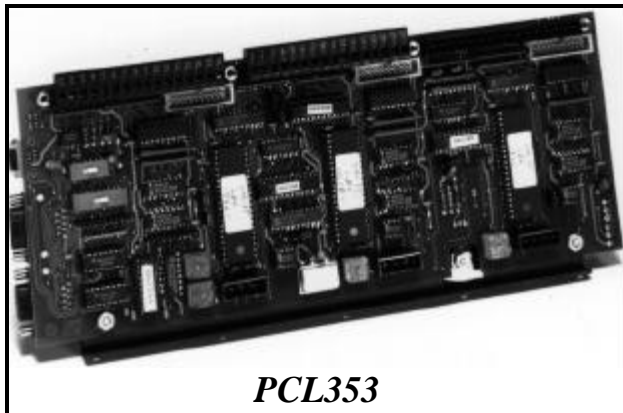


**MODELS: PCL352 and PCL353 INDEXERS
and
DPF723352 and DPF73353 DRIVER PACKS**



PCL353



DPF73352

ANAHEIM AUTOMATION

910 E. Orangefair Lane
Anaheim, CA 92801
TEL (714) 992-6990
FAX (714) 992-0471

COPYRIGHT

Copyright 1993 by Anaheim Automation. All rights reserved. No part of this publication may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language, in any form or by any means, electronic, mechanical, magnetic, optical, chemical, manual, or otherwise, without the prior written permission of Anaheim Automation, 910 E. Orangefair Lane, Anaheim, CA 92801. The only exception to this would be use of the program examples in this manual.

DISCLAIMER

Though every effort has been made to supply complete and accurate information in this manual, the contents are subject to change without notice or obligation to inform the buyer. In no event will Anaheim Automation be liable for direct, indirect, special, incidental, or consequential damages arising out of the use or inability to use the product or documentation.

LIMITED WARRANTY

All Anaheim Automation products are warranted against defects in workmanship, materials and construction, when used under Normal Operating Conditions and when used in accordance with specifications. This warranty shall be in effect for a period of twelve months from the date of purchase or eighteen months from the date of manufacture, whichever comes first. Warranty provisions may be voided if the products are subjected to physical damage or abuse.

Anaheim Automation will repair or replace at its option, any of its products which have been found to be defective and are within the warranty period, provided that the item is shipped freight prepaid, with RMA (return material authorization), to Anaheim Automation's plant in Anaheim, California.

TRADEMARKS

Control Link and Driver Pack are registered trademarks of Anaheim Automation.

IBM PC is a registered trademark of International Business Machines, Inc.

TABLE OF CONTENTS

	Page		Page
Introduction	1	Programming	18
Description	1	SMC35 Stored Program Generator	18
Ordering Information	2	Commands	18
Speed Considerations	2	Internally Stored Programs	18
Technical Support	2	Programmable Reset	18
Specifications	3	Command Summary	19
Communication Guidelines	4	Command Dictionary	21
Talking to the Indexer	4	Troubleshooting	28
RS232C	4	Glossary	29
RS422	5		
DTE vs DCE	5		
Handshaking Signals	5		
A Manner of Speaking	6		
RTS Defined	6		
CTS Defined	6		
Smart Indexers Disk	7		
Colors	8		
Setting Outputs	8		
Online/Offline	8		
Terminal Mode	8		
Installation	9		
Connector Listing	9		
Jumper Selections	9		
Handheld Terminal	9		
Step Motor Driver Pack	11		
Dimension Drawings	12		
Axis Selection	13		
Daisy chaining	13		
Indexer Terminal Block	14		
Limit Switch Inputs	15		
Home Type "0" Configuration	15		
Home Type "1" Configuration	15		
Programmable Inputs and Outputs	15		
Encoder Inputs	16		
Jog Inputs	16		
Hard Limits	17		
Baud Rate	17		
Torque-Speed Curves			

INTRODUCTION

The SMC35 based Indexer is available from 1 to 3 axes as a board level product and as a driver pack. This manual covers the 2 and 3 axis versions of the board and the driver pack. Driver Pack Model DPF72352 or DPFEN353 is a compact package used to control Step Motors. It can be programmed or controlled by a computer and then be set up to autostart. All the necessary motion parameters can be programmed, including the maximum speed the motor will turn, the minimum or base speed, the acceleration rate, the deceleration rate, as well as many other parameters. Encoder feedback can be used to verify and auto-correct the motor position while under computer control. Eight outputs can be turned on and eight inputs can be read per axis. The Driver Packs can be daisy-chained together to provide up to 32 axes of control.

The SMC35 has two modes of operation: Direct Mode and Stored Program Mode. The SMC35 can store a program 250 bytes long in its memory. This might not seem like a lot of memory, but it is usually more than enough. Since a program will not be lost after the unit is turned off, the user can write the program and then have the SMC35 autostart that program on power-up.

This manual is intended to help the user apply the SMC35 in motion control applications. Familiarity with computers, programmable logic controllers (PLC's), or terminals would be helpful, but is not essential. The user is expected to select the step motors and other machine requirements. Typical users range from programmers to machine designers, and this manual is written intending to be straightforward and yet technical enough for complex designs.

DESCRIPTION

Generally step motor controllers are open-loop systems, meaning that no information is sent back to the controller from the motor to verify the number of steps that were taken. A step motor is essentially a digital device - you give the step motor driver 10 clock pulses, and the motor moves 10 steps. Sometimes a closed-loop system is needed to verify that the motor indeed went 10 steps. The SMC35 will accept encoder inputs to form the closed-loop system. The encoder command can be used in conjunction with a computer to verify the position, and the computer can make any corrections that might be necessary.

The SMC35 is designed to communicate over a RS232C or RS422 bi-directional serial data bus. The RS422 serial bus is better suited for industrial environments with noise problems. RS422 can reliably travel to a distance of 4000 feet. The RS232C line can only be used to a distance of 50 feet in a noise free environment. Almost all computers have, or can be equipped with, an RS232C port. If you wish to send your RS232C signal over 50 feet, Anaheim Automation sells a RS232C to RS422 Data Converter (Model DC1709).

The SMC35 provides independent programming of acceleration, deceleration, base speed (start up speed), running speed, and the number of steps to be taken in both relative and absolute positioning modes. On absolute positioning moves, the SMC35 automatically determines the proper direction to go and the number of steps to take. The relative positioning will move a number of steps in the direction that the user defines. The SMC35 has a high level command set including: looping, conditional statements, time delays, power down motor, encoder feedback, and maskable I/O.

Hard, Soft, and Home Limit Switch inputs are provided for each axis. These features are generally required in most machine control designs. Eight testable Inputs and eight programmable Outputs are provided per axis. These I/O may be used for monitoring and controlling machine operation and/or interaxis coordination. These I/O are accessible independent of the busy state of the axis controls. The 8 inputs are TTL/CMOS compatible. The 8 outputs are current sinking, open collector darlington.

The SMC35's have a built-in programmable reset circuit so that all axes in the daisy-chain may be reset. The outputs are reset to the off state when the board is reset. Reset is automatic on power-up or with a "break" signal on the RS232 or RS422 input. A SMART INDEXERS disk is provided when you purchase the unit. This disk allows you to write and change programs that are to be stored in the SMC35 for autostart use. The disk also allows you to save the programs onto your computer disk, and easily retrieve them when needed. The program can upload the stored program from the SMC35, allow you to make changes, and then download the program back to the SMC35.

ORDERING INFORMATION

The below table lists a variety of products available from Anaheim Automation. These products include those covered by this manual along supporting cables and devices. We are continually adding new products to our line, so please consult your nearest Authorized Anaheim Automation Distributor or Representative for information on the latest releases.

PART NUMBER	DESCRIPTION
CL2373-2	DUAL-AXIS, PROGRAMABLE INDEXER, SMC35 SERIES, (Driver Pack replacement)
PCL352	DUAL-AXIS, PROGRAMABLE INDEXER, SMC35 SERIES, STANDALONE
CL2373-3	TRIPLE-AXIS, PROGRAMABLE INDEXER, SMC35 SERIES (Driver Pack replacement)
PCL353	TRIPLE-AXIS, PROGRAMABLE INDEXER, SMC35 SERIES, STANDALONE
DPF72352	DUAL-AXIS DRIVER PACK WITH SMC35 SERIES PROGRAMMABLE INDEXER AND 600 WATT POWER SUPPLY
DPFEN353	TRIPLE-AXIS ENHANCED DRIVER PACK WITH SMC35 SERIES PROGRAMMABLE INDEXER AND 500 WATT POWER SUPPLY
AA2680	6 FOOT SERIAL CABLE WITH MALE AND FEMALE CONNECTOR
AA2681	20 PIN RIBBON CABLE CONNECTOR, 24 INCHES
AA2220	20 PIN RIBBON CABLE CONNECTOR, 24 INCHES, FLYING LEADS
AA2M20	20 PIN BREAKOUT TERMINAL BOARD
TT1R2-1	HANDHELD TERMINAL

TABLE 1: ORDERING INFORMATION

SPEED CONSIDERATIONS

The SMC35 Chip was created to handle speeds from 50 steps per second (sps) to 20,000 sps. When maximum speeds of 10,000 sps or less are anticipated a few other chips are available that offer increased smoothness at these speeds (see Table 2). Contact your local distributor for information regarding the appropriate part number.

CHIP VERSION	SPEED RANGE
SMC35	50 to 20,000 sps
SMC36	35 to 10,000 sps
SMC37	35 to 5,000 sps
SMC38	35 to 2,500 sps

TABLE 2: SMC35 CHIP VARIATIONS

TECHNICAL SUPPORT

Everyone needs help on occasion. If you have problems using any of the equipment covered by this manual, please read the manual to see if that will answer the questions you have. Be sure to look in the TROUBLESHOOTING section located near the back of this manual. If you need assistance beyond what this manual can provide, you can call your Local Distributor where you purchased the unit from. If possible, have this manual in hand. It is often helpful to have the unit connected to a computer with the SMART INDEXERS DISK loaded.

SPECIFICATIONS

DRIVER PACK:

Power Requirements 105/125 Vac, 50/60Hz, 7A
 Fuse 7 Amp, 5mm, fast blow type

CL2373-2 or CL2373-3:

Power Requirements 8-16 VDC @ 1 Amp
 or 5VDC @ 1 Amp

GENERAL:

Operating Temperature 0 to 60 degree C

Driver Output Current Rating 1 to 6.5 Amp per phase
 Control Inputs TTL-CMOS Compatible

Pulse Output Range SMC35: 50 to 20,000 pps
 pps (pulses per second) SMC36: 32 to 10,000 pps
 SMC37: 32 to 5,000 pps
 SMC38: 32 to 2,500 pps

Inputs (TTL-CMOS) Logic "0": 0 to 0.8 VDC
 Logic "1": 3.5 to 5.0 VDC

Outputs (CLK, DIR, PWR): TTL-CMOS compatible
 Logic "0": 0 to 0.32 VDC, 4 Ma
 Logic "1": 4.3 to 5.1 VDC, 4 Ma

Output Clock: Selectable

RS422 Input Logic "0" -2 to -10 VDC, 1.5 Ma
 Logic "1" 2 to 10 VDC, -2.5 Ma
 sensitivity 200 mV

RS422 Output: Voltage Output High 2.5 VDC min, 20 Ma
 Voltage Output Low 0.5 VDC max, 20 Ma

RS232C Input Logic "0" 2 to 10 VDC, 1.5 mA
 Logic "1" -2 to -10 VDC, -2.5 mA
 sensitivity 200 mV

RS232C Output Logic "0" 0.5 VDC max, 20 mA
 Logic "1" 2.5 VDC min, 20 mA

Encoder Quadrature only
 Inputs TTL-CMOS Compatible
 Power 5 VDC @ 100 ma Max.

Baud Rate: 50 to 9600 BAUD
 Data Format: Half-Duplex, 1 start bit, 8 data bits, no parity, 1 stop bit

Outputs (8 programmable I/O): Open Collector Type
 Maximum voltage: 40 VDC
 Current sink: 500 ma (total, all on)

NOTE: For inductive loads, customers must connect the clamp input for fly-back protection.

COMMUNICATION GUIDELINES

TALKING TO THE INDEXER

Anaheim Automation programmable indexers communicate by using the RS232C or RS422 standards. Most computers contain at least one RS232C serial port. Some industrial computers have a RS422 serial port. To communicate with the SMC35, use connector P1 in Figure 1. P1 is used for either RS232C or RS422, and is set by sliding the two switches to the appropriate direction (see below) P1 is a DB9 Female. To communicate with subsequent axes, use P2, the RS422 output port. P2 is a DB9 Male, and is always set for RS422. The switches affect only the Input Port P1. The difference between the two types of communications is discussed below.

RS232

This serial communication mode is single ended. This means that for each signal there is one wire, and a common ground reference used by all the signals. For the 4 signals, RD, TD, CTS and RTS to be transmitted, RS232C requires 5 wires. The signal line maintains levels of +5VDC to +15VDC (LOW LOGIC INPUT) and -5VDC to -15VDC (HIGH LOGIC INPUT). The receiver for the RS232C looks for a voltage potential of +3 to +25 volts for a logic LOW, and -3 to -25 volts for a logic HIGH. For a valid logic level, the voltage must be +/-3 volts. RS232C works well at 9,600 baud over distances of 50 feet maximum. RS232C is susceptible to electrical noise, and should not be used in noisy areas. Always use the shortest cable connection possible.

Note: Keep control wiring separated from motor cable/wiring.

PIN #	FUNCTION	RS232 FUNCTION
2	RD	RD (RECEIVE DATA)
3	TD	TD (TRANSMIT DATA)
5	0VDC	SG (SIGNAL GROUND)
7	RTS	RTS (REQ TO SEND)
8	CTS	CTS (CLEAR TO SEND)

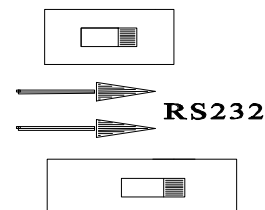


TABLE 3: RS232C 9 PIN CONNECTION (COMPUTER OR INDEXER)

PIN #	FUNCTION	RS232 FUNCTION
1	CG	CG (CHASSIS GROUND)
2	TD	TD (TRANSMIT DATA)
3	RD	RD (RECEIVE DATA)
4	RTS	RTS (REQ TO SEND)
5	CTS	CTS (CLEAR TO SEND)
7	0VDC	SG (SIGNAL GROUND)

NOTE: The Autostart function will not be activated while the switches are set to the RS232C mode. Place the switches to RS422 when autostarting the unit.

TABLE 4: RS232C 25 PIN CONNECTION (COMPUTER PORT)

RS422

To talk to the SMC35 in RS422 set the switches to RS422, and use P1. The RS422 serial communication standard is differential. This means that from each signal, there are two wires. For the 4 signals transmitted there needs to be 9 wires including the ground reference. The signal line maintains a voltage level of up to +12 volts on either line. The polarity of the line switches to obtain the logic levels. For example, if RD+ is more positive than RD- then it is a logic HIGH. If RD- is more positive than RD+, then it is a logic LOW. For a valid logic level, the voltage difference between RD+ and RD- needs to be greater than 200 millivolts. RS422 is unsusceptible to noise due to the differential lines. We normally specify a maximum of 9600 Baud at up to 4000 feet.

PIN #	FUNCTION	RS232C FUNCTION
1	SG	SG (SIGNAL GROUND)
2	CTS+	CTS (CLEAR TO SEND)
3	CTS-	CTS
4	TD+	TD (TRANSMIT DATA)
5	TD-	TD
6	RTS+	RTS (REQ TO SEND)
7	RTS-	RTS
8	RD+	RD (RECEIVE DATA)
9	RD-	RD

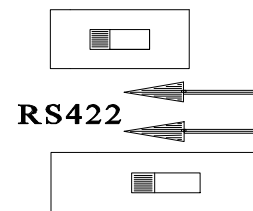


TABLE 5: RS422 9 PIN CONNECTION

DTE vs DCE

There are two types of devices defined. The first is called DTE (data terminal equipment). Examples of this would be a terminal, or an IBM Compatible Computer. The second type of device is a DCE (data communication equipment). Examples of this would be a modem or an Anaheim Automation Indexer such as the SMC35. DTE's have input pins of one type corresponding to output pins on the DCE's.

NOTE: THE SIGNAL NAMES ARE FROM THE POINT OF VIEW OF THE DTE (COMPUTER). FOR EXAMPLE, PIN 3 IS CALLED TD (TRANSMIT DATA) BY BOTH SIDES, EVEN THOUGH THE DTE (COMPUTER) SENDS IT AND THE DCE (SMC35) RECEIVES IT.

With a DB9, a DTE (such as a computer) transmits on pin 3 and receives on pin 2.

With a DB9, a DCE (such as a SMC35) transmits on pin 2 and receives on pin 3.

HANDSHAKING SIGNALS

There are two "handshaking" signals that we are concerned with; they are RTS and CTS. Some devices use these hand-shaking signals, and others do not. It is important to know if your device supports certain handshake signals. Anaheim Automation Indexers support both of these signals.

NAME	9 PIN	DIRECTION	FUNCTION
TD	3	DTE TO DCE	TRANSMITTED DATA
RD	2	DCE TO DTE	RECEIVED DATA
RTS	7	DTE TO DCE	REQ TO SEND (DTE READY)
CTS	8	DCE TO DTE	CLEAR TO SEND (DCE READY)

TABLE 6: PIN DESCRIPTION FOR RS232 WITH A DB9

THE COMPUTER IS THE DTE.....THE INDEXER IS THE DCE

A MANNER OF SPEAKING

The communication signals supported by Anaheim Automation Indexers are: **RECEIVE, TRANSMIT, CLEAR TO SEND (BUSY), AND REQUEST TO SEND.**

The method in which the Computer and the Indexer communicate is as follows:

When the computer wants to send some information, it looks at the CTS (Clear To Send) line. This will inform the computer if the Indexer is ready to receive information. If a logic LOW is read (meaning it is clear to send), the computer will send information on pin 3, in which the Indexer will receive on pin 3.

When the Indexer receives data that requires some computational time, it will pull the CTS HIGH meaning it is not clear to send data.

When the Indexer is ready to send something to the Computer it looks at the RTS signal which will inform the Indexer if the Computer is busy. If the RTS is low then the Indexer will send information on pin 2, which will be received by the Computer on pin 2 also.

RTS DEFINED

On the SMC35, there is an option to either enable, or disable the RTS. If RTS is enabled, then the above description applies. If RTS is disabled, then when the SMC35 wants to send information to the Computer, it will send it without looking at the RTS line. This is used when the computer does not support the RTS line.

CTS DEFINED

The CTS line must always be supported. No information should be sent to any indexer unless the CTS line is low. Otherwise the data sent may be lost, and the indexer could possibly stop communicating.

NOTE: THE SIGNAL NAMES ONLY MAKE SENSE FROM THE POINT OF VIEW OF THE DTE. FOR EXAMPLE, PIN 3 IS CALLED TD (TRANSMIT DATA) BY BOTH SIDES, EVEN THOUGH THE DTE SENDS IT AND THE DCE RECEIVES IT.

PIN #	FUNCTION	RS232C FUNCTION
1	CG	CG (CHASSIS GROUND)
2	TD	TD (TRANSMIT DATA)
3	RD	RD (RECEIVE DATA)
4	RTS	RTS (REQ TO SEND)
5	CTS	CTS (CLEAR TO SEND)

TABLE 7: RS232C 25 PIN CONNECTION (COMPUTER PORT)

Refer to the SMC35WIN USER's Manual for software assistance. Please Contact the factory for additional programming questions.

Manual No. SMC35WIN

SMC35 SERIES INDEXER HOOKUP INFORMATION

This section applies to all models covered by this manual. The SMC35 Series Indexer has several connectors that can be used for communication, and several Detachable Terminal Blocks that can be used to integrate switches, sensors, encoders, and other various items to the Indexer.

LIST OF CONNECTORS

There are several connectors in which the user must become familiar with. These connectors include communication to the indexer, limit switch terminal block, and encoder terminal block.

FUNCTION	CONN #	TABLE	TYPE
RS422 Input	P1	Table 3	DB-9 female
RS232C Input	P1	Table 1 & 2	DB-9 female
RS422 Output	P2	-----	DB-9 male
Encoder Input	TB4, TB5, TB6	Table 11	4 pin T.B.
Limit Switches	TB1, TB2, TB3	Table 9	20 pin T.B.
Inputs/Outputs	P3, P4, P5	Table 10	20 pin header
Handheld Terminal	J1	-----	RJ11 Socket

TABLE 9: LIST OF CONNECTORS FOR THE INDEXER

Refer to Figure 2 for location of connectors

JUMPER	JUMPER	FUNCTION
JP10, 11 & 12	1-2	SELECT AXIS ADDRESS NUMBERS G - V
	2-3	SELECT AXIS ADDRESS NUMBERS 0 - F
JP7,8 & 9	1-2	SELECTS POSITIVE GOING CLOCK OUTPUT
	2-3	SELECTS NEGATIVE GOING CLOCK OUTPUT
JP2*,4 & 6	1-2	SETS TB1-16 AS DIR. CONTROL OUTPUT
	2-3	SETS TB1-16 AS HOME L. S. INPUT
JP1*,3 & 5	1-2	SETS TB1-15 AS CLOCK OUTPUT
	2-3	SETS TB1-15 AS SOFT L. S. INPUT

TABLE 10: JUMPER SELECTIONS

Refer to Figure 2 for location of jumpers

*jumpers are located on the reverse side of the board

HANDHELD TERMINAL

The Handheld Terminal is a RS-232 Serial communications device, operating on +5Vdc. To order this unit, use part number TT1R2-1.

PIN #	DESCRIPTION	PIN #	DESCRIPTION
1	+5 VDC input	4	Receive Data
2	Request to Send	5	Transmit Data
3	Clear to Send	6	0 VDC Return (Common)

TABLE 11: Standard pinout for TT1R2-1

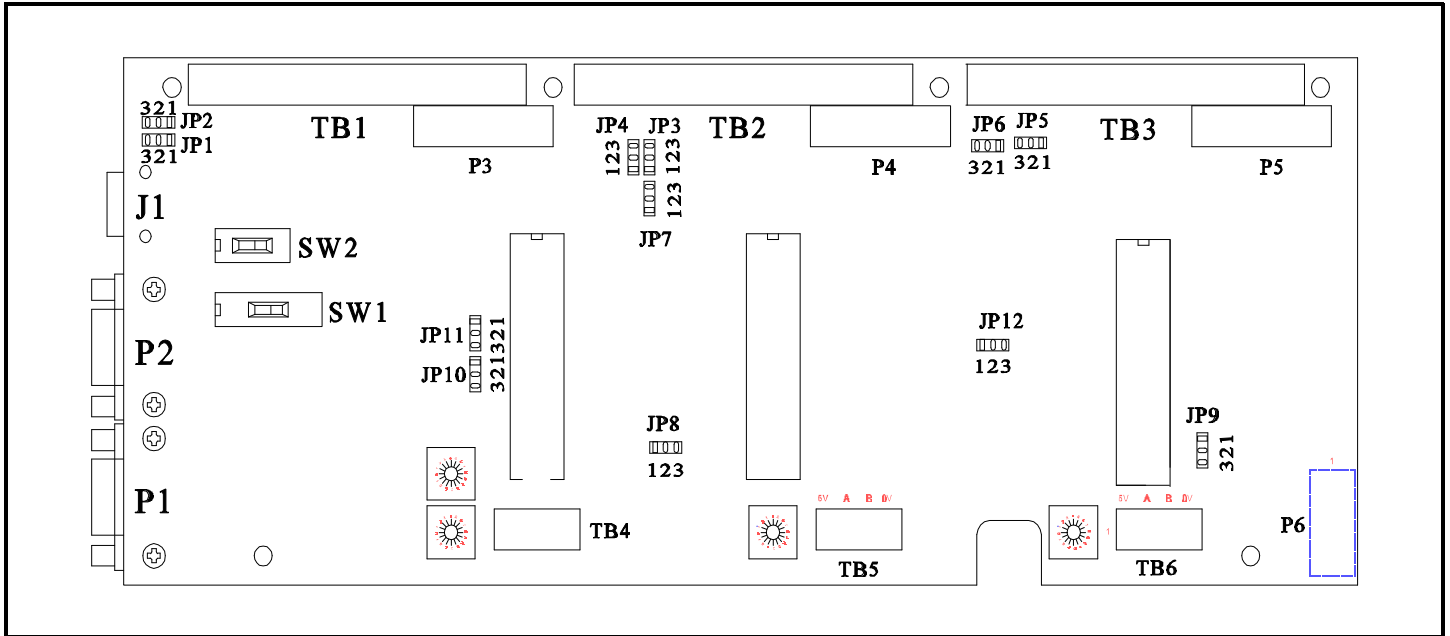


FIGURE 2: SMC35 SERIES INDEXER PHYSICAL LOCATIONS

AXIS SELECTION

Each SMC35 can be set to 1 of 32 possible axis numbers. This can be changed by turning the axis rotary switch, SW3 to the appropriate position. For axes greater than "F", internal jumpers, JP11, 15 & 16 must be changed. For axes 0 through "F", the jumper should be across position 2 and 3. For axes "G" through "V", the jumper should be across position 1 and 2. refer to Figure 1 on page 9 for the placement of the switch and jumper.

INDEXER TERMINAL BLOCK

The Indexer Terminal Block connector contains three INPUTS (#0-#2), three OUTPUTS (#0-#2), Limit Switch inputs, and Jog inputs. Table 9 shows the pin connections of the Indexer's Detachable Terminal Block.

PIN #	FUNCTION	COMMENTS
1	HOME / (DIRECTION OUTPUT) **	ACTIVE LOW
2	HOME	ACTIVE LOW
3	SOFT / (CLOCK OUTPUT) **	ACTIVE LOW
4	SOFT	ACTIVE LOW
5	HARD +	ACTIVE LOW
6	HARD -	ACTIVE LOW
7	INPUT 2	*HIGH = 4
8	INPUT 1	*HIGH = 2
9	INPUT 0	*HIGH = 1
10	FAST	ACTIVE LOW
11	JOG +	ACTIVE LOW
12	JOG -	ACTIVE LOW
13	OUT 0	*HIGH = 1
14	OUT 1	*HIGH = 2
15	OUT 2	*HIGH = 4
16	O VDC	REFERENCE

TABLE 9: INDEXER TERMINAL BLOCK CONNECTOR

***BINARY WEIGHT**

****JUMPER SELECTABLE**

DAISYCHAINING

The output of one SMC35 module can be connected to the input of a subsequent module, making it possible to daisychain up to 32 axes of SMC35 controllers. The SMC35 can be manually reset by holding the RTS line at 0Vdc for approximately 0.5 seconds. The RS422 output port, P2 is connected to the subsequent model's RS422 port, P1. A standard 9 pin cable can be used, and is available from Anaheim Automation. This can also be done by sending a "break" signal to the unit. In many communication programs, this can be done by the HOME key.

LIMIT SWITCH INPUTS

The Limit Switch Inputs are internally pulled up by a resistor making them normally +5 volts. To activate the input, the pin must be grounded to pin 16 (0 VDC) on the terminal block. For an explanation of Home, Soft, and Hard Limit Switches, see the description of the Home command in the Command Dictionary and the Glossary. Figure 5 shows an example hookup for a system using soft limit and home limit switches.

HOME TYPE "0" CONFIGURATION

Using Home Type "0" requires two grounding type limit switches called HOME and SOFT. The first limit switch SOFT will decelerate the motor down to base speed. It will continue to run at base speed until it receives a HOME Limit Switch input causing the motor to stop. The HOME Limit Switch only activates after a SOFT Limit is sensed. These switches are not directional, meaning that they will work in either direction. The SOFT Limit Switch will work for any type of motion. The HOME Limit Switch will work only for HOME motions.

NOTE: Whenever a SOFT Limit Switch is activated, the motor will decelerate and run at base speed. Be sure to come back passed the SOFT Limit Switch to set any origins, otherwise the motor will decelerate as it goes passed the Soft Limit Switch.

HOME TYPE "1" CONFIGURATION

This type of homing differs from Home Type "0" in that only one Limit Switch is needed. The HOME Limit Switch in this case cause the motor to ramp down to Base Speed, reverse direction and continue until the Limit Switch is released. This is a good way to compensate for any backlash in the system. It is also useful for minimizing the number of limit switches needed for homing.

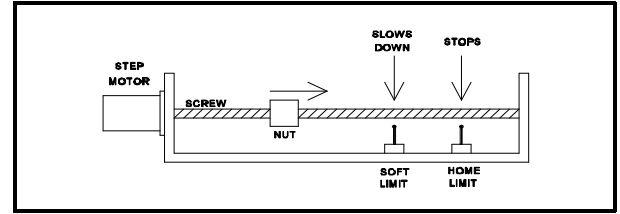


FIGURE 5: HOME TYPE "0" SETUP

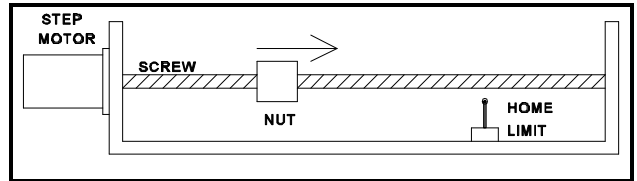


FIGURE 6: HOME TYPE "1" SETUP

PROGRAMMABLE INPUTS AND OUTPUTS

Eight general purpose inputs and outputs are provided per axis. The inputs may be used to initiate a machine cycle, for inter-axis coordination (in stored program mode), for operator intervention, for sensing a machine condition such as out of stock, or to wait for temperature to be reached. Outputs may be used to operate coolant valves, air cylinders, relays, or, with the right interfacing, any electrically controlled device. Pin assignments are listed in Table 10.

Note: For inductive loads, customers must connect the clamp input in order to provide adequate fly-back protection. Input wiring should be kept separate from step motor wiring.

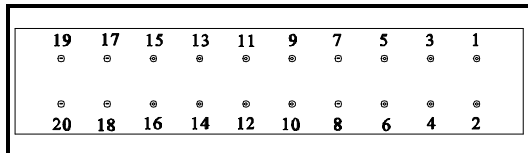


FIGURE 7: I/O HEADER

PIN #	FUNCTION	PIN #	FUNCTION
1	+5VDC	11	OUTPUT #4
2	CLAMP INPUT	12	INPUT #4
3	OUTPUT #0	13	OUTPUT #5
4	INPUT #0	14	INPUT #5
5	OUTPUT #1	15	OUTPUT #6
6	INPUT #1	16	INPUT #6
7	OUTPUT #2	17	OUTPUT #7
8	INPUT #2	18	INPUT #7
9	OUTPUT #3	19	0VDC REFERENCE
10	INPUT #3	20	0VDC REFERENCE

TABLE 10: INPUT/OUTPUT CONNECTOR

The 8 inputs and 8 outputs are available on a 20 pin male header type connector (P5). The first 3 inputs and outputs are also brought out to the terminal block (P9, 10 & 11) for easy access, see Table 9. The inputs are TTL compatible. Since the inputs have on-board pull up resistors, all that is required for a signal is a switch closure to ground (0VDC). With zero volts on the input, the pull up resistor source current is approximately 5 mA.

These outputs can drive all types of common peripheral power loads, including lamps, relays, solenoids, LEDs, printer heads, and heaters. For inductive loads, it will be necessary to connect the Clamp input as indicated in Figure 6. The outputs can also be used as drivers for higher power loads requiring discrete power semiconductors. The outputs are current sinking, open collector darlington. They are capable of sinking up to 150 mA per output but not more than 500 mA total when all 8 outputs are on, with voltages up to 40 VDC.

ENCODER INPUTS

A Rotary Encoder is a device that measures rotation of a shaft, in this case a step motor shaft, the encoder may also be mounted on the load for a true position. The encoder sends signals in a format called quadrature to the controller which will take this data and use it to verify the motor position. The encoder has four wires: Power, Ground, Channel 'A', and Channel 'B'. These lines should be connected to the SMC35 via Terminal Block P3. The encoder can be used with the SMC35 to form a closed-loop system when it is used with a computer. The stored program mode does not allow the use of the encoder. See the CP function on page 14 for more information.

PIN	FUNCTION	COMMENTS
1	+5 VDC	ENCODER POWER
2	CHANNEL A INPUT	ACTIVE LOW
3	CHANNEL B INPUT	ACTIVE LOW
4	GROUND (0 VDC)	ENCODER GROUND

TABLE 11: ENCODER TERMINAL BLOCK

JOG INPUTS

Jog is a manual function. The user can select the direction and speed (fast or slow) by grounding the appropriate combinations of inputs on a particular axis. These inputs are located on the Detachable Terminal Block (P4). To jog a motor, it is necessary to ground the Jog input on that axis for the direction (+ or -) desired. For Fast Jog, both the Fast and Jog command for the appropriate direction must be low at the same time. The first closure of Jog causes just one step. In order to get a continuous stream of pulses, the Jog input must be held low. The actual Jog rates can be programmed. Fast Jog is simply the Base rate. The Jog Factor command is used to determine the slow jog rate by dividing the Base speed by the jog factor. The position register will keep track of the number of steps that are taken during jogging.

EXAMPLE: If you have a Base speed of 400 pulses per second and a Jog factor of 5, then the Slow Jog Speed will be:

$$\text{Jog Speed} = 400/5 = 80 \text{ pps}$$

$$\text{Fast Jog} = 400 \text{ pps}$$

Note: Encoder and Jog input wiring should be kept separate from step motor wiring.

Once a +Jog or -Jog function has been performed, the direction register will retain the last direction of movement; that is, a subsequent Go command will be in the same direction as the last jog command.

HARD LIMITS

When a hard limit switch is encountered, the motion will stop. The position counter will also cease counting. Hard Limits are intended as an emergency stop for your system. It should not be used to do any indexing type functions - use the limit switches for this.

BAUD RATE

The Baud Rate is the transfer rate of the serial communications. This is how fast the ASCII Data is sent over the transfer lines. The number specifies the number of bits that are sent per second. With a baud rate of 9600, 9600 bits of information are sent in one second. For standard communications (like the SMC35), there is one start bit, one stop bit, and 8 data bits. This means that for every ASCII Character 10 bits are sent, so for the 9600 Baud Rate, 960 ASCII Characters will be sent every second. The Baud Rate is selected by adjusting the Baud Rate Rotary Switch (SW4 in figure 1). This switch not only determines the baud rate, but also sets the parameter RTS, for communication with your computer. Table 3.8 shows the position of the switch for the corresponding baud rates. If you are not sure if your computer uses RTS, the trial by error method works best, or you can refer to your software manual. Most IBM PC compatibles will work with either RTS ON or OFF.

BAUD RATE	SWITCH POSITION	
	RTS ON	RTS OFF
75	0	8
150	1	9
300	2	A
600	3	B
1200	4	C
2400	5	D
4800	6	E
9600	7	F

TABLE 12: BAUD RATE SWITCH

Refer to the DPF73003 Driver Manual for Driver Information.
Contact the factory if you have any questions.

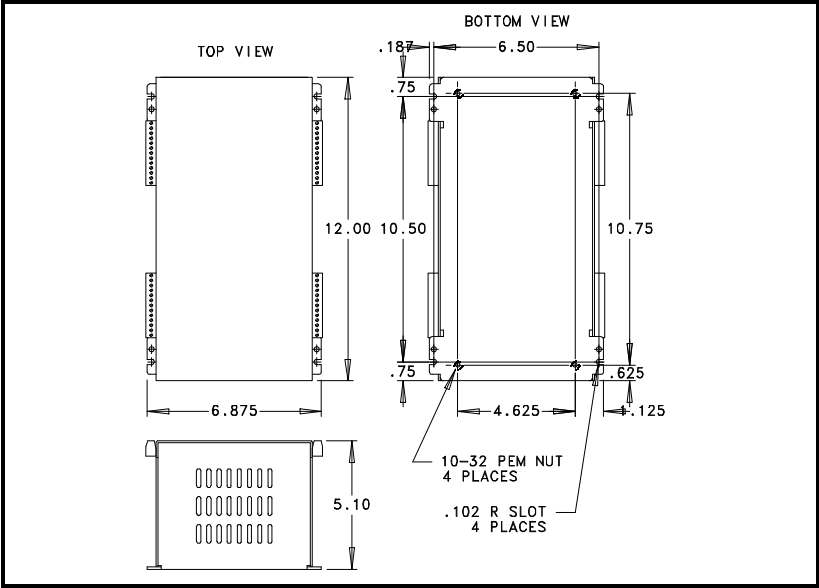


FIGURE 7: DPFEN353 DIMENSION DRAWING

PROGRAMMING

SMC35 STORED PROGRAM GENERATOR

The easiest way to program the Indexer is to use the software provided. This program is on the SMART INDEXERS DISK.

INTERNALLY STORED PROGRAMS

A stored program is a sequence of commands stored in an external EEPROM of the SMC35. The EEPROM can hold 250 bytes of code. More than one program can be stored by entering the first program byte in a buffer location following the last byte of the preceding program. Each program may be run independently by sending the Run command with that program's first byte buffer location. To stop the execution of an internal program the Period (.) command is used.

The Enter command itself uses no program buffer locations. All programs are terminated by a Quit (Q) command which uses one location. Terminators (comma, carriage return, and line feed), spaces, and illegal commands do take up any buffer location. See page 20 for a listing of the number of bytes used for each command. One buffer location is one byte.

It should be noted that any parameters stored directly will be used by a program without the need to reenter that parameter within the program. Any parameter can be changed within the program. A parameter will have the value last specified whether specified directly or by a statement executed within a program.

PROGRAMMABLE RESET

The SMC35 units have a built-in programmable reset circuit so that all axes in the daisychain may be reset. The outputs are reset to the off state when the board is reset. Reset is automatic on power-up.

COMMAND	CODE	MODE	DESCRIPTION
Acceleration	Axx	Both	set acceleration
Base Speed	Bdddd	Both	set base speed
Holding Current	CHxx	Direct	set time motor is on after index
Set Autostart	CSzz	Direct	set autostart flag at address zz
Encoder Position	CPrrrr	Direct	set encoder position
Deceleration	Dxx	Both	set deceleration
Enter Program	Ezz	Direct	enter program at address zz
Finish Move	F	Direct	finish index then continue
Go	G	Both	begin motion
Home	Hx	Both	find home position
Inputs	Ixx,yy,zz	Stored	if inputs, as defined by mask xx are equal to yy then goto zz
Jog	Jxx	Both	set jog rate factor
Loop	Lyy,zz	Stored	loop back yy times to location zz
Maximum Speed	Mdddd	Both	set maximum speed
Number of Steps	Nrrrrr	Both	set number of steps to move
Outputs	Oxx,zz	Both	output zz as defined by mask xx
Motor Position	Prrrrr	Both	set next absolute position
Quit	Q	Both	quit entering program or stop motion
Run	Rzz	Both	run stored program at address zz
Slew	S	Direct	slew motor
Trace	T	Direct	single step through the program
Until	Uxx,yy,zz	Stored	if inputs, as defined by mask xx are <u>not</u> equal to yy then goto address zz
Verify	V	Direct	verify specified data
Wait	Wxx	Both	wait for a period of time in (.01 sec increments)
Continue	X	Direct	continue internal program
Zero	Zrrrrr	Both	set position register
Select Axis	@c	Direct	select axis or axes
Clockwise	+	Both	select CW direction
Counterclockwis	-	Both	select CCW direction
Messages	%	Direct	pole axis for message
Identify Version	?	Direct	return revision and type
Stop All Motion	.	Direct	stop motion and stored program

TABLE 13: COMMAND SUMMARY

-Direct means the command is used only with a computer, or terminal.

-Stored means the command is used only in the stored program.

-Both means either the Direct or the Stored mode.

c	character	Character = 1 byte
x	0 byte	0 or 1 (HOME only) = 0 byte
xx	1 byte	0 - 255 = 1 byte
yy	1 byte	256 - 65,535 = 2 bytes
zz	1 byte	65,536 - 16,777,215 = 3 bytes
dddd	up to 2 bytes	
rrrrr	up to 3 bytes	

When using the SMC35 in the stored program mode, the user must keep track of how many bytes each command uses and the addresses of each command. When using the Anaheim Automation Smart Indexer Disk that came with the unit, byte counting is done automatically by the software. The chart below can be used to determine the byte count for each command.

NOTE: A comma is not considered as a character therefore it has 0 byte.

Number Range	Byte Count
1 - 255	1
256 - 65,535	2
65536 - 16777215	3
ASCII character	1

TABLE 14: ASCII BYTE COUNT

Examples:

A5	requires 2 bytes, 1 byte for A, 1byte for 5
M10000	requires 3 bytes, 1 byte for M, 2 bytes for 10000
G	requires 1 byte
H1	requires 1 byte

COMMAND DICTIONARY

A (2 to 127) The **ACCELERATION** command controls the time that the motor will take to move from base speed to maximum speed. The higher the value, the slower the motor will accelerate. The default value is 5.

B (50 to 3500) The **BASE SPEED** is the speed at which motion starts and stops. It is entered directly as the number of steps per second. This is also the stepping rate in the Fast Jog Mode. Not all base speeds will be possible. On the computer, if you enter "B2455", and then "VB", the SMC35 would return a speed of 2466. A verify of this parameter will return the actual base speed obtainable by the unit. The closest base speed possible is always chosen. The default value is 1000.

CH (0 to 127) The **HOLDING CURRENT ON/OFF** command sets the time that the motor will be supplied holding current after a move. The number entered is in 0.01 second increments. If the value of CH is 0 then the power is left on indefinitely. If you enter "N1000,CH115,+G" the motor will go 1000 steps, stop, and remain energized for 1.15 seconds. The default value is zero.

Note: A sufficient value for CH is needed to allow the mechanical system to stabilize - if the value is too small, errors might occur.

CP (0 to 16,777,215) The **ENCODER POSITION** command sets the encoder position to a designated value. If you enter "CP100000," the encoder position will be set to 100,000. A 400-line, quadrature encoder will count 1600 steps for every revolution the motor takes. If you then move 400 steps clockwise (one full revolution half-stepping in the clockwise direction) then enter "VCP" the new encoder position will be 101600. The Encoder Position cannot be used in the stored program mode, but can effectively be used when interfaced with a computer.

of encoder counts per step = $\frac{\text{encoder lines per rev} * 4}{400 \text{ half steps per rev}}$

CS (0 to 249) The **SET AUTOSTART** command is used to set the Autostart flag to a specified address. To Autostart a program enter the first line of the program after CS. "CS10" will autostart the program starting at line 10, and save the current contents of the program in the EEPROM.

NOTE: To autostart the program be sure that the communication switch is on **RS422**.

It is advisable to include a wait command of 100 milliseconds (W10) at the start of the Autostart program to allow everything to power up properly.

NOTE: To turn off the autostart flag, send "CS250," and the autostart flag will be inactive.

D (2 to 127) The **DECELERATION** command determines the time it takes to go from Maximum speed to Base speed. The higher the value, the slower the motor will decelerate. The default value on power up is 10.

E (0-249) The **ENTER** command allows you to enter a program to be saved in the SMC35's memory. This command sets the stored program pointer to the specified address byte, and puts the controller in the mode to enter a program. The information you type in will overwrite any previous information stored there. Typing E0 will allow you to begin entering the program at address 0. More than one program can be stored in the memory - be sure to separate the programs by the Q command. Each axis you may be using must be independently programmed. Two or more axes can communicate with each other through the 8 inputs and 8 outputs associated with each axis. The **ENTER** command can be used to edit an existing stored program by simply specifying the byte where you wish to start editing. You can exit the Enter - program mode at any time with a carriage return.

F (no value) When using a computer, the **FINISH** command is used directly after a Go command. With this command, the SMC35 will send a busy signal to the host computer until the move is complete before accepting any further inputs. The **FINISH** command is used in the direct mode only. Unless the F command is used, the computer will keep on sending data, even though the SMC35 is not ready to receive it. This data will be ignored by the SMC35, so the program will not work as expected.

G (no value) The **GO** command causes the motion to start in the direction last specified. This command will move the motor the number of steps given by the N command or to the absolute position given by the P command. This is one of three ways to start motion; the other two are the H command and the S command.

H (0 or 1) The **HOME** command starts the controller searching for Home in the direction last set. Motion will start immediately after a terminator ", " is supplied. There are two homing modes. The proper syntax is H0 or H1. The default value on power up is H0. H0 or H1 counts only as one byte. See Figure 4.

H0 causes the motor to run to the maximum speed in the last direction programmed. The motor will run until a Soft limit switch is encountered at which time the driver will decelerate to the base speed and continue to run in the same direction until a Home limit is encountered. Proper spacing is required between Soft and Home limit switches as the Home limit switch will not respond until Base speed is reached.

H1 causes the motor to run to the maximum speed until a Home limit switch is encountered. It will then decelerate to the base speed, stop, reverse direction and continue in the opposite direction until it is off the Home limit switch. Since the inputs are edge triggered, they need not be held closed until the deceleration and reversal are complete.

When a hard limit switch is encountered, all motion ends. Absolute positioning information is lost because the controller then assumes it is no longer valid.

Ixx,yy,zz (0-255,0-255,0-249) The **INPUT** command reads, "If the input pins, as defined by the mask xx, are equal to yy, then go to program location zz". The first data entered, xx, specifies the binary-weighted value of the input pins to be tested. The second data entered, yy, is the binary-weighted pattern that these selected inputs are to match. If the data and selected pins match, the program will execute the next command given by the address location specified by zz. If not equal the program will just continue on. Since the inputs are pulled up internally, they will read "high" if no signal is applied.

The mask is defined as follows:

BINARY WEIGHT	1	2	4	8	16	32	64	128
INPUT	I0	I1	I2	I3	I4	I5	I6	I7

The mask defines which inputs out of the eight bits that will be tested. For instance, the following numbers will only test these inputs.

$$255 = 1 + 2 + 4 + 8 + 16 + 32 + 64 + 128$$

$$233 = 1 + 8 + 32 + 64 + 128$$

$$98 = 2 + 32 + 64$$

$$34 = 2 + 32$$

255 masks	I0	I1	I2	I3	I4	I5	I6	I7
233 masks	I0			I3		I5	I6	I7
98 masks		I1				I5	I6	
34 masks		I1				I5		

SAMPLE STORED PROGRAM

<u>address</u>	<u>command</u>	<u>remarks</u>
0	A10	set the acceleration to 10
2	D15	set the deceleration to 15
5	N440	set the number of steps to 440
8	M10000	set the maximum speed to 10000
12	I98,34,2	loop to address 2 if the mask given by 98 is equal to 34 mask 98 = I1, I5, and I6 34 binary value: I1 = high, I5 = high, I6 = low if mask 98 is <u>not</u> equal to 34, continue
16	H0	home type 0
18	Q	quit

J(0 - 255) The **JOG FACTOR** sets the slow jog rate. The slow jog rate is the base speed divided by the jog factor. The default value on power up is 20.

Lxx,yy (0 to 255,0 to 249) The **LOOP** instruction reads "loop xx times to address yy" If x is equal to zero then the loop is endless. No nesting of loops is allowed (i.e. a loop cannot have another loop).

SAMPLE STORED PROGRAM

<u>address</u>	<u>command</u>	<u>remarks</u>
0	A10	set acceleration to 10
2	D18	set deceleration to 18
4	B500	set base speed to 500
7	M5000	set maximum speed to 5000
10	N1000	set number of step to 1000
13	+G	set the direction to CW, then index
15	W100	wait 1 second before continuing
17	L5,10	LOOP 5 times to address 10
20	H0	home type 0
21	Q	quit

M (50 to 20,000) The **MAXIMUM SPEED** is the top speed the user wants the motor to run at. The default value on power up is 10,000 pulses per second. The Maximum Speed can never be set below the Base Speed.

N (1 to 16,777,215) This specifies the **NUMBER OF STEPS** to be moved for the Go command. The default value on power up is 0.

Oxx,yy (0 to 255,0 to 255) The **OUTPUT** command reads "set the outputs defined by mask xx to the binary-weighted number specified by yy". (See INPUT command for explanation of the mask and binary-weighted numbers) Keep in mind that the inputs are active low while the outputs are active high.

EXAMPLE:

O127,7 would read as: look at output 0 to 6, turn on output 0, 1 and 2 and turn off output 3, 4, 5 and 6.

P (0 to 16,777,215) The **POSITION** command specifies the next absolute position to go to when the GO command is given. The SMC35 automatically sets the direction and number of steps needed to go to that position. The default value on power up is 0.

Q (no value) The **QUIT** command, used within a stored program, stops execution of the program. In the direct mode, the QUIT command will cause the motor to ramp down and then stop.

R (0 - 249) The **RUN** command starts a stored program execution at the address specified. This allows multiple programs to be stored in the EEPROM so that any one of them can be started individually. Each program must be terminated with the Q command. The RUN command is also used as an unconditional branch in the internal program.

If the sample stored program below is already in the SMC35's EEPROM, the program can be started by typing "R20". The R20 at address 31 is an unconditional branch.

SAMPLE STORED PROGRAM

<u>Address</u>	<u>Command</u>	<u>Remarks</u>
20	A5	Set acceleration to 5
22	B100	Set base speed to 100
24	M5000	Set Maximum Speed to 5000
27	I1,1,33	If INPUT #0 is high then go to address 33
31	R20	Goto to address 20
33	N3320	Set number of steps to 3320
36	G	Start Indexing
37	Q	End program

S (no value) The **SLEW** command will accelerate the motor up to maximum speed and continue to run at that speed until reaching a hard limit switch or receiving a quit (Q) command.

T (no value) The **TRACE** command will allow you to single-step through the stored program one step at a time. Each time a 'T' is entered, the next command of the program will be executed. In order to specify the initial program address location, the program pointer can be set with the Enter (E) command, followed immediately by a carriage return.

Uxx,yy,zz (0 - 255,0 - 255,0 - 249) The **UNTIL** command reads "Until the input pins represented by the mask xx are equal the value yy, branch to location zz."

This command is opposite of the Input command (see p. 16).

SAMPLE STORED PROGRAM

address	command	remarks
0	B500	set base speed to 500
3	M20000	set maximum speed to 20000
6	N2300	set number of steps to 2300
9	G	index 2300 steps in the last direction used
10	W210	wait 2.10 seconds
12	U254,49,9	loop to address 9 until the input mask 254 equals 49
16	H1	home type 1
17	Q	quit

V (appropriate code) **VERIFY** causes the SMC35 to send data back to whatever it is communicating with. The data is sent as an ASCII decimal string followed by a carriage return and a line feed. If a verify Enter command (VE) is sent the SMC35 returns the entire internal stored program. No more than one axis at a time can be addressed with this command, or they would contend for the bus. The permissible verify commands are shown below.

W (0 - 255) In the stored program mode, the **WAIT** command pauses the program for the specified number of 0.01 seconds.

SAMPLE INTERNAL STORED PROGRAM

address	command	remarks
0	N4000	set number of steps to 4000
3	+G	set the direction to clockwise, and index
5	W150	WAIT for 1.5 seconds before continuing
7	-G	set the direction to counterclockwise, and index
9	Q	quit

X (no value) The **CONTINUE** command will continue the stored program from the address where the stored program was stopped.

Z (0 to 16,777,215) The **ZERO POSITION** command sets the position register to a designated value. The number following the (Z) will be the new absolute position of the motor. The default value is 0.

SAMPLE BASIC PROGRAM

```
10 OPEN "COM1:9600,N,8,1,CS65535,DS,CD" AS #1
20 PRINT#1,"@0,A10,D10,B500,M5000,-H1F,Z1000,P4000,GF,"
```

VA	Acceleration
VB	Base Speed
VCP	Encoder Position
VD	Deceleration
VE	Internal Program
VG	Step remaining in current move
VH	Hold Time
VI	Input Terminals
VJ	Slow Jog Divisor
VM	Maximum Speed
VN	Number of Steps to Index
VO	Output Terminals
VP	Position
VR	Internal Program Pointer
VW	Ticks remaining in Wait counter

TABLE 14: VERIFY COMMANDS

@ (0 to 9 and A to V) The **SELECT AXIS** command will designate an axis or axes. Any or all devices can be addressed simultaneously to receive commands from the SMC35. However, only the most recently selected controller will send data to the host (such as during a Verify). This is necessary to prevent contention on the bus. The list of characters must be terminated by a comma. If just the @ command is sent with no axes addresses, then all axes are deselected. The axes 0 to 9, and A to V represent 32 possible axes that can be selected all at one time or any combination of them.

+ (no value) Set motor direction to clockwise (CW).

- (no value) Set motor direction to counterclockwise (CCW).

% (no value) POLL the device for any waiting messages such as errors or end of move. The responses are defined in Table 15. As in the Verify command, only one axis at a time may be addressed with this command. The POLL command is especially useful in debugging a program.

#	DESCRIPTION
0	Normal
1	Command error, illegal command sent
2	Range error, an out of range number was sent
3	Command invalid while moving
4	Command only valid in stored program
5	End of move notice, previous Go command complete
6	End of wait notice, a previous Wait command is
7	Hard limit stop, move was stopped by hard limit
8	End of program notice, internal program completed
G	Motor is moving and no other notice pending

TABLE 15: RESPONSES TO POLL COMMAND (ERRORS AND MESSAGES)

? (no value) This command returns two numbers. The first number is the part identifier which is always 35 (for the SMC35 controller IC). The second number is the revision number. A quick test to see if you are communicating with the SMC35 is to use this command.

. (no value) If a period is received, the motor will stop, the timer will be cleared and the internal program will stop. It is possible for this command to stop execution of the internal program in the middle of an instruction, causing the parameter for that instruction to be read incorrectly. For this reason, the period command is only intended as a debugging tool.

TROUBLESHOOTING

My computer won't talk to the SMC35.

To use a computer to communicate to the SMC35, you must use a communications program such as Crosstalk, or a programming language such as BASIC, or C language. The communication parameters must be set up correctly for 8 Data Bits, No Parity Bits, and 1 Stop Bit. The Baud Rate can be set up for rates between 75 Hz to 9600 (75, 150, 300, 600, 1200, 2400, 4800, 9600). **Check the Baud Rate setting on the yellow and black rotary switch on the side of the unit.** This setting must match to the baud rate you specified (see Table 12). The Request To Send (RTS) signal is supported by some software and not others. Refer to the software manual to see what you need, or just use trial and error - it will not damage anything. Generally use RTS on, or the first 8 positions of the dip switch. Once the communications are set up you finally need to talk to the SMC35. This is done by selecting the axis you want to talk to. **Position the Axis Select for the desired axis number for your unit.** If you chose axis 0 for example, the rotary dip switch would be pointing to 0. To communicate to this axis, type a period, the @ sign, the axis number, a comma, and a question mark. (.@0,?) The SMC35 should then return two numbers to your screen - first the number 35, and then the revision number of the chip. Now you are communicating.

The unit will not Autostart.

Be sure the that the communication switch is set to RS422.

NOTE: Axis F will not autostart.

Motor is stalling.

Check the kick current pot setting on the driver, be sure it is set to motor's current rating. Check the wiring of the motor to the driver (Miswiring can damage the driver). Different step motors have different performance, some may be able to start faster than others if your motor is stalling at start or during ramping lower the base and max speed and increase the acceleration time (B500, M1000 and A10 are settings that should be good for testing most motors).

There is no power to the unit.

If the fan of the DPF73353 is not on, check the fuse in the fuse tray in the power connector terminal (use 5 amp slow blow fuse only). If the fuse continues to blow call factory for assistance.

GLOSSARY

Absolute Mode A positioning coordinate reference wherein all positions are specified relative to some reference, or "home" position. This is different from relative, or incremental programming, where distances are specified relative to the current position.

Baud Rate A term used frequently in serial data communications but often is misunderstood. A 'baud' is defined as the reciprocal of the shortest pulse duration in a data word (signal), including start, stop, and parity bits. This is often taken to mean the same as "bits per second", a term that expresses only the number of 'data' bits per second. Very often, the parity bit is included as an information or data bit.

Break Signal A break is often used to signal a remote computer to stop transmission. Typically a Break Signal is produced by holding the data terminal equipment (DTE) transmit data (TXD) low for some time significantly longer than the time it takes to send a word.

See Section 4.A.3. for an implementation on the IBM PC.

Daisychain A term used to describe the linking of several RS422/RS232C devices in a sequence such that a single data stream flows through one device and on to the next. Daisy-chained devices usually are distinguished by device addresses, which serve to indicate the desired destination for data in the stream.

Debug A term used to define refinements to a system or program that remove undesirable effects.

EEPROM Electrically Erasable Programmable Read-Only Memory. A memory device frequently used with microprocessors, that can be erased and reprogrammed without removing it from the circuit. This creates non-volatile memory; i.e. memory that won't be lost if the power is turned off.

Hard Limit Switch A switch (i.e. photo, Hall-effect or mechanical) that defines the absolute limit of motion in a particular direction. It may be used to prevent collisions or out-of-bounds conditions.

Home A reference position in a motion control system, usually derived from a mechanical datum. Often designated as the "zero" position.

Home Limit Switch The switch used to establish the reference position designated "home".

Program Counter The Program Counter is used by the processor to point to the address of the next instruction to be executed by the processor in the stored program mode.

Mask A binary-weighted number that conceals some or all of the bits in an associated memory address or register.

Relative Mode A coordinate system where positions or distances are specified relative to the current position.

Stack A register or buffer in memory that uses Last-In-First-Out (LIFO) entry and retrieval of data.

Soft Limit Switch This switch is used exclusively in Homing Mode 0 (zero).

If positioned properly for the appropriate parameters, it causes the motor to ramp down to the Base Speed before encountering the Home Limit Switch. This ensures that the motor speed is within the start-stop region.

Start-Stop Region That range of speeds in which a step motor can start, stop, or reverse direction in synchronism with the external pulse signal.