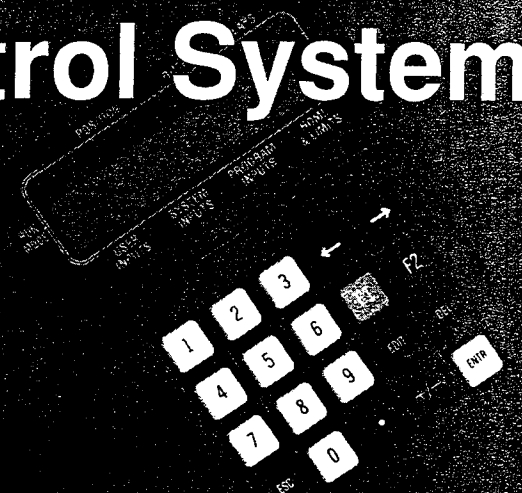
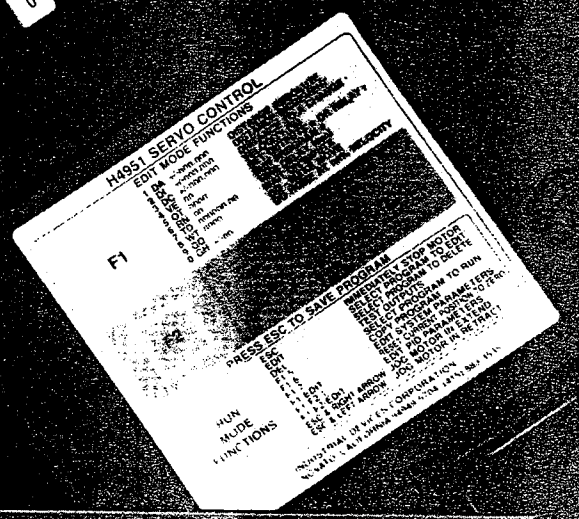
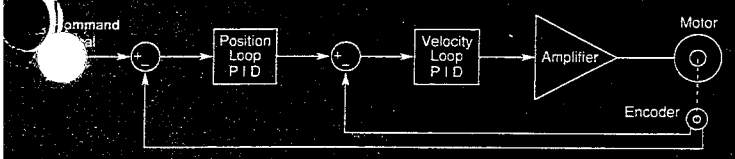
H3951 & H4951 Electric Linear Servo Control System

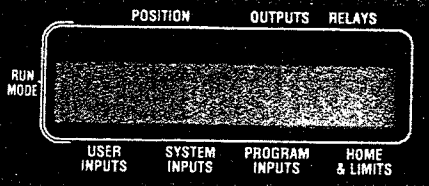
Operator's Manual

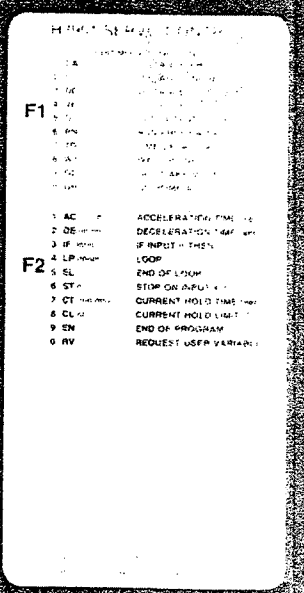




Servo Loop Control







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Effective February 1, 1999

H3951 & H4951 Electric Linear Servo Control System

Operator's Manual

P/N PCW-4436 Rev. 1.00 2/93

This manual can be used with the following IDC products:

H3951 — DC servo control with integral LCD/keypad for NH and RH cylinders

H3952 — DC servo control with remote LCD/keypad for NH and RH cylinders

H4951 — DC servo control with integral LCD/keypad for TH cylinders

Overview

The Controls. . .
The H3951 and H4951 controls are both microprocessor-based, closed loop servo positioning systems which use incremental encoder feedback to provide accurate positioning control to IDC H Series Cylinders. The H3951 is used to control both NH Series Rod Type & RH Series Rodless Cylinders and the H4951 is used to control the TH Series High Thrust Cylinders.

The Programming. . .
Both units use an advanced (yet easy to use) motion control language accessed by a built in Keypad/LCD Display or by RS232C Serial Communication to create up to 98 programs containing move profiles and functional operations. The total memory capacity is 8K bytes of non-volatile EEPROM memory with individual programs allowing up to 1000 characters.

The Servo Loops. . .
Both controls use an advanced move algorithm to reduce move cycle time, providing fast system throughput. The move algorithm closes a velocity servo loop to provide smooth and reliable speed regulation and closes a position servo loop to obtain accurate positioning coupled with the ability to hold position before and after moves. Both servo loops can be optimized with adjustable PID tuning parameters accessible to users.

The Interface. . .
Each unit has twelve inputs and ten outputs which offer a variety of I/O configurations, allowing the units to stand alone or be easily interfaced with external devices such as computers, PLC's, or simple pushbutton operator stations.

The H3951 & H4951 are powerful multi-position servo controls that are:

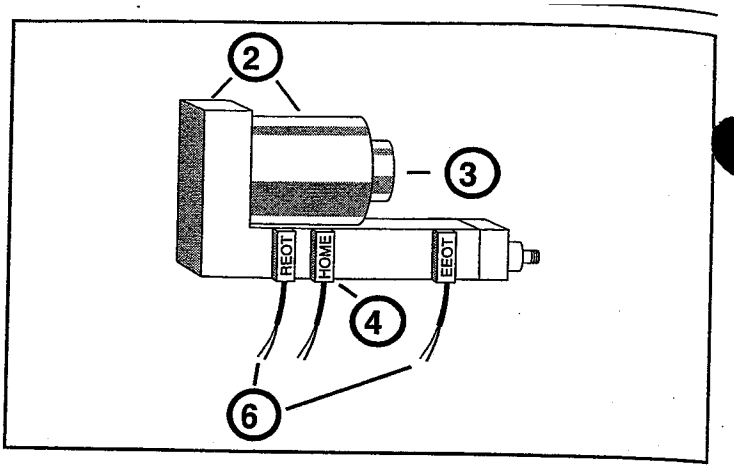
- Easy to program
- Easy to interface, and
- Easy to operate

Note
Throughout this manual, any listing of *Hx951* denotes an H3951 or H4951 Control.

1.1 Getting Started

5 EASY STEPS

1. Identify System Components
2. Identify Control Hardware Features
3. Basic Wiring to Operate Your Control
4. Applying Power to your Unit & Identifying the functions on the LCD Display.
5. Configuring the *Hx951* to your Actuator and Running a Test Program.



1. Identify System Components

H3951 System	H4951 System
(1) 1 H3951 Control	(1) 1 H4951 Control
(2) 1 NH or RH Series Electric Actuator with a mounted H Motor	(2) 1 TH Series Electric Actuator with a mounted H4 Motor

(3) 1 Encoder: 500 line

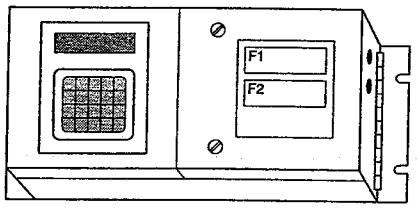
(4) 1 Home Switch
Normally Open Magnetic Position Sensor
IDC Part # RPS-1 (Reed Switch)
RP1 (Hall Effect)

(5) 1 H3951/H4951 Manual

(6) 2 End of Travel "Extend and Retract" Limit Switches
Normally Closed Magnetic Position Sensors
IDC Part # RPS-2 (Reed Switch)
RP2 (Hall Effect)

Extend and Retract End of Travel Limit Switches are Not Required for System Operation but are RECOMMENDED for Overtravel Protection.

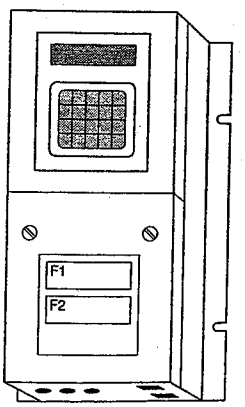
H3951



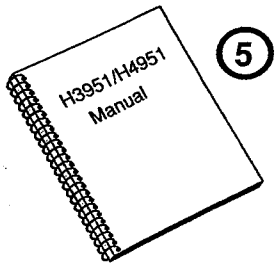
Horizontal Orientation

(1)

H4951



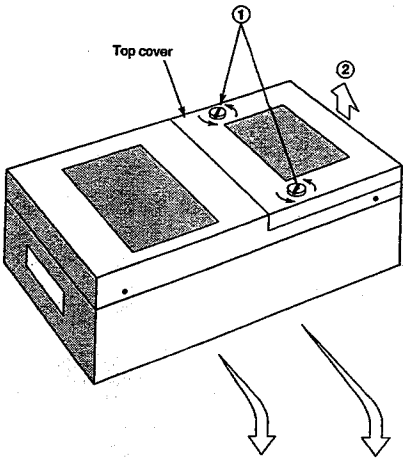
Vertical Orientation



(5)

2. Identify Control Hardware Features

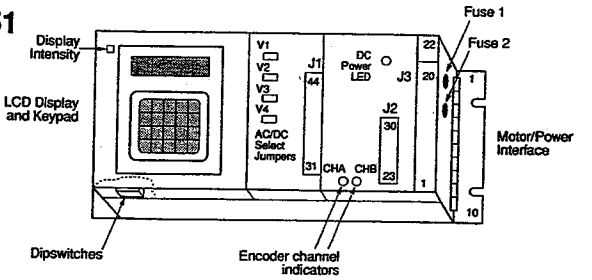
Removing the Top Cover *Hx951* Control



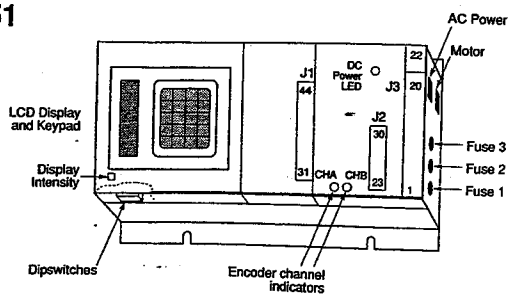
1 With a coin or screwdriver, turn the slot of each of the two plastic cover screws counter-clockwise, one quarter-turn.

2 Firmly grasp the outside edge of the top cover, lift upwards to remove.

H3951



H4951



J1 Connector: I/O Interface–High Level Logic
J2 Connector: Encoder Interface
J3 Connector: I/O Interface–Low Level Logic

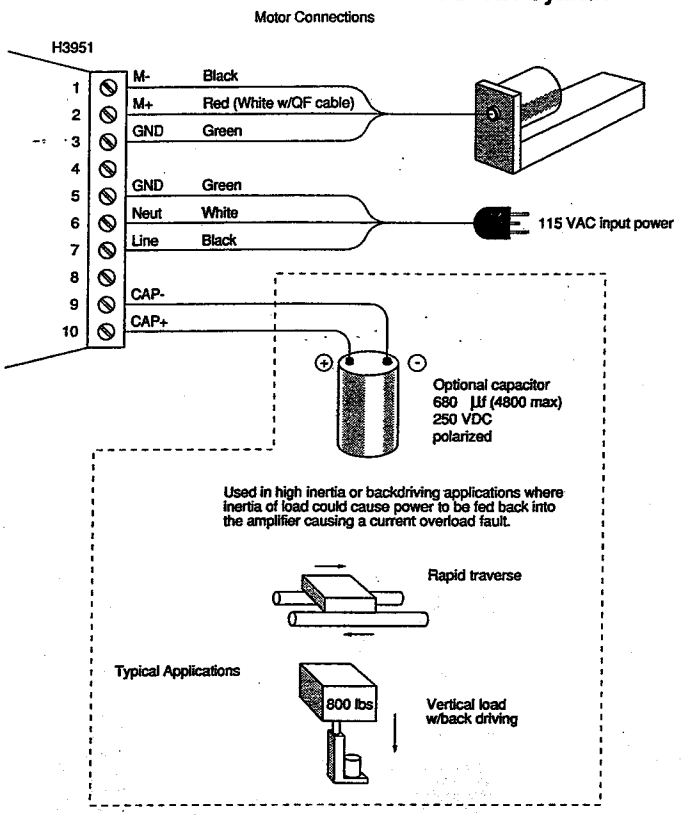
Note: Hx951 denotes an H3951 or H4951 Control

3. Basic Wiring to Operate Your Control

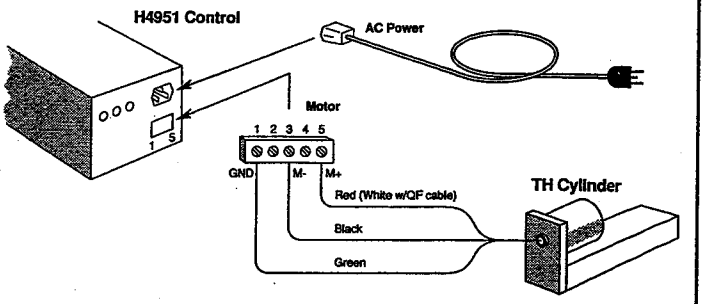
Figures 1-4 indicate the necessary interface wiring to operate your *Hx951* Control. Wire the control and proceed to step 4.

Fig. 1 Motor/Power Interface Wiring: H3951

NH or RH Cylinder



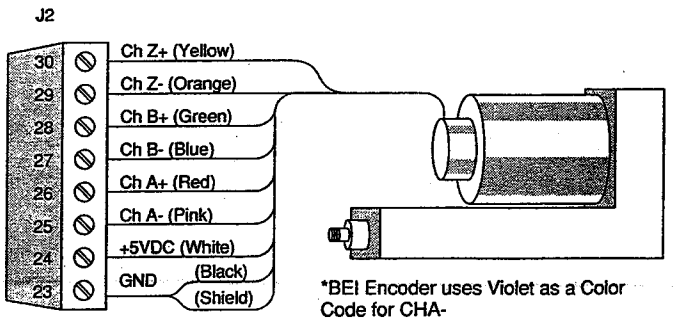
Motor/Power Interface Wiring: H4951



* AC Power: Unit comes with 3 conductor, 6 ft. AC line cord
* Motor Connection: Unit comes with a 5 pin removable Phoenix Connector

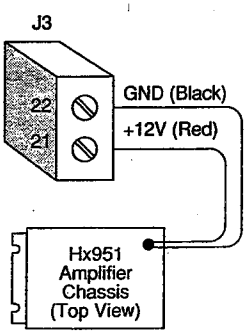
CAUTION: Motor drives are high voltage. Voltage may be present on motor power connections even when motor is stopped. Never touch motor power connections unless AC power is removed from the control.

Fig. 2 Encoder Wiring



*BEI Encoder uses Violet as a Color Code for CHA-

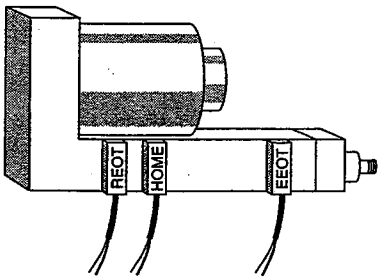
Fig. 3 Logic Power

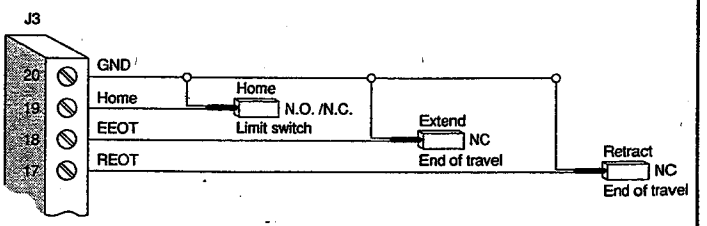


Logic Power Input
Prewired to internal *Hx951* Amplifier Supply, Red and black wire supply 12 volts DC at 500 mA.

Note: The red and black internal power supply wires extend out from the lower amplifier chassis through a junction hole located below the main logic board and the J3 logic power input

Fig. 4 Home and End of Travel Limit Switches





Note 1: Home switch may be mounted anywhere along the length of the cylinder sides containing the internal magnets.

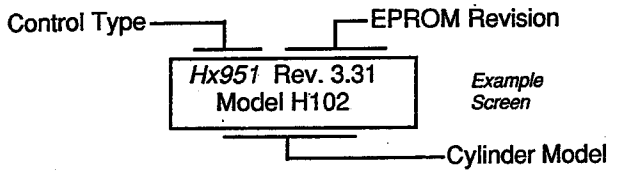
Note 2: If no end of travel limit switches are used, Inputs, REOT and EEOT must be jumpered to Ground (GND).

Note: Hx951 denotes an H3951 or H4951 Control

4. Applying Power to your unit and Identifying the Functions on your LCD display

1. Apply Power (115VAC) to your unit.

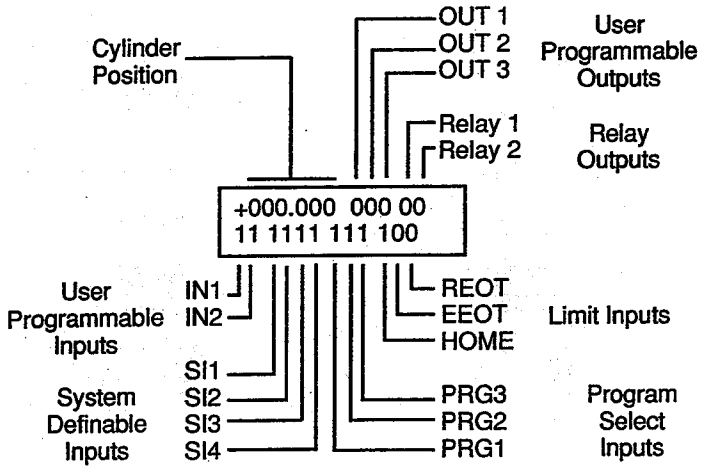
After 2 seconds, the LCD screen will briefly flash the following display, indicating the Control Type, the Software EPROM Revision, and the Model Number of the Cylinder in which the control is configured.



2. Identify functions on the RUN MODE Display

Your unit will complete its power up cycle by entering into the Run Mode. The LCD screen will enter and remain in the Default Run Mode Display which indicates the cylinder position and I/O "ON/OFF" Status.

DEFAULT RUN MODE DISPLAY



LCD Display: Functional Description

Cylinder Position: Real-time position feedback report indicating cylinder position in inches or centimeters. The displayed position range is +/- 000.000 to 999.999 inches. When the internal position counter is reset, the LCD position display sets itself to zero. This condition occurs upon power up, after a system reset, or completion of a successful homing routine.

INPUTS : LCD displays Input ON/OFF Status (0 or 1)
0 = Input ACTIVATED(grounded low)
1 = Input OFF (open circuit high)

OUTPUTS: LCD displays Output ON/OFF Status (1 or 0)
1 = Output ON (Sinking to Ground)
0 = Output OFF(Open Circuit)

LCD displays Relay Output ON/OFF Status (1 or 0)
1 = Relay ENERGIZED (Contacts Active)
0 = Relay DE-ENERGIZED (Contacts in Normal State)

5. Configuring the *Hx951* to your Actuator and Running a Test Program.

1. Configuring the *Hx951* to your Actuator

The System Parameter Model Number must be defined to match the actuator being used to allow for proper operation. This command configures the *Hx951* control to operate with a specified cylinder's gear ratio and screw pitch by converting the system's encoder feedback pulses into inches (or cm) of linear travel. This will also determine the maximum linear speed of the actuator based on a maximum motor speed of 3600 RPM (H3951) or 2400 RPM (H4951).

Cylinder Information

NH and RH Series (Rod and Rodless): H3951

Available Linear Speeds — Model Number: 3 or 4 Digit Code

Cyl. Model	Eng. in/sec	Metric (cm/s)	Cyl. Model	Eng. in/sec	Metric (cm/s)	Cyl. Model	Eng. in/sec	Metric (cm/s)
H102	30.0	(76.20)	H105	12.0	(30.48)	H108	7.5	(19.05)
152	20.0	(50.80)	155	8.0	(20.32)	158	5.0	(12.70)
202	15.0	(38.10)	205	6.0	(15.24)	208	3.8	(9.52)
352	8.6	(21.33)	355	3.4	(8.64)	358	2.1	(5.33)
992	30.0	(76.30)	995	12.0	(30.45)	998	7.5	(9.05)

Ballscrew 2 pitch — Acme/Ballscrew 5 pitch — Acme 8 pitch

TH Series (Rod Type): H4951

Available Linear Speeds — Model Number: 3 or 4 Digit Code

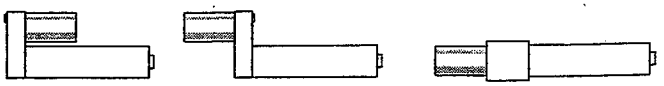
Cyl. Model	Eng. in/sec	Metric (cm/s)	Cyl. Model	Eng. in/sec	Metric (cm/s)	Cyl. Model	Eng. in/sec	Metric (cm/s)
TH4101	40.0	(101.60)	TH4104	10.0	(25.40)	TH4106	6.7	(17.02)
151	27.0	(68.58)	154	6.7	(17.02)	156	4.4	(11.18)
201	20.0	(50.80)	204	5.0	(12.70)	206	3.3	(8.38)
501	8.0	(20.32)	504	2.0	(5.08)	506	1.3	(3.30)
1001	4.0	(10.16)	1004	1.0	(2.54)	1006	.67	(1.70)
991	40.0	(101.60)	994	10.0	(25.40)	996	6.7	(17.02)

Ballscrew 1 pitch — Ballscrew 4 pitch — Acme 6 pitch

Cylinder Motor Mounting Configurations

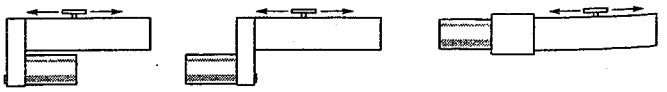
Rod Type Cylinder Configurations (NH & TH)

Parallel — Reverse/Parallel — Inline



Rodless Cylinder Configurations (RH Series)

Parallel — Reverse/Parallel — Inline



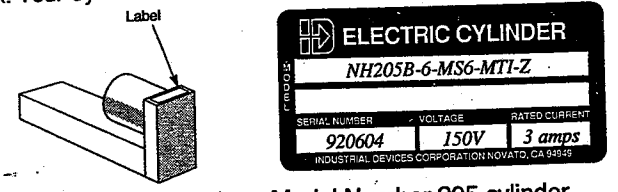
Note 1: Final move speeds are LOAD & LENGTH DEPENDENT
Note 2: Metric units for velocity are used when the MU (Metric Units) Command is enabled in System Parameters
Note 3: The label on the Cylinder indicates the system model number and specifies the Gear Ratio and Screw Pitch.

Note: Hx951 denotes an H3951 or H4951 Control

Entering your Model Number is a 2 Step Process

STEP 1 Identify & Enter Your Cylinder 3 Digit Code as done in the following example.

Ex. Your Cylinder has this label attached



Configure the *Hx951* for a Model Number 205 cylinder.

RUN MODE Default Display	+000.000 000 00 11 1111 111 100

KEYPAD ENTRY	*Hx951* DISPLAY	
F1	F1: Enter Run Mode Function	
EDIT	Alter Sys Params YES=ENTR NO=ESC	
ENTR	Model # MN:102 VE100=30.00 in/s	*This Display will show the current cylinder your unit is configured for.*
2 0 5	Model # MN:205	
ESC	Saving System Parameters	System Parameters have been Saved

RUN MODE	+000.000 000 00 11 1111 111 100

*To confirm your Model # Configuration Press [F1] [EDIT] [ENTR] (in that order)

Your System Parameter Display will read:	Model # MN:205
	VE100 = 6 in/s

Press [ESC] to exit back to Run Mode

Tuning

Note: The H3951 and H4951 Controls are servo based systems that may require adjustments to the PID Gain Parameters to optimize system response for varying load and move requirements.

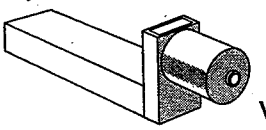
Review Chapter 8 Tuning with PID "Gain" Parameters for detailed information on tuning your control.

Note: Hx951 denotes an H3951 or H4951 Control

STEP 2 Identify Your Motor Mounting Configuration from the table below. Cylinders with Reverse/Parallel mounts ONLY must denote an "R" (F2 Key) at the end of the 3 digit code when entering the System Model Number(MN).

Reverse/Parallel mounts require the control to reverse the motor polarity during moves so that a positive move Extends the cylinder.

Ex. From the previous example, the NH205B-6-MS6-MT1-Z-RM cylinder is configured with a Reverse/Parallel Motor Mount.



Specify Model Number & Reverse/Parallel Mount

Via Keypad Enter the Model Number as;

2	0	5	F2
2	0	5	R

*To confirm your Model # Configuration Press [F1] [EDIT] [ENTR] (in that order)

Your System Parameter Display will read:	Model # MN:205R
	VE100 = 6 in/s

Press [ESC] to exit back to Run Mode

2. Running Test Program 99

With your control configured for the proper cylinder, you can now test your system for proper operation by running test program 99.

Program 99 is a permanent test program in memory and cannot be erased. The program tells the cylinder to extend 1 inch, pause, and then retract 1 inch.

RUN MODE Default Display	+000.000 000 00 11 1111 111 100

KEYPAD ENTRY	*Hx951* DISPLAY
F1	F1: Enter Run Mode Function
6	Enter Program to Run RN:__
9 9 ENTR	Enter Program to Run RN: 99

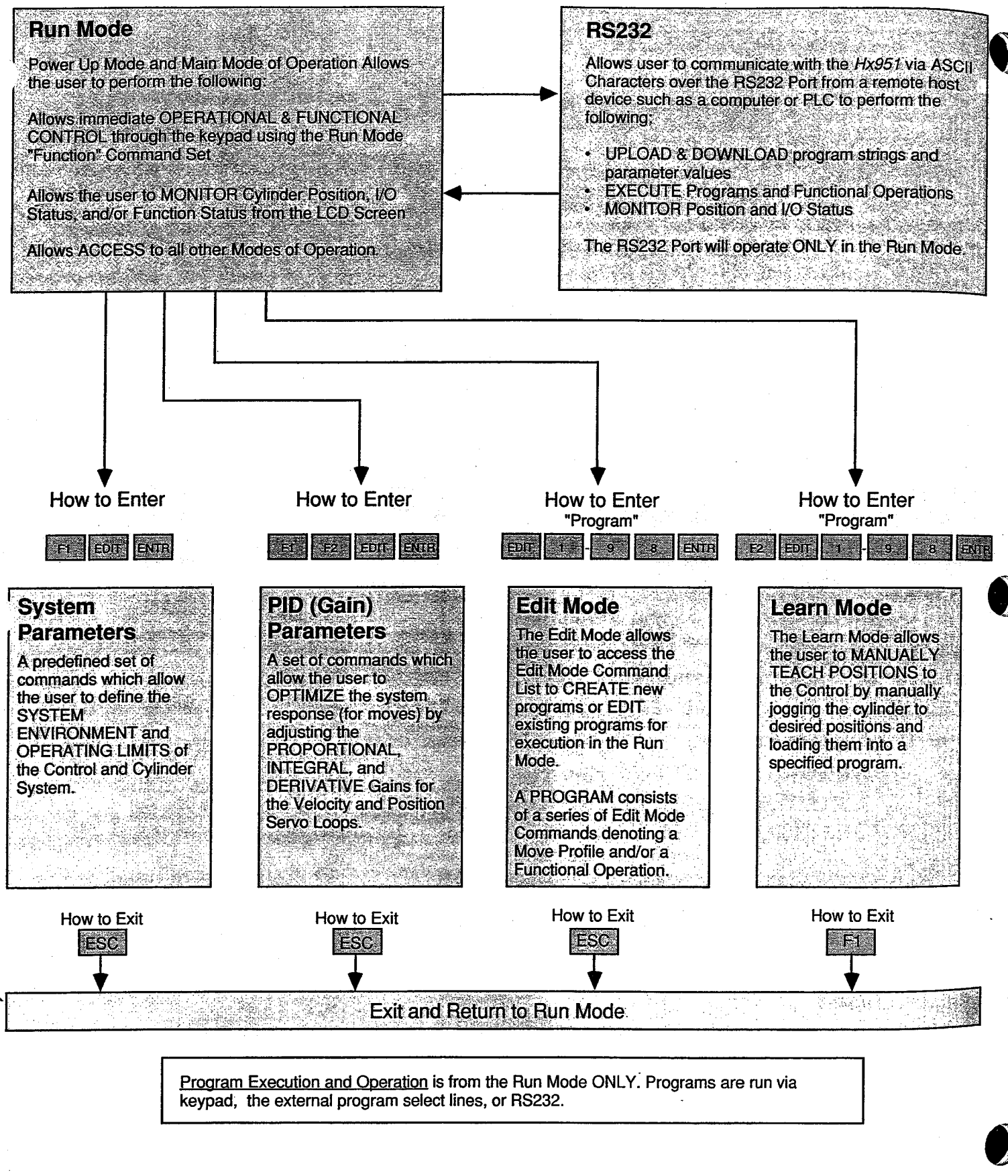
Your cylinder should now Extend 1 inch, pause, and then Retract 1 inch.

RUN MODE DISPLAY	+000.000 000 00 11 1111 111 100	*Unit Returns to Run Mode Default Display*

YOUR SYSTEM IS OPERATIONAL

Note: If your cylinder did not perform the above move profile REVIEW STEPS 3-5. of this Chapter.

Operation Flowchart Diagram



Program Execution and Operation is from the Run Mode ONLY. Programs are run via keypad, the external program select lines, or RS232.

Note: Hx951 denotes an H3951 or H4951 Control

2.1 Multi-Function Keypad Definitions

The *Hx951* Control assigns different functional abilities to keys in the five Modes of Operation. The following chart designates the Basic "Key" functions within each mode.

ESC	ESCAPE: Emergency Stop, Terminate Program Execution. Immediately stops any motion, time delay, loop, wait function, or scanning of the program select inputs currently being executed. The Escape key is also used to exit from other Run Mode Functions to the Run Mode Default Display and to jog the cylinder when pressed simultaneously with arrow keys.
RUN MODE	

Selected Key	RUN Mode	PID and System Parameters	EDIT Mode	Learn Mode
ESC	See Above	Exit & Save Parameters & then return to Run Mode	Exit the Edit Mode, Save the Program that was optional, & then return to Run Mode	Pressed simultaneously with arrow keys to jog cylinder
ENTR	Enter/Execute the specified Run Mode function.	Scroll forward to the next parameter display	Insert a "space" character in a program (acts as a Space Bar)	Enter (LOAD) present cylinder position into the present "Learn" Program
F1	Select a Run Mode function	Scroll backward to the previous Parameter Display	Select Edit Mode Command Function	Save "Learned" Program, Exit Learn Mode, & return to Run Mode
F2	Select a Run Mode function	Scroll forward to the next Parameter Display	Select Edit Mode Command Function	———
EDIT	Select a Program to Edit or a Function Select Entry	———	———	———
DEL	Select a Program to Delete or a Function Select Entry	Deletes the Character at the cursor in the Parameter Display Field	Deletes the character located at the cursor	———
→	Pressed simultaneously with ESC Key to jog cylinder in the extend (+) direction	Move cursor to the right in the Parameter Display Field	Move cursor to the right on the Edit Mode Display Screen	Pressed simultaneously with ESC Key to jog cylinder in the extend (+) direction
←	Pressed simultaneously with ESC Key to jog cylinder in the retract (-) direction	Move cursor to the left in the Parameter Display Field	Move cursor to the left on the Edit Mode Display Screen	Pressed simultaneously with ESC Key to jog cylinder in the retract (-) direction
+/-	———	Toggle "sign" of entered numeric data	Toggle "sign" of entered numeric data	———
.	———	Decimal point used with Numeric Data Entry	Decimal point used with Numeric Data Entry	———
0 - 9	Run Mode Fuction Selection & Alpha Numeric Data Entry	Alpha Numeric Data Entry	Edit Mode Command Function Selection or Alpha Numeric Data Entry	———

2.2 Operation Descriptions: Programming via Keypad

Five modes of operation allow the user access to a powerful group of commands which easily configure and operate the *Hx951* System to meet specific application needs. The following sections describe the functional operations within each of these five modes.

1. Operating in the RUN MODE

The Run Mode allows immediate manual & functional control of the *Hx951* from the keypad interface using the Run Mode Function Set.

RUN MODE (*Hx951* Power Up &) (Operational Mode)

Run Mode Monitor Display: `+000.000 000 00` / `11 1111 111 100` (Default)

Run Mode Function Set	Function Display	Now
To select a function in Run Mode, press the correlating function keys (in order shown)	This is what your display should read.	Enter a variable or key specifier
EDIT	Enter Program Number:__	*Edit a Program __=1 to 98*
DEL	Enter Program to Delete:__	*Delete a Program __ = 1 to 98*
F1 0	Bytes Remaining in EEPROM 7546	*EEPROM Available Memory*
F1 5	OT00000 OUTPUTS nnnrr ACTIVE	*Test Outputs (0 = OFF 1 = ON)*
F1 6	Enter Program to Run RN:__	*Run a Program __= 1 to 99*
F1 7	Enter Source PRG # to Copy:__	*Copy a Program __= 1 to 99*
F1 EDIT	Alter Sys Params YES=ENTR NO=ESC	*Enter System Parameters*
F2 EDIT	Learn Program Number:	*Enter Learn Mode __= 1 to 98*
F1 F2 EDIT	Alter PID Params YES=ENTR NO=ESC	*Enter PID Parameters*
F1 F2 ENTR	*Hx951* REV 3.31 Model H105	*Display EEPROM Revision & Cylinder Model #*
F1 F2 DEL	Original Config? YES=ENTR NO=ESC	*Erase all Programs Restore all Default Parameter Values*
F1 F2 1	Set Position to Zero ? YES=ENTR	*Set current cylinder position to zero*
F1 F2 3	Sending a string over RS232	*Send an ASCII string to host device over RS232 Port*
F1 F2 8	Restore Defaults YES=ENTR NO=ESC	*Restore Default Values to Move & System Parameters*
F1 F2 9	Reset System ? YES=ENTR NO=ESC	*Issue a System Reset (Software Warm Boot)*

Escape Key

Run Mode Monitor Display

ESC → `+000.000 000 00` / `11 1111 111 100` (Default)

Terminates all Program and Functional Operations in the Run Mode. After terminating the operaton, the unit exits to the Default Run Mode Monitor Display

ESC & →	`+xxx.xxx 000 00` / `11 1111 111 100`	*Jog Cylinder in the Extend (+) Direction*
ESC & ←	`+xxx.xxx 000 00` / `11 1111 111 100`	*Jog Cylinder in the Retract (-) Direction*

Reference: For Detailed Run Mode "Function" Descriptions See Run Mode Functions Command List/Description.

Note: Hx951 denotes an H3951 or H4951 Control

Running a Program

All programs must be executed from the run mode where they can be run from the keypad or from the external program select lines.

Example Run Program 7

RUN MODE Default Display	+000.000 000 00 11 1111 111 100	In Run Mode

KEYPAD ENTRY	*Hx951* DISPLAY	
F1	F1: Enter Run Mode Function	Select a Run Mode Function
6	Enter Program to Run RN:	Select a program to run
	Enter a Program Number (1 - 99) to execute.	
7	Enter Program to Run RN:7	Select Program 7 to run
ENTR	+xxx.xxx 000 00 11 1111 111 100	Execute Program 7

While any program is executing the screen will show the Run Mode Default Display which will monitor the cylinder position and I/O status.

Reference: To RUN Programs from the External Program Select Lines

See System Parameters: XP Command (external program select)
Hardware Reference: Wiring & specifications for the Program Select Low Level Inputs

Note: Hx951 denotes an H3951 or H4951 Control

2. Operating in System Parameters

System Parameters are a predefined set commands which allow the user to define the System Environment and Operating Limits.

+000.000 000 00 11 1111 111 100	Run Mode Display

1. Enter System Parameters from the Run Mode by entering the following:

Your Display Reads

F1: Enter Run Mode Function

Alter Sys Params YES=ENTR NO=ESC

F1 → EDIT, ENTR

System Parameters

MNnnn
Model Number
	Model # MN:102
	VE100=30.00 in/s
		To enter values, scroll to the appropriate Command Dislay and enter desired values through numbers on the keypad and press enter.

CEnn *Current Overload Extend*	Cur Overload Ext CE:65	
CRnn *Current Overload Retract*	Cur Overload Rtr CR:65	
CSn *Coordinate System*	Coordinate Sys CS:0 (0 or 1)	
DPn *Display Mode*	Display Mode DP:1 (1 or 2)	
ECn *Echo*	Echo RS232 EC:1 1=ON/0=OFF	
HAmn *Home Algorithm*	Home Algorithm HA(mn):01	
HO+/-nnn.nnn *Home Offset*	Home Offset HO:+000.000	
JAnn.nn *Jog Acceleration*	Jog Accel time JA:00.10	
JVnn *Jog Velocity*	Jog Velocity JV:10	
MUn *Metric Units*	Metric Units MU:0 1=on/0=off	
PUnn *Power Up Mode*	Power Up Mode PU:00	
SDnn.nn *Stop Decel Time*	STn decel time SD:00.10	
SImnxy *System Inputs*	System Inputs SI(mnxy):8800	
SOmn *System Outputs*	System Outputs SO(mn):00	
UNnn *Unit Number*	Unit Number UN:01	
XPn *External Prog. Select*	Ext Prog Select XP:0 1=on/0=off	

F1 (Scrolls Up)

ENTR (Scrolls Down)

ESC (Returns to Run Mode and saves system parameters)

Reference: Detailed Command Descriptions See System Parameter Command List/ Descriptions

Altering a System Parameter

Example: Configure the *Hx951* for a Model Number 205 cylinder, and for use in Coordinate System Mode 1.

Enter System Parameters from RUN MODE via keypad: +000.000 000 00 / 11 1111 111 100 — Run Mode Display

KEYPAD ENTRY	*Hx951* DISPLAY	
F1	F1: Enter Run Mode Function	Perform a Run Mode Function
EDIT	Alter Sys Params YES=ENTR NO=ESC	Do you wish to alter System Parameters
ENTR	Model # MN:102 VE100=30.00 in/s	Model # is first Parameter Display
2 0 5	Model # MN:205	Enter Model # 205
ENTR	Cur overload Ext CE: 65	Scroll to next screen
ENTR	Cur overload Rtr CE: 65	Scroll to next screen
ENTR	Coordinate sys CS:0 (0 or 1)	Coordinate System Display
1	Coordinate sys CS:1	Select Mode 1
ESC	Saving System Parameters	System Parameters have been Saved
RUN MODE	+000.000 000 00 / 11 1111 111 100	Return to Run Mode Display

Note: Hx951 denotes an H3951 or H4951 Control

3. Operating in PID Parameters

A set of commands which allow the user to OPTIMIZE the system response (for moves) by adjusting the PROPORTIONAL, INTEGRAL, & DERIVATIVE Gains for the Velocity and Position Servo Loops.

+000.000 000 00 11 1111 111 100	Run Mode Display

1. Enter PID Parameters from the Run Mode by entering the following:

Your Display Reads

F1: Enter Run Mode Function

Alter PID Params YES=ENTR NO=ESC

F1 F2

EDIT ENTR

PID Parameters

PPnn *Position Loop/Proport. Gain*	Enter Position P Gain PP:10
PInn *Position Loop/Integral Gain*	Enter Position I Gain PI:10
PDnn *Position Loop/Derivative Gain*	Enter Position D Gain PD:10
VPnn *Velocity Loop/Proport. Gain*	Enter Velocity P Gain VP:10
VInn *Velocity Loop/Integral Gain*	Enter Velocity I Gain VI:10
VDnn *Velocity Loop/Derivative Gain*	Enter Velocity D Gain VD:10

F1 (Scrolls Up)

ENTR (Scrolls Down)

ESC (Returns to Run Mode and saves parameters)

To enter values, scroll to the appropriate Command Dislay and enter desired values through numbers on the keypad and press enter.

Reference: Chapter 8 "Tuning with PID Parameters" for more detailed information on using PID Gains to optimize system response.

Altering a PID Parameter

Example: Configure the *Hx951* for a position loop integral gain of 3 and a velocity loop proportional gain of 12.

Enter PID Parameters from RUN MODE via keypad

+000.000 000 00 11 1111 111 100	Run Mode Display

KEYPAD ENTRY	*Hx951* DISPLAY	
F1 F2	F1: Enter Run Mode Function	Perform a Run Mode Function
EDIT	Alter PID Params YES=ENTR NO=ESC	Do you wish to alter PIDParameters
ENTR	Enter Position P Gain PP:10	Position Loop Proportional Gain 1st Display Screen
ENTR	Enter Position I Gain PI:10	Scroll to Next Screen
3 DEL	Enter Position I Gain PI:3_	Enter Integral Gain of 3 and Delete 2nd Digit
ENTR	Enter Position D Gain PD:10	Scroll to next screen
ENTR	Enter Velocity P Gain VP:10	Scroll to next screen
1 2	Enter Velocity P Gain VP:12	Enter Proportional Gain of 12
ESC	Saving PID Parameters	PID Parameters Saved

RUN MODE	+000.000 000 00 11 1111 111 100	Return to Run Mode Display

Note: Hx951 denotes an H3951 or H4951 Control

4. Operating in the Edit Mode

The Edit Mode allows the user to access the Edit Mode Command List to create new programs or edit existing programs for execution in the Run Mode.

Preliminary Programming Instructions

A program consists of a group of Edit Mode Commands denoting a move profile and/or a functional operation followed by the End of Program (EN) command. Each command is a group of ASCII characters of the form;

ASCII nn <sp>
[command][parameters][delimiter]

where; command :is two upper-case ASCII letters (A-Z) denoting a specific EDIT MODE command.

parameters :are command specific numbers denoting command value or function status.

delimiter :is a SPACE seperating commands.

Example: The following program demonstrates the proper command syntax. AC.5 DE.5 VE75 DA4 GO EN

EDIT MODE COMMAND LIST

F1		Function	Range of Parameter Values
1	DA	Distance Absolute	(+/- 000.000 - 999.999 in.)
2	DI	Distance Incremental	(+/- 000.000 - 999.999 in.)
3	DC	Distance to Change	(+/- 000.000 - 999.999 in.)
4	VE	Velocity	(1-100% of max speed)
5	OT	Outputs Set	(0=off, 1=on, 2=no change)
6	RN	Run Program #	(1-99)
7	TD	Time Delay	(.01-99999.99 sec.)
8	WT	Wait On Inputs	(0=grounded,1=open,2=ignore)
9	GO	Go - Make Move	
0	GH	Go Home	(1-100% of max speed)

F2		Function	Range of Parameter Values
1	AC	Acceleration Time	(.01 to 15 sec.)
2	DE	Deceleration Time	(.01 to 15 sec.)
3	IF	IF - THEN	(0=grounded,1=open,2=ignore)
4	LP	Loop	(0 to 99999)
5	EL	End of Loop	
6	ST	Stop On Input #	(1-4)
7	CT	Current Hold Time	(.01-99999.99 sec)
8	CL	Current Hold Limit	(0-100%)
9	EN	End of Program	
0	UV	User Variable	

Entering a "Program" is a 3 Step Process

Step 1 Enter the Edit Mode from the Run Mode and select a program to edit. The selected program number can be from 1 to 98.

Step 2 Enter a program by choosing commands from the Edit Mode Command List by selecting a function key (F1 or F2) followed by the digit corresponding to the desired command. Enter a numeric value following the command if needed.

Note 1: Total available memory for programming is 7.5 KB with individual programs limited to 1000 characters (1 Byte = 1 Character)
Note 2: A "space" is considered a character.

REVIEW OF EDIT MODE KEYPAD FUNCTIONS

F1	or F2	Enter command from Command Table
0	9	Numeric Data Entry & Function Selection
+/-		Toggle "sign" for Numeric Data
.		Decimal Point for data entry
→		Move Cursor to the right
←		Move Cursor to the left
DEL		Delete Character at cursor
ENTR		Insert a "space" character
ESC		Save Program then exit to Run Mode

Step 3 Exit the Edit Mode, save your program, and return to the Run Mode.

Note 1: All programs are saved to non-volatile EEPROM memory.

Entering a NEW Program

Example: Enter the following command string into Program 7;
AC.5 DE.6 VE75 DA4 GO EN

Step 1 Enter the Edit Mode from the Run Mode and select Program 7 to edit.

RUN MODE Default Display	+000.000 000 00 11 1111 111 100	Begin in Run Mode

KEYPAD ENTRY	*Hx951* DISPLAY	
EDIT	Enter Program Number:_	Select Edit Mode
	Enter a Program Number (1-98) to edit.	
7	Enter Program Number: 7	Select Program 7 to edit
ENTR	—	Edit Mode Display *(Program 7)*

Step 2 Enter Program 7 by choosing commands from the Edit Mode Command List by selecting a Function Key (F1 or F2) followed by the digit corresponding to the desired command. Enter a numeric value following the command if needed.

	—	Edit Mode

KEYPAD ENTRY	*Hx951* DISPLAY	
F2 1	AC__	Enter Acceleration Command (AC)
- 5 ENTR	AC.5__	Enter Acceleration Value
F2 2	AC.5 DE__	Enter Deceleration Command (DE)
- 6 ENTR	AC.5 DE.6__	Enter Deceleration Value
F1 4	AC.5 DE.6 VE__	Enter Velocity Command (VE)
7 5 ENTR	AC.5 DE.6 VE75__	Enter Velocity Value
F1 1	AC.5 DE.6 VE75 DA__	Enter Distance Absolute Command (DA)
4 ENTR	AC.5 DE.6 VE75 DA4__	Enter Distance Absolute Value
F1 9	AC.5 DE.6 VE75 DA4 GO__	Enter Go (execute) Command

Step 3 Exit the Edit Mode, Save Program 7, and Return to Run Mode.

KEYPAD ENTRY	*Hx951* DISPLAY	
ESC	Saving Program Number: 7__ *Specified Program is Saved*	Save Program 7, Exit Edit Mode, & Return to Run Mode

Note: When the ESC key is pressed an EN (End of Program) command is automatically appended to the end of the program.

RUN MODE DISPLAY	+000.000 000 00 11 1111 111 100	Returned to the Run Mode

Edit an Existing Program

Example: Edit Program 7 from the previous example. Change the entered velocity to 50 (%) and insert a Go Home Command (GH) of 30% in the retract (-) direction after the GO command. Follow the same 3 Step Process as previously outlined.

Program 7 AC.5 DE.6 VE75 DA4 GO EN

Change *Insert New Command*

Step 1 Enter the Edit Mode from the Run Mode and select Program 7 to edit.

RUN MODE Default Display	+000.000 000 00 11 1111 111 100	Begin in Run Mode

KEYPAD ENTRY	*Hx951* DISPLAY	
EDIT	Enter Program Number:__	Select Edit Mode
7	Enter Program Number: 7	Select Program 7 to edit
ENTR	AC.5 DE.6 VE75 DA4 GO EN	Edit Mode Display *(Program 7)*

Step 2 Insert and make program changes

1. Change VE75 to VE50
   a. Move Cursor b. Delete old value
   c. Enter new value

a.	→	AC.5 DE.6 VE75 DA4 GO EN	Move cursor to the right
		Use arrow keys to move the cursor to the character you wish to delete	
b.	DEL DEL	AC.5 DE.6 VE_ DA4 GO EN	Delete character at cursor
		Press the delete key twice to delete the 7 and the 5. The command string will shift one space to the left as each character is deleted.	
c.	5 0	AC.5 DE.6 VE50 DA4 GO EN	Enter new value

2. Insert the Go Home Command (GH-30) after the GO

→	AC.5 DE.6 VE50 DA4 GO EN	Move cursor to the right
	Move the cursor with the arrow keys to the position where you would like to insert a command.	
F1 0	AC.5 DE.6 VE50 DA4 GO GHEN	Enter GH Command
+/- 3 0	AC.5 DE.6 VE50 DA4 GO GH-30EN	Enter GH Value
ENTR	AC.5 DE.6 VE50 DA4 GO GH-30 EN	Insert a Space

Step 3 Exit the Edit Mode, Save Program 7, and Return to Run Mode.

KEYPAD ENTRY	*Hx951* DISPLAY	
ESC	Saving Program Number: 7__	Save Program 7, Exit Edit Mode, & Return to Run Mode

RUN MODE DISPLAY	+000.000 000 00 11 1111 111 100	Returned to the Run Mode

New Program 7 AC.5 DE.6 VE50 DA4 GO GH-30 EN

5. Operating in the Learn Mode

The Learn Mode allows the user to manually teach positions (move points) to the *Hx951* Control by manually jogging the cylinder to desired positions and loading them into a specified program.

Entering a "LEARN" Program is a 4 Step Process

Step 1 Enter the Learn Mode from the Run Mode by selecting a program to learn positions. The selected program number can be from 1 to 98.

Step 2 In the Learn Mode, jog the cylinder to a desired position and load that position into program memory. Repeat this step for all positions to be learned.

JOGGING THE CYLINDER

ESC → Jog (+) Extend

ESC ← Jog (-) Retract

Pressing the ESCape & the desired ARROW key simultaneously will allow the user to jog the cylinder from the keypad.

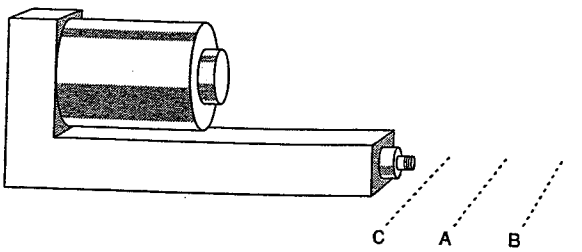
Step 3 Exit Learn Mode after all desired positions have been loaded into the program and return to the Run Mode.

Step 4 The existing program containing the Learned Positions can now be accessed via the EDIT MODE where ramp times (AC & DE), velocities (VE), and command functions can be entered to create the desired move profiles and control interaction.

Note: If no velocities or ramp times are entered into the learned program positions. The move profiles will use the last values entered into the buffer from a previously executed move or if none were entered, the unit will use the default values (AC = .3 sec, DE = .3 sec, VE = 25% speed).

Note: Hx951 denotes an H3951 or H4951 Control

Detailed Learn Mode Example



Example: Teach Program 13 to "Learn" positions A, B, and C (in that order) in the above diagram.

Step 1 Enter the Learn Mode from the Run Mode by selecting Program 13 to learn positions, A, B, and C.

RUN MODE Default Display	+000.000 000 00 11 1111 111 100	Begin in Run Mode
KEYPAD ENTRY	*Hx951* DISPLAY	
F2	F2: Enter Run Mode Function	Select a Run Mode Function
EDIT	Learn Program Number:_	Select Learn Mode
	Enter a Program Number (1-98) to "Learn" Positions	
1 3	Learn Program Number: 13	Select Program 13
ENTR	+000.000 F1 Exit	Learn Mode Display

Step 2 In the Learn Mode, jog the cylinder to each desired position and load those positions into program memory.

	+000.000 F1 Exit	Learn Mode
KEYPAD ENTRY	*Hx951* DISPLAY	
ESC →	+xxx.xxx F1 Exit	Jog Cylinder in Extend Direction to position A
	Cylinder Position is indicated on the LCD Screen at all times	
	+002.037 F1 Exit	Release Jog Keys at Position A
	Example Position	
ENTR	+002.037 F1 Exit DA2.037 GO	Load Position A (2.037") into Program 13
	Desired position is entered into the Program as an Absolute Distance (DA) appended with a GO command	

REPEAT the above procedure for the remaining positions.

ESC →	+xxx.xxx F1 Exit DA2.037 GO	Jog Cylinder in Extend Direction to position B
ENTR	+004.381 F1 Exit DA4.381 GO	Load Position B (4.381") into Program 13
ESC ←	+xxx.xxx F1 Exit DA4.381 GO	Jog Cylinder in Retract Direction to position C
ENTR	+000.025 F1 Exit DA+0.025 GO	Load Position C (0.025") into Program 13

Step 3 Exit Learn Mode and Save program 13 after positions A, B, and C have been loaded into Program Memory. Return to Run Mode.

KEYPAD ENTRY	*Hx951* DISPLAY	
F1	Saving Program Number: 13	Save Program 13 Exit Learn Mode
	Specified Program is Saved	
RUN MODE DISPLAY	+000.025 000 00 11 1111 111 100	Returned to the Run Mode

Step 4 Enter the Edit Mode and edit existing Program 13 and add the desired move profile parameters and function commands to the saved positions.

Program 13
DA+2.037 GO DA+4.381 GO DA+0.025 GO EN

Within the program the distances will appear in the order they were saved in the Learn Mode. Simply insert desired commands from the Edit Mode Command List as described in the previous section on Operating in the Edit Mode.

Note: Hx951 denotes an H3951 or H4951 Control

1 • Escape, Terminate Program Execution
2 • Enter Edit Mode, Edit Program
3 • Delete Program
4 • Available Memory Request
5 • Test Outputs
6 • Run Program
7 • Copy Program
8 • Enter System Parameters
9 • Enter Learn Mode
10 • Enter PID Parameters
11 • Display EEPROM Software Revision
12 • Set to Original Configuration
13 • Zero Current Position
14 • Transmit RS232 String
15 • Restore Default Values
16 • System Reset
17 • Jog Extend
18 • Jog Retract

RUN MODE DEFAULT DISPLAY

```
+000.000  000  00
11 1111   111  111
```

Function Keys Selected — Function Description

1. ESC — ESCAPE: Emergency Stop, Terminate Program Execution. Immediately stops any motion (at a rate set by the SD command in System Parameters), time delay, loop, and/or a wait input currently being executed. The Escape key is also used to exit from other Run Mode Function Displays to the Run Mode Default Display and used to jog the cylinder if pressed simultaneously with arrow keys.

2. EDIT — EDIT: Enter EDIT MODE. Prompts the user to select a program to edit or create. The program number can be from 1 to 98. ESC returns to the Run Mode.

```
Enter Program
Number:_
```
RUN MODE FUNCTION DISPLAY

Reference: "Operating in the Edit Mode" Section in Ch. 2 for detailed operating information in this mode.

3. DEL — DELETE: Prompts the user to select a program to delete.
The program number can be 1 to 98.

```
Enter Program
to Delete:_
```
RUN MODE FUNCTION DISPLAY

4. F1 0 — AVAILABLE MEMORY REQUEST: Displays the available memory remaining for programming. Starting available memory is 7.5-7.7K Bytes where one ASCII character equals one byte of memory.

```
Bytes Remaining
in EEPROM 7691
```
RUN MODE FUNCTION DISPLAY

5. F1 5 — TEST OUTPUTS: Prompts the user to test the interface for the User Programmable and Relay Outputs by allowing the outputs to be manually turned ON or OFF.

```
OT10110  OUTPUTS
  nnnrr  ACTIVE
```
RUN MODE FUNCTION DISPLAY

Move the cursor with the arrow keys to the desired output digit where a 1 or 0 can be entered to turn the output on or off. NOTE: nnn refers to User Programmable Outputs 1, 2, and 3, respectively, and rr refers to Relays 1 and 2. Once turned ON, an Output remains set until changed by the Test Output Function, an Edit Mode Output (OT) command, a System Reset, or Power is Cycled.

```
OT n   n   n   r      r
   OUT1 OUT2 OUT3 RELAY1 RELAY2
```

n = 1 Output ON (Sinking to Ground)
n = 0 Output OFF (Open Circuit)

r = 1 Relay ON (Contacts in Active State)
r = 0 Relay OFF (Contacts in Normal State)

6. F1 6 — RUN PROGRAM: Prompts the user to select a program to execute. The Program Number can be 1 to 99.

```
Enter Program
to Run RN:_
```
RUN MODE FUNCTION DISPLAY

7. F1 7 — COPY PROGRAM: Prompts the user to select a source program to copy and its destination location. The Program Number can be 1 to 99.

```
Enter Source Prg.
# to Copy:_
```
RUN MODE FUNCTION DISPLAY

After entering the Source Program the unit will prompt the user to enter the destination program. The Program Number can be 1 to 99.

```
Enter Destination
Prg. #:_
```
RUN MODE FUNCTION DISPLAY

Notes: 1. After a program is copied, the contents of the source program will still exist in the original program location.

2. If a program exists in a destination location when attempting to copy, the unit will prompt the user to overwrite or to abort.

8. F1 EDIT SYSTEM PARAMETERS: Alter System Parameters. Prompts the user to Enter System Parameters to alter parameter values. Press ESC to return to Run Mode.

Alter Sys Params YES=ENTR NO=ESC	RUN MODE FUNCTION DISPLAY

Reference: "Operating in System Parameters" Section in Ch. 2 for detailed operating information in this mode.

9. F2 EDIT LEARN MODE: Enter Learn Mode. Prompts the user to select a program to learn positions using the Learn Mode Program Editor. Program can be 1 to 98. Press F1 to return to Run Mode.

Learn Program:__	RUN MODE FUNCTION DISPLAY

Reference: "Operating in the Learn Mode" Section in Ch. 2 for detailed operating information in this mode.

10. F1 F2 ENTR PID PARAMETERS: Prompts the user to enter PID Parameters to alter "gain" parameter values. Press ESC to return to Run Mode.

Alter PID Params YES=ENTR NO=ESC	RUN MODE FUNCTION DISPLAY

Reference: "Operating in PID Parameters" Section in Ch. 2 for detailed operating information in this mode.

11. F1 F2 ENTR DISPLAY SOFTWARE REVISION: The LCD Screen displays the *Hx951* EEPROM Software Revision and Cylinder Model Number.

Hx951 REV 3.31 Model H105	RUN MODE FUNCTION DISPLAY

12. F1 F2 DEL ORIGINAL CONFIGURATION: Sets the EEPROM to its original default state as if the control were a new unit. The buffer is cleared, all programs are erased, and all commands are set to their default values.

ORIGINAL CONFIG. YES=ENTR NO=ESC	RUN MODE FUNCTION DISPLAY

13. F1 F2 1 ZERO POSITION: Resets the current position to zero. All absolute moves are now referenced from this point.

SET POSITION TO ZERO ? YES=ENTR	RUN MODE FUNCTION DISPLAY

14. F1 F2 3 TRANSMIT RS232 STRING: Tests RS232 Serial Communication setup by sending an ASCII string from the control to a Host Device connected to the RECEIVE, TRANSMIT, and GROUND terminals on the RS232 Port. The transmitted string contains the EEPROM software revision and the Cylinder Model Number Configuration for your *Hx951*.
ex. *Hx951* REV 3.31 Model H105
(Sent to host)

Sending a String over RS232	RUN MODE FUNCTION DISPLAY

15. F1 F2 8 RESTORE DEFAULT VALUES: Restores all EDIT MODE, PID and SYSTEM PARAMETER commands to their default values except for the System Parameter Model Number command. This function does not modify or erase any programs.

Restore Defaults Yes=ENTR No=ESC	RUN MODE FUNCTION DISPLAY

16. F1 F2 9 SYSTEM RESET: (Software Warm Boot) resets the *Hx951* Software, clearing the buffer, and resetting the control to its power up state (equivalent to cycling power). The reset cycle will disable the controller for approximately 5 seconds before entering Run Mode. (Programs and Parameter Settings are NOT erased)

Reset System ? Yes=ENTR No=ESC	RUN MODE FUNCTION DISPLAY

17. ESC & → JOG EXTEND: Simultaneously pressing both keys jogs the cylinder in the extend direction at a velocity determined by the JV System Parameters Command. When the keys are released, motion stops. The cylinder position will be shown on the LCD display at all times.

+xxx.xxx 000 00 11 1111 111 100	RUN MODE FUNCTION DISPLAY

18. ESC & ← JOG RETRACT: Simultaneously pressing both keys jogs the cylinder in the retract direction at a velocity determined by the JV System Parameters Command. When the keys are released, motion stops. The cylinder position will be shown on the LCD display at all times.

+xxx.xxx 000 00 11 1111 111 100	RUN MODE FUNCTION DISPLAY

Note: For fine positioning of the actuator, momentary activation of the keypad Jog Keys will move the actuator in .001 inch increments.

Reference: Setting Jog Velocity or Jog Acceleration
See System Parameters:JV (Jog Velocity) & JA (Jog Acceleration) Commands

1.	AC	Acceleration
2.	CL	Current Hold: Limit
3.	CT	Current Hold: Time
4.	DA	Distance Absolute
5.	DC	Distance to a Change
6.	DE	Deceleration
7.	DI	Distance Incremental
8.	EL	End Loop
9.	EN	End Program
10.	GH	Go Home
11.	GO	GO(execute a move profile)
12.	GO(n)	Go on Input
13.	IF	IF-Then
14.	LP	Loop
15.	OT	Output Set
16.	RN	Run Program
17.	ST	Stop on Input
18.	TD	Time Delay
19.	UV	User Variable
20.	VE	Velocity
21.	WT	Wait on Input

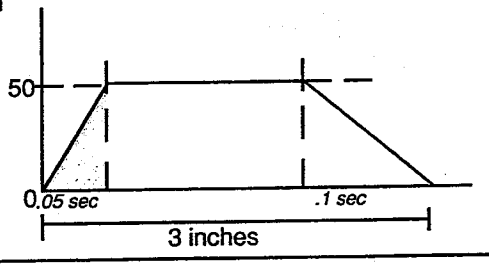
1. ACnn.nn

Command: Acceleration
Range: .05 sec to 15 sec
Syntax: F2 1
Description: Ramp time corresponding to any change of velocity from a lower speed to a higher speed. Once specified it is used in all subsequent moves until it is re-specified. (Default is .3 seconds)

EX. AC.05 DE.1 VE50 DA3 GO

For an absolute move profile of 3 inches, ramp up to 50% max speed in .05 seconds.

Acceleration



2. CLnn

Command: Current "Hold" Limit
Range: 1 to 99
Syntax: F2 8
Description: Current Limit setting determines the maximum allowed current draw of the motor during a move. If the CL Limit is exceeded, the current level is clamped to the CL Level for a time determined by the CT Command or until the move is completed. nn is from 1 to 99% of peak motor current where 99% = 4.5 amps for the H3951 and 7.5 amps for the H4951.

EX. CL20 CT5 DA6 GO EN (for H3951)

The Current Limit for the move to absolute distance of 6 inches is set for 20% (where 20% is .9 amps (.20 x 4.5 amps)).

By controlling the motor current, the motor torque is controlled which determines the maximum linear output thrust/holding force of your cylinder.

To Determine the Linear Holding Force

1. Convert CL(%) value to a proportional current level (I);
   I_{Motor} (amps) = CL (%) x $\frac{Ipk}{100\%}$
   where Ipk = 4.5 amps (H Motor) Ipk = 7.5 amps (H4 Motor)
2. Convert Current (I_{Motor}) to proportional Motor Torque (T_{Motor})
   T_{Motor} (oz-in)= I_{Motor} (amps) x $\frac{K_T}{amp}$
   K_T = 54 oz-in/amp (H Motor) K_T = 67 oz-in/amp (H4 Motor)
3. Calculate the Linear Output Thrust/Holding force (F_{Thrust}) for your cylinder
   $F_{Thrust} = \frac{2\pi}{16} \times T_{Motor}$ (oz-in) x Drive Ratio x Screw Pitch x Efficiency

Final Thrust values could vary ±10%

NH and RH Cylinders

Model Number	Drive Ratio	Screw Pitch	Eff(%)
992B/102B	1.0	2	0.81
152B	1.5	2	0.81
202B	2.0	2	0.81
995B/105B	1.0	5	0.81
155B	1.5	5	0.81
205B	2.0	5	0.81
355B	3.5	5	0.63
995A/105A	1.0	5	0.36
155A	1.5	5	0.36
205A	2.0	5	0.36
355A	3.5	5	0.28
998A/108A	1.0	8	0.36
158A	1.5	8	0.36
208A	2.0	8	0.36
358A	3.5	8	0.28

TH Cylinders

Model Number	Drive Ratio	Screw Pitch	Eff(%)
991B/101B	1.0	1	0.81
151B	1.5	1	0.81
201B	2.0	1	0.81
501B	5.0	1	0.68
1001B	10.0	1	0.68
994B/104B	1.0	4	0.81
154B	1.5	4	0.81
204B	2.0	4	0.81
504B	5.0	4	0.68
1004B	10.0	4	0.68
994A/106A	1.0	6	0.28
156A	1.5	6	0.28
206A	2.0	6	0.28
506A	5.0	6	0.23
1006A	1.0	6	0.23

Note 1:The CL Command Must be used with the CT Current Hold Time Command when used in a program.
Note 2: The CL command should always be set less than the CE or CRCurrent Overload Setting) Commands in System Parameters. If this is not done, the unit will get a "Current Overload" Fault before allowing the Current Hold to initialize.
Note 3: The Current Level can be monitored (real-time) on the Hx951 LCD Display when Display Mode 2 is activated in System Parameters (DP Command).
Note 4: The Normal Servo Position Hold is NOT ACTIVE while the CL Command is active.
Note 5: Velocity is adjusted to coincide with the programmed torque/holding force requirements.

3. CTnnnnn.nn

Command: Current "Hold" Time
Range: .01 to 99999.99 seconds
Syntax: F2 7
Description: Current Time determines the amount of time the current hold is applied during a specific move once the Current "Hold" Limit is exceeded.

Note 1: The CT Command MUST be used with the CL Current Hold Limit Command within a program.
Note 2: If the move distance is completed before the CT timer expires, the move terminates normally.
Note 3: If the CT Timer expires before the Move is complete, the move is terminated and proceeds to the next stop in the program.
Note 4: The Current Hold Timer real-time count can be monitored the H3951 LCD Display when Display Mode 2 is activated System Parameters (DP Command).

EX. CL20 CT5 DA6 GO EN

The Current Hold Time is set for 5 seconds, if the Current Hold Limit exceeded during the 6 inch absolute move, a holding force of 20% will be applied for 5 seconds or until the move is complete (whichever is first).

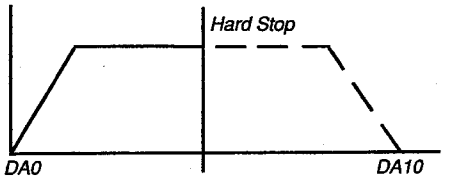
Current Hold Feature

This feature uses the CL & CT commands simultaneously in a program. They are programmed prior to a specific Distance Command (DA or DI) and used (once enabled) during the move to clamp the current to a set level (CL) for a set period of time (CT). The current hold is enabled once the current level reaches the CL Limit wherein the clamp and CT Time are initiated.

Note 1: If the load and speed requirements are such that the CL value is never reached, the move is completed as though the CL command were not activated.
Note 2: The Current Hold Feature can be terminated by activating a Stop on Input, a STOP/KILL via RS232 or System Input, or by pressing the ESC key.
Note 3: A System Output (SO) can be defined to signal that the Current Limit has been tripped.

1. Move to a Hardstop and apply a Holding Force (CL) for a Period of Time (CT)

EX. CL25 CT15 DA10 GO DA0 GO EN



The program will attempt to complete a 10 inch move (DA10), if a hard stop is encountered, the current hold feature will be enabled where a holding force of 25% will be applied for 15 seconds. After this time the hold feature is disabled and the next series of program commands are executed (moving to the absolute zero (DA0) position.) If NO hard stops are encountered, the unit complete the 10 inch move and program normally.

2. Detect a Mechanical Bind or Jam in the cylinder or load during a move, once detected, terminate move, and execute the next move or command in the program.

EX. CL20 CT.1 DA6 GO DA0 GO EN

The program attempts to complete a 6 inch move, if a mechanical bind/jam is encountered, move is terminated after .1 sec then immediately returns to the absolute zero position. This can be used in place of the Current Overload commands (CE & CR) in System Parameters which would terminate program execution and initiate a fault state in the control necessitating the control to be reset.

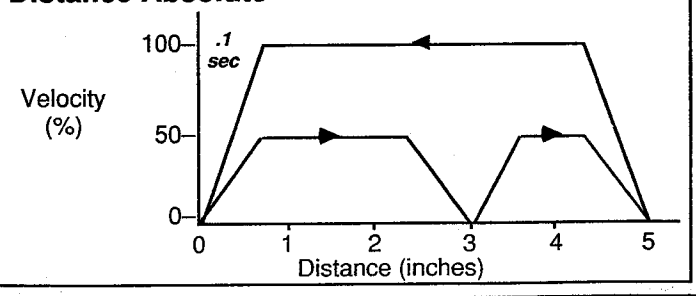
4. DA(+/-)nnn.nnn

Command: Distance Absolute
Range: (+/-)000.000 to 999.999 inches
Syntax: F1 1
Description: Sets position profiles to absolute. All move distances are referenced to/from absolute zero.
Note 1: Range is (±) 0-999.999 centimeters if Metric Units are used. Enabled by System Parameter MU Command.

Ex. AC.1 DE.1 VE50 DA3 GO DA5 GO VE100 DA0 GO

Move to absolute position 3 inches at 50% speed, stop.
Move to absolute position 5 inches at 50% speed, stop.
Move to absolute position 0 inches at 100% speed, stop.

Distance Absolute



5. DC(+/-)nnn.nnn

Command: Distance to a Change
Range: (+/-) 000.000 to 999.999 inches
Syntax: F1 3
Description: Defines a distance to change or insert a command within a move profile.

Note 1: The DC command cannot be issued prior to the DA or DI command.
Note 2: A maximum of 20 DC commands may be inserted within a move profile.
Note 3: The DC command is specified in absolute or incremental units depending on the initial move specification (DA or DI). When used as incremental, DC is always specified as a positive number.
Note 4: Range is (±) 0-999.999 centimeters if Metric Units are used. Enabled by System Parameter MU Command.

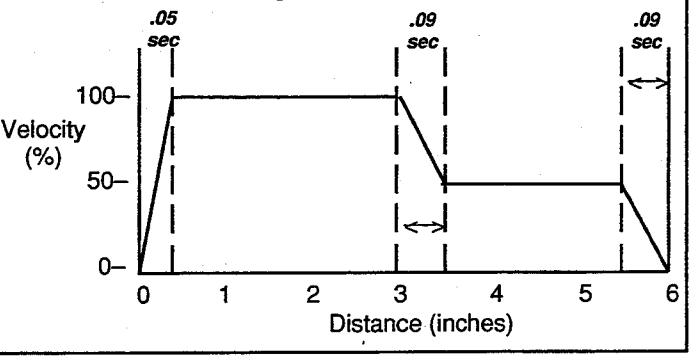
EX. 1 AC.05 DE.05 VE10 DA4 DC1 OT10000 DC2 OT01000 DC3 OT00100 GO

While moving to an absolute position of 4 inches turn on output 1 at 1 inch, output 2 at 2 inches and output 3 at 3 inches.

EX. 2 AC.05 DE.09 VE100 DA6 DC3 VE50 GO

Move to absolute position 6 inches with a starting speed of 100%. At 3 inches, reduce speed to 50% (change on Fly) and complete move.

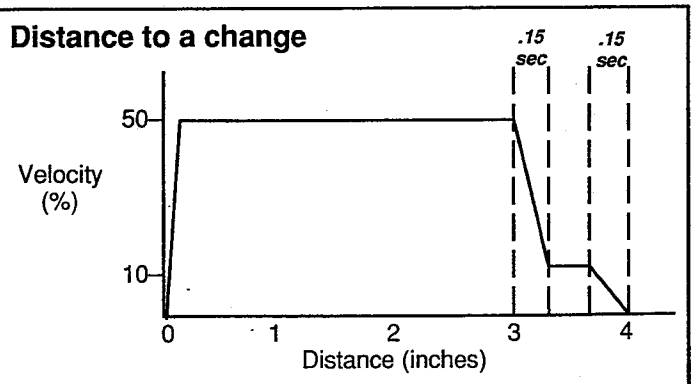
Distance to a change



EX. 3 AC.05 DE.15 VE50 DI4 DC3 VE10 GO

At a starting speed of 50%, begin moving an incremental distance of 4 inches. After 3 inches, ramp down to 10% speed and continue until the final position is reached.

Distance to a change



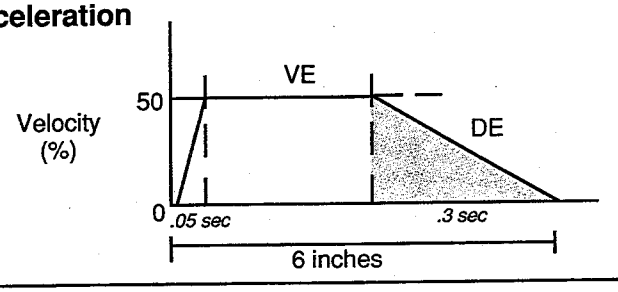
6. DEnn.nn

Command: Deceleration
Range: .05 sec to 15 sec
Syntax: F2 2
Description: Ramp time corresponding to any change in velocity from a higher speed to a lower speed. Once specified it is used in all subsequent moves until it is re-specified. (Default .3 seconds)

EX. AC.05 DE.3 VE50 DA6 GO

Within an absolute motion profile. Ramp Down from 50% max speed to 0% speed in .3 seconds.

Deceleration



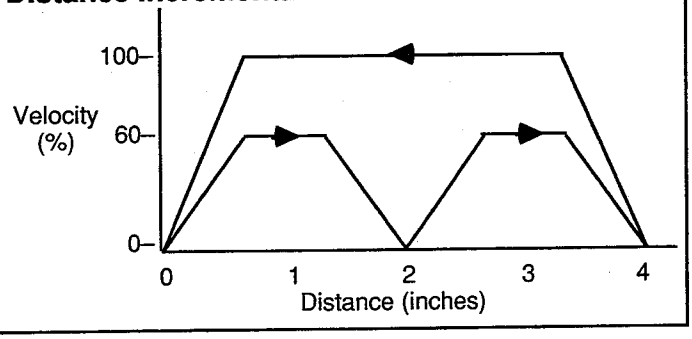
7. DI(+/-)nnn.nnn

Command: Distance Incremental
Range: (+/-) 000.001 to 999.999 inches
Syntax: F1 2
Description: Sets position profiles to incremental. All move distances are referenced to the starting position of each move.
Note 1: Range is (±) 0-999.999 centimeters if Metric Units are used. Enabled by System Parameter MU Command

EX. AC.1 DE.1 VE60 DI2 GO DI2 GO VE100 DI-4 GO

At 60% speed, increment 2 inches extend, stop, increment 2 more inches extend, stop, and then retract 4 inches at 100% speed.

Distance Incremental



8. EL

Command: End Loop
Range: Not Applicable
Syntax: F2 5
Description: EL marks the end of a loop. Used in conjunction with the LP command which allows all commands between LP and EL to be repeated the number following LP.

EX. AC.08 DE.08 VE25 LP2 DI3 GO TD.1 EL OT10000

Execute two incremental moves of 3 inches and then turn on output 1.

9. EN

Command: End of Program
Range: Not Applicable
Syntax: F2 9
Description:Program terminator which flags the end of a program.

Note: An EN command is automatically appended to the end of a program when it is saved using the ESC key.

EX. AC.05 DE.05 VE80 DA5 GO EN

EN marks the end of the absolute motion program indicating a 5 inch move at 80% speed.

10. GH(+/-)nn

Command: Go Home
Range: 1 to 99
Syntax: F1 0
Description: This command will initiate the Homing Routine which will seek and establish the home reference position used by the control. The homing routine is executed in three stages.

Stage 1: Upon execution of the Go Home Command, the *Hx951* will seek the activation of the HOME Input (J3 Pin #19) by the specified edge of the home switch. Simultaneously, the unit will initiate the home move, commanding the cylinder to seek the home switch in a specified direction at a specified speed.

GH(+/-)nn + = extend direction
- = retract direction
nn= available linear speed (%)

Stage 2: Once the input is triggered by the specified switch edge(retract or extend), the unit will ramp down and reverse direction, seeking the designated switch edge at 1% available speed.

Stage 3: When the desired edge of the switch edge is found. Velocity reduces to a creep speed and scans for the Z Marker Pulse on the encoder wherein the unit will stop motion and reset the position counter to zero. (marker pulse occurs once per revolution)

Note 1: The control will reverse direction if an End of Travel (REOT or EEOT) limit switch is encountered while searching for Home. If the second End of Travel switch is encountered in the new direction, the unit will abort the Go Home move and generate a fault condition.

Note 2: The acceleration and deceleration ramps for the Go Home move are generated by the same AC and DE Commands used in normal move profiles.

Note 3: To specify which edge of the home switch to activate the home input or to configure your home switch to be Normally Open or Normally Closed, the Home Algorithm command, HA(mn), in System Parameters is used.

HA(mn) = 01 where
m=0 Retract edge n=0 Switch/NC
m=1 Extend edge n=1 Switch/NO

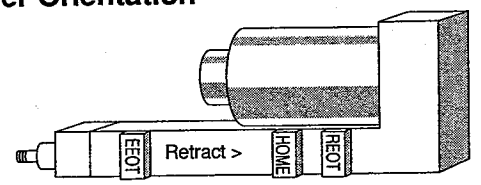
Note: Hx951 denotes an H3951 or H4951 Control

Homing Routine

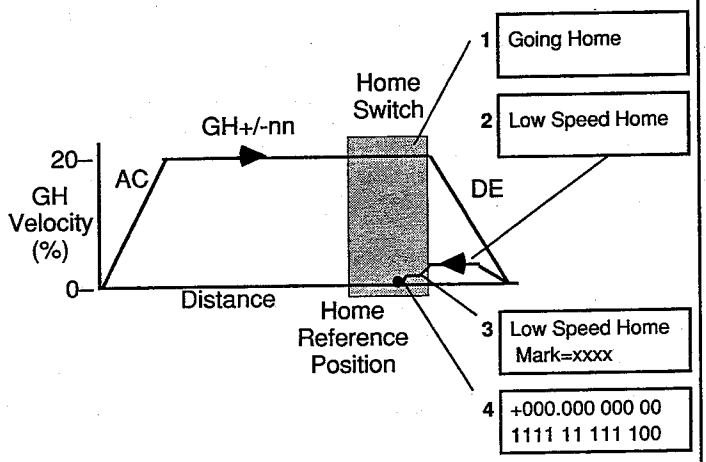
Example AC.05 DE.05 GH-20 with HA(mn) = 01

Homing Program: Unit will seek home in the retract direction at 20% of the available linear speed, referencing the Retract edge and using a Normally Open Home Switch.

Cylinder Orientation



Hx951 Display During Homing Routine



1. Stage 1: Unit seeking home in the specified direction and speed determined by GH(+/-)nn.

2. Stage 2: Home input has been triggered, unit is now approaching home at low speed from the opposite direction. (low speed = 1%)

3. Stage 3: Specified edge of home switch has activated the home input at low speed, cylinder motion reduced to creep speed and is scanning for the encoder marker pulse. The encoder count from the marker pulse is shown on the LCD Display.

4. Motor stopped and the position counter set to zero.

Reference: Overview of Homing Profiles
See System Parameters Home Algorithm (HAmn) Command

11. GO

Command: GO (Execute a Move Profile)
Range: Not Applicable
Syntax: F1 9
Description: Executes a move profile as defined. Execution response time is proportional to the number of commands there are to be processed in the profile to be executed.

EX. AC.05 DE.05 VE50 DI5 GO

GO initiates calculation of a move profile using buffered parameters (.05 second Accel and Decel Ramp, 50% speed, 5 inch incremental move) and then executes it.

12. GO(n)

Command: Load and Go
Range: 1-4
Syntax: F1 9
Description: Calculates a move profile in advance and waits for input n to be activated before execution. n is 1-4 user programmable input IN1, IN2, IN3 or IN4 respectively. This command allows for immediate execution of a move.

*Note: *IN3 & IN4 are defined by configuring two System Inputs (SI1-SI4) to be additional user programmable inputs by the SI Command (Configuration 8) in System Parameters.*

If NO SI inputs are configured as additional user programmable inputs (IN) the digit assigned for IN3 or IN4 is ignored when using the GO(n) Command in a program.

EX. 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: Hx951 denotes an H3951 or H4951 Control

13. IFnnnn

Command: IF-THEN
Range: 0, 1, or 2
Syntax: F2 3
Description: If the user programmable inputs match the configuration indicated by nnnn, then execute the next command in the program. If the inputs do not match, skip the next command in the program.

where IFnnnn
IN4 IN3 *Additional User Programmable Inputs defined by the SI (System Inputs) Command in System Parameters
IN2
IN1

Note 1: IN3 & IN4 are defined by configuring two of the 4 System Inputs (SI1-SI4) to be additional user programmable inputs by the SI Command (Configuration 8) in System Parameters. If no SI inputs are configured as additional user programmable inputs (IN) the digits assigned for IN3 & IN4 are ignored when using the IF Command in a program.
Note 2: Ignore Input (N=2) should be used in the digit(s) of an "IF" statement which are being simultaneously used by a WT, GO(n), or ST(n) command or when not being used.

n = 0 input on (grounded)
n = 1 input off (open circuit)
n = 2 ignore input state

EX. LP IF0112 RN10 IF1012 RN20 IF1102 RN30 EL
This program continuously loops until one of 3 inputs is activated. Activating input 1 runs Program 10, activating input 2 runs Program 20, and activating input 3 runs Program 30 (input 4 is ignored).
Note: Two System Inputs have been configured for additional User Programmable Inputs (IN3 & IN4)

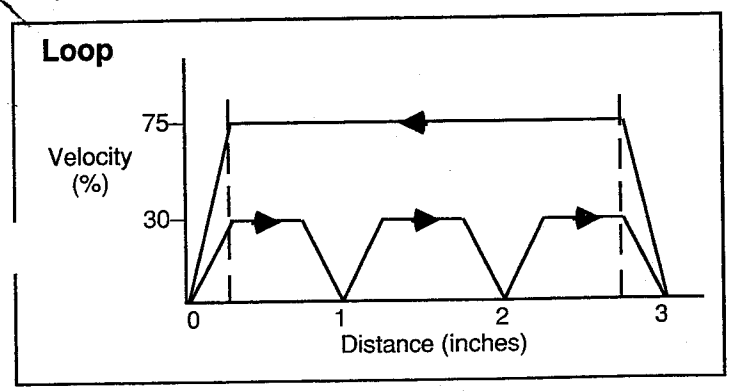
14. LPnnnnn

Command: Loop
Range: 1 to 99999
Syntax: F2 4
Description: Used in conjunction with the EL (end loop) command. The LP command will cause all commands between LP and EL to be repeated nnnnn times. If LP is entered with no number following it or 0, the loop will be repeated continuously

Note 1: Up to 50 nested loops (one inside the other) are allowed, each LP command must have a corresponding EL command to end the loop.
Note 2: An RN command within a loop will terminate the loop and jump to a new program.

EX. AC.09 DE.09 LP3 VE30 DI1 GO EL VE75 DI-3 GO

The actuator will perform an incremental move of 1 inch at 30% speed three times and then retract 3 inches at 75% speed.



15. OTnnnrr

Command: Output Command
Range: 0, 1, 2
Syntax: F1 5
Description: Sets the 3 sinking outputs and 2 output relays on or off.

OTnnnrr is assigned as follows;

n	n	n	r	r
Out 1	Out 2	Out 3	Relay 1	Relay 2

n = 0 Sets sinking output off (open collector)
n = 1 Sets sinking output on (sinking to ground)
n = 2 Output remains unchanged, previous state of the output is retained.

r = 0 Sets relay off (contacts in inactive state)
r = 1 Sets relay on (contacts in active state)
r = 2 Relay remains unchanged, previous state of the contacts is retained.

Note 1: Once an output is turned on, it will remain set until changed by another output command, a system reset (software warm-boot) is issued, or power is cycled.
Note 2: All outputs are set off upon power up or during a system reset(software warm-boot).

EX. AC.05 DE.05 VE100 DA6 GO OT10000 TD.5 OT00000

After completing an absolute move of 6 inches, activate output 1 for .5 seconds and then turn it off.

16. RNnn

Command: RUN Program
Range: 1-99
Syntax: F1 6
Description: Program number nn will be loaded into the command buffer and executed.

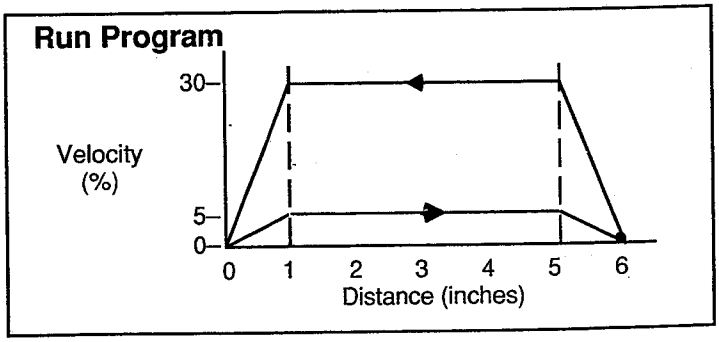
Note 1: This command is used within a program to start another. Upon execution, all subsequent commands in the first program are ignored while the program number following RN__ is executed. (This command acts similar to a GOTO command, NOT A GOSUB.)
Note 2: RN99 is reserved for test verification of the product. It is stored in ROM and cannot be modified.

Program 99 VE25 DI1.0 TD.5
DI-1.0 GO EN

EX. Program 13 AC1 DE1 VE5 DA6 GO RN1 EN

Program 01 GH-30 OT10000 TD.3 OT00000 EN

Executing program 13, move to absolute position 6 inches. After the move is complete, run program 1 which commands the actuator to return home at 30% speed.



17. STn

Command: Stop on Input
Range: 0-4
Syntax: F2 6
Description: Stop Move Execution (or current hold) on the input specified by n, where n may be (1-4) user programmable input IN1, IN2, IN3, or IN4 respectively*

Note 1: IN3 & IN4 are defined by configuring two of the four System Inputs (SI1-SI4) to be additional user programmable inputs by the SI Command (Configuration 8) in System Parameters. If no SI inputs are configured as additional user programmable inputs (IN) the digit assigned for IN3 or IN4 is ignored when using the ST command in a program.

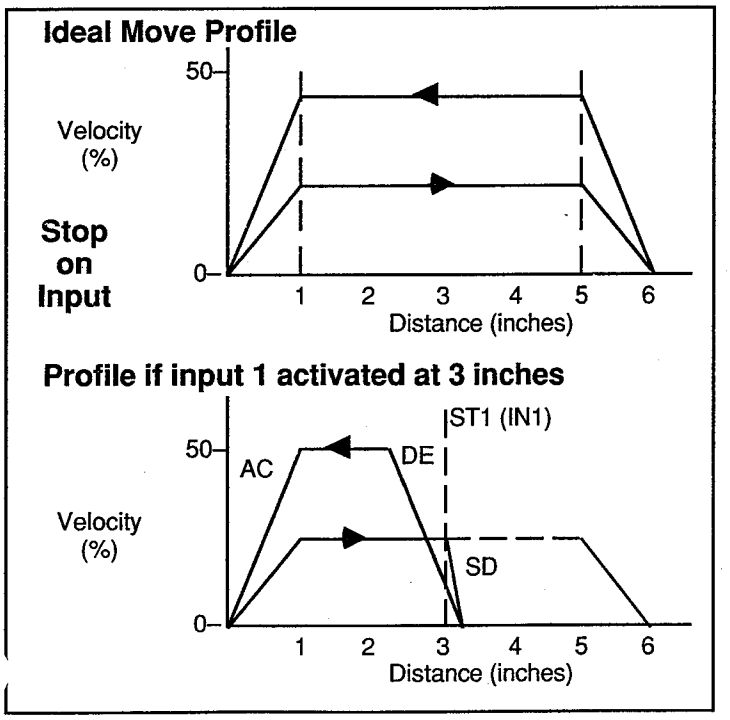
n = 0 Disables/turns off the STn command

n = (1-4) Upon execution, the specified input is monitored during every "move profile" encountered. If the input is activated, the current "move in progress" is terminated, stopping all motion and program execution until the input is deactivated or ST0 is issued. Immediately following deactivation (release) of the input, the next move profile or functional command is instantaneously executed.

Note 1: The motor is stopped upon command execution at the deceleration rate specified by the System Parameter, SDnn.nn(Stop Decel Rate: Default 0.1).
Note 2: Once issued, Stop on Input remains active until it is turned off by the ST0 command, a system reset (software warm-boot) is issued, or power is cycled.

EX. ST1 AC1 DE1 VE25 DA6 GO VE50 DA0 GO EN

At 25% max speed, move to absolute position 6 inches. If input 1 (IN1) is activated while moving, Stop Motion. When the input is deactivated, immediatley execute the next move profile which is to move to the absolute zero position at 50% speed. (Note: If input 1 is not activated the cylinder would complete its 6 inch move before executing the absolute zero move).



18. TDnnnnn.nn

Command: Time Delay
Range: .01 to 99999.99 seconds
Syntax: F1 7
Description: Time Delay between motion profiles or command functions. Not valid while the motor is moving.

Note: The time delays real time count can be shown on the Hx951 LCD Display when Display Mode 2 is activated in System Parameters (DP Command).

EX. AC.05 DE.05 VE50 DI4 GO OT11000 TD.5 OT00000

Move 4 inches, turn outputs 1 and 2 on, delay .5 seconds, and then turn outputs 1 and 2 off.

19. UVnnn

Command: User Variable
Range: Not Applicable
Syntax: F2 0
Description: Allows individual Edit Mode Commands within a program to "prompt" the user to enter a numerical variable via the LCD/Keypad when executing a program.

Note 1: User variables can be assigned to the following Edit Mode Commands; AC, CL, CT, DA, DC, DE, DI, LP, RN, TD, and VE.
Note 2: A single program can contain a maximum of 8 User Variables
Note 3: Variable names ONLY are saved as part of a program, variable values are lost if power is cycled, a system reset is issued, a program is modified, or each time a new program is executed.

EX. 1 AC.1 DE.1 VE10 DA_UV_POS GO EN
For the basic absolute move profile, the absolute distance command (DA) is assigned a user variable (whose prompt is POS).

EX. 2 AC_UV_ACC DE_UV_ACC DA_UV_DIS GO
DI_UV_DIS GO EN
The above program string would prompt the user for two variables ACC and DIS, both of which are used multiple times with different command.

EX. 3 AC.1 DE.1 LP10 VE_UV_VEL
DI2 GO EL EN
The above program would prompt the user once to enter in a Velocity Value VEL before executing a 2 inch incremental move 10 times.

User Variable continued on following page. . . .

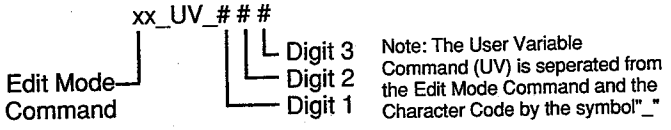
Note: Hx951 denotes an H3951 or H4951 Control

User Variable Programming

Entering A User Variable: A 2 Step Process

1. Assign a User Variable to an EDIT MODE COMMAND

In the Edit Mode after entering a command, press the User Variable Key Sequence (F2 0) which will append_UV_ to the command.



2. Assign a Character Code for the user "Prompt"

The keypad functions are now changed to allow the user to assign a 1 to 3 character code to the user variable per the chart shown below. This character code will be displayed by the LCD when prompting the User to enter a variable during program execution.

Character Chart

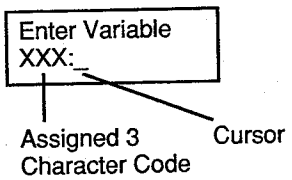
KEY	Character	KEY	Character
1	A B C	6	P Q R
2	D E F	7	S T U
3	G H I	8	V W X
4	J K L	9	Y Z -
5	M N O	0	< > %

Using the right & left arrow keys will allow the user to position the cursor to 1 of the 3 digit locations. While at a location, pressing one of the listed keys (above) a specific number of times will allow you to select the desired characters. For example, pressing the "1" key will display an A in the selected character location, pressing twice will display a B, and so on. After the characters are selected, pressing the Enter Key (ENTR) will complete the entry.

Run Time Operation of User Variables

When a program is executed and a UV fuction is detected, the LCD Display will "prompt" the user to enter the desired variable.

Typical "Prompt" Display



Keying in the requested data and pressing Enter (ENTR) will download the information to the program.

Note 1: When a progam is executed, the Hx951 scans the program for any UV commands. If any are detected, the user is prompted to enter all the UV data PRIOR to executing any commands in the program. If multiple user variables are in a program, the UV prompts will occur in the order detected.
Note 2: User variable values can contain six digits with a decimal.

Note: Hx951 denotes an H3951 or H4951 Control

20. VEnnn

Command: Velocity
Range: 1 to 100%
Syntax: F1 4
Description: Percentage of available speed(in/sec or cm/s) for a given move profile. Once velocity is specified, it is used in all subsequent moves until it is respecified. (Default 25%)

Note 1: Available Linear speed for a given actuator is determined by its MODEL NUMBER.
Note 2: Velocity % can represent in/s or cm/s as determined by the system parameter command MU.

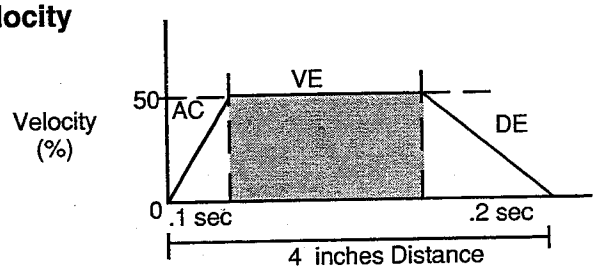
EX. For an NH105B actuator execute the following program.
AC.1 DE.2 VE50 DA4 GO

Move to absolute position 4 inches at 50% max speed.

NH105B Actuator — If Metric Units are used
Available Linear Speed = 12 in/sec = 30.48 cm/s
VE100 = 12 in/sec VE50 = 6 in/sec = 15.24 cm/s

Reference : Available Linear Speeds for different actuators. See System Parameters: (MN) Model Number Command for a complete listing.

Velocity



21. WTnnnn

Command: Wait on Inputs
Enter Range: 0, 1, or 2
Syntax: F1 8
Description: Wait for the inputs to match the configuration indicated by nnnn before continuing execution of a program.

where WTnnnn
IN4, IN3 — *Additional User Programmable Inputs defined by the SI (System Inputs) Command in System Parameters
IN2
IN1

Note 1: IN3 & IN4 are defined by configuring two of the 4 System Inputs (SI1-SI4) to be additional user programmable inputs by the SI Command (Configuration 8) in System Parameters. If no SI inputs are configured as additional user programmable inputs (IN) the digits assigned for IN3 & IN4 are ignored when using the WT Command in a program.
Note 2: Ignore Input (N=2) should be used in the digit(s) of an "WI" statement which are being simultaneously used by an IF, GO(n), or ST(n) command or when not being used.

n = 0 input on (grounded)
n = 1 input off (open circuit)
n = 2 ignore input state

EX. AC.07 DE.07 VE40 DA3 GO
WT0112 VE60 DA5 GO

Move to an absolute position of 3 inches. Stop and wait until the input pattern (Input 1 ON (grounded), Inputs 2 and 3 off (open circuit), and Input 4 ignored) is matched before moving to absolute position of 5 inches at 60% speed.
Note: Two System Inputs have been configured for additional User Programmable Inputs (IN3 & IN4)

1.	MN	Model Number
2.	CE	Current Overload Extend
3.	CR	Current Overload Retract
4.	CS	Coordinate System
5.	DP	Display Mode
6.	EC	Echo on/off RS232
7.	HA	Home Algorithm
8.	HO	Home Offset
9.	JA	Jog Acceleration
10.	JV	Jog Velocity
11.	MU	Metric Units
12.	PU	Power Up Mode
13.	SD	Stop Decel Rate
14.	SI	System Inputs
15.	SO	System Outputs
16.	UN	Unit Number (Device Address)
17.	XP	External Program Select

1. MNnnn

Parameter: Model Number
Range: See Models Below (3 digit Code)
Description: This command configures the *Hx951* control to operate with a specified cylinder's gear ratio and screw pitch by converting the system's encoder feedback pulses into inches of linear travel. This will also determine the maximum linear speed of the actuator based on a maximum motor speed of 3600 RPM (H3951) or 2400 RPM (H4951).

NH and RH Series (Rod and Rodless): H3951

Available Linear Speeds — Model Number: 3 or 4 Digit Code

Cyl. Model	Eng. in/sec	Metric (cm/s)	Cyl. Model	Eng. in/sec	Metric (cm/s)	Cyl. Model	Eng. in/sec	Metric (cm/s)
H102	30.0	(76.20)	H105	12.0	(30.48)	H108	7.5	(19.05)
152	20.0	(50.80)	155	8.0	(20.32)	158	5.0	(12.70)
202	15.0	(38.10)	205	6.0	(15.24)	208	3.8	(9.52)
352	8.6	(21.33)	355	3.4	(8.64)	358	2.1	(5.33)
992	30.0	(76.30)	995	12.0	(30.45)	998	7.5	(9.05)

Ballscrew	Acme/Ballscrew	Acme
2 pitch	5 pitch	8 pitch

TH Series (Rod Type): H4951

Available Linear Speeds — Model Number: 3 or 4 Digit Code

Cyl. Model	Eng. in/sec	Metric (cm/s)	Cyl. Model	Eng. in/sec	Metric (cm/s)	Cyl. Model	Eng. in/sec	Metric (cm/s)
TH4101	40.0	(101.60)	TH4104	10.0	(25.40)	TH4106	6.7	(17.02)
151	27.0	(68.58)	154	6.7	(17.02)	156	4.4	(11.18)
201	20.0	(50.80)	204	5.0	(12.70)	206	3.3	(8.38)
501	8.0	(20.32)	504	2.0	(5.08)	506	1.3	(3.30)
1001	4.0	(10.16)	1004	1.0	(2.54)	1006	.67	(1.70)
991	40.0	(101.60)	994	10.0	(25.40)	996	6.7	(17.02)

Ballscrew	Ballscrew	Acme
1 pitch	4 pitch	6 pitch

Note 1: Final move speeds are LOAD & LENGTH DEPENDENT

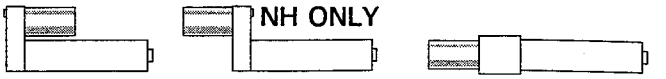
Note 2: Metric units for velocity are used when the MU (Metric Units) Command is enabled in System Parameters

Note 3: The label on the Cylinder indicates the system model number and specifies the Gear Ratio and Screw Pitch.

Cylinder Motor/Mounting Configurations

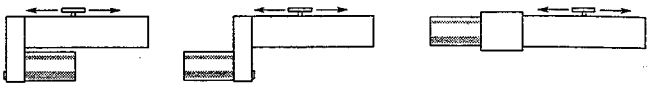
Rod Type Cylinder Configurations (NH & TH Series)

Parallel — Reverse/Parallel — Inline



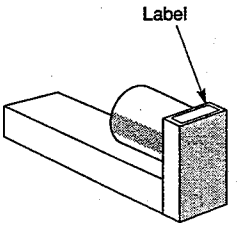
Rodless Cylinder Configurations (RH Series)

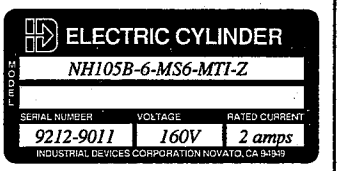
Parallel — Reverse/Parallel — Inline



Entering your Model Number is a 2 Step Process

STEP 1 Identify & Enter Your Cylinder 3 Digit Code
Ex. Your Cylinder has this label attached





Enter 105 as your Model # (via Keypad or RS232)

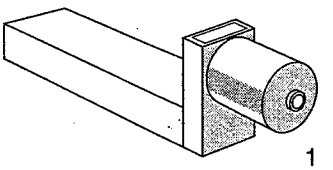
Your System Parameter Display will read:

Model # MN:105
VE100 = 12 in/s

STEP 2 Identify Your Motor Mounting Configuration from the table below. Cylinders with Reverse/Parallel mounts ONLY must denote an "R" (F2 Key) at the end of the 3 digit code when entering the System Model Number(MN).

Reverse/Parallel mounts require the control to reverse the motor polarity during moves so that a positive move Extends the cylinder.

Ex. From the previous example, the NH105B-6-MS6-MT1-Z-RM cylinder is configured with a Reverse/Parallel Motor Mount.

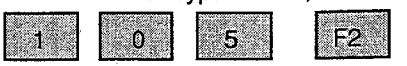


Specify Model Number & Reverse/Parallel Mount

Via RS232 Enter;

1 0 5 R

Via Keypad Enter;



Your System Parameter Display will read:

Model # MN:105R
VE100 = 12 in/s

Note: Hx951 denotes an H3951 or H4951 Control

2. CEnn

Parameter: Current Overload Extend
Range: 1 to 99
Description: Current Overload setting for current being drawn by the motor during movement in the extend direction where nn is from 1 to 99% of peak motor current (99% = 4.5 amps on H3951 and 7.5 amps on H4951)

System Parameter Display

Ex.

Cur Overload Ext
CE:50

Default 65%

Unit will overcurrent at 2.25A (.50x4.5 amps) in the extend direction (H3951).

3. CRnn

Parameter: Current Overload Retract
Range: 1 to 99
Description: Current Overload setting for current being drawn by the motor during movement in the retract direction where nn is from 1 to 99% of peak motor current (99% = 4.5 amps on H3951 and 7.5 amps on H4951)

System Parameter Display

Ex.

Cur Overload Ret
CR:65

Default 65%

Unit will overcurrent at 4.88A (.65x7.5 amps) in the retract direction (H4951).

4. CSn

Parameter: Coordinate System
Range: 0 or 1
Description: Defines Direction for Positive Moves.

n = 0 Positive (+) moves extend the actuator
Negative (-) moves retract the actuator

n = 1 Negative (-) moves extend the actuator
Positive (+) moves retract the actuator

Note: Coordinate System directly affects Jog Mode Direction and the following edit mode commands; Distance Absolute(DA), Distance Incremental(DI) and Go Home(GH).

System Parameter Display

Ex.

Coordinate Sys
CS:1

Default 0

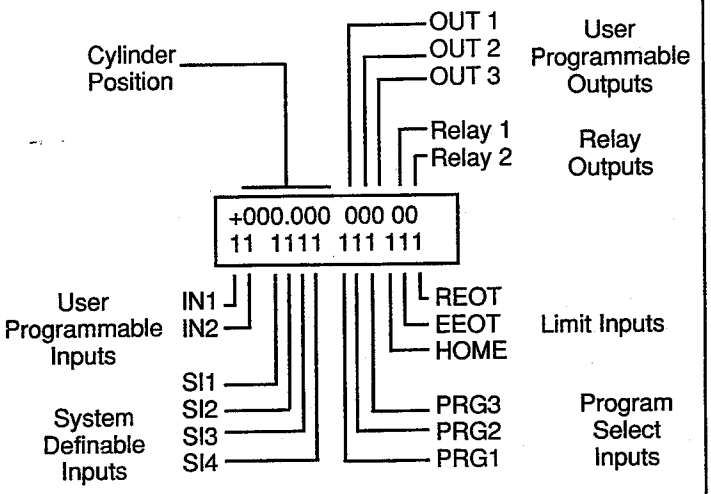
Positive moves will Retract the cylinder & Negative moves will Extend the cylinder.

A typical application for reversing the Coordinate System is referencing the Cylinder Home Position near full Extension. All subsequent positive moves would be in the Retract direction.

5. DPn

Parameter: Display Mode
Range: 1 or 2
Description: Defines the Run Mode Display

n = 1 RUN MODE DISPLAY 1



LCD Display: Functional Description

Cylinder Position: Real-time position feedback report indicating cylinder position in inches. The displayed position range is +/- 000.000 to 999.999 inches (± 000-999.999 centimeters when Metric Units (MU) entered). When the internal position counter is reset, the LCD position display sets itself to zero. This condition occurs upon power up, after a system reset, or completion of a successful homing routine.

INPUTS : LCD displays Input ON/OFF Status (0 or 1)
0 = Input ACTIVATED (grounded low)
1 = Input OFF (open circuit high)

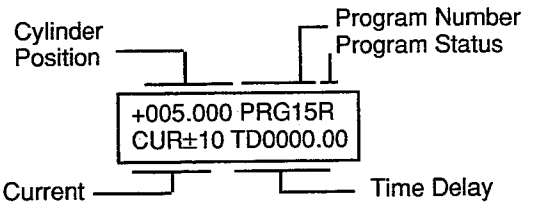
OUTPUTS: LCD displays Output ON/OFF Status (1 or 0)
1 = Output ON (Sinking to Ground)
0 = Output OFF (Open Circuit)

LCD displays Relay Output ON/OFF Status (1 or 0)
1 = Relay ENERGIZED (Contacts Active)
0 = Relay DE-ENERGIZED (Contacts in Normal State)

INPUT/OUTPUT Location and Description

Input	Connector	Pin #	Description
IN1	J3	13	User Programmable Input #1
IN2	J3	12	User Programmable Input #2
SI1	J1	44,43	System Definable Input #1
SI2	J1	42,41	System Definable Input #2
SI3	J1	40,39	System Definable Input #3
SI4	J1	38,37	System Definable Input #4
PRG1	J3	16	Program Select Input #1 (LSB)
PRG2	J3	15	Program Select Input #2
PRG3	J3	14	Program select Input #3 (MSB)
HOME	J3	19	Home Limit Input
EEOT	J3	18	Extend End of Travel Limit Input
REOT	J3	17	Retract End of Travel Limit Input
Output	**Connector**	**Pin #**	**Description**
OUT1	J3	11	User Programmable Output #1
OUT2	J3	10	User Programmable Output #2
OUT3	J3	09	User Programmable Output #3
Relay 1	J1	33	COM1 Common Terminal
		32	NC1 Normally Closed Terminal
		31	NO1 Normally Open Terminal
Relay 2	J1	36	COM2 Common Terminal
		35	NC2 Normally Closed Terminal
		34	NO2 Normally Open Terminal

n = 2 RUN MODE DISPLAY 2



LCD Display: Functional Description

Cylinder Position: Real-time position feedback report indicating cylinder position in inches. The displayed position range is +/- 000.000 to 999.999 inches (±0-999.999 centimeters when Metric Units (MU) entered.) When the internal position counter is reset, the LCD position display sets itself to zero. This condition occurs upon power up, after a system reset, or completion of a successful homing routine.

Current: Specified percentage of peak current output to the motor (0 to 99%). (See CE & CR commands in System Parameters & CL command in Edit Mode List)

Program Number: Indicates the number of the program currently running or, if no program is running, the last program run.

Program Status: Flags indicate the status of the program running or, if none are running, the last program executed.
Status Flags
R = Program RUNNING
E = Program ENDED, completed successfully
S = Program STOPPED by ESC key or System Input activation(configured as Stop)
F = Program terminated by a FAULT condition
none = No program is running

Time Delay: Indicates real-time Time Delay Count. The display counts down time in seconds when the timer (TD or CT Commands) is active in a program.

System Parameter Display

Ex.

```
Display Mode
DP:1  (1 or 2)
```

Default 1

Control set for RUN MODE DISPLAY 1

6. ECn

Parameter: Echo Command
Range: 0 or 1
Description: Turns the RS232 Echo on or off where 0 is echo off and1 is echo on. An echo is where the Hx951 retransmits the character it receives back to the host device (or the next device on a Daisy Chain link).

Note: ECHO ON is required for RS232 Daisy Chaining (Multiple controls along the RS232 Link)

System Parameter Display

Ex.

```
Echo RS232
EC:1  1=on/0=off
```

Default 1

RS232 Echo Set On
Note: Hx951 denotes an H3951 or H4951 Control

7. HAmn

Parameter: Home Algorithm
Range: 0 or 1
Description: Defines the type of home limit switch to be used and which edge of the home switch to reference during the final go home move.

HA(mn) m=0 Retract Edge n=0 Normally Closed Switch
m=1 Extend Edge n=1 Normally Open Switch

Note: Homing profiles are determined by the Home Algorithm command in System Parameters, the edit mode Go Home command, and the final approach towards the home switch.

System Parameter Display

Ex.

Home Algorithm
HA(mn):01

Default 01

Home input activated by the retract edge of a Normally Open home switch.

8. HO(+/-)nnn.nnn

Parameter: Home Offset
Range: 0 to 999.999 inches (0-999.999 centimeters with Metric Units)
Description: When the home reference position is established following a successful homing routine, this command sets the zero position counter to an offset value from the home reference position where "+" is the extend direction ahead of home and "-" is the retract direction behind home.

System Parameter Display

Ex.

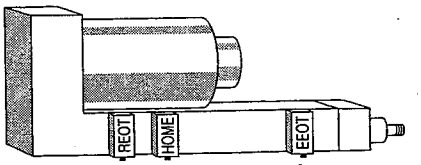
Home Offset
HO+001.000

Default 000.000

When the unit finds the home reference position, the control sets the position counter to 1.0 inch. The Absolute Zero position is now located 1 inch behind the mechanical home. All absolute moves will be referenced from this position.

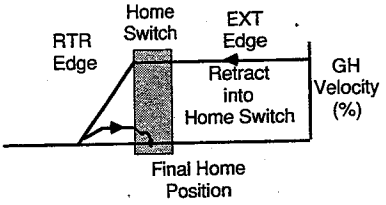
Homing Routine Profiles

Cylinder Orientation



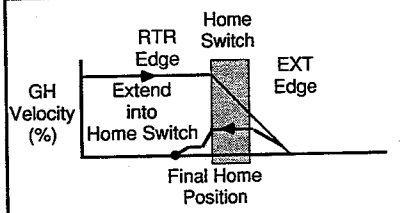
Extension > Retraction <

*An internal magnet moving proportionally with the thrust tube activates the limit switches.



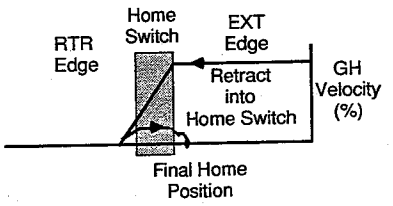
Home Switch –Reference–	Homing Approach
Retract Edge	Retract Direction

Go Home Velocity = GH+/-nn
Low Speed Home = 1% speed



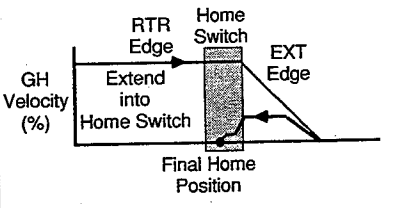
Home Switch –Reference–	Homing Approach
Retract Edge	Extend Direction

Go Home Velocity = GH+/-nn
Low Speed Home = 1% speed



Home Switch –Reference–	Homing Approach
Extend Edge	Retract Direction

Go Home Velocity = GH+/-nn
Low Speed Home = 1% speed



Home Switch –Reference–	Homing Approach
Extend Edge	Extend Direction

Go Home Velocity = GH+/-nn
Low Speed Home = 1% speed

* Homing Profiles are the same for a Normally Open or Normally Closed Home Switch

9. JAnn.nn

Parameter: Jog Acceleration
Range: .05 sec to 15 sec
Description: Defines the time it takes the cylinder to ramp up from zero speed to the specified Jog Velocity(JVnn) when a Jog Input or Jog Key is activated.

Note: The time entered also specifies the deceleration time for the unit to go from the Jog Velocity to zero speed after a Jog Input or Jog Key is released.

System Parameter Display

Ex.

Jog Accel time
JA:00.10

Default .1

Jog Acceleration & Deceleration
Ramp Times are .1 second each.

10. JVnn

Parameter: Jog Velocity
Range:1 to 99
Description: Defines the jog mode velocity used when maintaining the Keyboard Jog Keys or Jog Inputs during Run Mode Operation. Where nn is 1 to 99% of the actuators Available Linear Speed.

Keyboard Jog Keys: ESC & Right Arrow Jog Extend
ESC & Left Arrow Jog Retract

Jog Inputs: System Inputs (SI Command)
Configuration 1 Jog Extend
Configuration 2 Jog Retract

Note: For fine positioning of the actuator, momentary activation of the Keyboard Jog Keys or Jog Inputs will move the actuator in .001 inch increments.

System Parameter Display

Ex.

Jog Velocity
JV:30

Default 10

Jog Velocity set for 30% Speed

11. MUn

Parameter: Metric Units
Range: 0 or 1
Description: Defines the units of scale for position and velocity in terms of English or Metric units.

n = 0 English Units, where distance is measured in "in" (inches) and velocity "in/s" (inches per second)

EX. DA1 Absolute Distance of 1 inch

n = 1 Metric Units, where distance is measured in "cm" (centimeters) and velocity "cm/s" (centimeters per second)

EX. DA1 Absolute Distance of 1 centimeter

Note 1: Repeatability English Units ±.001 in
Repeatability Metric Units: ±.003 cm
Note 2: Distance values already stored programs are not converted from English to Metric Units (or viceversa) when changing between units.
Note 3: Edit Mode Commands affected by MU: DA (Distance Absolute), DI (Distance Incremental), DC (Distance to a Change)
Note 4: System Parameter Commands affected by MU: MN (Model Number), DP (Display Mode), HO (Home Offset)

System Parameter Display

EX.

Metric Units
MU:0 1=on/0=off

Default 0

Metric Units are Disabled, Using English Units

12. PUnn

Parameter: Power-Up Mode
Range: 0 to 99
Description: This command will cause a single program to be executed on power up or system reset.

Note 1: For nn=00, no program will be executed on Power Up.
Note 2: If the scanning of the program select lines is also active (System Parameter Command XP:1), the unit will first execute the program designated by PU:nn on power up or after a system reset, and then will initiate the scanning operation of the program select lines.

System Parameter Display

EX.

Power Up Mode
PU:13

Default 00

Program 13 is executed on Power Up

13. SDnn.nn

Parameter: Stop Decel Time (100% Speed Decel Time)
Range: .05 to 15 sec
Description: The time entered determines the DECELERATION RATE for your specific cylinder given any speed when the Stop on Input (STn command) is activated or when a Stop (S) command is issued via RS232.

1. Specifically, the time entered will represent the time your cylinder takes to ramp down from a maximum reference velocity of 100% to 0% speed.

2. The constant DECELERATION RATE can be determined from this knowing the change in velocity (100%) over the change in time(SD time entered).

3. Knowing the constant Deceleration rate, you can now determine the actual TIME TO STOP for any given linear speed when the stop on input is activated.

System Parameter Display

Ex. | STn Decel time
SD:01.00 | Default 1.0

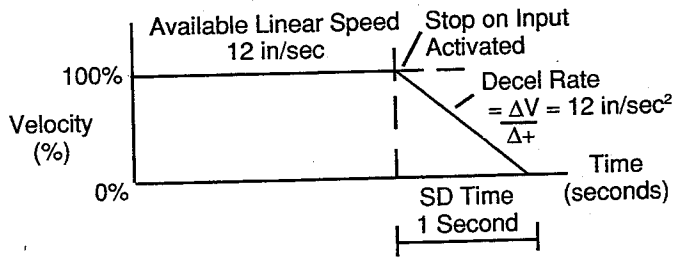
Time entered is 1 second

Example: Using a Model NH105 Cylinder and a Default SD time of 1 second.

1. Determine the Stop Decel Rate for the NH105 Cylinder
2. Calculate the "Time to Stop" for various Linear Velocities in which a Stop on Input may be used.

NOTE : For an NH105 cylinder the Available Linear Speed VE100% = 12 in/sec.

$$\text{1. DECEL RATE} = \frac{v(\text{in/sec})}{t(\text{sec})} = \frac{\text{Available Linear Speed}}{\text{SD time}} = \frac{12\text{in/sec}}{1\text{sec}} = 12\text{in/sec}^2$$



2. The Time to Stop once the STn input is activated is a function of the SD time and the Linear Move Velocity of the cylinder at the time the STn input is activated.

$$\frac{\text{Time to Stop}}{\text{Move Velocity}} = \frac{\text{SD time (100\% speed decel time)}}{\text{100\% Velocity}}$$

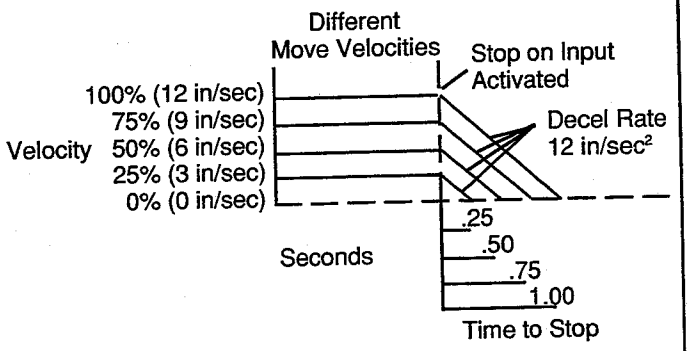
$$\text{Time to Stop} = \text{SD Time} * \frac{\text{Move Velocity}}{\text{100\% Velocity}} = (\text{SDnn.nn}) * \frac{(\text{VEnn})}{\text{VE100\%}}$$

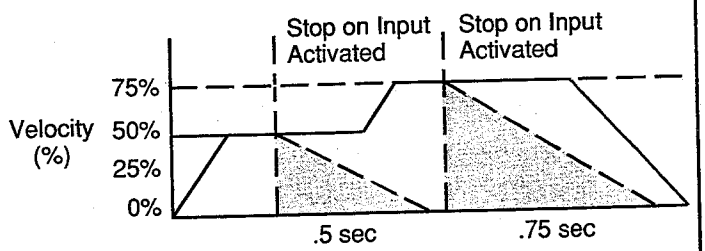
$$\frac{\text{Velocity}}{\text{VE100\%}}\ \text{Time to Stop} = (1\text{ sec}) * \frac{(100\%)}{100\%} = 1\text{sec} * 1 = 1.00\text{sec}$$

$$\text{VE75\% Time to Stop} = (1\text{ sec}) * \frac{(75\%)}{100\%} = 1\text{sec} * .75 = .75\text{ sec}$$

$$\text{VE50\% Time to Stop} = (1\text{ sec}) * \frac{(50\%)}{100\%} = 1\text{sec} * .50 = .50\text{ sec}$$

$$\text{VE25\% Time to Stop} = (1\text{ sec}) * \frac{(25\%)}{100\%} = 1\text{sec} * .25 = .25\text{ sec}$$





The Move Profile displays the Deceleration Ramps for the example NH105 cylinder if a Stop on Input is activated during move execution at the speeds of 50 or 75%.

14. SImnxy

Parameter: System Inputs
Range: 0-8
Description: Defines the System Definable Inputs to be configured as follows, where:
m = System Input 1 (SI1) x = System Input 3 (SI3)
n = System Input 2 (SI2) y = System Input 4 (SI4)

m or n defined as
0 Not Used
1 Jog + Extend (Same as ESC & Right Arrow Key)
2-Jog - Retract (Same as ESC & Left Arrow Key)
3 Kill Motion
4 Disable Keyboard
5 Warm boot—System reset

6 Additional Program Select Inputs (PRG): Binary Format
7 Additional Program Select Inputs (PRG): BCD Format
8 Additional User Programmable Inputs (IN)
9 Interrupt

Note: Configuration 6 & 7 cannot be used simultaneously, it will result in undefined program selection.

System Parameter Display

Ex.

System Inputs
SI(mnxy):6635

Default 8800

System Input 1 is used as an Additional Program Select Line (PRG4): Binary Format
System Input 2 is used as an Additional Program Select Line (PRG5): Binary Format
System Input 3 is used to Kill Motion
System Input 4 is used to issue a System Reset

Reference: See Hardware Reference for Wiring and Specifications regarding System Inputs (SI1-SI4), High Level Inputs.

Note: Hx951 denotes an H3951 or H4951 Control.

System Inputs: Function Descriptions

1 **Jog + Extend:** When activated the cylinder will Jog in the extend direction at a velocity determined by the JV System Parameters Command. When the input is released, motion stop. (Same as Run Mode: ESC & Right Arrow Key)

2 **Jog - Retract:** When activated the cylinder will Jog in the retract direction at a velocity determined by the JV System Parameters Command. When the input is released, motion stops. (Same as Run Mode: ESC & Left Arrow Key)

3 **Kill Motion:** When activated, any program execution or functional operation is immediately stopped. This includes any motion, time delays, loops, faults, and scanning of the Program Select/User Programmable Inputs.

4 **Disable Keypad:** When activated, keypad is disabled allowing NO user access. Keypad resumes normal operation when input released.

5 **Warm Boot—System Reset:** When activated, resets the *Hx951* software, clearing the RAM Buffer, and resetting the control to its power up state. (Programs & Parameters are NOT ERASED). This is typically used to restart system when a fault condition occurs.

6 **Additional Program Select Inputs (PRG): Binary Format** One to four additional program select lines may be added to allow user to select more programs
System Input 1 = PRG4 Input
System Input 2 = PRG5 Input
System Input 3 = PRG6 Input
System Input 4 = PRG7 Input

See Binary Decoding table on next page and System Parameters XP:n Command.

7 **Additional Program Select Inputs (PRG): BCD Format** One to four additional program select lines may be added to allow user to select more programs
System Input 1 = PRG4 Input
System Input 2 = PRG5 Input
System Input 3 = PRG6 Input
System Input 4 = PRG7 Input

See BCD (Binary to Decimal) decoding table on next page and System Parameters XP:n Command.

8 **Additional User Programmable Inputs (IN)**
One to two additional user programmable inputs may be added to allow user more I/O Logic interaction within a program. "IN" inputs are used with the Edit Mode Commands WT (Wait On Input), IF (If-Then), GOn (Go on Input), & ST (Stop on Input). The first additional input defined is IN3 and the second is IN4.

9. **Interrupt**
When activated, any executing program or functional operation is terminated and PROGRAM 98 (interrupt program) is immediately executed. After Program 98 is complete, the unit resumes scanning of the program select lines.

Note 1: If a move is executing when the interrupt is activated, the move is terminated (decelled at a rate determined by the SD command in System Parameters).
Note 2: If no commands are listed in program 98, the unit will go to Run mode and immediately begin scanning program select lines. The XP Command must be active for the Program Select Lines to be scanned.

System Inputs (SI1-SI4)

The System Parameter XP:n Command must be enabled to initialize the program select lines in order for the system inputs to be used as additional program select lines. XP=External Program Select

Binary Decoding Table:

	MSB						LSB
Program #	SI4	SI3	SI2	SI1	PRG3	PRG2	PRG1
0	1	1	1	1	1	1	1
1	1	1	1	1	1	1	0
2	1	1	1	1	1	0	1
3	1	1	1	1	1	0	0
4	1	1	1	1	0	1	1
5	1	1	1	1	0	1	0
6	1	1	1	1	0	0	1
7	1	1	1	1	0	0	0
8	1	1	1	0	1	1	1
9	1	1	1	0	1	1	0
10	1	1	1	0	1	0	1
11	1	1	1	0	1	0	0
12	1	1	1	0	0	1	1
13	1	1	1	0	0	1	0
14	1	1	1	0	0	0	1
15	1	1	1	0	0	0	0
16	1	1	0	1	1	1	1
17	1	1	0	1	1	1	0
18	1	1	0	1	1	0	1
19	1	1	0	1	1	0	0
20	1	1	0	1	0	1	1
21	1	1	0	1	0	1	0
22	1	1	0	1	0	0	1
23	1	1	0	1	0	0	0
24	1	1	0	0	1	1	1
25	1	1	0	0	1	1	0
26	1	1	0	0	1	0	1
27	1	1	0	0	1	0	0
28	1	1	0	0	0	1	1
29	1	1	0	0	0	1	0
30	1	1	0	0	0	0	1
31	1	1	0	0	0	0	0
32	1	0	1	1	1	1	1
33	1	0	1	1	1	1	0
34	1	0	1	1	1	0	1
35	1	0	1	1	1	0	0
36	1	0	1	1	0	1	1
37	1	0	1	1	0	1	0
38	1	0	1	1	0	0	1
39	1	0	1	1	0	0	0
40	1	0	1	0	1	1	1
41	1	0	1	0	1	1	0
42	1	0	1	0	1	0	1
43	1	0	1	0	1	0	0
44	1	0	1	0	0	1	1
45	1	0	1	0	0	1	0
46	1	0	1	0	0	0	1
47	1	0	1	0	0	0	0
48	1	0	0	1	1	1	1
49	1	0	0	1	1	1	0
50	1	0	0	1	1	0	1

1 = off (open circuit) 0 = on (grounded)

Addition Program Select Lines: Binary Format

Configuration	# of programs allowed
SIXXXX	7
SI6XXX	15
SI66XX	31
SI666X	63
SI6666	99

X = Any other System Input Configuration

	MSB						LSB
Program #	SI4	SI3	SI2	SI1	PRG3	PRG2	PRG1
51	1	0	0	1	1	0	0
52	1	0	0	1	0	1	1
53	1	0	0	1	0	1	0
54	1	0	0	1	0	0	1
55	1	0	0	1	0	0	0
56	1	0	0	0	0	1	1
57	1	0	0	0	1	1	0
58	1	0	0	0	1	0	1
59	1	0	0	0	1	0	0
60	1	0	0	0	0	1	1
61	1	0	0	0	0	1	0
62	1	0	0	0	0	0	1
63	1	0	0	0	0	0	0
64	0	1	1	1	1	1	1
65	0	1	1	1	1	1	0
66	0	1	1	1	1	0	1
67	0	1	1	1	1	0	0
68	0	1	1	1	0	1	1
69	0	1	1	1	0	1	0
70	0	1	1	1	0	0	1
71	0	1	1	1	0	0	0
72	0	1	1	0	1	1	1
73	0	1	1	0	1	1	0
74	0	1	1	0	1	0	1
75	0	1	1	0	1	0	0
76	0	1	1	0	0	1	1
77	0	1	1	0	0	1	0
78	0	1	1	0	0	0	1
79	0	1	1	0	0	0	0
80	0	1	0	1	1	1	1
81	0	1	0	1	1	1	0
82	0	1	0	1	1	0	1
83	0	1	0	1	1	0	1
84	0	1	0	1	0	1	1
85	0	1	0	1	0	1	0
86	0	1	0	1	0	0	1
87	0	1	0	1	0	0	0
88	0	1	0	0	1	1	1
89	0	1	0	0	1	1	0
90	0	1	0	0	1	0	1
91	0	1	0	0	1	0	0
92	0	1	0	0	0	1	1
93	0	1	0	0	0	1	0
94	0	1	0	0	0	0	1
95	0	1	0	0	0	0	0
96	0	0	1	1	1	1	1
97	0	0	1	1	1	1	0
98	0	0	1	1	1	0	1
99	0	0	1	1	1	0	0

Note 1: For the configurations SIX666, SI6X66, SI66X6, SI666X, SI66XX, SI6X6X, SI6XX6, SIX66X, SIX6X6, SIXX66, SI6XXX, SIX6XX, SIXX6X, & SIXXX6 where X is any other configuration number, the missing Program Select Input in the above table defaults to a binary 1.

System Inputs (SI1-SI4)

The System Parameter XP:n Command must be enabled to initialize the program select lines in order for the system inputs to be used as additional program select lines. XP=External Program Select

BCD Decoding Table:

	MSB						LSB
Program #	SI4	SI3	SI2	SI1	PRG3	PRG2	PRG1
0	1	1	1	1	1	1	1
1	1	1	1	1	1	1	0
2	1	1	1	1	1	0	1
3	1	1	1	1	1	0	0
4	1	1	1	1	0	1	1
5	1	1	1	1	0	1	0
6	1	1	1	1	0	0	1
7	1	1	1	1	0	0	0
8	1	1	1	0	1	1	1
9	1	1	1	0	1	1	0
10	1	1	0	1	1	1	1
11	1	1	0	1	1	1	0
12	1	1	0	1	1	0	1
13	1	1	0	1	1	0	0
14	1	1	0	1	0	1	1
15	1	1	0	1	0	1	0
16	1	1	0	1	0	0	1
17	1	1	0	1	0	0	0
18	1	1	0	0	1	1	1
19	1	1	0	0	1	1	0
20	1	0	1	1	1	1	1
21	1	0	1	1	1	1	0
22	1	0	1	1	1	0	1
23	1	0	1	1	1	0	0
24	1	0	1	1	0	1	1
25	1	0	1	1	0	1	0
26	1	0	1	1	0	0	1
27	1	0	1	1	0	0	0
28	1	0	1	0	1	1	1
29	1	0	1	0	1	1	0
30	1	0	0	1	1	1	1
31	1	0	0	1	1	1	0
32	1	0	0	1	1	0	1
33	1	0	0	1	1	0	0
34	1	0	0	1	0	1	1
35	1	0	0	1	0	1	0
36	1	0	0	1	0	0	1
37	1	0	0	1	0	0	0
38	1	0	0	0	1	1	1
39	1	0	0	0	1	1	0
40	0	1	1	1	1	1	1
41	0	1	1	1	1	1	0
42	0	1	1	1	1	0	1
43	0	1	1	1	1	0	0
44	0	1	1	1	0	1	1
45	0	1	1	1	0	1	0
46	0	1	1	1	0	0	1
47	0	1	1	1	0	0	0
48	0	1	1	0	1	1	1
49	0	1	1	0	1	1	0
50	0	1	0	1	1	1	1

1 = off (open circuit) 0 = on (grounded)

Addition Program Select Lines: BCD Format

Configuration	# of programs allowed
SIXXXX	7
SI7XXX	9
SI77XX	19
SI777X	39
SI7777	79

X = Any other System Input Configuration

	MSB						LSB
Program #	SI4	SI3	SI2	SI1	PRG3	PRG2	PRG1
51	0	1	0	1	1	1	0
52	0	1	0	1	1	0	1
53	0	1	0	1	1	0	0
54	0	1	0	1	0	1	1
55	0	1	0	1	0	1	0
56	0	1	0	1	0	0	1
57	0	1	0	1	0	0	0
58	0	1	0	0	1	1	1
59	0	1	0	0	1	1	0
60	0	0	1	1	1	1	1
61	0	0	1	1	1	1	0
62	0	0	1	1	1	0	1
63	0	0	1	1	1	0	0
64	0	0	1	1	0	1	1
65	0	0	1	1	0	1	0
66	0	0	1	1	0	0	1
67	0	0	1	1	0	0	0
68	0	0	1	0	1	1	1
69	0	0	1	0	1	1	0
70	0	0	0	1	1	1	1
71	0	0	0	1	1	1	0
72	0	0	0	1	1	0	1
73	0	0	0	1	1	0	0
74	0	0	0	1	0	1	1
75	0	0	0	1	0	1	0
76	0	0	0	1	0	0	1
77	0	0	0	1	0	0	0
78	0	0	0	0	1	1	1
79	0	0	0	0	1	1	0

Note 1: For the configurations SIX777, SI7X77, SI77X7, SI777X, SI77XX, SI7X7X, SI7XX7, SIX77X, SIX7X7, SIXX77, SI7XXX, SIX7XX, SIXX7X, & SIXXX7 where X is any other configuration number, the missing Program Select Input in the above table defaults to a binary 1.

15. SOmn

Parameter: System Outputs
Range: 0 - 6
Description: Defines the function of the two System Definable Outputs; configured as follows where
m = System Output 1 (SO1)
n = System Output 2 (SO2)

m or n
0 Not used
1 Direction of Cylinder Motion

Extending = Output Off (Open Collector High)
Retracting = Output On (Sinking to Ground)

Output remains set until the cylinder begins motion in the opposite direction.

2 Direction of Motion
Retracting = Output Off (Open Collector High)
Extending = Output On (Sinking to Ground)

Output remains set until the cylinder begins motion in the opposite direction.

3 Brake Mode 1:
Any Motion = Output On (Sinking to Ground)
No cylinder Motion = Output Off (Open collector High)

4 General Fault: Output set ON (Sinking to Ground) during any fault condition.

Fault Conditions:
"Amplifier Fault"
"Current Overload"
"EEPROM Check Sum Error"
"ENCODER Fault"
"ERROR finding Home"
"Hit A Limit"
"Motor Stalled"
"Motor Shutdown due to unstable gains"

5 Amp Fault: Output set on (Sinking to Ground) during an amplifier fault.

6 Stall Fault: Output set on (Sinking to Ground) during a stall fault.

Note: For Fault outputs, the output will remain set until the power is cycled or a system reset is issued.

7 Current "Hold" Limit Active
Output set ON (sinking to ground) when the Current "Hold" Limit (set by Edit Mode CL Command) is tripped while being used with a programmed move.
Note: Output remains latched until a new move is executed, power is cycled, or a system reset is issued.

System Parameter Display

Ex.

System Outputs
SO(mn):13

Default 00

System Output 1: set on when the actuator retracts and off when the actuator extends.
System Output 2: set on during any actuator motion and is off when the cylinder is stopped.

Reference: See Hardware Reference for Wiring and Specifications regarding System Outputs(SO1 & SO2), Low Level Outputs.

16. UNnn

Parameter: Unit Number
Range: 1 - 98
Description: RS232 Device Address, used primarily for daisy-chain operation of multiple controls along the serial communication link.

System Parameter Display

Ex.

Unit Number
UN:01

Default 01

Reference: Operating in RS232 Serial Communication

17. XPn

Parameter: Execute Programs from External Program Select Lines
Range: 0 or 1
Description: Tells unit to scan the program select inputs, PRG1, PRG2, and PRG3, and execute the program whose binary number pattern appears.

XP:1 Enables the scanning of the program select inputs at the end of each program and executes the next program number that appears. Power must be cycled or a system reset must be issued to begin scanning operation.

XP:0 Disables the scanning operation, ignoring the program select inputs.

PROGRAM SELECT INPUTS	MSB PRG3	PRG2	LSB PRG1	
	1	1	1	NO Program Executed
	1	1	0	Execute Program 1
	1	0	1	Execute Program 2
0 = input grounded	1	0	0	Execute Program 3
1 = open circuit	0	1	1	Execute Program 4
	0	1	0	Execute Program 5
	0	0	1	Execute Program 6
	0	0	0	Execute Program 7

Note: While XP1 is enabled, the program inputs are continually scanned until one of the following occurs;

1. The ESC key is pressed on the keypad.
2. An end of travel limit is encountered.
3. A System Input (SI1 or SI4) is activated when set for Configuration 3: Kill Motion.
4. An RS232 "K" Kill Command is issued.

To start or resume scanning operation execute one of the following;
1. Cycle the power
2. Perform a System Reset
   via Run Mode Keypad press F1-F2-9, in that order
   via RS232 enter <a>ZZ, <a>=device address
   via System Input (SI1-SI4) Activation when set for Configuration 5: Warm Boot.

System Parameter Display

Ex.

Ext Prog Select
XP:0 1=On/0 =off

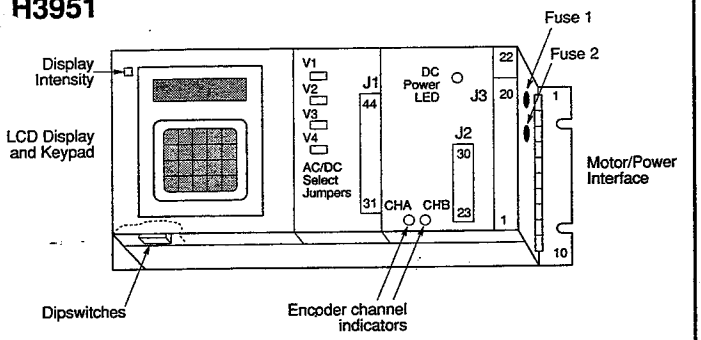
Default 0

Scanning Operation Off

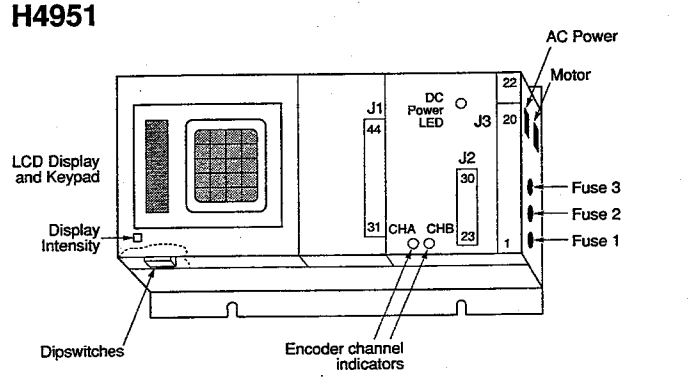
Reference: Additonal Program Select Lines See System Parameters: SI Command (System Inputs)

6.1 Functional Interface

H3951



H4951



1. LCD Display and Keypad
2. Dipswitches (1-8)
3. Jumpers (V1-V4)
4. LED Indicators
5. Fuses

Note 1: Top cover must be removed to expose the Jumpers and LED Indicators
Note 2: Main cover must be removed to expose the Dipswitches

1. LCD Display and Keypad

Function:

Keypad — 20 multi-function keys which allow for program entry and manual operation of the *Hx951* control.

LCD Display — 32 character (16x2) Liquid Crystal Display which displays software entry via keypad or RS232 Serial Communication.

Display Intensity Control — Single turn potentiometer used to control the intensity of the LCD Display.

CW rotation decreases display intensity
CCW rotation increases display intensity

Note: Hx951 denotes an H3951 or H4951 Control

2. Dipswitches (1-8)

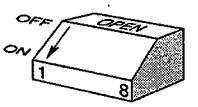
Function: 8 Dipswitches allow user to enable or disable system control functions (Default: All dipswitches are off)

Dipswitches

Switch	Function
1-5	Reserved
6	Keypad Access
7	Keypad Access
8	Keypad Access

Dipswitch Settings: Keypad Access

6	Function
off	Normal Keypad Operation
on	Disables Edit & Del Keys



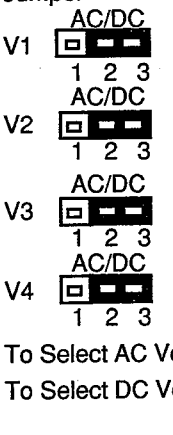
7	8	Function
off	off	Normal keypad operation
on	off	Reserved
off	on	All keys disabled except ESC
on	on	All keys are disabled

Note 1: When keypad is disabled, control operation is through external I/O interface.
Note 2: RS232 program upload and download still functional during keypad disable.

Main Cover must be removed to expose the Dipswitches. Cover held in by four Allen screws(5/64)

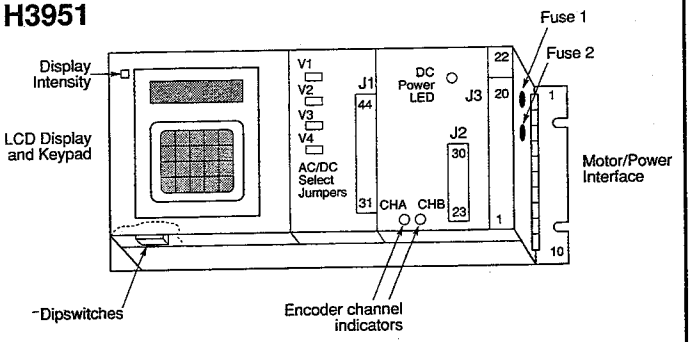
3. Jumpers (V1-V4) (H3951 ONLY)

Function: Allow user to individually select AC or DC voltage sourcing levels to activate each of the four high level logic inputs on connector J1. (Default: All inputs set for DC Voltage)

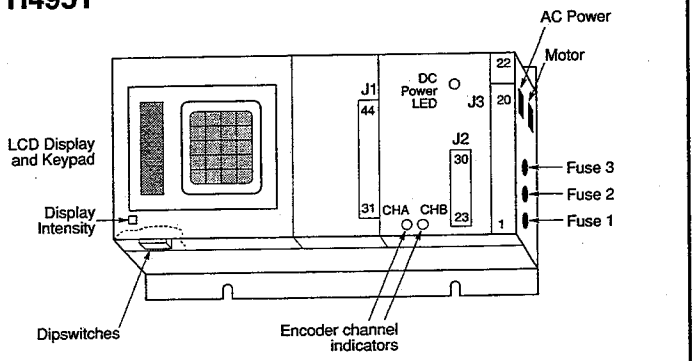


Note 1: The top cover must be removed to expose the AC/DC Select Jumpers
Note 2: The H4951 control allows only DC voltages.

H3951



H4951



4. LED Indicators

Function:

DC Power LED — LED "ON" when the main logic board is being supplied DC power (12-16 VDC) on pins 21(PWR) and 22(GND), on connector J3.

CHA (encoder) — LED "ON" when encoder channel A is active.

CHB (encoder) — LED "ON" when encoder channel B is active.

Note 1: Both encoder LED's will pulsate at low intensity levels during any cylinder motion, indicating both encoder channels are active.
Note 2: At rest, the encoder LED's will cease pulsating, locking into a binary pattern indicating that the cylinder is stationary (no backdriving or drift).

The top cover must be removed to expose the LED Indicators.

5. Fuses

H3951

Fuse 1 Protects the internal 12vdc amplifier power supply prewired to the main logic board, pins 21(PWR) and 22(GND) on connector J3, from shorts or excessive current draw.

Rating: 1 amp, 250 volt, fast-blow type AGC 1

Fuse 2 Protects the internal amplifier from surges or shorts on the Motor Output Terminals.

Rating: 5 amp, 250 volt non-time delay, type ABC 5

H4951

Fuse 1 Protects the internal amplifier from surges or shorts on the Motor Output Terminals.

Rating: 8 amp, 250 volt non-time delay, type MDA 8

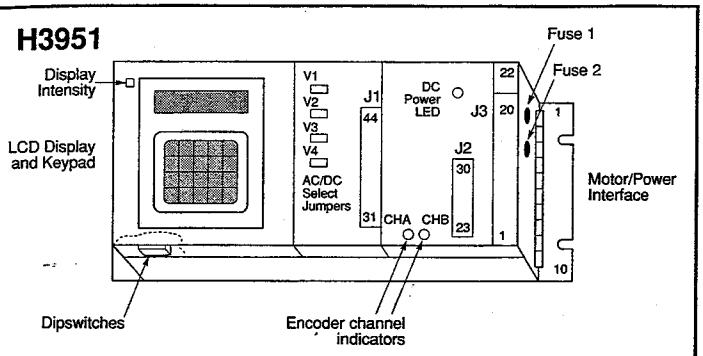
Fuse 2 Protects the internal Low Level Logic Supply from shorts or excessive current draw.
Rating: .25 amp, 250 volt, fast-blow type AGC 1/4

Fuse 3 Protects the isolated internal 12vdc amplifier power supply prewired to the main logic board, pins 21 (PWR) and 22 (GND) on connector J3, from shorts or excessive current draw.

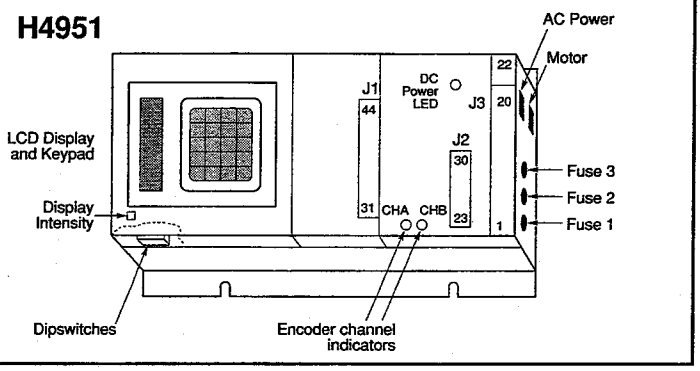
Rating: 1 amp, 250 volt, fast-blow type AGC 1

6.2 Electrical Interface/Pinouts

H3951



H4951



Terminal/Connector Pinouts

1. Motor Power Interface
   H3951: AC PWR & Motor Output — 10 Pin Terminal Strip
   H4951: AC PWR — 3 Conductor AC Line
   Motor Output — 5 Pin Phoenix Connector
2. J1 I/O Interface: Low Level Logic — 14 Pin Phoenix Connector
3. J2 Encoder Interface — 8 Pin Phoenix Connector
4. J3 I/O Interface: High Level Logic — 20 Pin Phoenix Connector
   — 2 Pin Phoenix Connector

1. Motor/Power Interface

H3951

Terminal	Label	Description	Color Code
1	M-	Motor Negative Lead	Black
2	M+	Motor Positive Lead	Red(White w/QF Cable)
3	GND	Motor Case Ground	Green
4	---	No Connection	
5	GND	Earth Ground,	Green
6	NEUT	120 VAC Neutral	White
7	LINE	120 VAC Hot or Line	Black
8	---	No Connection	
9	CAP-	Optional External Capacitor Negative Terminal Connection	
10	CAP+	Optional External Capacitor Positive Terminal Connection	

H4951

Terminal	Label	Description	Color Code
5	M+	Motor Positive Lead	Red(White w/QF Cable)
4	---	No Connection	
	M-	Motor Negative Lead	Black
2	---	No Commection	
1	GND	Earth Ground,	Green

*AC Power: 3 conductor, 6 ft AC Line Cord

2. J1 I/O Interface: High Level Logic

Term.	Label	Description	Function
44	SI1+	System Definable Input, positive	
43	SI1-	System Definable Input, negative	
42	SI2+	System Definable Input, positive	High
41	SI2-	System Definable Input, negative	Level
40	SI3+	System Definable Input , positive	Inputs
39	SI3-	System Definable Input , negative	
38	SI4+	System Definable Input , positive	
37	SI4-	System Definable Input , negative	
36	COM2	RELAY 2 Common terminal	
35	NC2	RELAY 2 Normally Closed terminal	
34	NO2	RELAY 2 Normally Open terminal	Relay
33	COM1	RELAY 1 Common terminal	Outputs
32	NC1	RELAY 1 Normally Closed terminal	
31	NO1	RELAY 1 Normally Open terminal	

3. J2 Encoder Interface

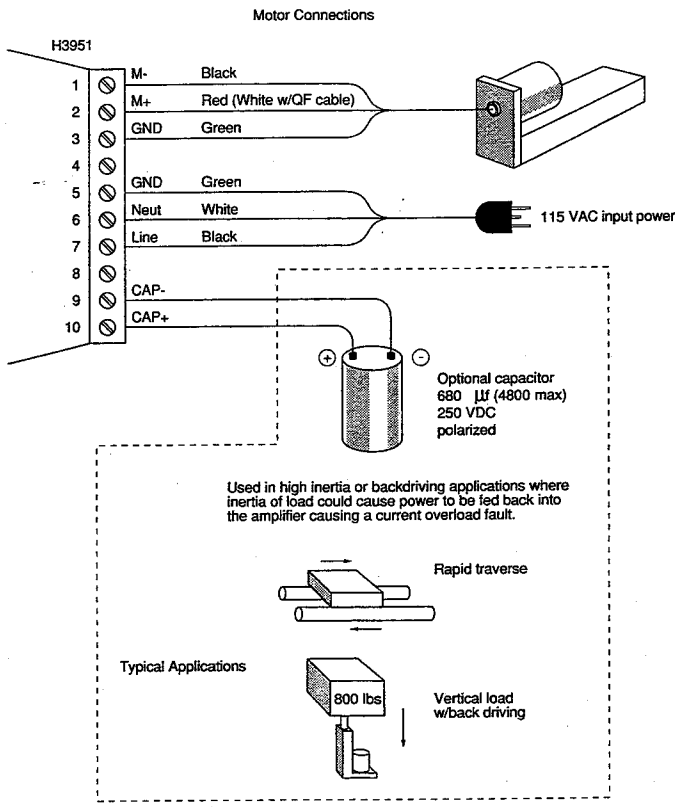
Term.	Label	Description	Color Code	Function
30	ChZ+	Channel Z,	(Yellow)	
29	ChZ-	Channel Z Not,	(Orange)	
28	ChB+	Channel B,	(Green)	
27	ChB-	Channel B Not	(Blue)	Feedback
26	ChA+	Channel A,	(Red)	
25	ChA-	Channel A Not,	(Pink) or (Violet)	
24	5V	5 Volts DC (regulated)	(White)	
23	GND	DC Ground	(Black/Shield)	

4. J3 I/O Interface: Low Level Logic

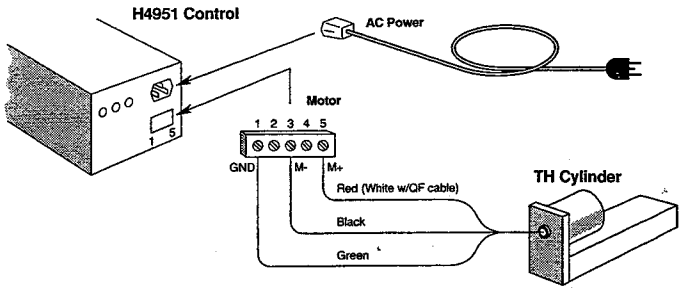
Term.	Label	Description	Function
22	GND	DC GROUND	
21	PWR	12 VOLTS (unregulated)	Logic Power
20	GND	DC GROUND	
19	HOME	Home Limit Switch	
18	EEOT	Extend End-of-Travel Limit	
17	REOT	Retract End-of-Travel Limit	
16	PRG1	Program Select Input 1 (LSB)	Low Level
15	PRG2	Program Select Input 2	Inputs
14	PRG3	Program Select Input 3 (MSB)	
13	IN1	Input 1, User programmable	
12	IN2	Input 2, User programmable	
11	OUT1	Output 1, User programmable	
10	OUT2	Output 2, User programmable	
9	OUT3	Output 3, User programmable	
8	SO-1	System Definable Output 1	Low Level
7	SO-2	System Definable Output 2	Outputs
6	HOUT	At Home	
5	LOUT	At an End-of-Travel Limit	
4	MCOM	Move Complete	
3	TX	RS232 Transmit	
2	RX	RS232 Receive	Communication
1	GND	Ground	

6.3 Wiring Diagrams

Fig. 1 Motor/Power Interface Wiring: H3951
NH or RH Cylinder



Motor/Power Interface Wiring: H4951



* AC PWR: Unit comes with 3 conductor, 6 ft. AC line cord
* Motor Connection: Unit comes with a 5 pin removable Phoenix Connector

CAUTION: **Motor drives are high voltage.** Voltage may be present on motor power connections even when motor is stopped. Never touch motor power connections unless AC power is removed from the control.

Fig. 2 Encoder Wiring

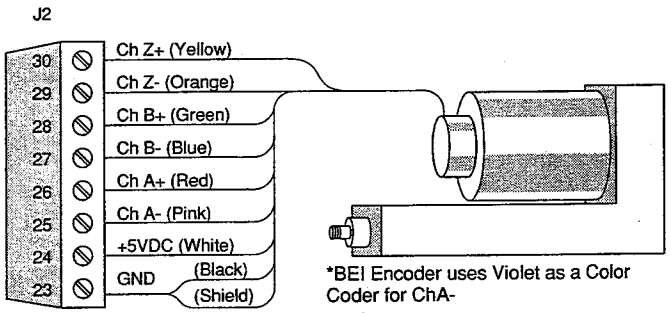
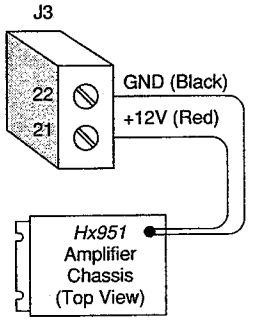


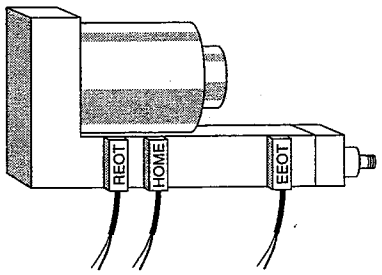
Fig. 3 Logic Power

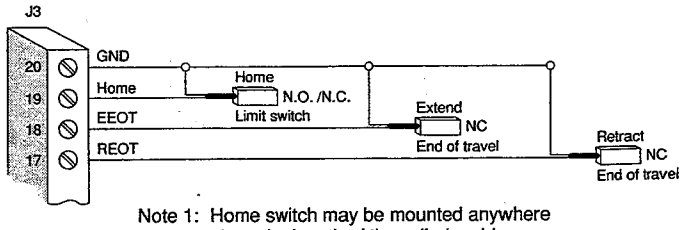


Logic Power Input
Prewired to internal *Hx951* Amplifier Supply, Red and black wire supply 12 volts DC at 500mA.

Note: The red and black Internal Power Supply wires extend out from the lower Amplifier Chassis through a junction hole located below the main logic board and the J3 logic power input.

Fig. 4 Low Level Inputs: EOT & Home Limit Switches

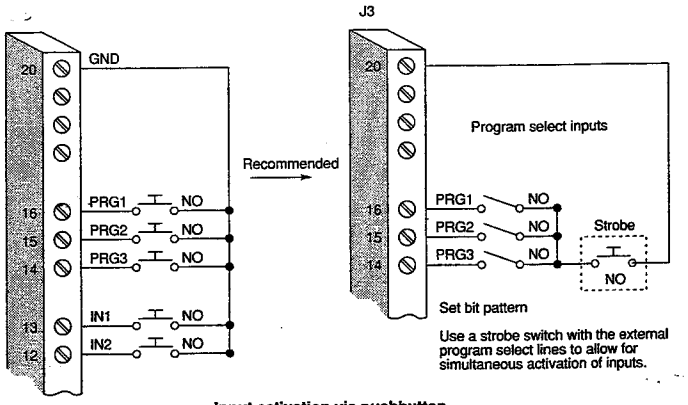




Note 1: Home switch may be mounted anywhere along the length of the cylinder sides containing internal magnets.
Note 2: If no end of travel limit switches are used, inputs, REOT & EEOT must be jumpered to ground (GND).

Note: Hx951 denotes an H3951 or H4951 Control

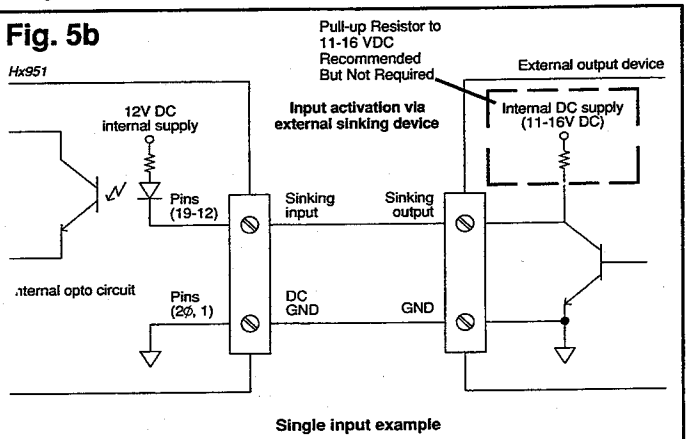
Fig. 5a Low Level Inputs: Program Select Lines and User Programmable Inputs



Input activation via pushbutton or contact closure

Note: Above inputs can be interfaced to a device such as a PLC or PC Output Card with a sinking output capable of sinking 20mA per input at 12 VDC configuration below.

Fig. 5b



Single input example

Fig. 6a High Level Inputs: System Inputs

Electrical "Sinking" Configuration: Activation via Pushbutton/Comtact Closure

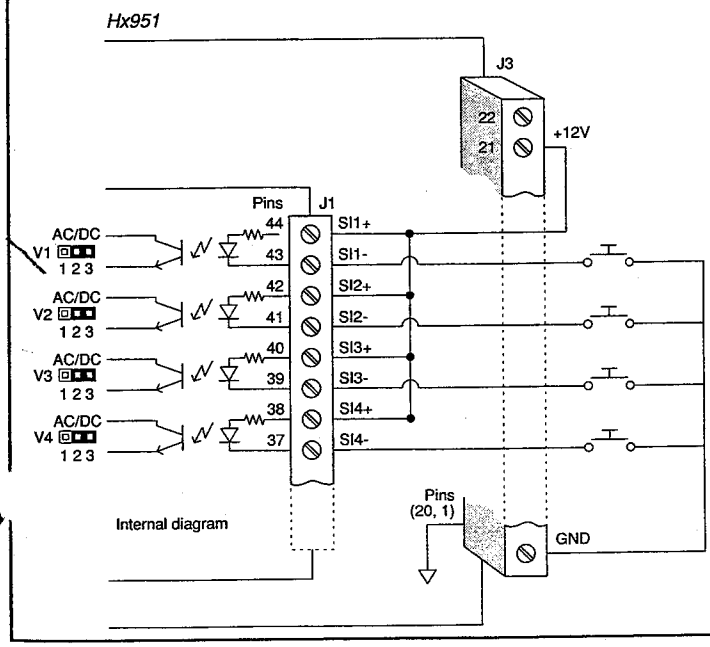
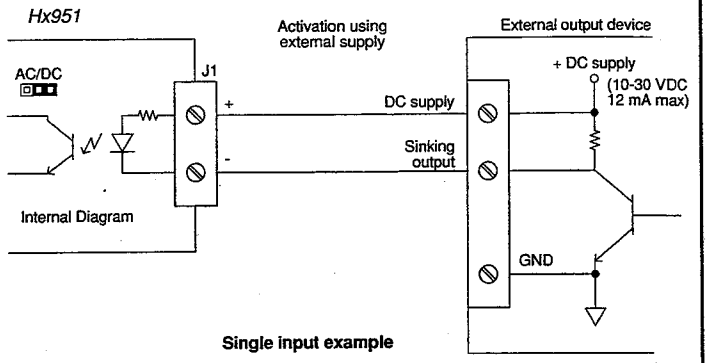


Fig. 6b High Level Inputs: System Inputs

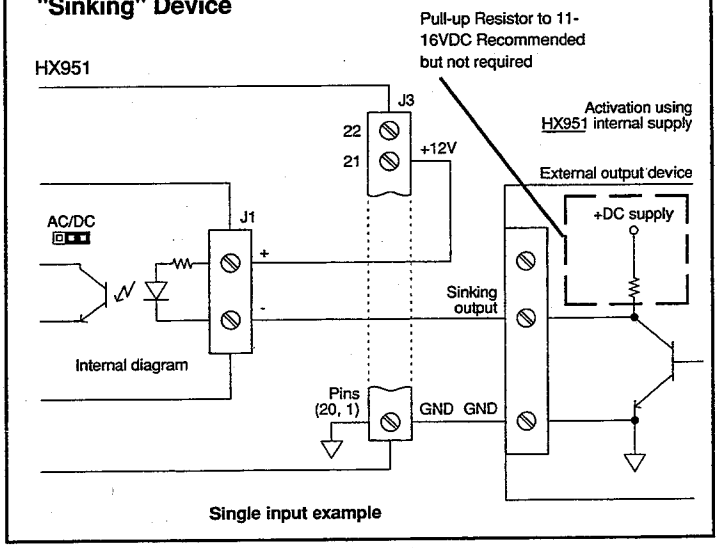
Sinking Configuration Input: Activation via External "Sinking" Device



Single input example

Fig. 6c High Level Inputs: System Inputs

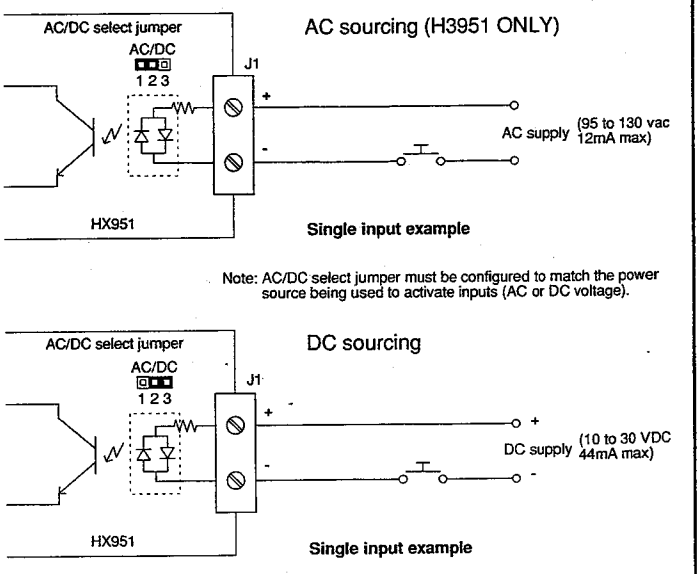
Sinking Configuration Input: Activation via External "Sinking" Device



Single input example

Fig. 6d High Level Inputs: System Inputs

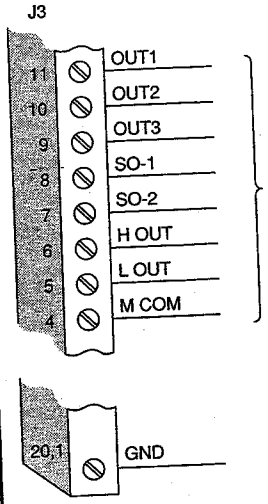
Sourcing Configurations: AC & DC Voltage Activation



Note: Hx951 denotes an H3951 or H4951 Control

Outputs

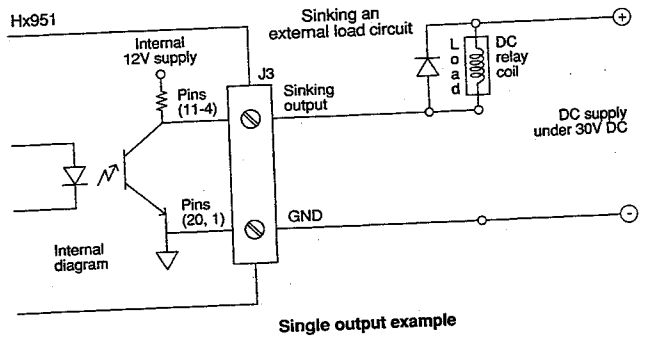
Fig. 7a Low Level Outputs: User Programmable, System, and Dedicated Outputs



Sinking outputs

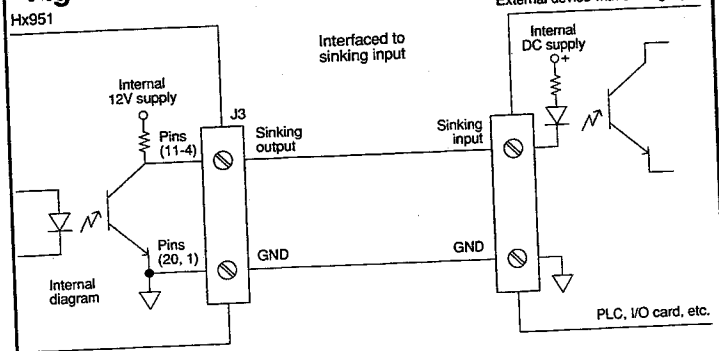
Any of the *Hx951* low level oututs can be used in either of the wiring configurations shown below

Fig. 7b Low Level Outputs



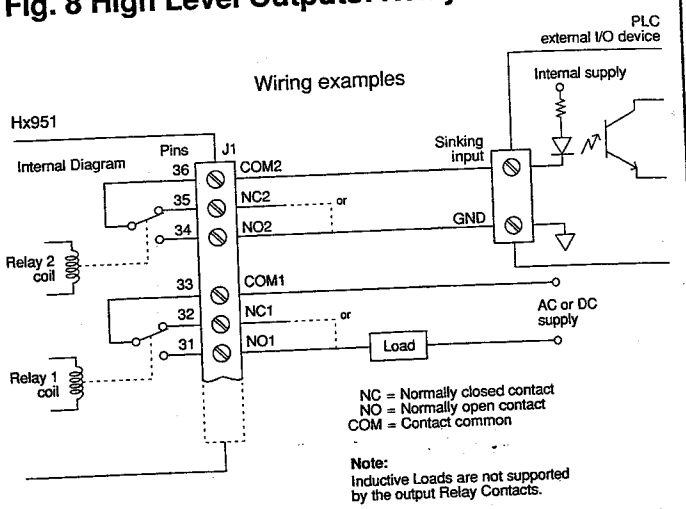
Single output example

Fig. 7c Low Level Outputs



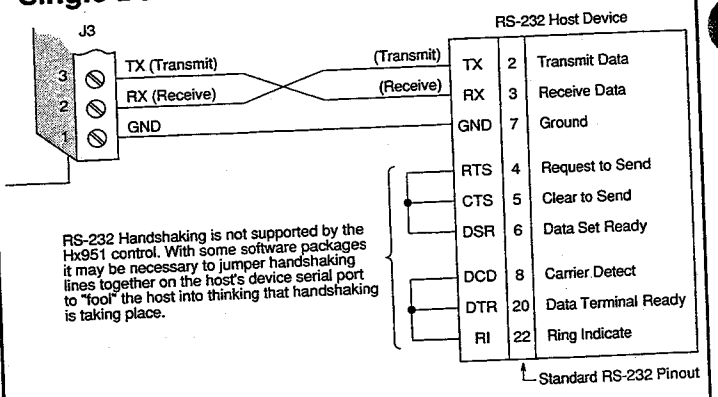
Single output example

Fig. 8 High Level Outputs: Relays 1 & 2



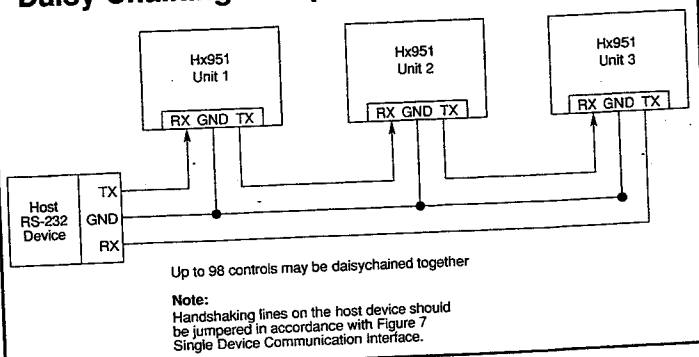
RS232

Fig. 9 RS232 Communication Interface: Single Device



Serial RS-232 communication link

Fig. 10 RS232 Communication Interface: Daisy Chaining Multiple Devices



Note: Hx951 denotes an H3951 or H4951 Control

6.4 Specifications

1. Enviromental Specifications

Temperature	
Drive:	32 F to 130 F (0 to 55 C) *Note: An internal thermostat will shut down the drive if the internal air temperature exceeds 160 F (71 C).*
Storage:	-40 to 185 F (-40 to 85 C)
Heatsink Temp.:	212°F (100°C)
Cylinder:	-20 F to 140 F (-29.4 to 60 C) *Note: Below 32 F use "F" sub freezing option* *Above 110 F use "High-Temp" option*
H or H4 Motor:	Maximum Case temp., 180 F (82 C)

2. Operational

Velocity Range:	100:1 (Linear Speeds are Cylinder Dependent)
Accel/Decel Range:	.05-15 sec.
Position Range:	(+/-) 0-999.999 inches (or centimeters)
Coordinate System:	Absolute or Incremental
Linear Positioning Repeatability:	.001" (.003" for NH or RH Series Cylinders W/ 2 pitch ball screw or TH series w/1 pitch ballscrew)

3. Motor/Power (H3951)

Input Power:	95 to 130 VAC at 50/60 Hz., 5 amps max. 10 amps peak
Motor Output:	2 amps continuous, 4.5 amps peak at 160 VDC
Output Type:	PWM, MOSFET bipolar H-bridge switching at 20 KHz.
Capacitor:	680 µf (4700 µf max) 200VDC, Polarized
Terminal Strip	M- (1), GND (5), CAP- (9) M+ (2), NEUT(6), CAP+(10) GND(3), LINE (7)

Motor/Power (H4951)

Input Power:	95 to 132 VAC @ 50/60 Hz; 7.5 amps max, 15 amps peak
Motor Output:	160 VDC @ 5 amps continuous; 7.5 amps peak
Output Type:	PWM, MOSFET bipolar H-bridge switching at 20 KHz.
Built in Regen	1KW Peak
Connections:	
AC Power	3 Prong, 6 ft AC Line Cord
Motor	5 pin Phoenix Connector M+ (5) - - - (4) M- (3) - - - (2) GND (1)

4. H Motor (H3951 w/NH or RH Cylinder)

Operational:	Permanent Magnet Pole DC Motor, 2 lead
Voltage:	Rated 160 VDC, 180 VDC max
Current:	2 amps continuous, 4.5 amps peak
Torque:	108 oz-in
No Load Speed:	3600 RPM
Windings	
Resistance:	10.33 ohms
Inductance:	28.75 mh
Cabling :	Less than 50ft (16AWG), 50-100ft (14AWG), 100-200ft (10 AWG)
Brushlife:	5 Million Cycles, 5000 Hours

H4 Motor (H4951 w/TH Cylinder)

Operational:	Permanent Magnet Pole DC Motor, 2 lead
Voltage:	Rated 160 VDC, 180 VDC max
Current:	5 amps continuous, 7.5 amps peak
Torque:	335 oz-in
No Load Speed:	2400 RPM
Windings	
Resistance:	1.5 ohms
Inductance:	12 mh
Cabling :	Less than 50ft (16AWG), 50-100ft (14AWG), 100-200ft (10 AWG)
Brushlife:	5 Million Cycles, 5000 Hours

5. Logic Power

Rating:	12 VDC unregulated at 500 ma 250 ma available to power external devices
Connector J3:	GND(22), PWR(21) (Pre-wired)

6. Encoder

Operational:	Dual Channel TTL Level Feedback
Power Requirement:	5 VDC at 90ma
Pulses Per Rev.:	500 lines with quadrature(2000PPR)
Interface:	Line Driver, Differential
Cabling:	8 Wire Shielded Cable W/Twisted Pair Maximum length 200ft. (22AWG)
Connector J2:	CHZ+(30), CHB+(28), CHA+(26), 5V (24) CHZ- (29), CHB- (27), CHA- (25), GND(23)

7. Communications

Operational:	Serial RS232 Communication
RS232C Setup:	9600 baud, 8 data bits, no parity, 1 stop bit Three wire implementation (no handshaking).
Connector J3:	TX (3), RX (2), GND(1)

8. Software/Programming

Memory:	8K Non-Volatile EEPROM (7.5K available for programming)
Programs:	Up to 98 Motion Programs Up to 1000 Characters per program (not to exceed 7.5K of total available program memory)
Command Format:	2 character upper-case ASCII
Program Entry:	Keypad or RS232 Serial Interface
Prog. Execution:	Keypad, RS232, or External I/O Interface

9. Inputs

High Level Inputs

Operational: Optically isolated Sinking or Sourcing Inputs
Jumper Selectable AC or DC Voltage Activation

Power Requirement: VDC 10 to 30 VDC at 44 ma max
VAC 95 to 130 VAC at 12 ma max (H3951 Only)

Connector J1: SI1+ (44), SI2+ (42), SI3+ (40), SI4+ (38)
SI1- (43), SI2- (41), SI3- (39), SI4- (37)

Input Functions
SI1-SI4 System Inputs: defined by the SI Command in System Parameters allowing for remote functional control of the unit. The inputs can be defined to execute the following;
Jog Extend
Jog Retract
Kills Motion (Terminate any motion or Program Operation)
Disable Keypad
Warm Boot—System Reset
Additional Program Select Lines (BCD or Binary)
Additional User Programmable Inputs (IN)

Low Level Inputs

Operational: Optically isolated sinking inputs
Rating: Draws 20 ma @ 12VDC (10-16VDC isolated voltage range)

Connector J3: HOME(19), PRG1(16), IN1(13)
EEOT (18), PRG2(15), IN2(12)
REOT (17), PRG3(14)

Home: Home Limit: used to terminate the home routine cycle initiated by the GH (Go Home) Edit Mode Command executed in a program. The input can be configured for normally open (RP1, RPS-1) or normally closed (RP2, RPS-2) operation by the System Parameters HA (Home Algorithm) Command.

EEOT, REOT: Extend & Retract End of Travel: optional, normally closed extend and retract end of travel limit switch inputs for cylinder overtravel protection. If a connection is broken, motion will come to an immediate stop and a fault condition will exist. If end of travel limits are not used, EEOT & REOT must be jumpered to ground (GND)

PRG1-PRG3: Program Select Lines: allow for program selection through external I/O via matching Binary or BCD patterns. Scanning of the inputs is activated by the System Parameters XP command.

IN1 & IN2: User Programmable Inputs: defined within a program by the Edit Mode Commands WT, IF, GO(n), & ST(n) to allow program interaction with external I/O logic.

10. Outputs

Relay Outputs

Operational: SPDT normally open/normally closed contacts
Contact Ratings: 2 amps at 30 VDC resistive
2 amps at 125 VAC resistive

Connector J1: COM2 (36), COM1 (33)
NC2 (35), NC1 (32)
NO2 (34), NO1 (31)

Relay 1 & 2: User Programmable Output Relays: activated within a program by the Edit Mode Command OT (Output). Once activated, a relay will remain set until it is changed with another output command, a software reset is issued, or power is cycled.

Low Level Outputs

Operational: Optically Isolated NPN Open Collector Sinking outputs
Ratings: ON Sinking to ground, 250 ma @ 1.5VDC
OFF Open circuit high, 2ma @ 12VDC

Connector J3: OUT1 (11), SO-1 (8), HOUT (6)
OUT2 (10), SO-2 (7), LOUT (5)
OUT3 (9), MCOM (4)

Output Function
OUT1-OUT3: User Programmable Outputs: activated within a program by the Edit Mode Command OT (Output). Once Activated (sinking to ground), an output will remain set until it is changed with another output command, a software reset is issued, or power is cycled.

SO1 & SO2: System Outputs: defined by the SO Command in System Parameters, providing an output signal to an external device when pre-defined function states exist within the *Hx951* control system. The following are the predefined states;

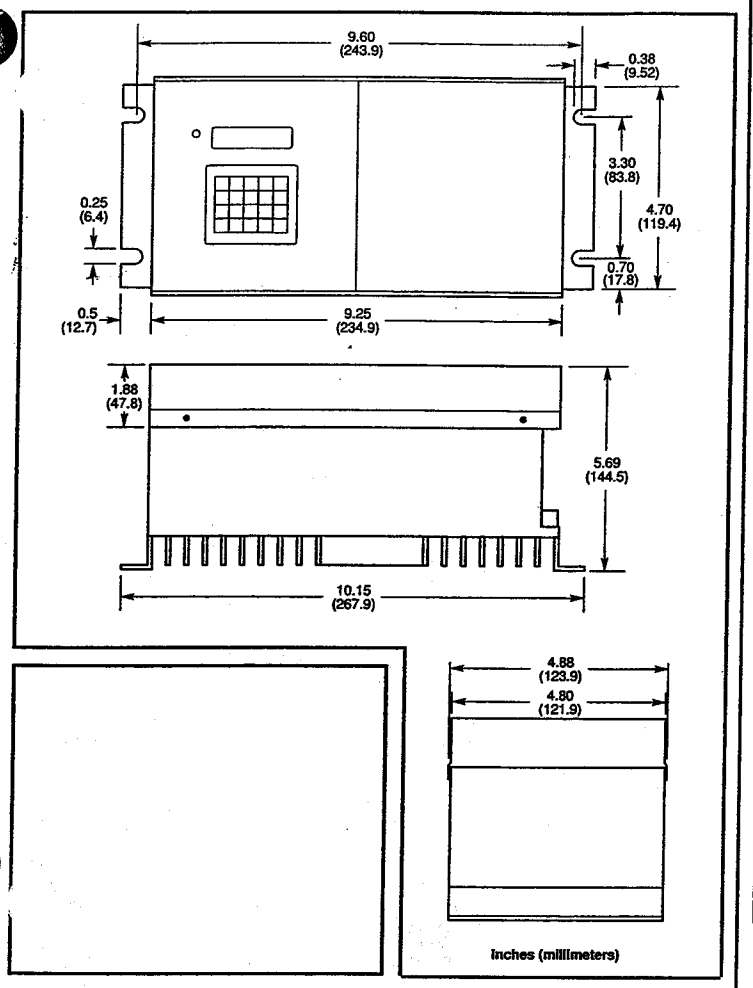
Direction of Cylinder Motion (RTR=On, EXT=Off)
Direction of Cylinder Motion (EXT=On, RTR=Off)
Brake Mode (Any Motion=On, No Motion=Off)
General Fault (Any Fault=On, No Fault=Off)
AMP Fault (Amp Fault=On, No Fault=Off)
Stall Fault (Stall Fault=On, No Fault=Off)

HOUT: Home Output: set (sinking to ground) when the homing routine has successfully been completed. The output will remain set until the next move is initiated.

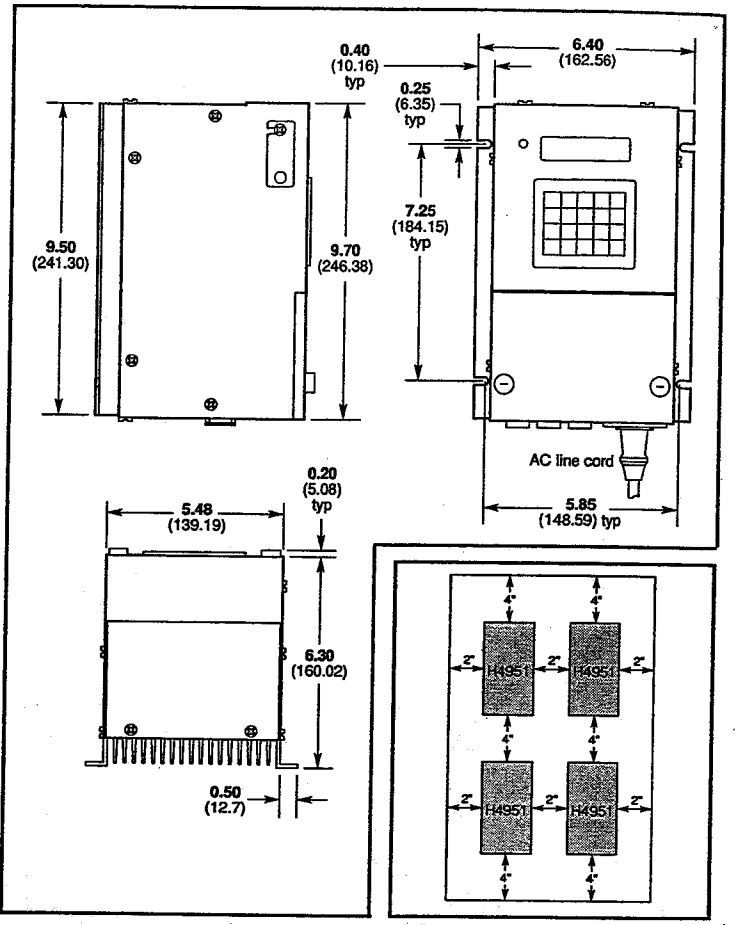
LOUT: Limit Output: set (sinking to ground) when an end of travel limit input (EEOT or REOT) is broken. Output remains set until motion begins in the opposite direction or a system reset is issued.

MCOM: Move complete: set (sinking to ground) when a move (initiated by a GO Command) within a program is successfully completed. The output will remain set until a new move begins.

Dimensions: H3951



Dimensions: H4951



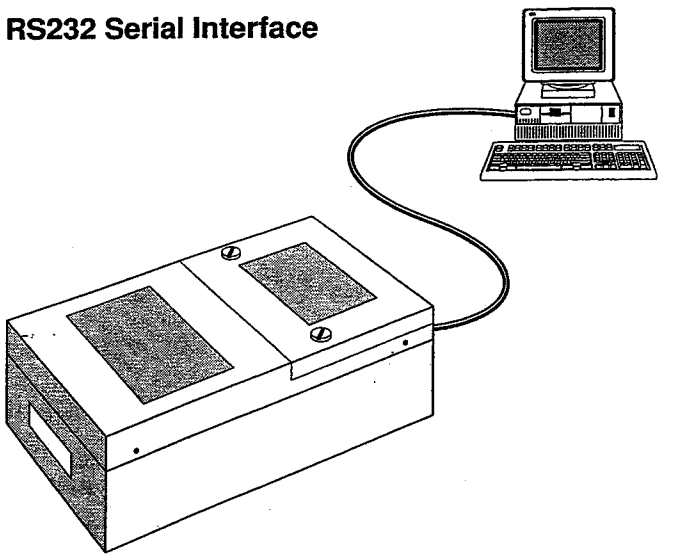
H3951 Mounting Considerations

1. The H3951 is meant to be mounted in a Horizontal Orientation (Heatsink fins point Up-Down).
2. Minimum recommended "Left-Right" clearance between the H3951 and other devices is 2 inches.
3. Minimum recommended "Top-Bottom" clearance between H3951 and other devices is 4 inches.
4. Do Not mount the control above any heat generating equipment.
5. Fan Cooling may be required in High Duty Cycle Applications or environments with high ambient temperatures where airflow is not adequate.

H4951 Mounting Considerations

1. The H4951 is meant to be mounted in a Vertical Orientation (Heatsink fins point Up-Down).
2. Minimum recommended "Left-Right" clearance between the H4951 and other devices is 2 inches.
3. Minimum recommended "Top-Bottom" clearance between H4951 and other devices is 4 inches.
4. Do Not mount the control above any heat generating equipment.
5. Fan Cooling may be required in High Duty Cycle Applications or environments with high ambient temperatures where airflow is not adequate.

RS232 Serial Interface



7.1 Summary: RS232 Programming

The RS232 port allows the *Hx951* Control to communicate to a host device (such as a Computer or PLC) via a 3 wire Serial Interface to UPLOAD, DOWNLOAD, & EXECUTE Programs, Parameters, and Functional Operations.

Four ASCII Command Sets are supported by the *Hx951* and are available to any host device supporting RS232 Serial Communication. These commands provide RS232 Communication support and denote program and parameter information.

The Command Sets are as follows;

RS232: Edit Mode Commands
Used to Create & Edit Programs

RS232: System Parameter Commands
Used to Configure Parameter Functions

RS232: PID Parameter Commands
Used to Configure PID "Gain" Parameters

RS232: Operational Command Set
Used to upload & download programs and initiate software control functions.

All *Hx951* commands used in the RS232 Command Sets are upper case ASCII characters of the form:

<a>	ASCII	nnn	<sp>
[device address]	[command]	[parameters]	[delimiter]

<a> device address — is the unit number of the control from 1 to 99. The *Hx951* assumes a default address of 1 if no address is entered.

ASCII command — is two upper-case ASCII letters (A-Z) denoting an *Hx951* Command function.

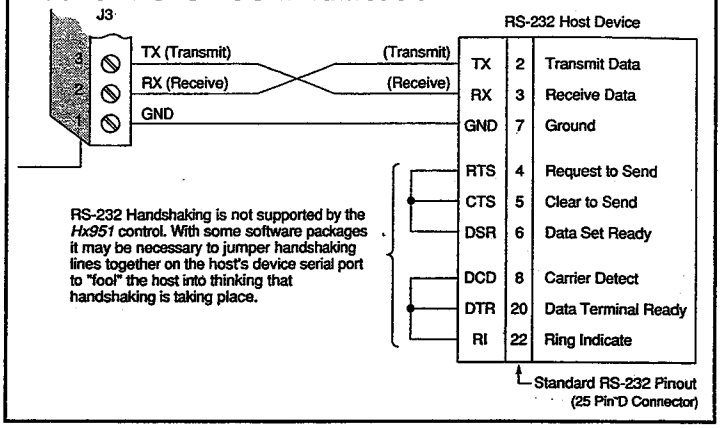
nnn parameters — are optional command specific numbers

<sp> delimiter — is a SPACE, CARRIAGE RETURN and/or LINE FEED.

7.2 Setting Up RS232 Communications: 3 Steps

1. CONNECT the *Hx951* RS232 Port to the Host Device Serial Port per the following diagram;

Serial RS232 Communication Link



2. SETUP the Serial Communication Port on the Host Device for 9600 baud, 8 data bits, no parity, and 1 stop bit.

3. TEST the communication link between the *Hx951* (in RUN MODE) and the Host Device(acting as a dumb terminal). This is done by sending a command string from the control to the host with the following keypad entry;

Enter on Keypad	Your *Hx951* LCD Display will read
F1 F2 3	Sending a string over RS232

The Host Device Screen will display the transmitted String —— *Hx951* REV 3.31 (EEPROM REVISION) MODEL H205 (CYLINDER MODEL #)

Note: If no character string appears on your host device review steps 1 and 2. Typically the receive(Rx) and transmit(Tx) lines need to be reversed.

Note: Hx951 denotes an H3951 or H4951 Control

Sending Commands from the HOST to the Control

After establishing communications you are now ready to download commands from the Host Device using the three RS232 Command Sets defined earlier. Each RS232 Command sent over the serial port will be read on the RUN MODE display as follows;

Run Mode Display

RS232 PROCESSING XXXX

where xxxx is the Command received by the *Hx951*.

*Pressing the ESC key on the *Hx951* during RS232 Processing will abort the operation. The program or command being downloaded will be lost.

Programming Examples

Example 1: DOWNLOAD A PROGRAM from the RS232 port into Program Number 13 on Device 1 denoting an absolute move of 5 inches at 70% speed. With the Host Device in Dumb Terminal Mode enter the following command string;

1DL13 AC.05 DE.09 VE70 DA5 GO EN

NOTE: A DELIMITER must seperate each command.

Command Entered Via Host Device	Description	What your *Hx951* Display will read
	RUN MODE Default Display	+000.000 000 00 11 1111 111 100

When no commands are being processed, the *Hx951* will revert to its RUN MODE default display.

1DL13	To Device 1, begin Downloading Program 13	RS232 PROCESSING 1DL13
AC.05	Load a move acceleration of .05 seconds	RS232 PROCESSING AC.05
DE.09	Load a move deceleration of .03 seconds	RS232 PROCESSING DE.09
VE70	Load a move velocity of 70% speed	RS232 PROCESSING VE70
DA5	Load an absolute move of 5 inches	RS232 PROCESSING DA5
GO	Load a move GO Command	RS232 PROCESSING GO
EN	End Program String 13 Save Program	RS232 PROCESSING saving program13

To confirm the Download has been successful, Upload the contents of Program 13 to the host screen by entering 1UL13.

AC.05 DE.09 VE70 DA5 GO

Example 2: DOWNLOAD SYSTEM PARAMETERS from the host device to the *Hx951*. Configure your control (Unit 2) for a Model 105 actuator and set the Jog Velocity to 25% speed. Enter the following string;

2MN105 2JV25

Example 3: DOWNLOAD PID GAIN PARAMETERS from the host device to the *Hx951*. Configure your control (Unit 1) for Position Loop Integral Gain of 3 and a Velocity Loop Proportional Gain of 12. Enter the following string;

1PI3 1VP12

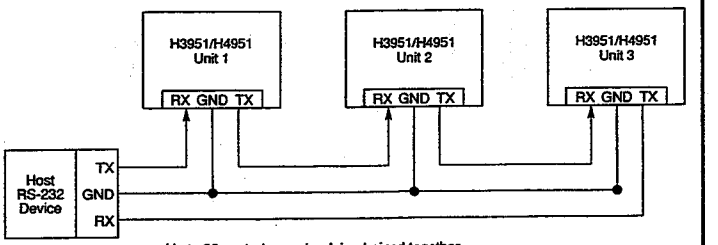
RS232 Daisy Chain Operation

When multiple units are daisy chained along the serial link, two System Parameter Commands must be set to insure proper RS232 Operation.

Unit Number (UNnn): must be used to define the device address for each control along the daisy chain where nn is a number from1 to 99. (default address = 1)

ECHO (ECn): must be turned ON (n=1) to allow controls along the serial link to retransmit (echo) the received characters to the next device on the RS232 daisy chain. (default = 1)

Communication Interface: Daisychaining Multiple Devices



Up to 98 controls may be daisychained together

Note:
Handshaking lines on the host device should be jumpered in accordance with Figure 7 Single Device Communication Interface.

Note: Hx951 denotes an H3951 or H4951 Control

7.3 Software Command List

1. RS232: EDIT MODE COMMAND LIST

Commands previously defined by the Edit Mode which are utilized in the RS232 Mode to create the programs to Download. The Edit Mode commands are entered through a command string (a program) which MUST be preceded by the Download Command (DL & DR) from the RS232 Operational Command Set and ended with the EN Command to SAVE the string. A delimiter should follow every command entered and a Device Address should be affixed to the download command ONLY.

ACnn<sp>	Acceleration
CLnn<sp>	Current Hold Limit
CTnnnnn.nn<sp>	Current Hold Time
DAnnn.nnn<sp>	Distance Absolute
DCnnn.nnn<sp>	Distance to a Change
DEnn<sp>	Deceleration
DInnn.nnn<sp>	Distance Incremental
EL<sp>	End Loop
EN<sp>	End Program
GH(+/-)nn<sp>	Go Home
GO<sp>	GO (execute a move profile)
GO(n)<sp>	Go on Input
IFnnnn<sp>	IF-Then
LPnn<sp>	Loop
OTnnnrr<sp>	Output Set
RNnn<sp>	Run Program
STn<sp>	Stop on Input
TDnnnnn.nn<sp>	Time Delay
_UV_###<sp>*	User Variable
VEnnn<sp>	Velocity
WTnnnn<sp>	Wait on Input

*Must include underline space bar when downloading

2. RS232: SYSTEM PARAMETERS COMMAND LIST

Commands previously defined in System Parameters which can be used in the RS232 Mode to configure the *Hx951* system functions. Each command must be preceded by the device address and followed by a delimiter. Commands are automatically saved upon *Hx951* reception.

<a>MNnnn<sp>	Model Number
<a>CEnn<sp>	Current Overload Extend
<a>CRnn<sp>	Current Overload Retract
<a>CSn<sp>	Coordinate System
<a>DPn<sp>	Display Mode
<a>ECn<sp>	Echo on/off RS232
<a>HAnn<sp>	Home Algorithm
<a>HOnnn.nnn<sp>	Home Offset
<a>JAnn<sp>	Jog Acceleration
<a>JVnn<sp>	Jog Velocity
<a>MUn<sp>	Metric Units
<a>PUnn<sp>	Power Up Mode
<a>SDnn<sp>	STOP, Decel Rate
<a>SInnnn<sp>	System Inputs
<a>SOnn<sp>	System Outputs
<a>UNnn<sp>	Unit Number (Device Address)
<a>XPn<sp>	External Program Select

3. RS232: PID PARAMETER COMMAND LIST

Commands previously defined in PID Paremters which can be used in the RS232 Mode to configure the system servo gains. Each command must be preceded by the device address and followed by a delimiter. Commands are automatically saved upon *Hx951* reception.

<a>PPnn<sp>	Position—Proportional Gain
<a>PInn<sp>	Position—Integral Gain
<a>PDnn<sp>	Position—Derivative Gain
<a>VPnn<ap>	Velocity—Proportional Gain
<a>VInn<sp>	Velocity—Integral Gain
<a>VDnn<sp>	Velocity—Derivative Gain

4. RS232: OPERATIONAL COMMAND LIST

Commands utilized only in RS232 Mode which provide Program and "Real-Time" Operational Control of the *Hx951* via the Host Device. Each Command must be preceded by a device address and followed by a delimiter.

<a>DLnn<sp>	DOWNLOAD PROGRAM
<a>DRnn<sp>	DOWNLOAD PROGRAM TO RAM
<a>ERnn<sp>	ERASE PROGRAM
<a>K<sp>	KILL PROGRAM
<a>OC<sp>	ORIGINAL CONFIGURATION
<a>RNnn<sp>	RUN PROGRAM
<a>S<sp>	STOP PROGRAM (Controlled Decel)
<a>SR<sp>	SOFTWARE REVISION
<a>TD<sp>	TELL DISTANCE
<a>TG<sp>	TELL GAINS
<a>TI<sp>	TELL INPUTS
<a>TO<sp>	TELL OUTPUTS
<a>ULnn<sp>	UPLOAD PROGRAM
<a>ZP<sp>	ZERO POSITION
<a>ZZ<sp>	SYSTEM RESET

Definitions (Operational Command List)

<a>DLnn<sp> DOWNLOAD: load a program from the host device to the *Hx951* EEPROM Memory, where nn is program number 1 - 98.

The DL Command initializes the beginning of a program string made up of Edit Mode Commands. To complete a program string, it MUST end with an EN command to be SAVED by the *Hx951*.

The DL command will not be saved with the contents of the program in the control. It is only a pointer to identify where the program is to be stored.

The Edit Mode Commands between the DL and the EN commands do not require a device address.

Note: Hx951 denotes an H3951 or H4951 Control

<a>DRnn<sp> DOWNLOAD TO RAM (Memory): load a program from the host device to the *Hx951* RAM Memory where nn is program number 1 - 98.

The DR Command initializes the beginning of a program string made up of Edit Mode Commands. To complete a program string, it MUST end with an EN command.

The programs downloaded with the DR command will NOT be saved when power is removed from the control.

The Edit Mode Commands between the DR and the EN commands do not require a device address.

> The DR command is typically used in applications where the *Hx951* is operated exclusively through RS232 via a Host Device which is constantly downloading NEW programs to the control.
>
> This reduces the number of times the EEPROM is "written" to which increases its usable life.

<a>ERnn<sp> ERASE PROGRAM: erase the desired program, where nn is program number 1 - 98.

<a>K<sp> KILL PROGRAM: Emergency Stop, Terminate Program Execution. Immediately stops any motion, operational function, or scanning of the program select inputs currently being executed.

<a>OC<sp> ORIGINAL CONFIGURATION: Resets the EEPROM to its original default state as if the control were a new unit. The buffer is cleared, all programs are erased and all commands are set to their default values.

<a>RNnn<sp> RUN PROGRAM: Run the desired program, where nn is program number 1 - 98.

<a>S<sp> STOP PROGRAM: Stops any motion, operational function, or scanning of the program select inputs currently being executed. If a move is in progress, it will ramp down (Controlled Decel) at a rate determined by the System Parameter SD (Stop Decel Time) Command.

<a>SR<sp> SOFTWARE REVISION: uploads the *Hx951* EEPROM software revision level to the host device display screen. The following characters should appear on the host screen;

Hx951 REV 3.20 MODEL H205

EEPROM REVISION — CYLINDER MODEL #

<a>TD<sp> TELL DISTANCE: Uploads the present cylinder position from the *Hx951* to the Host Device.

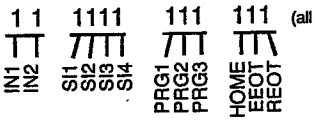
Ex. 1TD
(+)000.000

<a>TG<sp> TELL GAINS: Uploads the current value of the Position and Velocity Servo Loop PID Gains from the *Hx951* to the Host Device.

Ex. 1TG
PP10
PI 3
PD5
VP10
VI 5
VD5

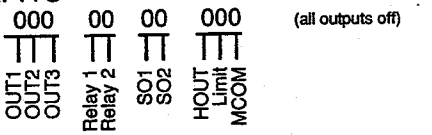
<a>TI<sp> TELL INPUTS: Uploads present status of all Logic Inputs on the *Hx951*. Status will be a 0 or 1 where 0=Input Activated and 1=Input Not Activated.

Ex. 1TI



<a>TO<sp> TELL OUTPUTS: Uploads present status of all Logic Outputs on the *Hx951*. Status will be a 0 or 1 where 0=Output On (Sinking to Ground) and 1=Output Off (Open Circuit High)

Ex. 1TO



<a>TP<sp> TELL PARAMETERS: Uploads all System Parameters and their current values from the *Hx951* to the host device.

Ex. 1TP

MN102	JA.1
CE65	JV10
CR65	MU0
CS0	PU00
DP1	SD.1
EC1	SI8800
HA01	XP0
HO+000.000	UN01

Complete list of Parameters and their current values sent to host display screen.

<a>ULnn<sp> UPLOAD: load a program from the *Hx951* to the host device, where nn is program number 1 - 99. An asterisk (*) is the response if the program is blank. The final ASCII characters sent following the program are a carriage return and a line feed.

<a>ZP<sp> ZERO POSITION: Sets the current cylinder position to zero (+000.000).

<a>ZZ<sp> SYSTEM RESET: resets the *Hx951* Software (Warm-boot), clearing the RAM Memory (including fault states) and resetting the control to its power up state (equivalent to cycling power). The reset cycle will disable the controller for approximately 5 seconds before entering RUN MODE. (Programs and Parameter settings are NOT erased)

Note: Hx951 denotes an H3951 or H4951 Control

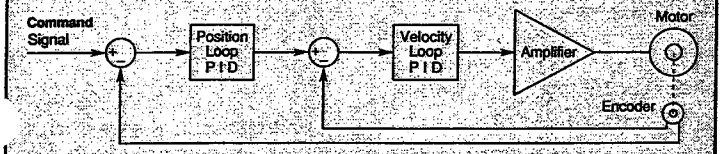
The H3951 & H4951 Controls, utilize encoder feedback to close servo loops to control both, velocity and position. The velocity loop is used to provide smooth and reliable speed regulation during moves and the position loop is used to provide accurate positioning in addition to maintaining position before and after moves.

Since varying load and move conditions can alter the "actual" system response, two sets of adjustable PID gain settings are available which allow the user to OPTIMIZE (tune) the system gain in order to obtain the desired response. The PROPORTIONAL, INTEGRAL, and DERIVATIVE Gain terms can be set for both, the Velocity and Position Servo Loops.

Servo Basics

A closed loop servo control is an error based system which utilizes feedback to dynamically control a motor output response. By comparing feedback data (typically representing actual position or velocity) with the commanded value, an error signal is generated. This error signal is sent to the amplifier and used to control the actual output to the motor in an attempt to correct the error by obtaining the commanded steady state level.

The system gain determines how "hard" it tries to correct the error and through the manual adjustment of the PID Gain Settings, the actual output response can be dynamically controlled to adapt to the specific load and move conditions.



Tuning Terms:

The following reference list defines the characterization terms associated with Servo Tuning.

Damping: the amplitude decay of an oscillation in a system.

Gain: the ratio of system output to system input.

Hunting: the oscillation of system response about a steady state value due to insufficient damping.

Oscillation: the periodic variation in the magnitude of velocity or position about a specified reference level or setpoint.

Overshoot: the maximum deviation between the move velocity or position with the expected steady state value.

Ringing: a dampened oscillation in a system which results from a sudden change of state.

Rise Time: the time required for a signal to rise from 10% of its final value to 90% of its final value.

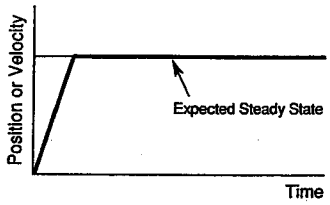
Servo: Closed loop system using feedback to regulate an output signal based on the amount of error in the system.

Settling Time: the time required for a controlled output (position or velocity) to achieve its commanded steady state level when experiencing a damped oscillation.

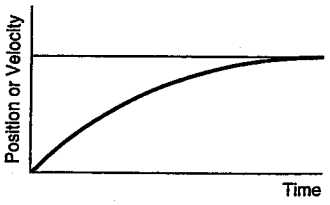
Servo Response Characteristics

The charts below give a graphical presentation of a basic step function to demonstrate the various forms of output response in a servo system. These characterizations can be applied to position and velocity on the H3951 & H4951 controls when tuning them for a specific cylinder under a given set of move and load conditions.

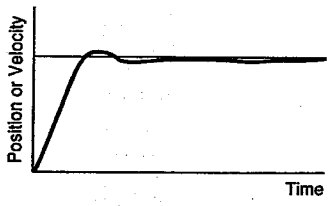
Note: The ultimate goal of the PID tuning parameters is to obtain a critically damped or slightly underdamped linear positioning system, providing optimum tracking (of velocity & position) with minimum settling time.



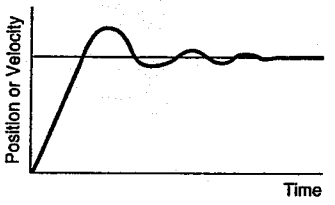
Theoretical Ideal



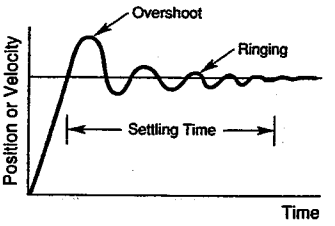
Overdamped
System recovers slowly, appears sluggish, noticable time to reach steady state



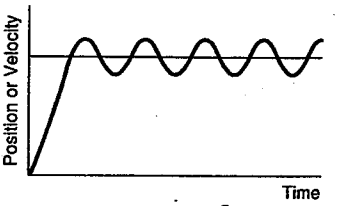
Critically Damped
Typified by the minimum possible rise time (fastest response) achievable with zero overshoot and zero ringing (damped oscillations).



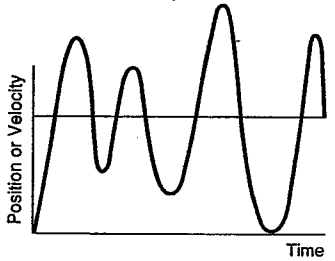
Underdamped (slightly)
Exhibits overshoot, beginning of ringing noticable settling time



Underdamped
Increased overshoot and ringing, longer settling time

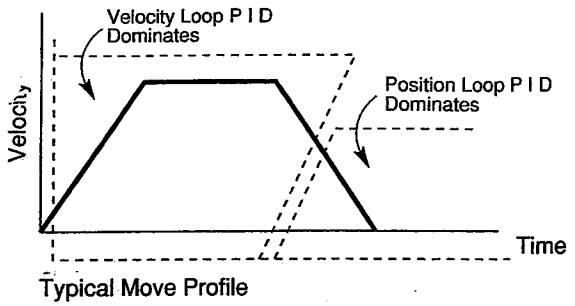


Oscillatory
Hunting about the setpoint



Oscillatory
Unstable, uncontrollable operation

Velocity and Position Loops



Typical Move Profile

For the H3951 & H4951 Systems, the velocity loop dominates the acceleration and constant velocity portions of the move profile to provide smooth and reliable speed regulation.

During the deceleration portion of a move, dynamic control shifts to the position loop which is first used to obtain accurate positioning and then used to maintain the final, steady state position.

8.1 Tuning Your System

In most applications tuning will not be required because of the mechanical reduction offered by the electric cylinders between the motor and the load. However, some applications will require PID tuning to "adapt" the servo response to the given set of load and move conditions.

Actual PID tuning is an iterative process whose affect on an output response is measured in terms of Overshoot, Ringing, & Settling time. Since PID gain parameters are interactive, knowing how each affects your output response is important when attempting to tune your system. . .

Basic "PID" Gain Interaction
The purpose behind adjustable PID Gains is to improve upon the basic servo response. The **Proportional Gain**, alone, will determine the "muscle" of the system response (or how hard it tries to correct the error and achieve the commanded signal). At the optimum setting, overshoot, slight ringing, and in many cases, drift will be present.

Adding **Integral Gain** introduces a force which attemps to recover from the overshoot and eliminate any steady state error (drift) over time. By adding integral gain however, increased ringing is added to the response as the corrective force tends to "overcorrect", making the output response "ring" about the steady state level (too much Integral will cause hunting about the setpoint).

Adding the **Derivative Gain** introduces a force reacting to changes in the rate of error which attempts to dampen out the ringing (effectively chopping the peaks of the ringing oscillation) and reducing the settling time.

PID "Gain Parameters

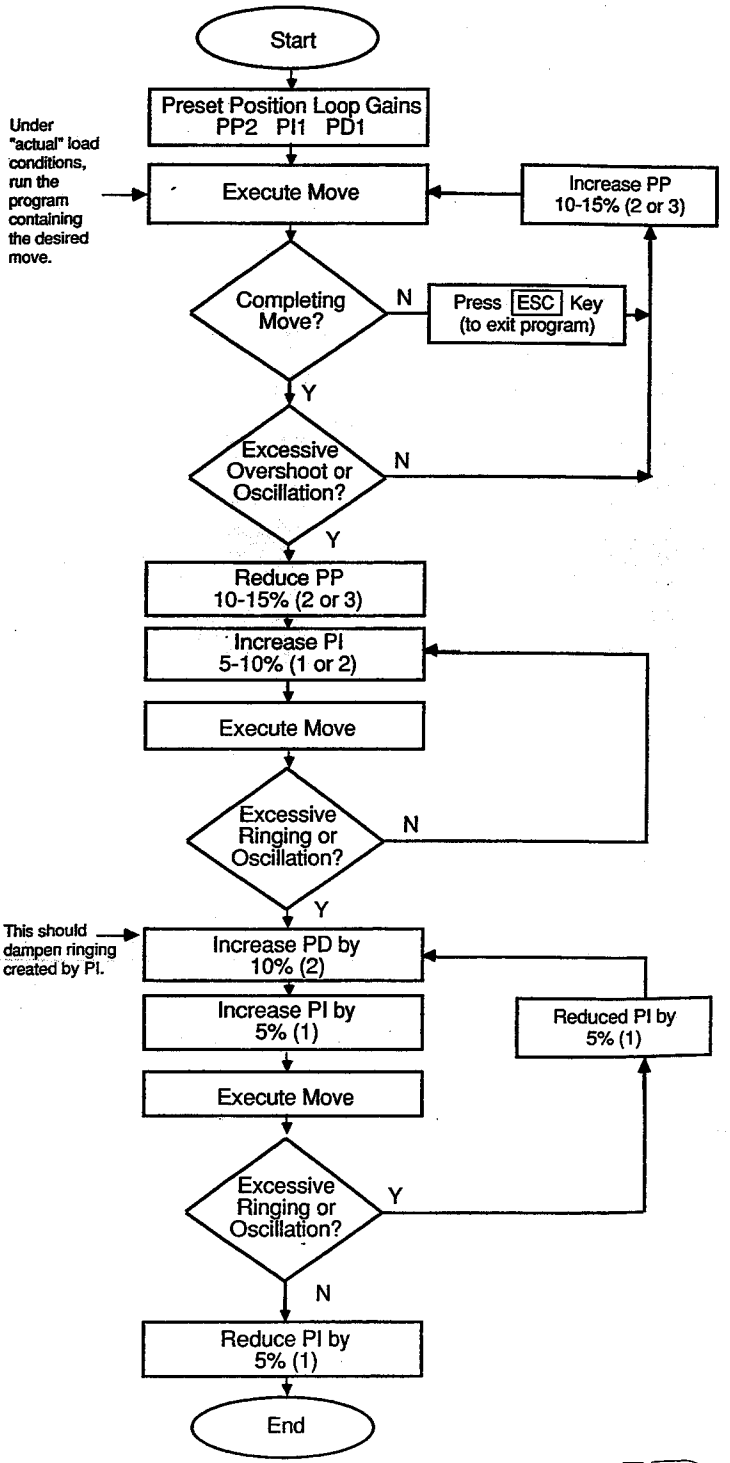
Parameter	Description	Range of Values	Default
PP	Position—Proportional Gain	(0-20)	10
PI	Position—Integral Gain	(0-20)	10
PD	Position—Derivative Gain	(0-20)	10
VP	Velocity—Proportional Gain	(0-20)	10
VI	Velocity—Integral Gain	(0-20)	10
VD	Velocity—Derivative Gain	(0-20)	10

PID Tuning "Flowchart"

The following flowchart is offered as a guide to optimize your H3951/H4951 system (by visually observing the cylinder "position" servo response).

Note 1: When tuning is required for an H3951 or H4951 System, most applications will involve tuning the Position Loop Gains ONLY. Velocity Loop Gains will often NOT have to be adjusted unless certain conditions exist where there is noticeable ringing (in velocity) near the acceleration/constant velocity breakpoint (review the following page for info on VP, VI & VD).

Note 2: It is recommended to "individually" obtain the optimum gain settings for various sets of move and load conditions which will occur during "actual" system operation. It may be necessary to compare these settings and compromise on values (gains & move parameters) to maintain stability through the entire range of operating conditions.



8.2 PID Parameters Command List/Description

PPnn

Parameter: Position Loop—Proportional Gain
Range: 0-20
Description: The Proportional Gain (or Sensitivity) provides a restoring force in a system which reacts to the amount of following or tracking error in position (typically due to load variations).

Note 1: The force is proportional to the amount of error, increasing linearly as the position error increases. It is indicative of the "stiffness" of a system, counteracting any "non-commanded" changes in position.

Too Low: Overdamped System, recovers too slowly (slow response), appearing sluggish, may undershoot and not complete move.

Too High: system recovers too quickly, causing overshoot, ringing, and oscillation.

PID Parameter Display

EX. | Enter Position
P Gain PP:10 | Default 10

PInn

Parameter: Position Loop—Integral Gain
Range: 0-20
Description: The Integral Gain (or reset) provides a corrective force during **steady state** conditions where position following error (or drift) is eliminated over time.

Note 1: In attempting to Reduce the Steady State position error (drift) over time, the force created is proportional to the amount of error, increasing linearly with time.
Note 2: Typically set to the smallest (value compromised by overshoot, settling time, and response time.

Too Low: "Thud" response, may not achieve final position.

Too High: Increases overshoot and ringing, cylinder may "hunt" about the set position, may also cause oscillation.

PID Parameter Display

EX. | Enter Position
I Gain PI:10 | Default 10

PDnn

Parameter: Position Loop—Derivative Gain
Range: 0-20
Description: The Derivative Gain is a differential term which reacts to the changes in the rate of position error, providing a damping force to eliminate oscillation, minimize overshoot and ringing, and to stabilize the system.

Note 1: The damping force provided by the derivative term it is proportional to the rate of change of the position error.
Note 2: Basic function is to act as "shock absorber" or transient dampener with regards to position.

Too Low: Overdamped response

Too High: Creates excessive ringing and settling time, may cause oscillation.

PID Parameter Display

EX. | Enter Position
D Gain PD:10 | Default 10

VPnn

Parameter: Velocity Loop—Proportional Gain
Range: 0-20
Description: The Proportional Gain (or Sensitivity) provides a restoring force in a system which reacts to the amount of following or tracking error in velocity (typically due to load variations).

Note 1: The force is proportional to the amount of error, increasing linearly as the velocity error increases. It is indicative of the "stiffness" of a system, counteracting any "non-commanded" changes in velocity.

Too Low: Overdamped System, recovers too slowly (slow response), appearing sluggish, may undershoot and not complete move.

Too High: System Recovers too quickly, creating a "hard" move response, may cause overshoot, ringing, and oscillation.

PID Parameter Display

EX. | Enter Position
P Gain VP:10 | Default 10

VInn

Parameter: Velocity Loop—Integral Gain
Range: 0-20
Description: The Integral Gain (or reset) provides a corrective force during **steady state** conditions where velocity following error (or drift) is eliminated over time.

Note 1: In attempting to Reduce the Steady State velocity error (drift) over time, the force created is proportional to the amount of error, increasing linearly with time.
Note 2: Typically set to the smallest value compromised by overshoot, settling time, and response time.

Too Low: Cylinder may not achieve final "constant velocity value"

Too High: Increases overshoot & ringing, cylinder may hunt about the set velocity.

PID Parameter Display

EX. | Enter Velocity
I Gain VI:10 | Default 10

VDnn

Parameter: Velocity Loop—Derivative Gain
Range: 0-20
Description: The Derivative Gain is a differential term which reacts to the changes in the rate of velocity error, providing a damping force to eliminate oscillation, minimize overshoot and ringing, and to stabilize the system.

Note 1: The damping force provided by the derivative term, it is proportional to the rate of change of the error.
Note 2: Basic function is to act as "shock absorber" or transient dampener with regards to velocity.

Too Low: Overdamped response

Too High: Creates ringing and oscillation.

PID Parameter Display

EX. | Enter Velocity
D Gain VD:10 | Default 10

Appendix A: Troubleshooting Guide (Symptom - Cause - Remedy)

Symptom	Cause	Remedy
"Amplifier Fault" (Error Code on LCD Display)	1. Fuse F2 Blown (H3951) Fuse F1 Blown (H4951) 2. Short in motor cable 3. Thermal Shutdown (Amplifier exceeded internal termperature limits, 160F) 4. Short detected in amplifier	1. Replace Fuse H3951: 5 amp, 250 volt, Type ABC5 H4951: 8 amp, 250 volt, Type MDA8 2. Check motor cabling 3. Remove Power from Control for 30 minutes, then Reapply Power. Have good air circulation through the drive heatsink & verify duty cycle limits of cylinder/motor 4. Return to IDC for Repair
"Current Overload" (Error Code on LCD Display)	1. Cylinder/Load Binding 2. Cylinder Rammed into Physical End of Travel 3. Velocity set too high for given load 4. Accel or Decel Rate set too high for given load 5. Current Limit Settings too low for given move	1. Check unloaded Cylinder Operation and mechanical mounting of load 2. Reverse Direction of Motion 3. Reduce VE setting 4. Increase AC or DE Time Setting (this reduces the Rate) 5. Increase Current Limit Settings CE & CR in System Parameters
"EEPROM CheckSum Error" (Error Code on LCD Display)	1. Data in EEPROM Corrupted 2. An error or malfunction has been detected in the control EEPROM chip.	1. Reformat EEPROM Press keys in order (not simultaneously) [.] [>] [DEL] Reformat (All Programs ERASED/Parameters Reset) 2. Replace EEPROM
"Encoder Fault" (Error Code on LCD Display)	1. Encoder Signal is faulty 2. Move attempted and Motor NOT Connected 3. Defective Encoder	1. Check Encoder wiring to control 2. Verify Motor Connections 3. Replace Encoder
"Error Finding Home" (Error Code on LCD Display)	1. Homing Routine was NOT successfully completed where both "end of travel limits" were reached without detecting any Home Input or the home input did not change state during the third stage of the homing routine.	1. Check for proper operation of Home Switch and verify signal connections to the Home Input.
"Hit a Limit" (Error Code on LCD Display)	1. An Extend (EEOT) or Retract (REOT), Normally Closed "End of Travel" Connection to Ground (GND) is broken (open circuit). 2. No power on the logic supply inputs 21 (PWR) and 22 (GND).	1. Check for End of Travel Limit Switch Activaton or check EEOT and REOT connections for a loose or broken wire. 2. Check for loose or broken connection on terminals 21 and 22 or verify fuse F1 (H3951) or F3 (H4951) is good.
"Motor Stalled" (Error Code on LCD Display)	This fault occurs when the "Speed" error bandwidth has been exceeded wherein the actual motor speed (indicated by encoder feedback) does not match the commanded motor speed. This condition can occur during the following; 1. Accel/Decel Rates too high for given load 2. Encoder Disconnected/Miswired 3. Cylinder/Load Binding 4. Belt or Gear Slip	1. Increase AC or DE Time Setting (this reduces the Rate) 2. Check Encoder Connections 3. Check unloaded Cylinder Operation and mechanical mounting of load. 4. Tighten Belt/Pulley or Gear
Garbled Characters in LCD Display	1. Data in EEPROM Corrupted	1. Reformat EEPROM Press keys in order (not simultaneously) [.] [>] [DEL] Reformat (All Programs ERASED/Parameters Reset)
Continuous Creep Speed during Home Routine	1. Control Cannot Detect Z Marker Pulse of Encoder during Final Stage of Homing Routine	1. Replace Encoder

Appendix B: H Series Cylinders

NH and RH Series (used with H3951)

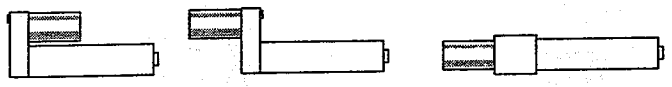
Model* Number	Drive Ratio	Screw Pitch	Eff(%)	Max Speed @NO Load	Max Thrust (lbs)
992B/102B	1.0	2	0.81	30.0	135
152B	1.5	2	0.81	20.0	200
202B	2.0	2	0.81	15.0	270
995B/105B	1.0	5	0.81	12.0	350
155B	1.5	5	0.81	8.0	550
205B	2.0	5	0.81	6.0	700
355B	3.5	5	0.63	3.4	800
995A/105A	1.0	5	0.36	12.0	150
155A	1.5	5	0.36	8.0	220
205A	2.0	5	0.36	6.0	290
355A	3.5	5	0.28	3.4	500
998A/108A	1.0	8	0.36	7.5	240
158A	1.5	8	0.36	5.0	360
208A	2.0	8	0.36	3.8	475
358A	3.5	8	0.28	2.1	800

* A = Acme, B = Ball screw

Note 1: Final move speeds are LOAD AND LENGTH DEPENDENT
Note 2: Max thrust values are also LENGTH DEPENDENT

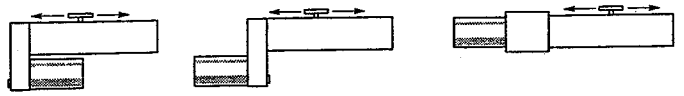
Rod Type Cylinder Configurations (NH Series)

Parallel Reverse/Parallel Inline



Rodless Cylinder Configurations (RH Series)

Parallel Reverse/Parallel Inline



TH Series (used with H4951)

Model* Number	Drive Ratio	Screw Pitch	Eff(%)	Max Speed @NO Load	Max Thrust (lbs)
991B/101B	1.0	1	0.81	40.0	120
151B	1.5	1	0.81	27.0	180
201B	2.0	1	0.81	20.0	260
501B	5.0	1	0.68	8.0	540
1001B	10.0	1	0.68	4.0	1080
994B/104B	1.0	4	0.81	10.0	480
154B	1.5	4	0.81	6.7	720
204B	2.0	4	0.81	5.0	1040
504B	5.0	4	0.68	2.0	2160
1004B	10.0	4	0.68	1.0	2400
994A/106A	1.0	6	0.28	6.7	280
156A	1.5	6	0.28	4.4	440
206A	2.0	6	0.28	3.3	640
506A	5.0	6	0.23	1.3	1330
1006A	1.0	6	0.23	0.67	2400

* A = Acme, B = Ball screw

Note 1: Final move speeds are LOAD AND LENGTH DEPENDENT
Note 2: Max thrust values are also LENGTH DEPENDENT

Rod Type Cylinder Configurations (TH Series)

Parallel Inline

H Motor

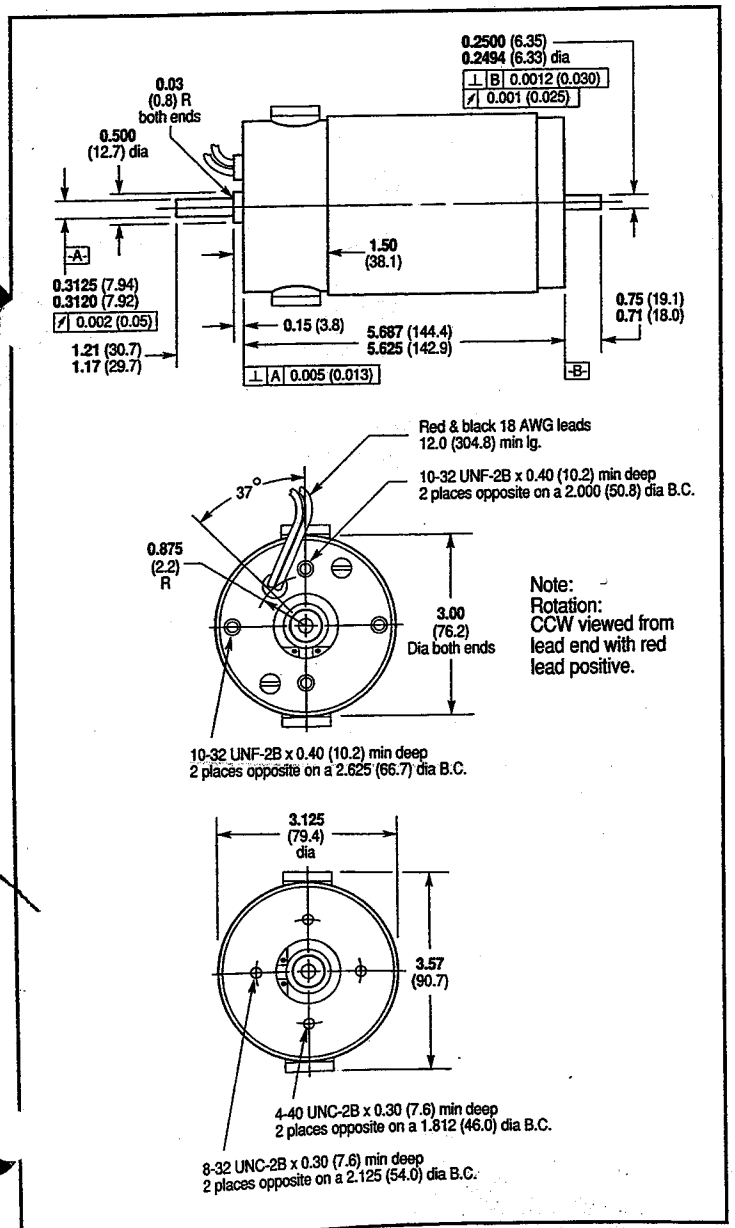
Used on NH & RH Cylinders with the H3951 Control

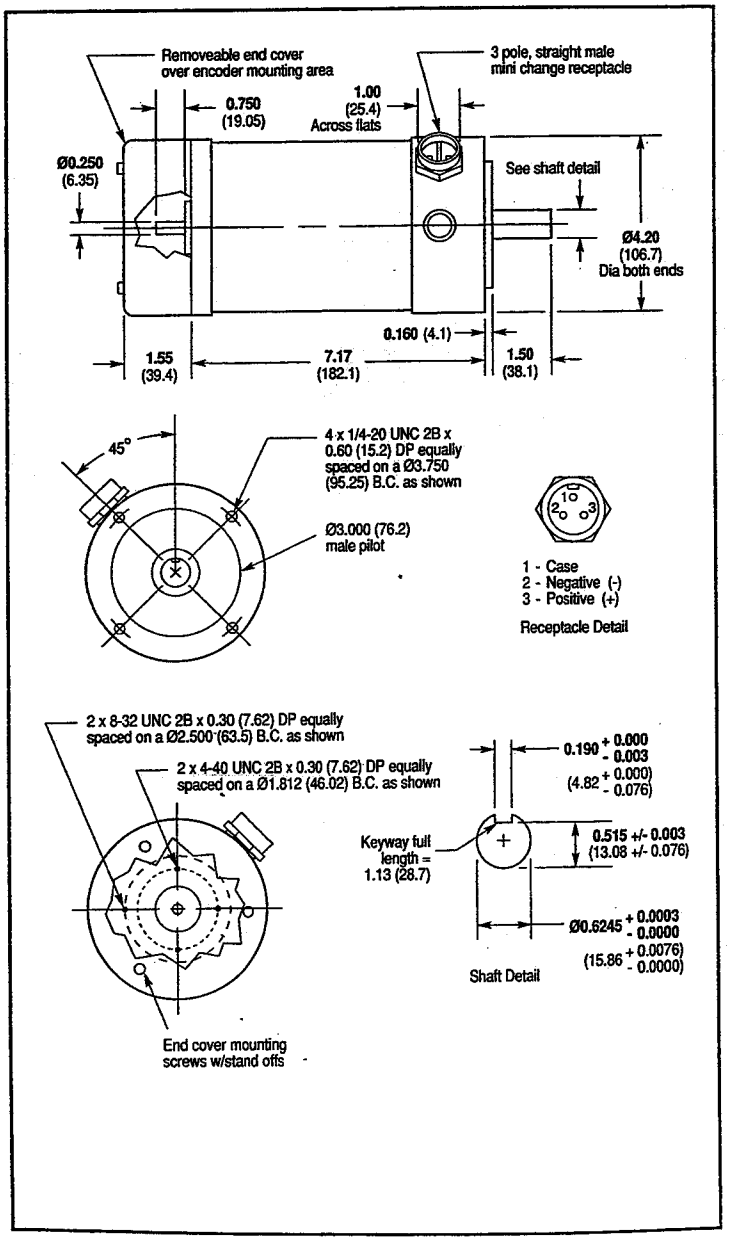
Operational:	Permanent Magnet 2 Pole DC Motor, 2 Lead
Voltage:	Rated 160 VDC, 180 VDC max
Current:	2.0 amps continuous, 6 amps peak
Torque:	108 oz-in
No Load Speed:	3600 RPM
Torque Constant:	54 oz/in amp
Moment of Inertia:	.034 oz-in-sec^2
Windings	
Resistance:	6.4 ohms
Inductance:	21mh
Cabling:	Less than 50ft (16AWG), 50-100ft (14AWG), 100-200ft (10AWG)
Brushlife:	5 Million Cycles, 5000 Hours

H4 Motor

Used on TH Cylinders with the H4951 Control

Operational:	Permanent Magnet 2 Pole DC Motor, 2 Lead
Voltage:	Rated 160 VDC, 180 VDC max
Current:	5 amps continuous,7.50 amps peak
Torque:	335 oz-in
No Load Speed:	2400 RPM
Torque Constant:	67 oz/in amp
Moment of Inertia:	.20 oz-in-sec^2
Windings	
Resistance:	1.5 ohms
Inductance:	12mh
Cabling:	Less than 50ft (16AWG), 50-100ft (14AWG), 100-200ft (10AWG)
Brushlife:	5 Million Cycles, 5000 Hours





Programming Chart

Run Mode Functions

ESC	Immediately Stop Motor
EDIT	Select Program to Edit
ENTR	Enter Data or Initiate Command
DEL	Select Program to Delete
F1-0	Display Available Memory
F1-5	Test Outputs
F1-6	Select Program to Run
F1-7	Copy Program
F1-Edit	Enter System Parameters
F2-Edit	Enter Learn Mode
F1-F2 Edit	Enter PID Parameters
F1-F2-ENTR	Display Software Revision
F1-F2-DEL	Original Configuration: Erase memory
F1-F2-1	Reset Current Position to Zero
F1-F2-3	Send String Over RS232
F1-F2-8	Restore Default Values
F1-F2-9	System Reset
ESC & →	Jog Motor in Extend (+) direction
ESC & ←	Jog Motor in Retract (-) direction

System Parameters

User	Description	Range of Values	Default	
MN	Model Number	xxxxxxxx	102	
CE	Cur Overload Extend	(0-100%)	65%	Peak Cur.
CR	Cur Overload Retract	(0-100%)	65%	Peak Cur.
CS	Coordinate System	(0 or 1)	0	Ext=Positive
DP	Display Mode	(1 or 2)	1	normal
EC	Echo RS232	(0 or 1)	1	echo on
HA	Home Algorithm(mn)	(0 or 1)	01	RTR edge/N.O.
HO	Home Offset	(0-9.999)	0.0	disabled
JA	Jog Acceleration	(.01-15)	.1	sec
JV	Jog Velocity	(0-100%)	10%	max speed
MU	Metric Units	(0 or 1)	0	English
PU	Power-up mode	(0-99)	00	disabled
SD	Stop on Input Decel Rate	(.01-15)	.1	second
SI	System Inputs (mnxy)	(0-8)	8800	User Prog/ disabled
SO	System Outputs (mn)	(0-6)	00	disabled
XP	External Prog. Select	(0 or 1)	00	disabled
UN	Unit Number (RS232)	(1-99)	01	device 1

PID "Gain" Parameters

Parameter	Description	Range of Values	Default
PP	Position—Proportional Gain	(0-20)	10
PI	Position—Integral Gain	(0-20)	10
PD	Position—Derivative Gain	(0-20)	10
VP	Velocity—Proportional Gain	(0-20)	10
VI	Velocity—Integral Gain	(0-20)	10
VD	Velocity—Derivative Gain	(0-20)	10

Edit Mode Command List

F1		Function	Range of Values
1	DA	Distance Absolute	(+/- 000.000 - 999.999 in or cm)
2	DI	Distance Increment	(+/- 000.000 - 999.999 in or cm)
3	DC	Distance to Change	(+/- 000.000 - 999.999 in or cm)
4	VE	Velocity	(1-100% of max speed)
5	OT	Outputs Set	(0=off, 1=on, 2=no change)
6	RN	Run Program #	(1-99)
7	TD	Time Delay	(.01-99999.99 sec.)
8	WT	Wait On Inputs	(0=grounded,1=open,2=ignore)
9	GO	Go - Make Move	
0	GH	Go Home	(1-100% of max speed)

F2		Function	Range of Values
1	AC	Acceleration	(.05 to 15 sec.)
2	DE	Deceleration	(.05 to 15 sec.)
3	IF	IF - THEN	(0=grounded,1=open,2=ignore)
4	LP	Loop	(0 to 99999)
5	EL	End of Loop	
6	ST	Stop On Input #	(1-4)
7	CT	Current Hold Time	(.01-99999.99 sec)
8	CL	Current Hold Limit	(0-100%)
9	EN	End of Program	
0	UV	User Variable	

Edit Mode: Command Default Values

Command	Description	Default Value
AC	Acceleration	.3 second ramp time
DE	Deceleration	.3 second ramp time
VE	Velocity	25% speed

Warranty and Service Policy

Industrial Devices Corporation warrants all electrical cylinders and electronic controllers to be free of defects in workmanship for a period of one year from the date of shipment to the end user.

Products that have expended their useful life in less than one year or have been improperly used or damaged, in the opinion of the company, are not subject to the terms of this warranty.

Repairs

Industrial Devices Corporation maintains a repair facility at its factory in Novato, California for all units which Industrial Devices Corporation manufactures, including a complete inventory of parts to ensure quick service turn around.

Returns

Prior approval by Industrial Devices is required before returning a product for any reason. All return packages must be accompanied by an RMA (Return Material Authorization) number. To obtain an RMA#, contact your local IDC distributor or Industrial Devices.

Products returned prepaid to the factory will be repaired or replaced at the company's option at no charge, and returned prepaid to the user.

In Case of Failure

1. Get the Model and Serial number of the defective unit.
2. Prepare a purchase order for the repair cost if the unit is out of warranty.
3. Contact your IDC Distributor or Industrial Devices Corporation (at 1-800-747-0064) for a Return Material Authorization RMA#. —Provide information describing the nature of the failure.
4. Ship the unit prepaid to:

Industrial Devices Corporation
64 Digital Drive
Novato, CA 94949
Attn: RMA # _____

NOTES

For More Information

If you require further information on the H3951, H4951 or another Industrial Devices product, please call your local IDC Distributor or Industrial Devices.

1. ***Local IDC Distributor***

   Company: _____

   Contact: _____

   Phone #: _____

2. ***Industrial Devices Corporation***

1-800-747-0064

To get quick response to specific information when calling Industrial Devices, ask for the area of expertise that relates to your question:

Technical Support?
Ask for Applications Engineering

Product Information, Repairs or Returns?
Ask for Inside Sales

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3925 Cypress Drive, Petaluma, CA 94954
1-800-747-0064 or 707-789-1000
Fax 707-789-0175
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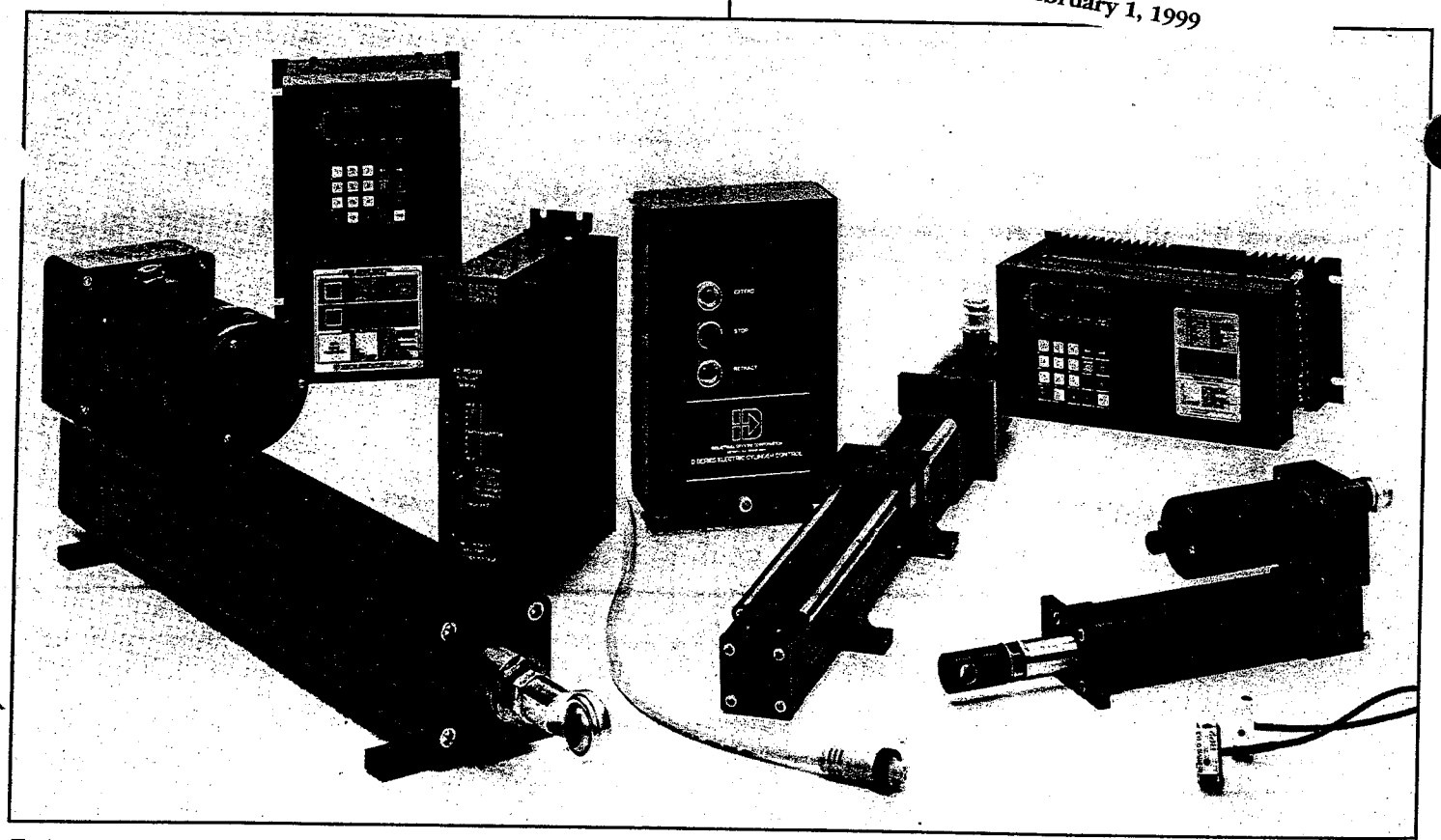

Today, more than 10,000 individual Industrial Devices systems are in use, in an extensive variety of industrial, scientific and commercial applications. For information on other Industrial Devices' electric linear positioning systems, contact your local distributor or call us.

Industrial Devices Corporation
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