tell Input States	**OS**	Tell Output States	**S**	Stop	**SS**	Tell System Status
K	Kill	**PA**	Tell Absolute Position	**SA**	Tell Axis Status		

Serial Supervisory Commands

AA	Auto Address	**EP**	End Program Definition	**OC**	Original Configuration	**UA**	Upload All
DP	Delete Program	**EX**	Ends UA or UL	**PR**	Define Program	**UL**	Upload Program
DR	Dwnld. Prog. to RAM	**LA**	Load All	**RN**	Run Program		
EC	RS-232 Echo Enable	**LS**	List Programs	**SW**	Tell Software Version		

Operators, Functions, and Expressions

[ ]	Name Program	**+**	Add	**<**	Less Than	**+=**	Increment by n
( )	Name Variable	**-**	Subtract	**>=**	Greater Than or Equal	**--**	Decrement Variable
&&	Logical AND	*****	Multiply	**<=**	Less Than or Equal	**-=**	Decrement by n
||	Logical OR	**/**	Divide	**&**	Bitwise Boolean AND	**<<**	Shift Left
!	Logical NOT	**=**	Equal	**|**	Bitwise Boolean OR	**>>**	Shift Right
!=	Not Equal	**>**	Greater Than	**++**	Increment Variable		

Built-In Variables

(AI9) thru (AI16)	Analog Input 9 - 16	Read Only	**(1TW)**	Scans Input 1-4 for BCD Digit	Read Only
(AO9) thru (AO16)	Analog Output 9 - 16	Write Only	**(2TW)**	Scans Input 1-8 for BCD Digit	Read Only
(AROWREL)	Current Status of Any Arrow Key	Read Only	**(TIME)**	Elapsed Time (ms) Since Last Power-Up or Reset	Read Only
(CPOS1), (CPOS2)	Cmnd. Pos. of axis 1, 2	Read Only	**(CRCS)**	Val. of Setup Checksum	Read Only
(EPOS1), (EPOS2)	Encoder Pos. of axis 1, 2	Read Only	**(CRCP)**	Val. of Prog. Checksum	Read Only
(POS1), (POS2)	Current Pos. of axis 1, 2	Read Only	**(SA1), (SA2)**	Value of Axes Status	Read Only
(VEL1), (VEL2)	Cmnd. Velocity of axis 1, 2	Read Only	**(SD1), (SD2)**	Value of Drive Status	Read Only
(EE1) thru (EE20)	Non-volatile Variables	Read/Ltd. Write	**(SS)**	Value of System Status	Read Only
(FKEY)	Val. of Func. Key Pressed	Read Only	**(INT98CTRL)**	Enable/Disable (ARM INT98)	Read/Write
(LASTKEY)	Val. of Last Function Key Pressed	Read/Write	**(ARM INT98)**	Enable/Disable INT98 if (INT98CTRL) is Enabled	Read/Write
(TERM)	Send Var. out RS232 Port	Write Only			

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Keypad Programming Template

Use this template to write MS (Message to Display) command menus or programs exactly as they will appear on the keypad LCD display. Each character-position on the keypad display is represented by a numbered blank square below. Please feel free to make copies of this page for writing your programs.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
FK1							FK2							FK3					

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
FK1							FK2							FK3					

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
FK1							FK2							FK3					

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
FK1							FK2							FK3					

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
FK1							FK2							FK3					

IDeal™ Programming Commands					
Command	**Description**	**Page**	**Command**	**Description**	**Page**
AC	Acceleration	6-2	**IV**	Input Variable	6-18
BR	Break	6-2	**LP**	Loop	6-19
DA	Distance Absolute	6-3	**LU**	Loop Until	6-19
DC	Distance to a Change	6-4	**LW**	Loop While	6-20
DE	Deceleration	6-5	**MC**	Move Continuous	6-21
DI	Distance Incremental	6-5	**MS**	Message to Display	6-25
EA	Enable/Disable Amplifier	6-5	**ON**	On Command	6-26
EB	End of Block	6-6	**OT**	Output	6-27
EN	End of Routine	6-6	**“ “**	Quote	6-27
FK	Function Key	6-7	**RG**	Registration	6-28
GH	Go Home	6-9	**SP**	Set Position	6-29
GI	Go Immediate	6-10	**SQ**	Square Root	6-29
GO	Go (start a move)	6-14	**ST**	Stop on Input	6-30
GP	Go Point	6-15	**TD**	Time Delay	6-30
GS	Gosub	6-16	**VE**	Velocity	6-31
GT	Go to a Program	6-16	**WT**	Wait	6-32
IF	If	6-17			

Industrial Devices Corporation
3925 Cypress Drive
Petaluma, CA 94954

(800) 747-0064
Outside the U.S. Call (707) 789-1000

World Wide Web: http://www.idcmotion.com
E-mail: info@idcmotion.com

S6961/S6962 User’s Manual, PCW-4757

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