PCL-839+

3-Axis Stepping Motor Control Card

User Manual

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Acknowledgements

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Product Warranty (2 years)

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This warranty does not apply to any products which have been repaired or altered by persons other than repair personnel authorized by Advantech, or which have been subject to misuse, abuse, accident or improper installation. Advantech assumes no liability under the terms of this warranty as a consequence of such events.

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5. Write the RMA number visibly on the outside of the package and ship it prepaid to your dealer.

CE

This product has passed the CE test for environmental specifications when shielded cables are used for external wiring. We recommend the use of shielded cables. This kind of cable is available from Advantech. Please contact your local supplier for ordering information.

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Step 1. Visit the Advantech web site at **www.advantech.com/support** where you can find the latest information about the product.

Step 2. Contact your distributor, sales representative, or Advantech's customer service center for technical support if you need additional assistance. Please have the following information ready before you call:
- Product name and serial number
- Description of your peripheral attachments
- Description of your software (operating system, version, application software, etc.)
- A complete description of the problem
- The exact wording of any error messages

Packing List

Before setting up the system, check that the items listed below are included and in good condition. If any item does not accord with the table, please contact your dealer immediately.

The IPPC-9170 Series industrial panel PCs include the following models:

1. PCL-839+ card
2. Companion CD-ROM (DOS and DLL driver included)
3. User Manual

Contents

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CHAPTER 1

General Information

If you have just purchased the PCL-839+, or just need to brush up on its features or specifications, you would want to read this chapter.

Sections include:

- Introduction
- Features
- Applications
- Specifications
- Block Diagram

Chapter 1 General Information

1.1 Introduction

The PCL-839+ is a high-speed three-axis stepping motor control card that simplifies stepping motor control, giving you added performance from your stepping motors.

Three-Axis Control

The PCL-839+ has one single-chip pulse generator on-board, which enables the simultaneous and independent control of three axes. The PCL-839+ provides digital pulse and directional control (+ and -) for each stepping motor axis.

User-Friendly Interface

The PCL-839+ has been designed to act as a user-friendly solution for your stepping motor control applications. Programming the PCL-839+ is very easy. 'C' Libraries are provided and they contain all the command functions needed for total control of your stepping motors.

Stand-Alone Interpreter

A stand-alone, non-resident command interpreter, PROGg39.EXE, can also be used to control your stepping motors without any programming.

Digital I/O

The PCL-839+ features 16 digital inputs and 16 digital outputs for general I/O use (on/off control etc.).

Isolation Protection

The PCL-839+'s PULSE and DIRECTION outputs and five limits input switches are isolated from the PC side.

1.2 Features

- One on-board pulse generator that enables simultaneous independent control of three stepping motors
- Two operating modes - two-pulse (+ and - direction pulse) or one-pulse (pulse-direction) mode
- Programmable step rate from 1 to 16382 pps (pulses per second).
- Programmable initial speed, final speed and time duration. Automatic trapezoidal acceleration/deceleration tamping is performed

16 I/O TTL Compatible Channels

- All inputs/outputs are optically isolated, providing 5000Vrms isolation protection
- 'C' libraries containing device drivers provided
- Command Interpreter provided that eases learning the PCL-839+ command set

1.3 Applications

- Precise X-Y-Z position control
- Precise rotation control
- Robotics and assembly equipment
- Other stepping-motor applications

1.4 Specifications

- Number of axes: Three independent axes (individually programmable)
- Operating modes: Two-pulse mode (+ or – direction) or one-pulse (pulse-direction) mode
- Steps per command: ±16777215 steps
- Step Rate: 1-200K
- Acceleration/deceleration ramping: User programmable start, run and ramping rates.
- Output polarity: Positive/negative going pulse (programmable)
- Pull-up voltage: external +5 V ~ +12 V
- Output protection: Opto-coupled with 1 kΩ pull-up resistor
- Output driving capacity: 20mA @ 0.4VDC
- Limit switch inputs: 2 "Emergency stop" inputs, 2 "Slow down/Accelerate" inputs and 1 "ORG" input. All limits switches are isolated from the PC.
- Limit switch input voltage: external +5V to +12V
- Interrupt channels: IRQ 2, 4, 5, 7, 10, 11, 12 or 15 (jumper selectable)
- Limit switch types: Normal –open (NO) or normal-closed (NC) – jumper selectable

1.4.1 Digital Input / Output

- Input channels: sixteen (+5V TTL compatible)
- Output channels: sixteen (+5V TTL compatible)
- I/O address range: sixteen consecutive I/O address

1.4.2 General

- Power Consumption: Typical 330mA, +5VDC
- Connector: 37-pin D-type connector
- Board Dimensions: 183.5 x 99.06 mm
- Operating Temperature: 0 ~70° C

1.5 Block Diagram

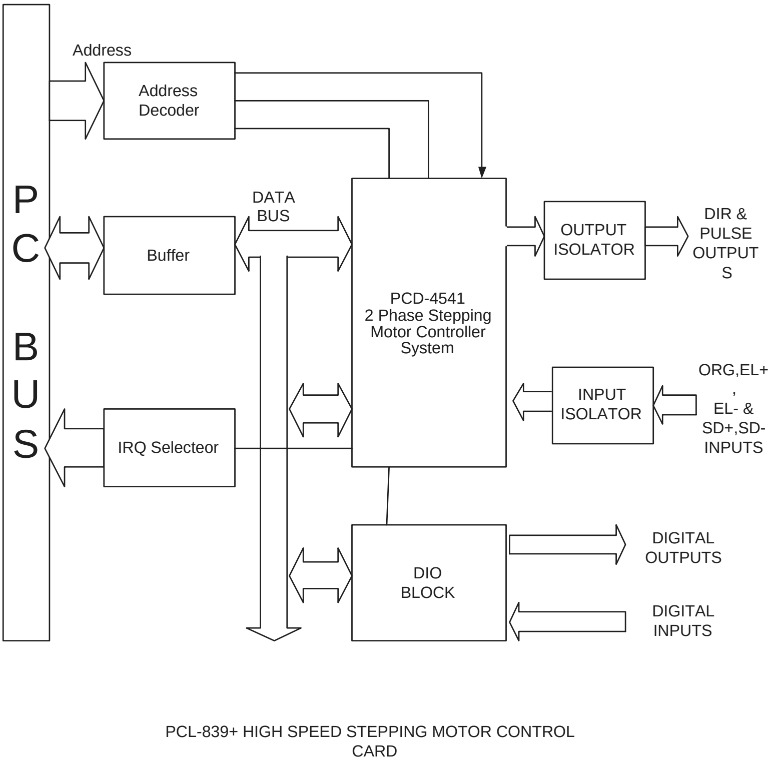

Figure 1.1: PCL-839+ 3-Axis Stepping Motor Control Card

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CHAPTER 2

Installation

If you have not yet configured and/or installed your PCL-839+, or need to change the configuration (e.g. set a different base address), this chapter will give you the information you require.

Sections include:

- Switch and Jumper Settings
- Limit Switch Configuration
- Limit Switch Polarity Setting
- Hardware Installation
- PCL-839+ Pin Connections

Chapter 2 Installation

2.1 Switch and Jumper Settings

Before you install the PCL-839+, you need to select the card's base address, and set the limit switch configurations as well as the interrupt level that the card will use. This section describes this procedure in detail.

2.1.1 Setting the PCL-839 Base I/O address (S1)

The PCL-839+ requires 16 consecutive I/O addresses. DIP switch S1 (shown below) sets the base I/O address.

Choose a base address that is not in use by any other I/O device. A conflict with another device may cause one or both devices to fail. The factory address setting (hex 300) is usually free as it is reserved for PC prototype boards.

Switch settings for various base addresses appear below:

Table 2.1: Card I/O addresses (S1)

Range (hex)	Switch position					
	9	8	7	6	5	4 <=Addr. Line
200 - 20F	OFF	ON	ON	ON	ON	ON
210 - 21F	OFF	ON	ON	ON	ON	OFF
:						
*300 - 30F	OFF	OFF	ON	ON	ON	ON
:						
3F0 – 3FF	OFF	OFF	OFF	OFF	OFF	OFF
* = default						

Switches 1-6 control the PC bus address lines as follows:

SWITCH	1	2	3	4	5	6
Line	A9	A8	A7	A6	A5	A4

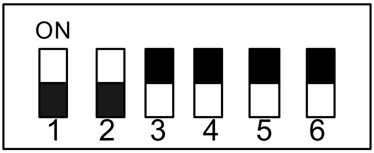


Figure 2.1: S1 - Base Address Setting

2.2 Limit Switch Configuration (JP1, JP2, JP3)

The PCL-839+ features 5 limit switches for additional control of the output.

2.2.1 EL+/ EL-

These are the End Limit signal inputs. When the signal of the same direction as the pulse output (in direction or pulse mode) becomes active, pulse output stops immediately.

2.2.2 SD+/SD-

These are the Slow-Down signal inputs. They are in operation in the SD-enable mode (refer to the control select modes). When the signal of the same direction as the pulse output (in direction or pulse mode) becomes active during high-speed start, the frequency ramps down. When the signal becomes inactive, the frequency ramps up again.

2.2.3 ORG

This is the Origin point input. When this signal becomes active during origin return (refer to the control select modes), pulse output stops immediately.

Although the PCL-839+ caters to five limit switches, not all of them have to be operation in one application. Refer to Fig 2.2 (on the next page) for an example of the use of limit switches.

2.3 Limit Switch Polarity Setting

JP1, JP2 and JP3 set the polarity for channels C, B and A respectively. When the jumper is set to LO (normal), the limit switch uses 'normally open' as default. When the jumper is set to HI, the limit switch uses' normally closed' as default.

2.3.1 JP1, JP2 and JPJ Selection

HI	**Normally Closed**
LO	**Normally Open**

The figures on below illustrate limit switch use and settings.

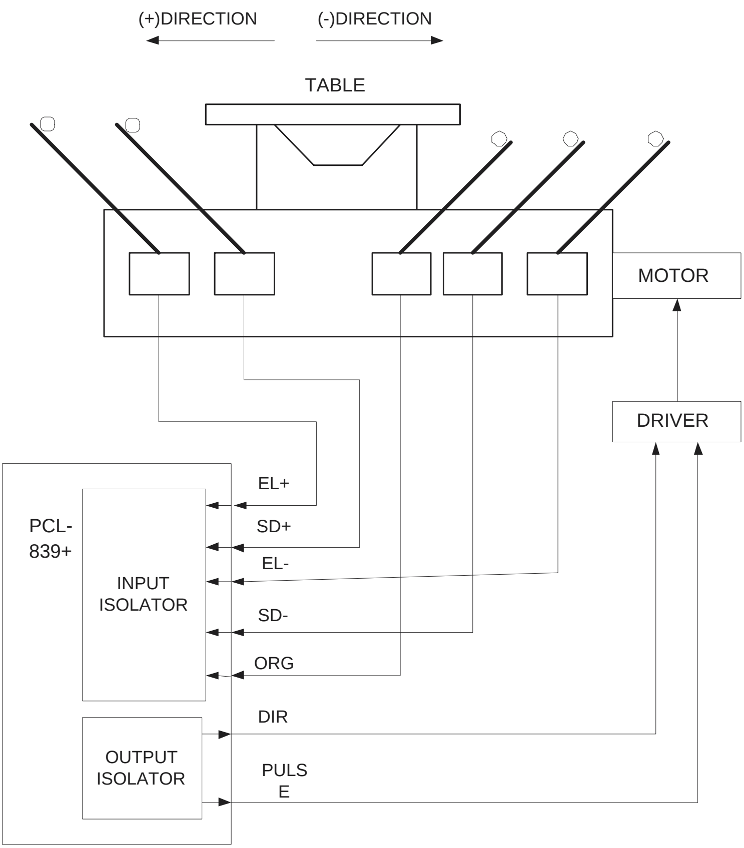
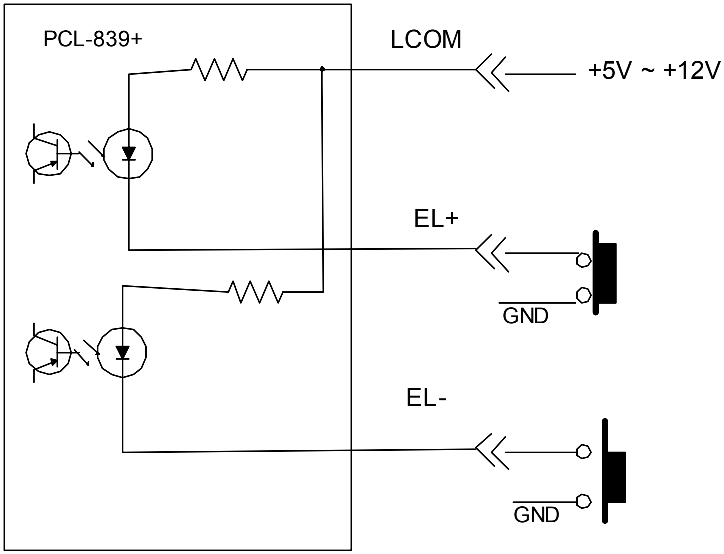
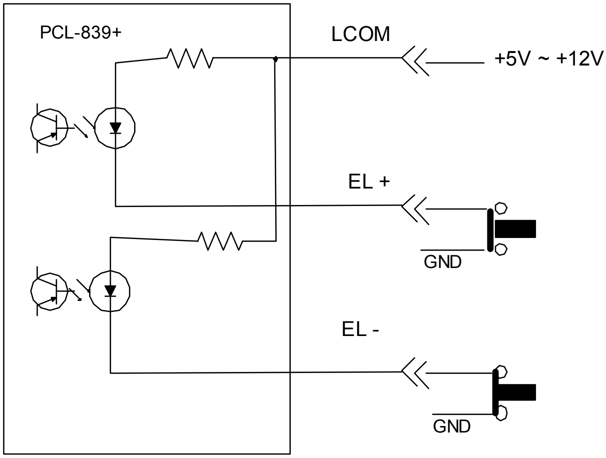


Figure 2.2: Using Limit Switches (1)



Limit switch is -- normal open type
Limit switch polarity jumper (JP1,2,3) must be put to -- LO position

Figure 2.3: Normally-Open Wiring



Limit switch is -- normal close type
Limit switch polarity jumper (JP1,2,3) must be put to -- HI position

Figure 2.4: Normally-Closed Wiring

2.3.2 Interrupt Level Selection (JP4)

You have to set jumper JP4 to select the card's interrupt level (2, 4, 5, 7, 10, 11, 12 or 15), as shown below:

Card interrupt (default = 7)

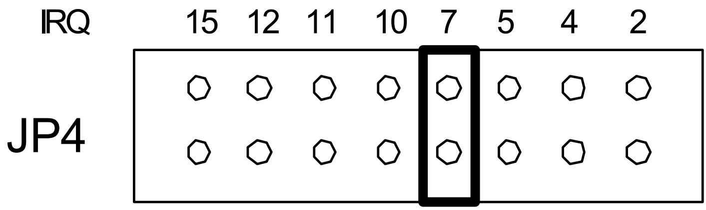


Figure 2.5: Setting the Interrupt Level

Do not select a level that is being used by another device unless you have performed special programming to share several devices on one interrupt. You can also control interrupt generation by software. If the interrupt is enabled by software, and the PCL-839+ completes a motion, it will generate an interrupt. Your program can then determine which channel caused the interrupt by reading the status register.

2.4 Hardware Installation

After you have set the base address, limit-switch configuration and the interrupt level (as described in the previous section), you are ready to install the card in your PC's chassis. The following section will assist you in installing the PCL-839+.

Warning! *Disconnect power from your PC whenever you install or remove the PCL-839+ or its cables*

2.4.1 Installing the Card in Your Computer:

- Turn off the computer and all peripheral devices (such as printers and monitors).
- Disconnect the power cord and any other cables from the back of the computer. Turn the chassis so that the back of the unit faces you.
- Remove the chassis cover. (See your computer user manual if necessary).
- Locate the expansion slots at the rear of the unit and choose an unused slot.
- Remove the screw that secures the expansion slot cover to the chassis. Save the screw to secure the PCL-839+.
- Carefully grasp the upper edge of the PCL-839+ card+. Align the hole in the retaining bracket with the hole on top of the expansion slot, and align the gold striped edge connector with the expansion slot socket. Press the board firmly into the socket.
- Replace the screw in the expansion slot-retaining bracket.
- Replace the chassis cover.
- Connect the D-37 male connector to the PCL-839+'s 37-pin female connector Connect the connector to your stepping motor driver according to the specifications outlined in Section 3.1.
- Connect the cables you removed in step 2. Turn on the computer.

Hardware installation is now complete.

2.5 PCL-839+ Pin Connections

This section assists with connecting the PCL-839+'s 37-pin connector (located at CN3) to a variety of stepping motor drivers.

The following diagrams give the PCL-839+'s pin connector assignments, and offer some examples of input/output circuit connections from the card to the driver. You should select the example that best supports your application needs and the capabilities of your stepping motor driver.

Note: Output circuit diagrams of the stepping motor can be found in Appendix A.

2.5.1 The 37-pin Female Connector (CN3)

Signal	Pin	Pin	Signal
DIR/-dir (CHA)	1	20	PULSE/+dir (CHA)
EXT.VCC (CHA)	2	21	COM (CHA)
NC	3	22	NC
DIR/-dir (CHB)	4	23	PULSE/+dir (CHB)
EXT.VCC (CHB)	5	24	COM (CHB)
NC	6	25	NC
DIR/-dir (CHC)	7	26	PULSE/+dir (CHC)
EXT.VCC (CHC)	8	27	COM (CHC)
NC	9	28	EL+ (CHA)
EL- (CHA)	10	29	SD+ (CHA)
SD- (CHA)	11	30	ORG (CHA)
LCOM (CHA)	12	31	NC
EL+ (CHB)	13	32	EL- (CHB)
SD+ (CHB)	14	33	SD- (CHB)
ORG (CHB)	15	34	LCOM (CHB)
NC	16	35	EL+ (CHC)
EL- (CHC)	17	36	SD+ (CHC)
SD- (CHC)	18	37	ORG (CHC)
LCOM (CHC)	19		

DIR/-dir: Direction signal output (in direction mode) or (-) direction pulse output (in pulse mode)

PULSE/+dir: Pulse signal output (in direction mode) or (+)direction pulse output (in pulse mode)

EXTVCC: External power input

COM : Isolated outputs common point for each channel

EL+ : (+) Direction emergency stop limit switch input

EL- : (-) Direction emergency stop limit switch input

SD+ : (+) Direction slowdown limit switch input

SD- : (-) Direction slowdown limit switch input

ORG : Original (home) point limit switch input

LCOM : Limit switch common point for each channel

2.5.2 Example Input / Output Circuit Connections

The figure below illustrates an isolated output connection from the PCL-839+ to the stepping motor driver.

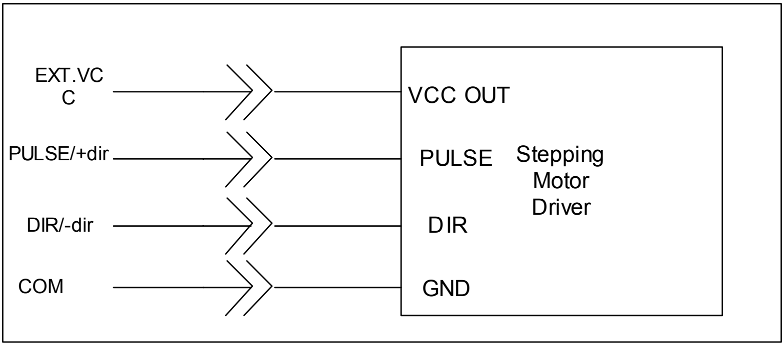


Figure 2.6: Isolated Output Connection

The next figure illustrates a non-isolated connection where the PC's +12 V output bias is used.

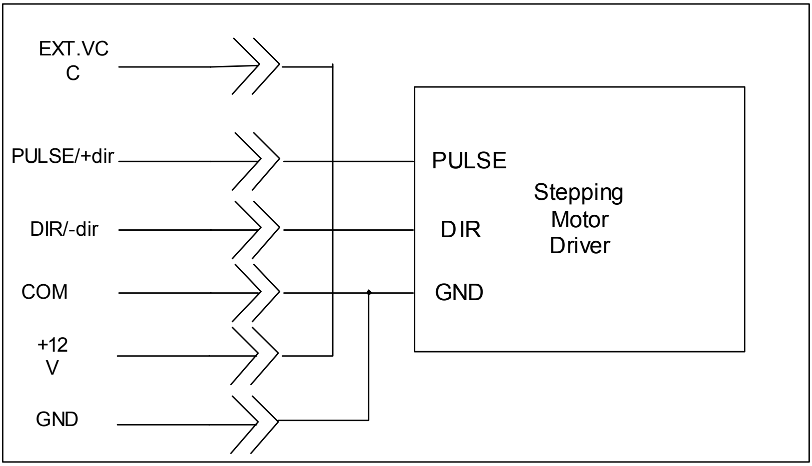


Figure 2.7: Non-Isolated 12 V Bias Connection

The next two figures illustrate a TTL compatible output circuit connection and a current-drive output connection between the PCL-839+ and the stepping motor driver.

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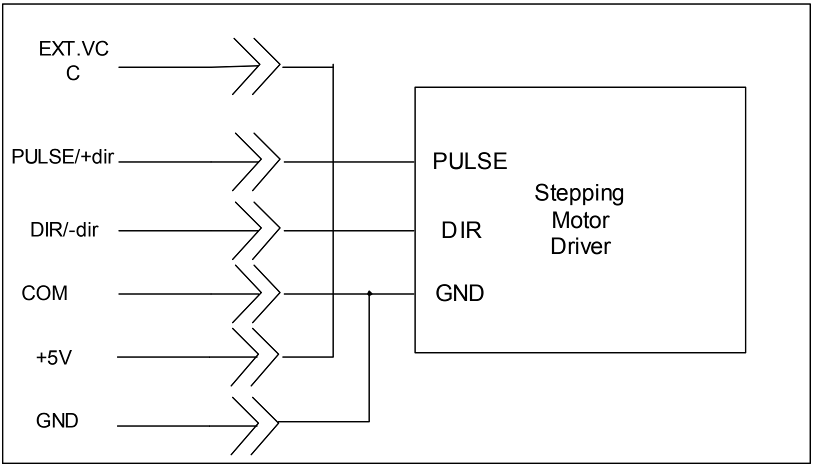

Figure 2.8: TTL Compatible Output Connection

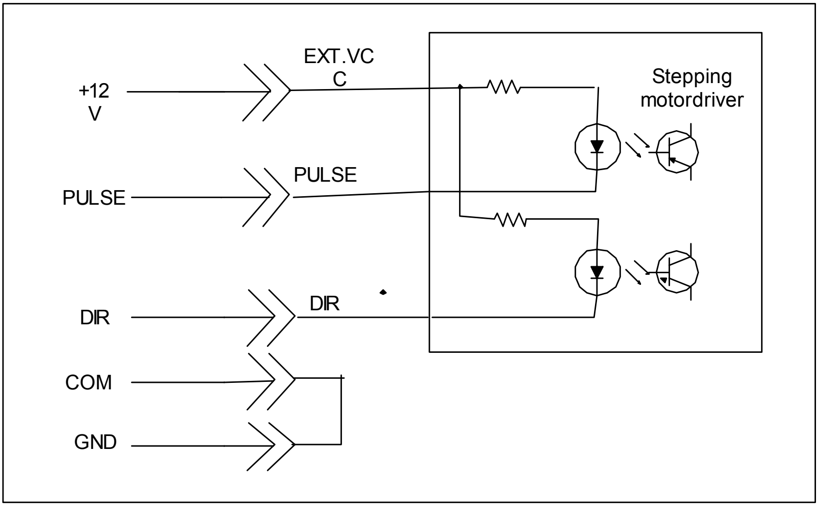

Figure 2.9: Current Driver Output Connection

2.5.3 Digital Input and Output Connectors (CN1, CN2)

The PCL-839+ provides two 20-pin digital input and output connectors, located at CNI (digital output) and CN2 (digital input). A variety of daughter-boards can be connected to these connectors. The PCLD-782B Isolated D/I board, the PCLD-785B Relay Output Board and the PCLD-786 SSR & Relay Driver Board are just three examples. The pin assignments for these connectors are given below.

D/O 0	1	2	D/O 1
D/O 2	3	4	D/O 3
D/O 4	5	6	D/O 5
D/O 6	7	8	D/O 7
D/O 8	9	10	D/O 9
D/O 10	11	12	D/O 11
D/O 12	13	14	D/O 13
D/O 14	15	16	D/O 15
GND	17	18	GND
+5V	19	20	+12 V

Figure 2.10: CN1 (Digital Output)

D/I0	1	2	D/I1
D/I2	3	4	D/I3
D/I4	5	6	D/I5
D/I6	7	8	D/I7
D/I8	9	10	D/I9
D/I10	11	12	D/I11
D/I12	13	14	D/I13
D/I14	15	16	D/I15
GND	17	18	GND
+5V	19	20	+12 V

Figure 2.11: CN2 (Digital Input)

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CHAPTER 3

PCL-839+ Software Library

This chapter describes the 'C' libraries and the functions they contain. If you want to write your own applications in 'C', this chapter will give you all the information you need.

Sections include:

- Introduction
- The PCL839P.H Header File
- The PCL839Px.Lib Library file
- Function Call Descriptions

Chapter 3 PCL-839+ Software Library

3.1 Introduction

On the floppy disk that came with your PCL-839+ card, there are 'C' library files. These libraries were developed in 'Turbo C', and you should be able to develop your own stepping motor applications (in 'C') using these files. The source code for the programming library ('LIB839P.C') can also be found on the floppy disk. This enables you to recompile the libraries for any 'C' compiler (although some minor changes may be necessary).

The following sections describe the files and functions that will assist you when you write applications for the PCL-839+.

3.2 The PCL839P.H Header File

To be able to use the functions contained in the software library, you have to include this header file in your source program (#include "PCL839P.H"). This file contains the headers (Prototypes) for all the functions defined in PCL839Px.LIB.

PCL839P.H contains the following:

```
int base = 0x300 ; /* base address , default = 0x300 */
int run_mode[3] ;
int run_comd[3] ;
int pulse_dir[3] ;
int P0 = 0 ;       /* DIO port #0 (8-bit) */
int P1 = 1 ;       /* DIO port #1 (8-bit) */
int P01 = 2 ;      /* DIO port #0 & #1 */
int CH1 = 1 ;      /* Channel #1 */
int CH2 = 2 ;      /* Channel #2 */
int CH3 = 3 ;      /* Channel #3 */
int CH12 = 4 ;     /* Channel #1 & #2 */
```

```
int CH13 = 5 ;     /* Channel #1 & #3 */
int CH23 = 6 ;     /* Channel #2 & #3 */
int CH123 = 7 ;    /* Channel #1,#2 and #3 */
int P_DIR = 0 ;    /* Positive (+) dirction */
int N_DIR = 1 ;    /* Negative (-) direction */
int FL = 0 ;       /* FL speed */
int FH = 1 ;       /* FH speed */
int DIR = 0 ;      /* Direction mode */
int PUS = 1 ;      /* Pulse mode */

int out_port(int port_no , int value);
int in_port(int port_no);
int set_base(int b);
int set_mode(int ch , int mode);
int set_speed(int ch , long r1 , long r2 , long r4);
int status(int ch);
int stop(int ch);
int sldn_stop(int ch);
int waitrdy(int ch);
int slowdown(int ch);
int arc(int plan_ch , int dirc , long x1 , long y1 , long x2 , long y2 ) ;
int line(int plan_ch , int dx , int dy );
int org(int ch , int dir1 , int speed1 ,
               int dir2 , int speed2 ,
               int dir3 , int speed3 );
int cmove(int ch , int dir1 , int speed1 ,
                 int dir2 , int speed2 ,
                 int dir3 , int speed3 );
int pmove(int ch , int dir1 , int speed1 , long step1 ,
                 int dir2 , int speed2 , long step2 ,
                 int dir3 , int speed3 , long step3 );
```

```
/* NOTE :  port_no = 0 , 1 , 2
           ch     = 1 , 2 , 3 , 4 , 5 , 6 , 7  beside
                      function status_ch(ch) that ch = 1 , 2 , 3
           dirc   = 0 : CW direction
                      1 : CCW direction
           plan_ch = CH12 , CH13 or CH23
           dir    = 0 , 1
           speed  = 0 , 1
           mode   = 0 , 1
*/
```

3.3 The PCL839Px.LIB Library file

Four library files have been included with the software. Although all these libraries contain the same functions, they have been compiled for different memory models:

PCL839PS.LIB 'Small model' library

PCL839PM.LIB 'Medium model' library

PCL839PC.LIB 'Compact model' library

PCL839PL.LIB 'Large model' library.

If you are using 'Turbo C' - one of the above libraries have to be included in the 'C' project-file that you are working on.

3.4 Function Call Descriptions

This section gives a detailed description of the functions available in the library files.

There are 15 functions in the PCL839 library. They are the following:

3.4.1 Function 1: set base

This function sets the base address of the PCL-839+. This enables the use of multiple PCL839s, if you require doing so.

Prototype:

int set_base(int BASE)

Parameters:

BASE: base address of PCL839 card

Return values:

0: No error occurred when setting the base address

-1: An error occurred when setting the base address

Example(s):

int error_code = set_base(0x2C0);

3.4.2 Function 2: set mode

This function sets the output mode for a channel, or a group of channels.

Prototype:

int set_mode (int ch, int mode);

Parameters:

channel:	channel number

1 for channel 1

2 for channel 2

3 for channel 3

4 for channels 1 & 2

5 for channels 1 & 3

6 for channels 2 & 3

7 for channels 1, 2 & 3

mode:	0 for Direction (one-pulse) mode

1 for Pulse (two-pulse) mode

Return values:

0: No error occurred

1: An error occurred

Example(s):

error_code = set_mode(CH4, DIR);

error_code = set_mode(CH3, PUS);

Channel 1 and 2 are set to direction mode, and channel 3 is set to pulse mode.

3.4.3 Function 3: set_speed

This function sets the low-speed pulse output frequency, high-speed pulse output frequency and acceleration/deceleration rate for a channel.

Prototype:

int set_speed(int ch, int FL, int FH, int AD);

Parameters:

ch	channel number	(See Function 2).
FL	Low-speed frequency1 - 16382 pps.	
FH	High-speed frequency1 - 16382 pps.	
AD	Acceleration/deceleration Rate2 – 1023	

Return values:

0: No error occurred

1: An error occurred

Example(s):

error_code = set_speed (CH123, 400, 3000, 500);

Channels 1, 2 and 3% FL are set to 400 pps, FH is set to 3000 pps and AD is set to 500 pps2.

3.4.4 Function 4: status

This function reads and returns the status of a channel.

Prototype:

int status(int ch);

Parameters:

ch   channel number

1 - channel 1

2 - channel 2

3 - channel 3

Return values:

-1: An error occurred

Other: The high byte will contain the value of 'Status 1' and the low byte the value of 'Status 0'.

Example(s):

```
int channel_status;
channel_status = status (CH1);
```

3.4.5 Function 5: stop

This function stops channel ch.

Prototype:

int stop(int ch);

Parameters:

ch	channel number	(See Function 2).

Return values:

0: No error occurred

1: An error occurred

Example(s):

```
int error_code;
error_code = stop(CH123) ;
```

Channels 1, 2 and 3 are stopped.

3.4.6 Function 6: slowdown

This function ramps the output frequency of channel(s) ch down to FL.

Prototype:

int slowdown (int ch)

Parameters:

ch channel number (See Function 2).

Return values:

0: No error occurred

-1: An error occurred

Example(s):

int error_code = slowdown(CH23) ;

Channel 2 and 3's speed is ramped down to FL.

3.4.7 Function 7: sldn_stop

This function ramps the output frequency of channel(s) ch down to FL.

Prototype:

int sldn_stop(int ch);

Parameters:

ch channel number (See Function 2).

Return values:

0: No error occurred

-l: An error occurred

Example(s):

error_code = sldn_stop(CH 12);

Channels t and 2's are ramped down to FL, and then stopped.

3.4.8 Function 8: waitrdy

This function checks the 'Stares0' of channel(s) ch and waits until bit 6 of 'Status0' is 0

Prototype:

int waitrdy (int ch)

Parameters:

ch   channel number   (See Function 2).

Return values:

0: No error occurred

-1: An error occurred

Example(s):

error_code = waitrdy (CH12);

A delay is caused until channels 1 and 2's 'Status0' is 0.

3.4.9 Function 9: out_port

This function outputs a value to the assigned port .

Prototype:

int out_port(int port_no, int value) ;

Parameters:

port_no: digital output port number

0 for port 0 (DO7-0)

1 for port 1 (DO15-8)

2 for ports 0 & 1

If port_no was set as "2" (output to both ports), the high-byte of the word will be output to port 1, and the low-byte of the word to port 0.

Return values:

0 ~ No error occurred

-1' An error occurred

Example(s):

error_code : outport(PO, 0XAA) ; /* 0XAA to port O */

error_code = out~ort(P01,0X55AA) ; /'* 0X55 to port 1 and 0XAA to port 0 */

3.4.10 Function 10: in_port

This function reads and returns the value of a digital input port.

Prototype:

int in_port (int port_no) ;

Parameters:

port_no: D/I port number

0 for port 0 (DI7-0)

1 for port 1 (DI15-8)

2 for ports 0 & 1

If port_no was set as "2" (input from both ports), the high-byte of the returned value will contain the value of port 1, and the low-byte the value of port 0.

Return values:

-1: Aah error occurred

Other: Port Value

Example(s):

port_value = in_port (PO) ;

port_value = in. oft (P01) ;

3.4.11 Function 11: org

This function returns all three channels to the 'ORIGIN' point. The direction and speed (frequency) that each channel has to use are supplied.

Prototype:

```
int  org(int ch,    int DiR1, int  SPEED1,
             int DIR2, int SPEED2,
             int DIR3, int SPEED3) ;
```

Parameters:

ch	channel number	(See Function 2).
DIRn	channel n direction	0 = (+) and I = (-)
SPEEDn	channel n frequency	0 =- FL and 1 = FH

Return values:

0: No error occurred

-1: An error occurred

Example(s):

error_code = org (CH12, P_DIR, FL, N_DIR, FH, 0, 0),

Channels 1 and 2 are returned to origin point - channel 1 pulses at FL frequency in the (+) direction, and channel 2 pulses at FH frequency in the (-) direction. Channel 3 is ignored.

3.4.12 Function 12: cmove

This function starts channel(s) ch in continuous mode. Channel 1 will move in DIR1 direction at SPEED1 speed, etc.

The channel(s) will stay in continuous move mode until 'stop' or 'stdn_stop' is executed.

Prototype:

```
int cmove (int ch, int DIR1, int SPEED1,
        int DIR2, int SPEED2,
        int DIR3, int SPEED3);
```

Parameters:

ch	channel number	(See Function 2).
DIRn	channel n direction	0 = (+) and 1 = (-)
SPEEDn	channel n frequency	0 = FL and 1 - FH

Return values:

0: No error occurred

-1: An error occurred

Example(s):

error_code = cmove {CH2,0,0, P_DIR, FH, 0, 0 },

Channel 2 is placed in continuous move mode, and pulses at FH in the (+) direction.

3.4.13 Function 13: pmove

This function starts channel(s) ch in continuous mode, for a certain amount of steps. Channel 1 will move in DIR1 direction at SPEED1 speed and will stop when it has completed STEP 1 steps, etc.

Prototype:

```
int pmove (int ch, int DIR1, int SPEED1, long STEP1,
    int DIR2, int SPEED2, long STEP2,
    int DIR3, int SPEED3, long STEP3);
```

Parameters:

ch	channel number	(See Function 2).
DIRn	channel n direction	0 = (+) and 1 - (-)
SPEEDn	channel n frequency	0 = FL and 1 - FH
STEPn	channel n steps	max. long.

Return values:

0: No error occurred

-1: An error occurred

Example(s):

error_code = pmove (CH123, P DIR, FL, 2000, P DIR, FH, 3000, N_DIR, FH, 2000);

Channel 1 moves in (+) direction at speed FL for 2000 steps,

Channel 2 moves in (+) direction at speed FH for 3000 steps and

Channel 3 moves in (-) direction at speed FH for 2000 steps.

Then they stop.

3.4.14 Function 14: line

If you are using two stepping motors simultaneously (in a plotter-type configuration), you can move to position (X, Y) from the current position, (0, 0). Both axes are measured in steps.

Prototype:

int line(int ch_plan, int X, int Y);

Parameters:

ch_plan channel numbers CH12 for channels 1 &2

CH13 for channels 1 &3

CH23 for channels 2 &3

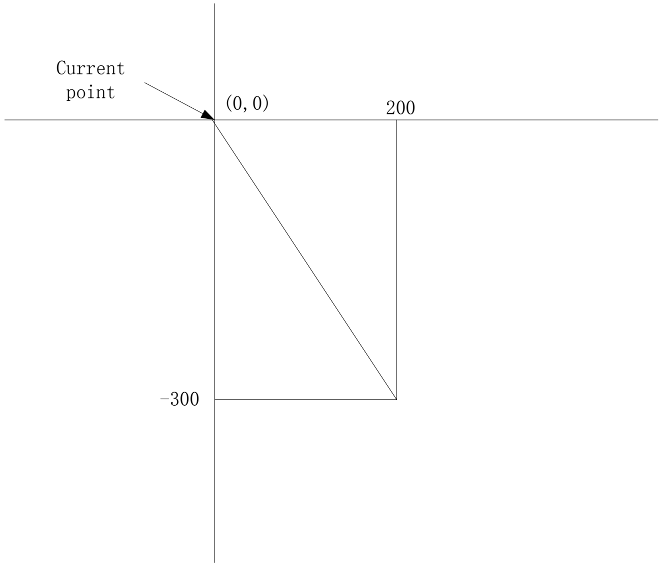
Return values:

0: No error occurred

-1: An error occurred

Example(s):

error_code = line(CH23, 200, -300) ;



3.4.15 Function 15: arc

If you are using two stepper motors simultaneously (in a plotter-type configuration), you can "draw an arc" from (X1, Y1) to (X2, Y2)

Prototype:

int arc (int ch_plan, int dir, long X1, long Y1, long X2, long Y2);

Parameters:

ch_plan:	channel numbers	CH12 for channels 1&2
		CH13 for channels 1&3
		CH23 for channels 2&3
dir:	direction	0 for clockwise
		1 for counterclockwise
X1, Y1	coordinates of starting point	
X2, Y2	coordinates of final point	

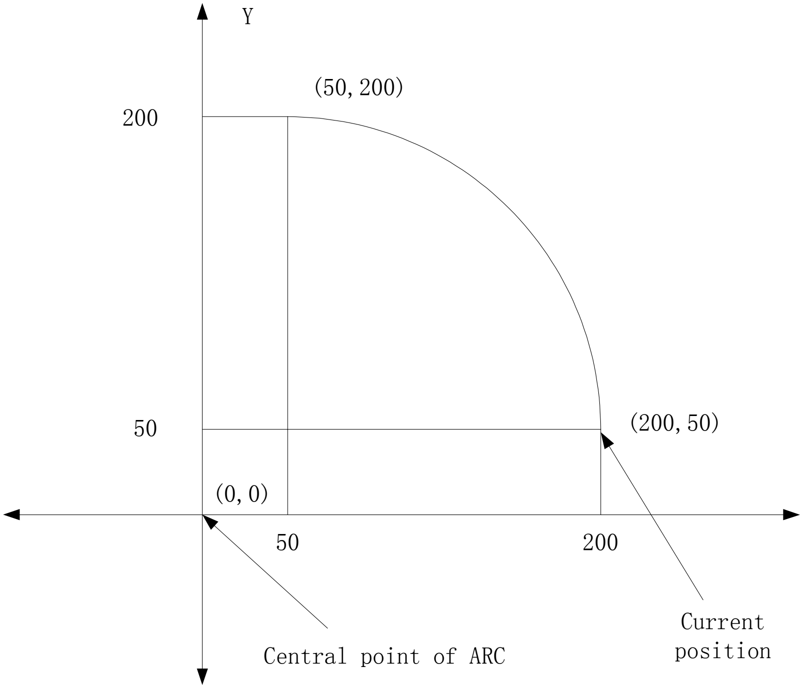
Return values:

0: No error occurred

-1: An error occurred

Example(s):

error_code = arc (CH13, 1, 200, 50, 50, 200) ;



CHAPTER 4

Register Programming

This chapter describes the PCL-839+'s hardware registers. It also contains typical operational procedures that will assist you in program design. This chapter is a good place to start getting to know and use the capabilities of the PCL-839+ to best suit your application.

Sections include:

- PCL-839+ Registers
- Programming the PCL-839+
- I/O Register Control Format
- Command buffers: WR0, WR4 and WR8
- Commands
- Read Status
- Typical Operational Procedures

Chapter 4 Register Programming

4.1 PCL-839+ Registers

Several registers are used to control the PCL-839+. The PCL-839+ uses these registers to store commands, speed, mode, number of pulses etc. The following sections describe these registers in detail.

4.1.1 R0 : Down-Counter (24 bits)

The down counter counts down when a pulse is output in manual mode, origin mode or preset mode. If the counter is stopped in operation mode, counting ceases. If a pulse is output when the counter has reached 0, the counter reverts to its maximum number (FFFFFF in Hex, 16777215 in Decimal).

The counter value can be read at any stage - in operation or during stand-still. When reading the value in operation, two quick reads must be done before the next pulse changes the value of the counter. Compare the two values - if they are the same then this is the true number of the residual pulses.

In preset mode you set the required number of pulses on the counter. The counter counts down when a pulse is output and pulse generation will stop when the counter reaches 0. The starting range is 00001 (hex) to FFFFFF (hex) (1 to 16777215 in decimal notation). If the counter is set to 0 when operation is started, no pulse generation will occur. At that time the operation flag will indicate the halt condition, but the INT signal is not output.

If counting is interrupted by a deceleration-stop or reset command, the current counter value is stored, and counting will continue as soon as the start command is received. As the counter will be at 0 when operation is complete, it is necessary to supply an initial value every time preset mode is started.

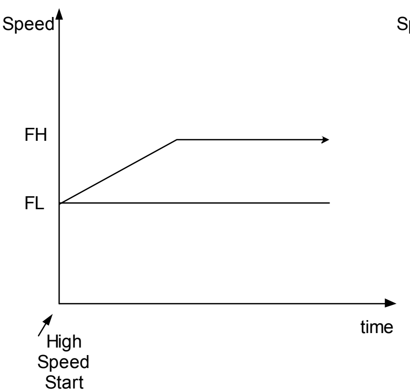
4.1.2 R1: FL Register (13 bits)

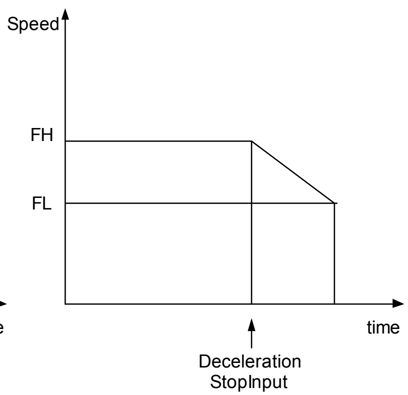
This register is used to set the FL (initial/low) speed. When started in high-speed mode, the generator starts at FL and ramps up to reach FH (Final/High speed). If the deceleration-stop command is received during high-speed operation, it ramps down to FL speed and then stops. Make sure that you set a FL speed.

The range for FL is 1 to 8191 (0001 to 1FFF in hexadecimal notation). For the relation between a set value and the output pulse frequency please refer to 4.1.5.

4.1.3 R2: FH Register (13 bits)

This register is used to set the FH speed. The range for FH is also 1 to 8191 (0001 to 1FFF in hexadecimal notation). Please ensure that FH is greater than FL. For the relation between a set value and the output pulse frequency, please refer to 4.1.5.





4.1.4 R3: Acc. / Dec. Rate Register (10 bits)

This register is used to set acceleration (ramping up) and deceleration (ramping down) characteristics. During high-speed mode, the generator starts at FL and accelerates to FH.

If the reference clock frequency is (TCLK)[sec], TSUD(the time required for the ramping-up/ramping-down) is:

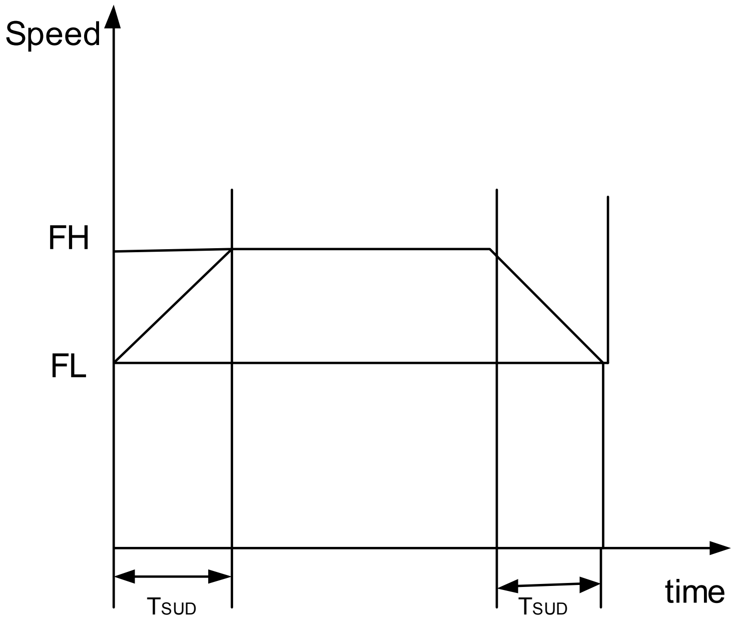
TSUD = [(R2)-(R1)]x (R3)x(TCLK) [sec]

Alternatively, if the ramping-up/ramping-down time is known, R3 can be calculated as:

R3 = TSUD /{[(R2)-(R1)] x(TCLK)}

The range for R3 is 002 (hex) to 3FF (hex) (2 to 1023 in decimal).

Note: For PCL-839+, Tclk = 203 ns



4.1.5 R4: Multiplier Register (10 bits)

For the speed registers, Rl and R2, a number of steps can be selected (1 to 8191). This register (R4) is used to assign an output frequency for one step. The reference clock inputted through the CLOCK terminal is divided and multiplied by the variable frequency divider and the frequency multiplier, and then outputted to the PULSE OUTPUT terminal. When a set value on the speed register is Rf (where Rf is a value set at R1 and R2), the frequency outputted at the PULSE OUTPUT terminal is

Fpout = {(Reference clock freq. [Hz] x (Rf)) / (8192 x (R4)}

= (Rf) x {(Reference clock freq.)} / {8192 x (R4)}

When (reference clock)/ [8192 x (R4)]= 1 ... 1x mode

When (reference clock)/ [8192 x (R4)]= 2 ... 2x mode

For the PCL-839+, the reference clock frequency is 4.9152 [MHz], Therefore

(R4)= 600 (=258 hex) 1x mode

(R4)= 300 (=12C hex) 2x mode

The setting range is 002 (hex) to 3FF (hex), which corresponds to 2 to 1023 in decimal notation. The smaller the set value, the higher the output frequency.

4.1.6 R5 :Ramping-down Point Register (16 bits)

During high-speed operation, the value of the down counter is compared with the value of this register. As soon as the value of the counter is less than the value of this register, ramping-down will start. If the value of R5 is higher than the down counter, when high-speed mode starts, ramping-up will not occur and the pulse generation will proceed at FL.

The range for R5 is 0001 (hex) to FFFF (hex) (1 to 65535 in decimal).

The ramping-down point is set in pulses.

Please note that in PCL-839+, the R5 value is calculated by user. The system will not define the R5 value automatically.

*** Setting of the ramping-down point**

When determining the ramping-down point, the FL frequency, the FH frequency and the deceleration rate has to be taken into account. If an improper value is set, pulse output may be terminated halfway during ramping-down (Fig. A) or may continue after ramping-down, causing longer FL speed operation (Fig. C).

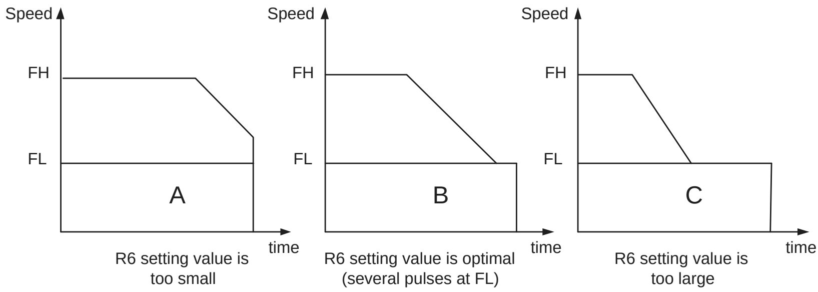
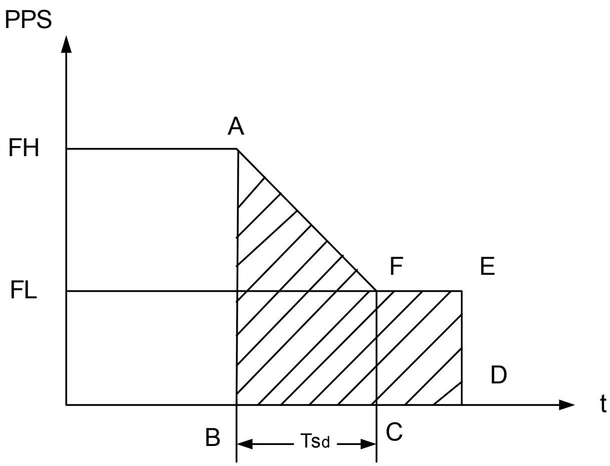


Figure 4.1: Relation Between R5 and Ramping Down Velocity

A ramping-down point is set based on the number of pulses output during ramping-down. Therefore the area marked by oblique lines in the chart below is the number of pulses to be calculated. FL and FH are the output pulse frequencies.



Tsd [sec], the time required for the deceleration is:

Tsd = [(R2)-(R1)]x(R3)/(CLOCK) (1)

where CLOCK = 4.9152 MHz

The relationship between the set value on speed register (Rf) and output frequency (F [PPS]) is:

F = (Rf)x(CLOCK)/[8192x(R4)] (2)

Therefore, FL output frequency FL [PPS] and FH output frequency FH [PPS] are:

FL = (Rl)x(CLOCK)/[8192x(R4)] (3)

FH = (R2)x(CLOCK)/[8192x(R4)] (4)

Psd, the number of pulses during T, [sec] is represented by the area of the trapezoid A-B-C-F:

Psd = {[(FL) + (FH)]*Ted}/2(5)

Substitute equations (1), (3) and (4) into equation (5):

Psd = $[(R2)^2 – (R1)^2]$ x (R3) / [16384 x (R4)]

When output 5 pulses at FL speed after the completion of the ramping-down, the set value of the ramping-down point register (R5) is

(R5) = Psd +5

(R5) = $[(R2)^2 – (R1)^2]$ x (R3)/ [16384 x (R4)] + 5

4.1.7 R6: Idling pulse register (3-bit)

To operate at high speed, the motor is accelerated quickly after start. Therefore, the speed calculated from the output pulse frequency will be higher than the FL speed that is set. If FL is set to a value lower than the self-start frequency, the motor will not start. Therefore, in order to be able to start from near the self-start frequency, the acceleration using the FL speed can be started from 1 to 7 pulses after the start command. The pulses that the start is delayed by are referred to as idling pulses.

The allowable range is 0 to 7. This is effective in high-speed operation. Setting this register to 0 will provide a normal start.

4.1.8 R7: Output type register (1-bit)

The allowable range is 0 or 1

0: CW/CCW pulse type

1: Pulse/DIR type

4.2 Programming the PCL-839+

The PCL-839+ stores a selected command in a buffer. This command remains there until a new command is received. The only command that can be RESET is the 'starting mode' command.

4.3 I/O Register Control Format

The following table depicts the PCL-839+ register's I/O address map.

Table 4.1: Register I/O Address Map

Axis	Offset Address	R/W	Definition
X (0)	0x00	Write	Command Buffer
		Read	Status0
	0x01	Write	Data Register (Lower Bit7 To Bit0)
		Read	Internal Data (Lower)
	0x02	Write	Data Register (Middle Bit15 To Bit8)
		Read	Internal Data (Middle)
	0x03	Write	Data Register (Upper Bit23 To Bit16)
		Read	Internal Data (Upper)

Table 4.1: Register I/O Address Map			
Axis	Offset Address	R/W	Definition
Y (1)	0x04	Write	Command Buffer
		Read	Status0
	0x05	Write	Data Register (Lower Bit7 To Bit0)
		Read	Internal Data (Lower)
	0x06	Write	Data Register (Middle Bit15 To Bit8)
		Read	Internal Data (Middle)
	0x07	Write	Data Register (Upper Bit23 To Bit16)
		Read	Internal Data (Upper)
Z (2)	0x08	Write	Command Buffer
		Read	Status0
	0x09	Write	Data Register (Lower Bit7 To Bit0)
		Read	Internal Data (Lower)
	0x0A	Write	Data Register (Middle Bit15 To Bit8)
		Read	Internal Data (Middle)
	0x0B	Write	Data Register (Upper Bit23 To Bit16)
		Read	Internal Data (Upper)
	0x0C	Write	Digital Output 0 ~ 7 (port0)
		Read	Digital Input 0 ~ 7 (port0)
	0x0D	Write	Digital Output 8 ~ 15 (port1)
		Read	Digital Input 8 ~ 15 (port1)
	0x0E	Write	IRQ control
		Read	IRQ status
	0x0F	Write	IRQ control
		Read	IRQ status

4.4 Command Buffers: WRO, WR4 and WR8.

Each of the three channels has a command buffer that enables individual programming. Channel l's command buffer is BASE + 0, Channel 2's is BASE + 4 and Channel 3's is BASE + 8. A command can be written to any of the three buffers, and the appropriate channel will respond to the command.

4.4.1 Register Format

The register format is as follows:

Table 4.2: Register Format

D7	D6	D5	D4	D3	D2	D1	D0
C1	C0						
Mode		Command					

4.4.2 Selection Modes

The two high-order bits of the command buffer specifies the command that will be executed. The remaining six bits contain command parameters. The command modes available are as follows:

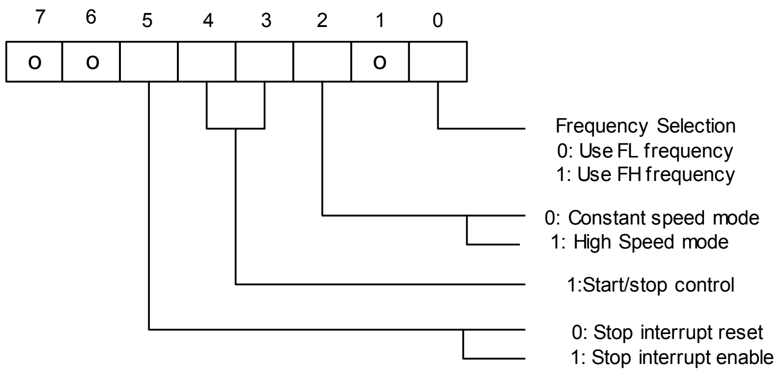
Table 4.3: Selection Modes

C1	C0	
0	0	Start-Stop command selection
0	1	Operation Mode Select command
1	0	Register Select command
1	1	Output Mode select command

4.5 Commands

The following sections describe all the available commands and their parameters in detail.

4.5.1 Start-Stop Command



0	0	*	1	0	0	0	0

Constant speed operation with the FL register. Operates at the speed set for the FL register.

0	0	*	1	0	0	0	1

Constant speed operation with the FH register. Operates at the speed set for the FH register.

0	0	*	1	0	1	0	1

High speed operation with the FH register. Frequency ramps up halfway from the rate of the FL to that of the FH. During high-speed start this command lets the frequency ramp up/down to the rate of the FH speed.

0	0	*	1	0	1	0	0

Dual rate operation (ramping down). Frequency ramps down to the level of the FL.

*   0 (no output of INT signal at stop)

      1 (output of INT signal at stop)

0	0	*	1	1	1	0	0

Decelerating stop (reset command is required after stop). Frequency ramps down to the rate of the FL, then stops.

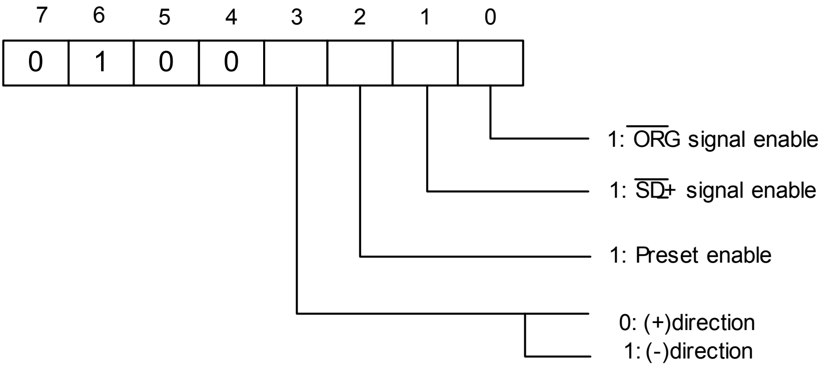
0	0	0	0	1	0	0	0

Reset command. This stops pulse generation under any condition. If you start with the start-command, be sure to reset with the reset command before the next start. This gives INT signal and the start command has to be reset. Contents in registers R0 through R7 are not changed.

*   0 (no output of INT signal at stop)

      1 (output of INT signal at stop)

4.5.2 Operation Mode Select Command



0	1	0	0	*	0	0	0

Manual mode. Operation initiated in the start mode continues until the stop command is transferred.

0	1	0	0	*	0	0	1

Origin return mode. Operation initiated in the start mode continues until the mechanical origin signal or stop command comes.

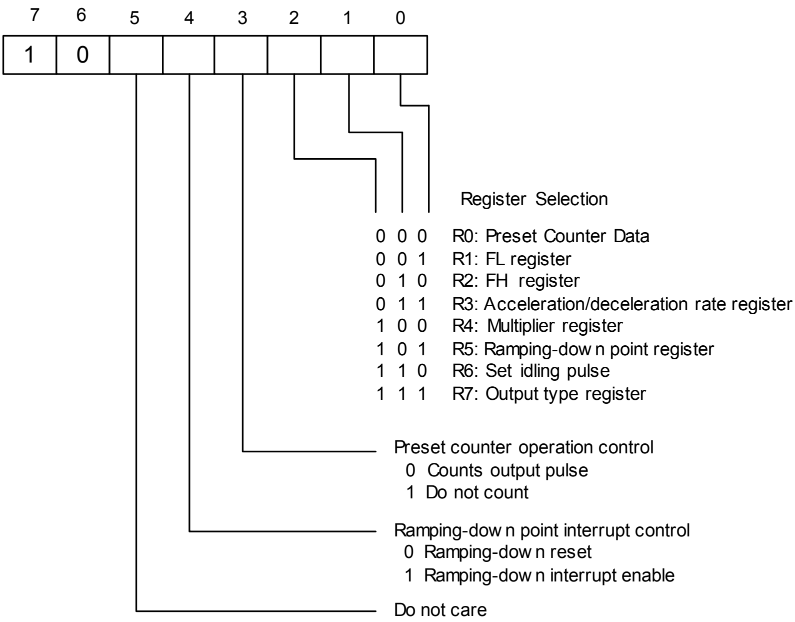
0	1	0	0	*	1	0	0

Preset mode. Operation initiated in the start mode, stops when the quantity set for register R0 is reached.

Operation in the high speed start mode, ramps down when the remaining quantity of the counter is less than the quantity set for register R5.

*: 0 (+) direction
   1 (-) direction

4.5.3 Register Select Command



Register Select Code

Selects an access register with last 3 bits.

Preset Counter Operation Control

When this bit is 1, the preset counter will stop counting. When this bit is 0, the preset counter will decrement by one for each pulse output.

Ramping-Down Point Interrupt Control

This bit controls whether or not the INT signal is output when the ramping-down point is reached. When this bit is 1 and the preset counter value becomes smaller than the ramping-down point setting in R5, it will output an INT signal. To reset the INT signal, set this bit to 0. If you want to mask this operation, leave this bit set to 0. The INT terminal output is the result of logically 'ORing' this signal with the interrupt signal when stopped. To determine which source has caused the INT signal to be output, check Status0.

Kinds of Registers and Data Bits

Description		Bits	R/W	Setting Range
R0	Preset counter data	24	R/W	0 to 16,777,215 (FFFFFF)
R1	FL register	13	W(R)	1 to 8,191 (1FFF)
R2	FH register	13	W(R)	1 to 8, 191 (1FFF)
R3	Acceleration / deceleration rate register	10	W(R)	2 to 1, 023 (3FF)
R4	Multiplier register	10	W(R)	2 to 1, 023 (3FF)
R5	Set ramping-down point	16	W(R)	0 to 65, 535 (FFFF)
R6	Set idling pulse	3	W(R)	0 to 7
R7	Output type register	1	W(R)	0 to (1)

Note1: * R/W: Read/Write register

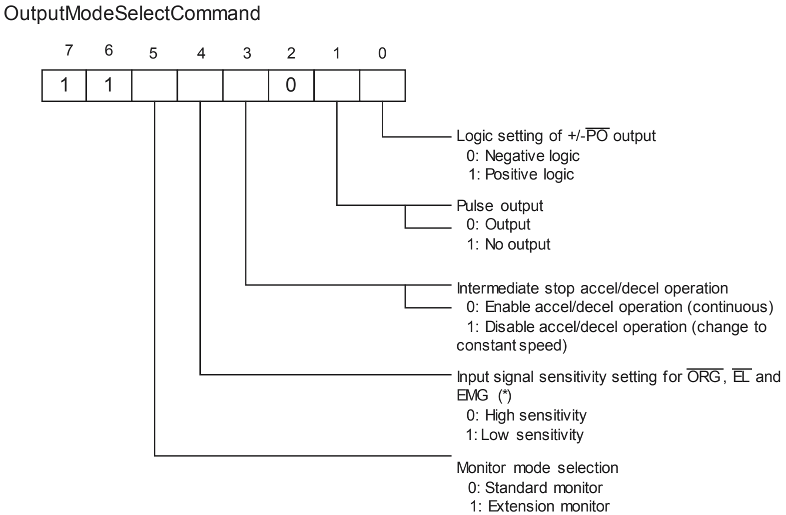
W(R): Write only register. However, it can be read using the extension monitor setting.

Note2: R7 is allowed to be 0 or 1.

R7 = 0, CW/CCW output type

R7= 1, Pulse/Direction output type

4.5.4 Output Mode Select Command



* Sensitivity setting:
Low : the input signal will be ignored when pulse width < 800ns
High: the input signal will be recognized when pulse width < 800ns

Figure 4.2: Output Mode Select Command

PULSE/DIRECTION logic control

PULSE/+dir and DIR/-dir output logic be changed as follows:

Setting	Direction	Directory Mode		Pulse Mode	
		PULSE/+dir	DIR/-dir	PULSE/+dir	DIR/-dir
0	(+)	⊔	H	⊔	H
	(-)	⊔	L	H	⊔
1	(+)	⊓	L	⊓	L
	(-)	⊓	H	L	⊓

4.6 Read Status

Users can set the standard monitor or extension monitor by the “Output mode select command”

Mode	**Address\ Register**	**RD0, RD4, RD8**	**RD1, RD5, RD9**	**RD2, RD6, RD10**	**RD3, RD7, RD11**
Standard Monitor	R0	Status0	R0 lower byte	R0 mid-dle byte	R0 upper byte
	R1 to R7	Status0	Status1	0	0
Extension Monitor	R0	Status0	R0 lower byte	R0 mid-dle byte	R0 upper byte
	R1	Status0	R1 lower byte	R1 upper byte	Start mode command
	R2	Status0	R2 lower byte	R2 upper byte	Control mode command
	R3	Status0	R3 lower byte	R3 upper byte	Register select com-mand
	R4	Status0	R4 lower byte	R4 upper byte	Output mode command
	R5	Status0	R5 lower byte	R5 upper byte	R7 data
	R6	Status0	R6 data	Speed lower byte	Speed upper byte
	R7	Status0	Status1	Status2	Status3

4.6.1 Channel Status Buffers (RD0, RD4 and RD8)

There is a status buffer for each channel (status 0). These buffers are found at BASE +0, BASE +4 and BASE +8 for channel 1, channel 2 and channel 3 respectively. These buffers enable you to read the internal status of each channel, and also get certain information on input signals or conditions.

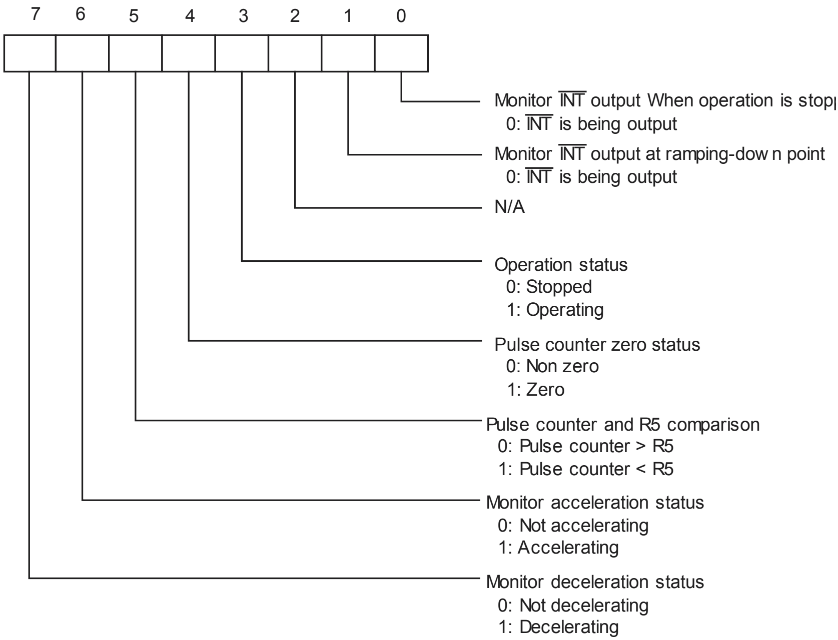


Figure 4.3: Status 0-bit Configuration

4.6.2 Data Buffers: WR1, WR5 and WR9

One data-buffer for each channel is found at BASE 1, BASE 5 and BASE 9, for channel 1, channel 2 and channel 3 respectively. When writing (output), these buffers contain data bits 0-7 of the respective channels.

4.6.3 Data Buffers: WR2, WR6 and WR10

One data-buffer for each channel is found at BASE+2, BASE+6 and BASE+ 10, for channel 1, channel 2 and channel 3 respectively. When writing (output), these buffers contain data bits 8-15 of the respective channels

4.6.4 Data Buffers: WR3, WR4 and WR11

One data-buffer for each channel is found at BASE+3, BASE+7 and BASE+I 1, for channel 1, channel 2 and channel 3 respectively. When writing (output), these buffers contain data bits 16 -24 of the respective channels.

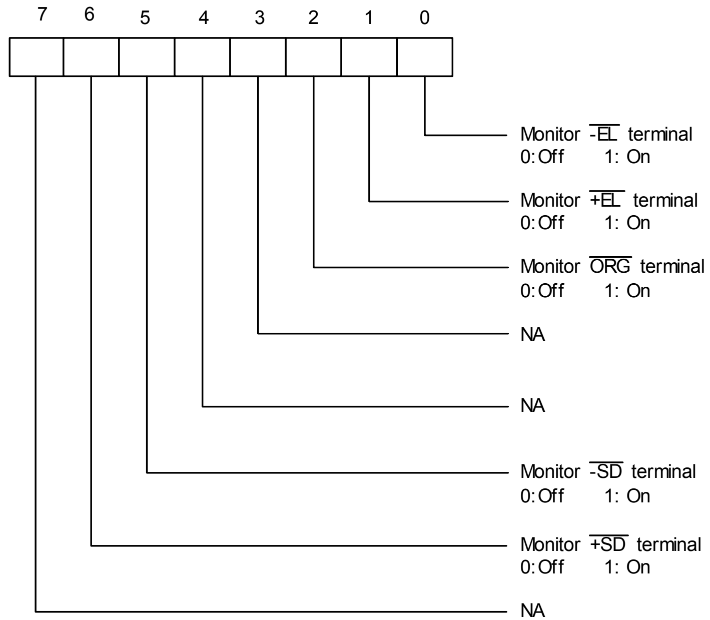


Figure 4.4: Status 1 Bit Configuration

When the Extension Monitor is selected, users can check the value of each register

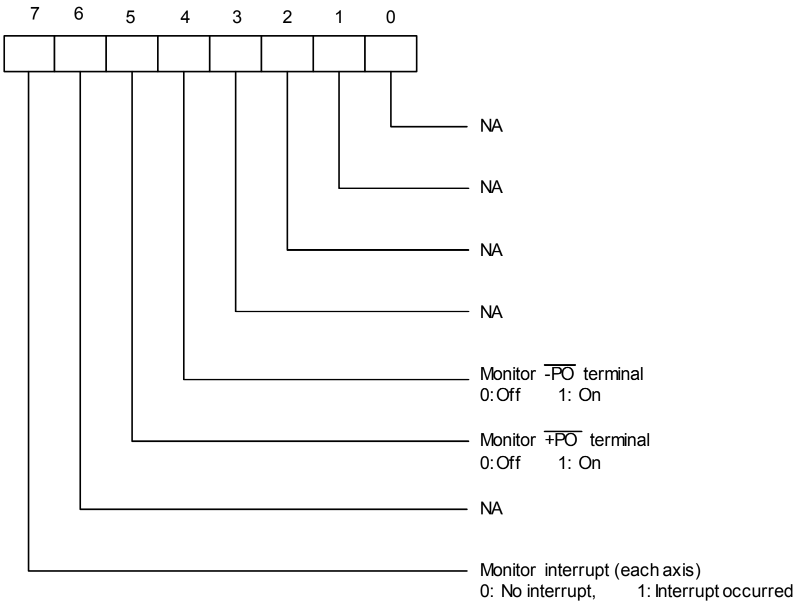


Figure 4.5: Status 2 Bit Configuration

For the value of Status3, it should be “0100-0000”, which represents the PCD4541 chipset.

4.6.5 Digital Outputs: WR12 and WR13

WR12 is the low byte of the digital output and WR13 the high byte. To write to these buffers write to BASE12 and BASE13 respectively. The bit definition is as follows:

Bit	7	6	5	4	3	2	1	0
	DO15	DO14	DO13	DO12	DO11	DO10	DO9	DO8

WR13

Bit	7	6	5	4	3	2	1	0
	DO7	DO6	DO5	DO4	DO3	DO2	DO1	DO0

WR12

4.6.6 Digital Inputs: RD12 and RD13

RD12 is the low byte of the digital input, and RD13 the high byte. To read these buffers, address BASE+12 and BASE+13 respectively. The bit definition is as follows:

Bit	7	6	5	4	3	2	1	0
	DI15	DI14	DI13	DI12	DI11	DI10	DI9	DI8

RD13

Bit	7	6	5	4	3	2	1	0
	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0

RD12

4.6.7 Interrupt Control: WR14

WR14 is the interrupt control register for the PCL-839+, and is found at BASE +14. Only one bit, b0, of the byte is used. When b0=1, interrupts are enabled, and when b0-0, disabled, ifb0=1, and the channel-interrupt of the specific channel is also enabled (see Start-Stop command, bit 5), an interrupt will be generated when that channel reaches its 'stop position'.

Bit	7	6	5	4	3	2	1	0
	—	—	—	—	—	—	—	IRQ

WR14

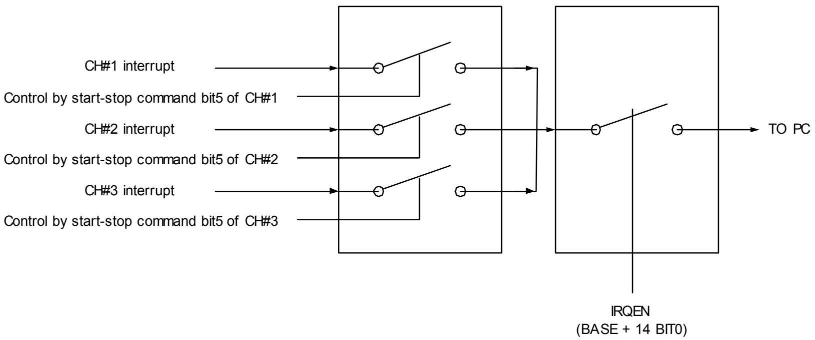


Figure 4.6: Interrupt Path of the PCL-839+

4.6.8 Interrupt Status Register: RD14

RD14 is used to obtain the interrupt status for each channel. It is found at BASE+14, and contains the interrupt status for all channels. When an interrupt occurs, this register will be set. If the bit = 1, then an interrupt has occured for that channel. The bit configuration is as follows:

bit	7	6	5	4	3	2	1	0
	...	...	...	...	...	...	...	IRQ

Note: When this register is read, bit 0 w ill be cleared

4.6.9 Example of reading Status Register

In this section, we will demonstrate how to get the emergency stop limit switch status by reading the Status Register.

Step1:

Setting the "Output Mode Select Command" and you can choose the "Monitor mode" as Standard monitor or Extension monitor. In Standard monitor mode user can get Status0 ~ 1, and in Extension monitor mode Status0 ~ 3 can be read. Since the status of emergency stop limit switch is defined in Status1, so both Standard and Extension monitor mode is workable. In this case, we set the monitor mode as "Extension"

outportb(base+(CH*4+CommandBufferIndex),DATA);

//CH : Axes 0 ~ 2

//CommandBufferIndex = 0

//DATA is just setting The [Output Mode Command] Monitor Mode Selection Bit5

//DATA = (CurrentAxesOutputModeCommandValue & (~FORCE_EXTENSION_MODE)) | (FORCE_EXTENSION_MODE)

Step2:

Select R7 Register. (If you want to read another status such as R0, R1, or Current Speed.., then you must select another Register such as R0, R1… R6. Please refer to the Table in section 4.6)

outportb(base+(CH*4+CommandBufferIndex,DATA);

//DATA is just setting The [Register Select Command] As R7

//DATA = (CurrentAxesRegisterSelectCommandValue & (~0x07)) | (FORCE_SELECT_R7)

Step3:

Read the Status1 register. For X-Axes (RD0, RD1, RD2, RD3), Y-Axes (RD4 ~ RD7), Z-Axes (RD8 ~ RD11) Please refer to the Table in section 4.6

Status0 Of n-Axes = inportb(base+(CH*4+0))

Status1 Of n-Axes = inportb(base+(CH*4+1))

Status2 Of n-Axes = inportb(base+(CH*4+2))

Status3 Of n-Axes = inportb(base+(CH*4+3))

Step4:

Get The EL+/EL-

For EL- = Status1.BIT0

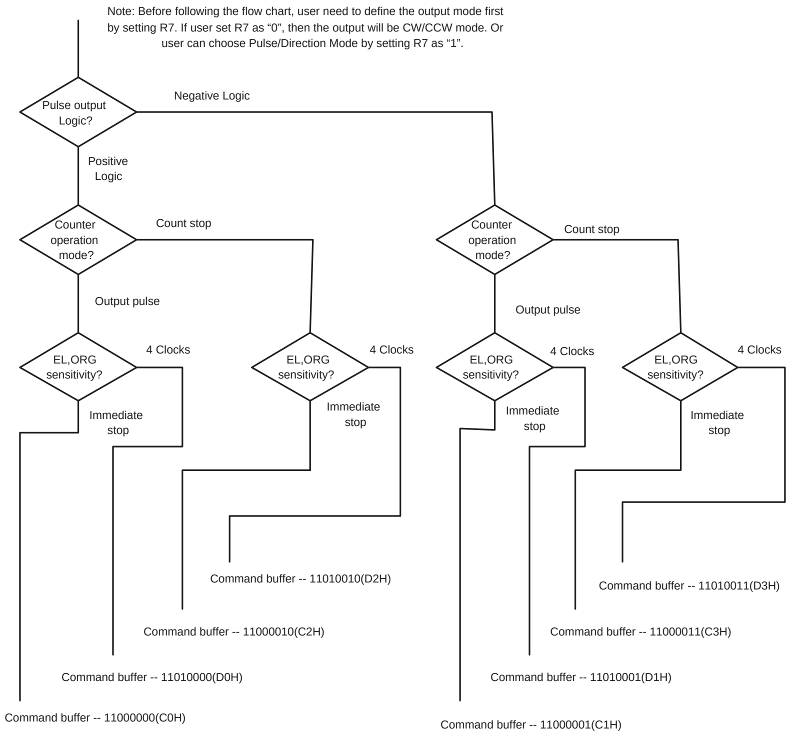
EL+ = Status1.BIT1

EL- Of n-Axes = ((Status1 Of n-Axes) & 0x01)>>0

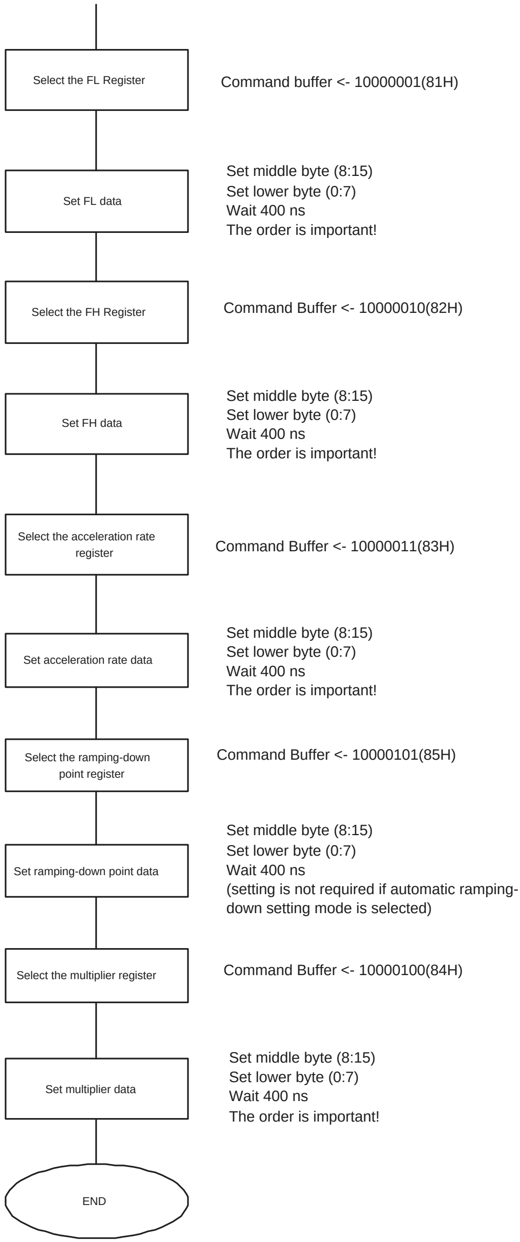
EL+ Of n-Axes = ((Status1 Of n-Axes) & 0x02)>>1

4.7 Typical Operational Procedures

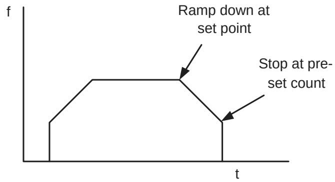
4.7.1 Initialization

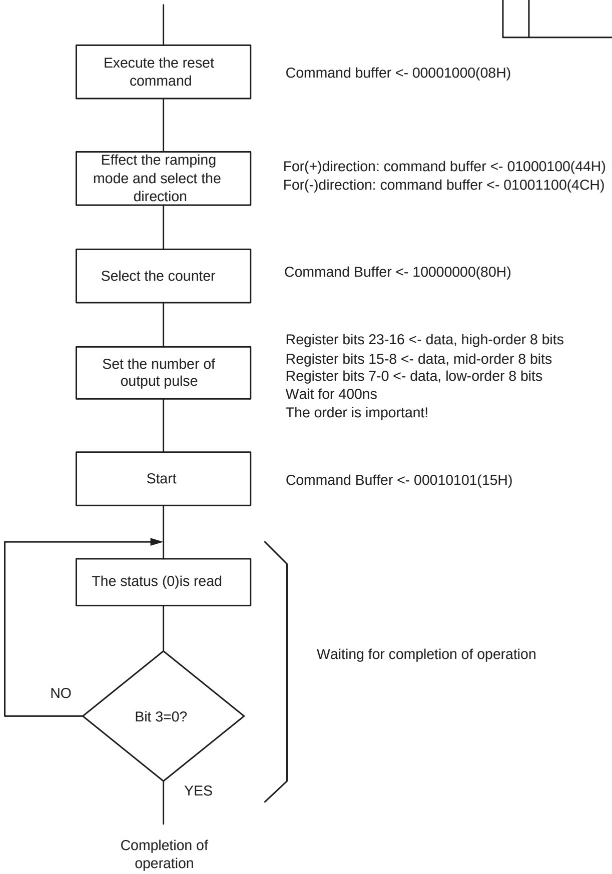


4.7.2 Setting Speed Data

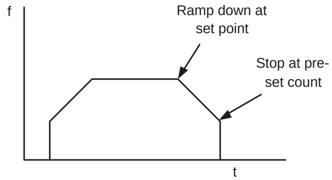


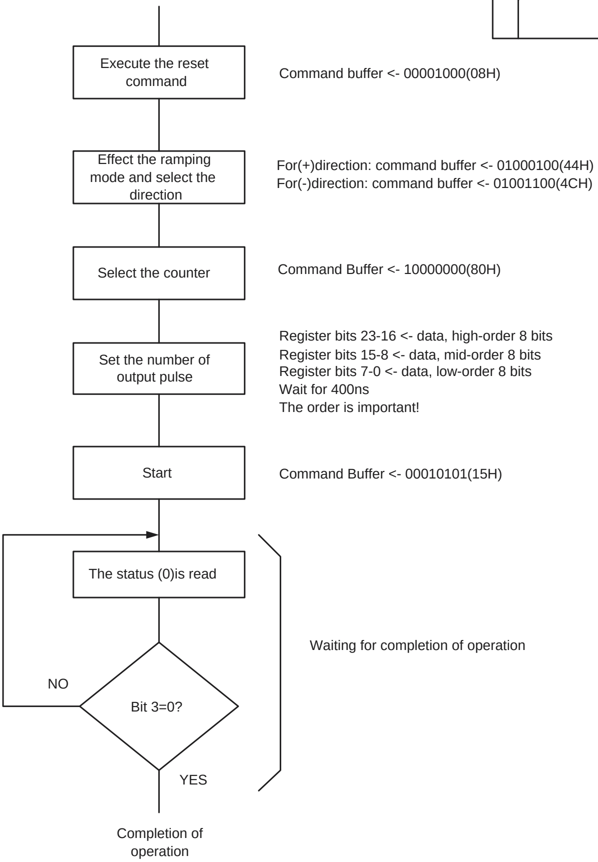
4.7.3 Constant Speed Preset Model



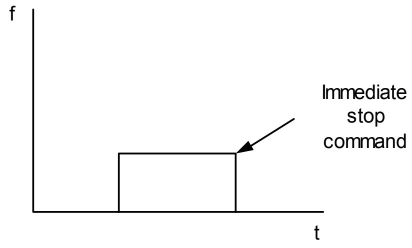


4.7.4 High Speed Preset Model





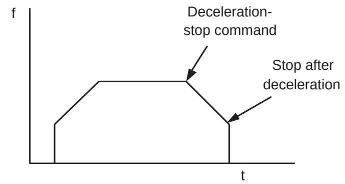
4.7.5 Constant Speed Continuous Mode

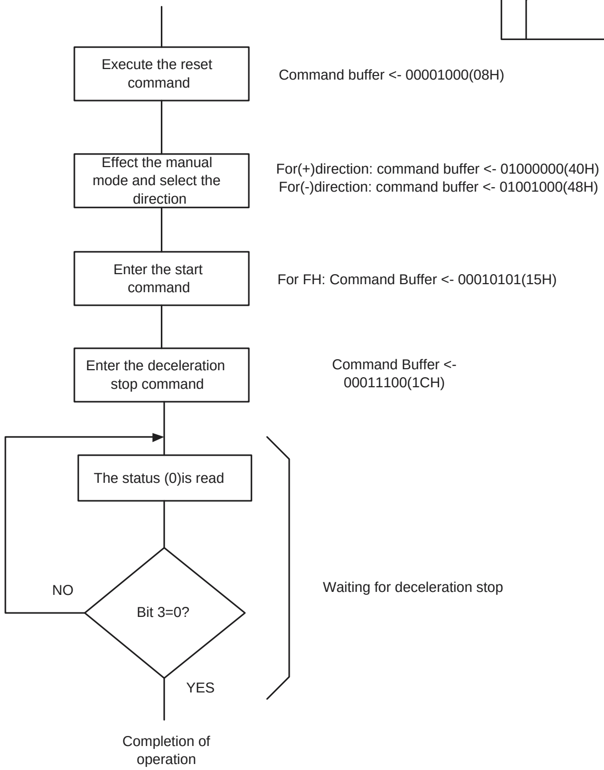


Execute the reset command	Command buffer <- 00001000(08H)
Effect the manual mode and set the direction	For(+)direction: command buffer <- 01000000(40H) For(-)direction: command buffer <- 01001000(48H)
Enter the start command	For FL: Command Buffer <- 00010000(10H) For FH: Command Buffer <- 00010001(11H)
Enter the immediate stop command	Command buffer <-00001000(08H) (reset command)

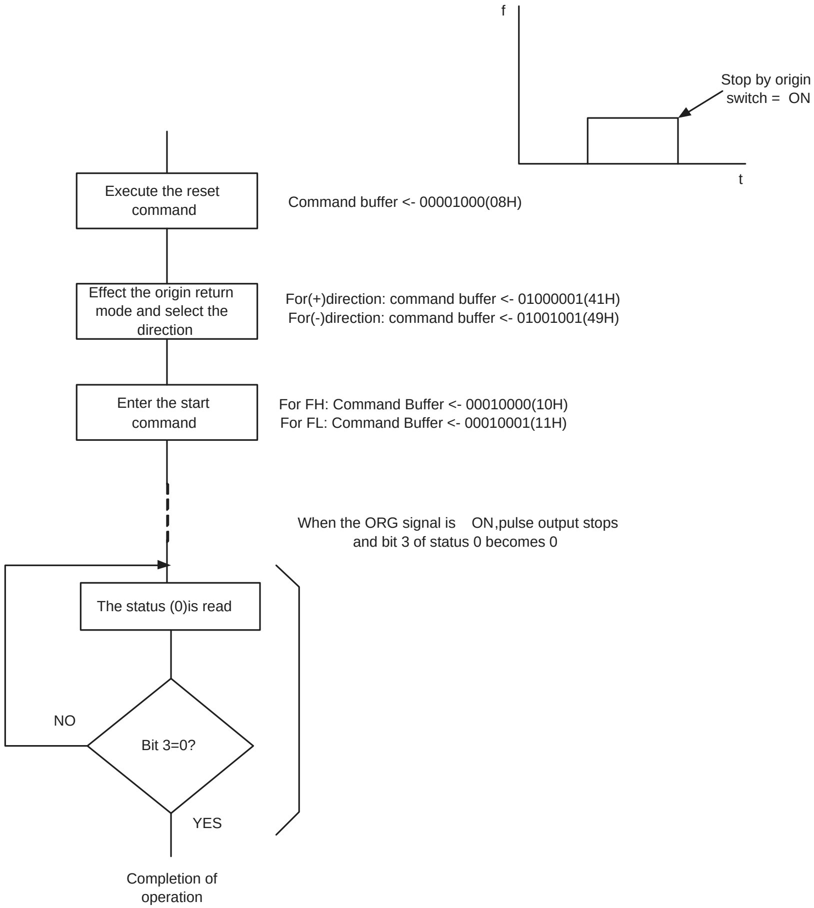
Completion of operation

4.7.6 High Speed Continuous Mode

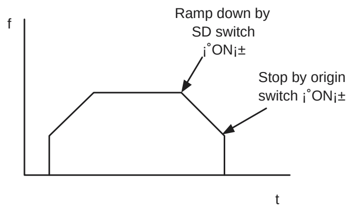


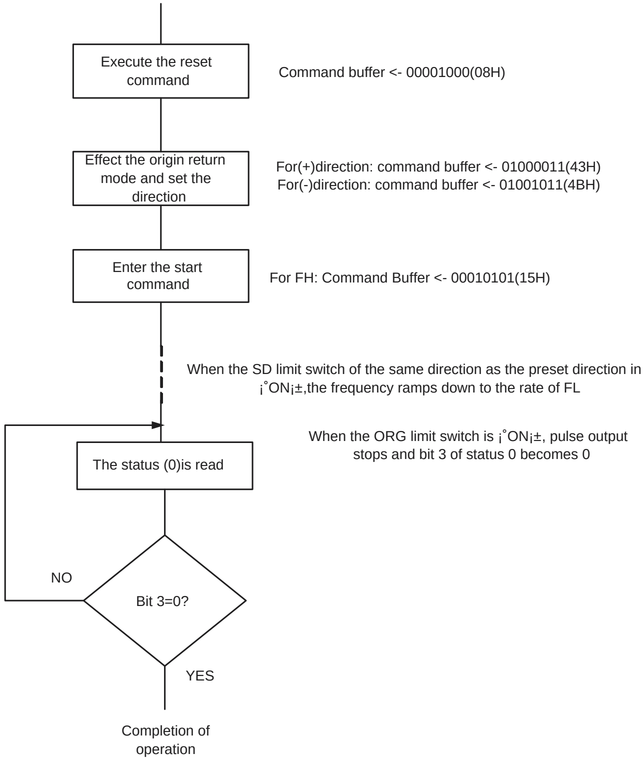


4.7.7 Constant Speed Origin Return Model



4.7.8 High Speed Origin Return Model





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APPENDIX B

Simple Stepping Motor Driver

This chapter provides extra diagrams related to the simple stepping motor driver.

Appendix B Simple St. Motor Driver

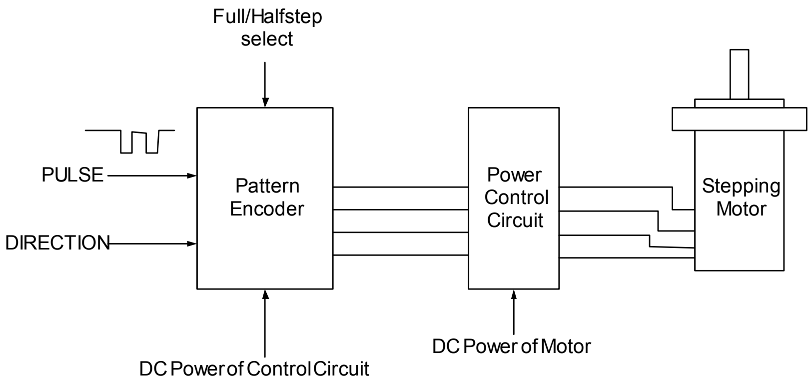

Figure B.1: Simple Stepping Motor Driver Block Diagram

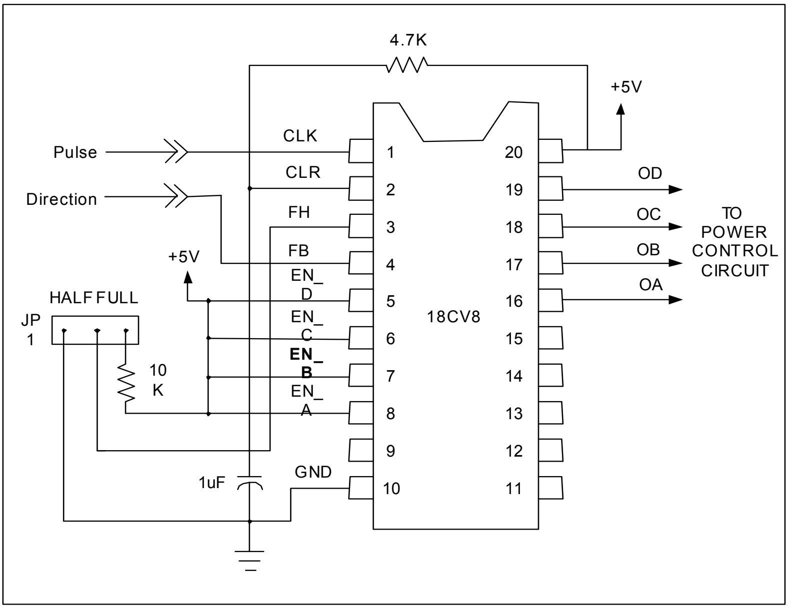

Figure B.2: Pattern Encoder Connection

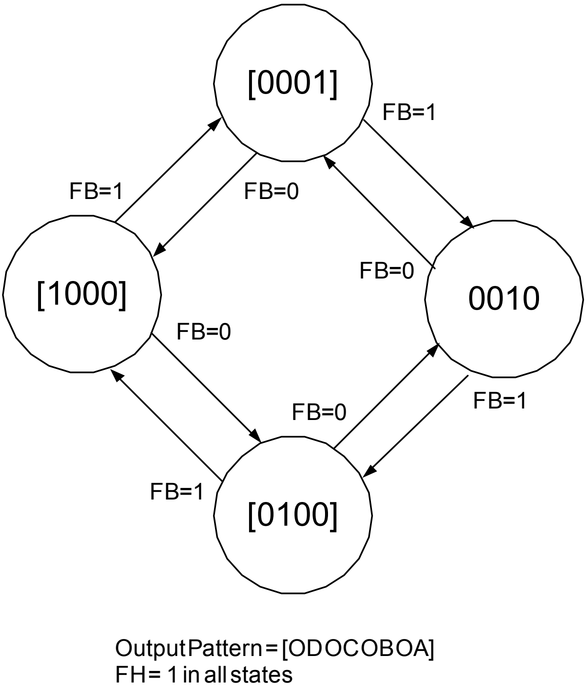

Figure B.3: JP1 at Full Step Control

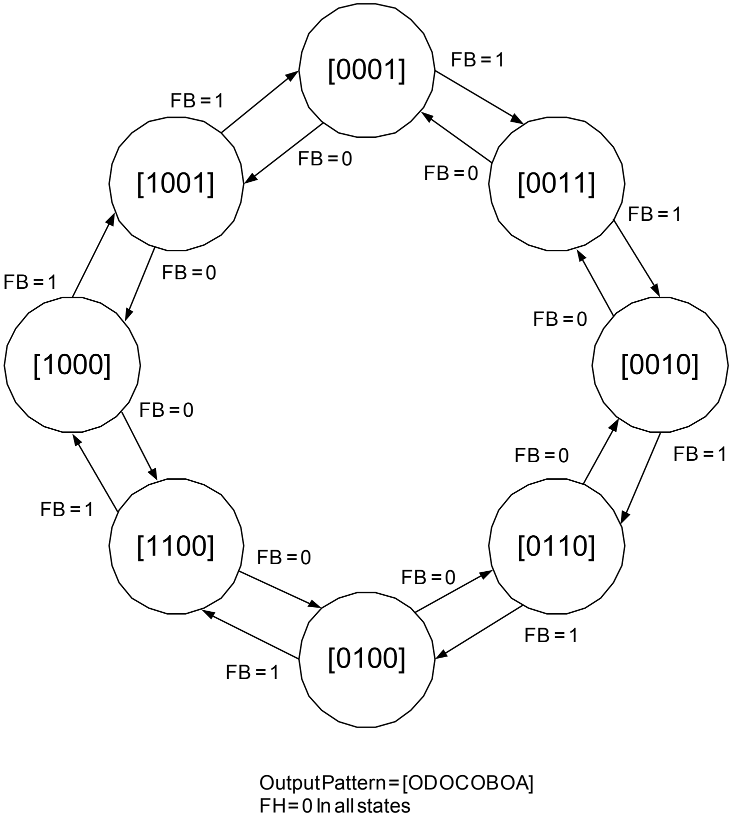

Figure B.4: JP1 at Half Step Control

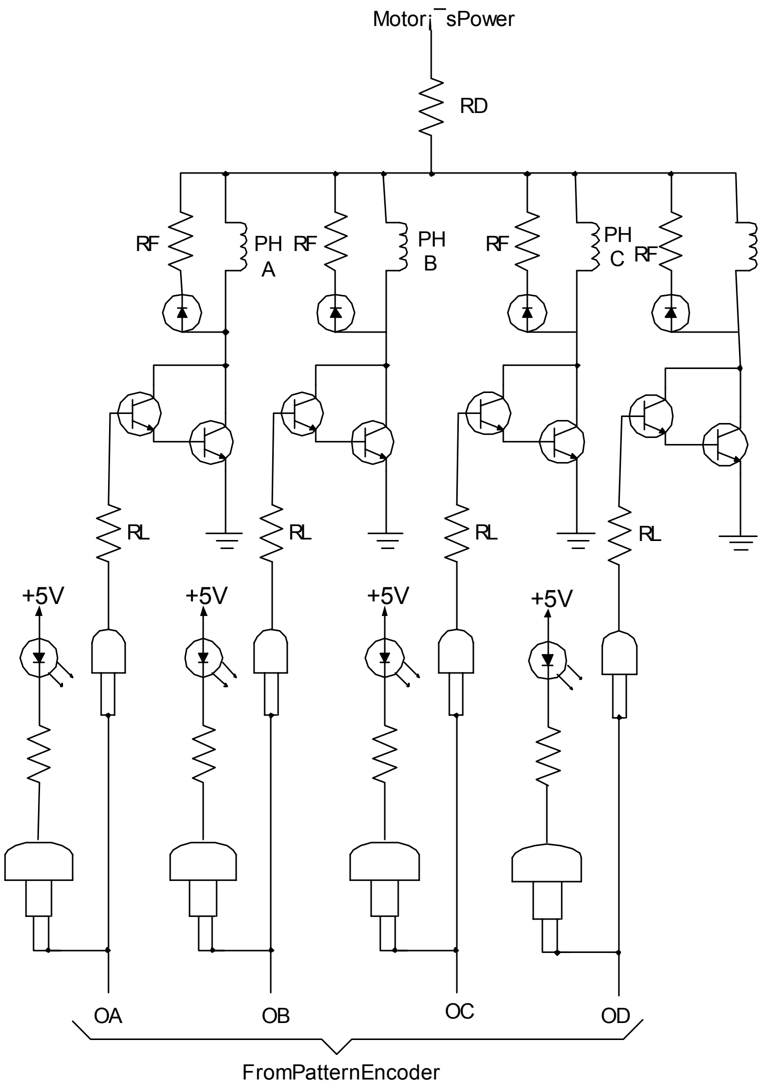

Figure B.5: 4-Phase Stepping Motor Power Control Circuit

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APPENDIX

A

Diagrams

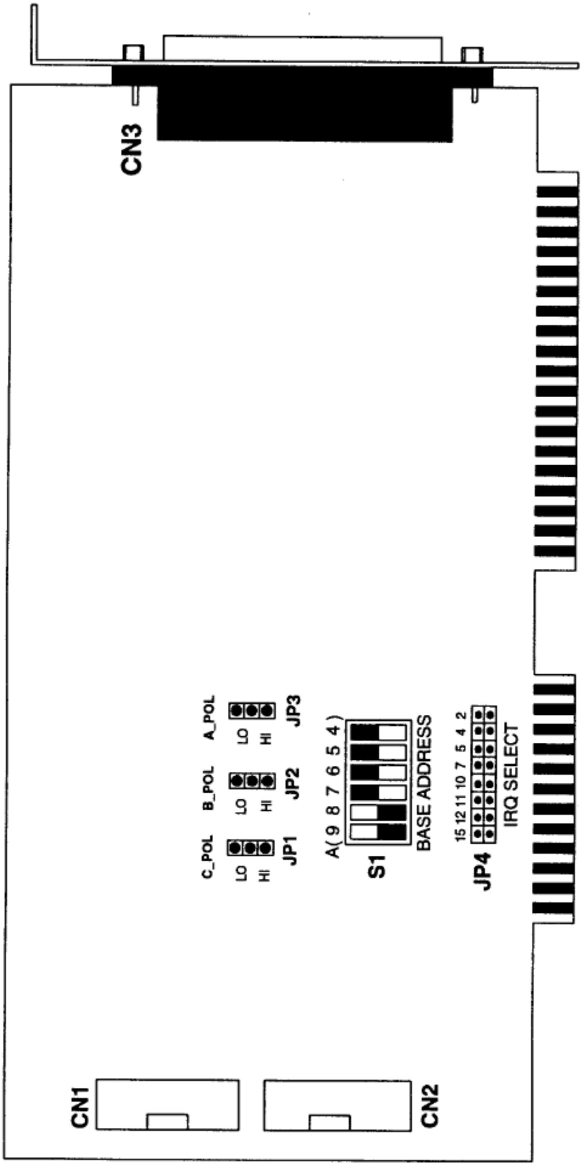
This chapter provides diagrams for some of the major functions of PCL-839+.

Sections include:

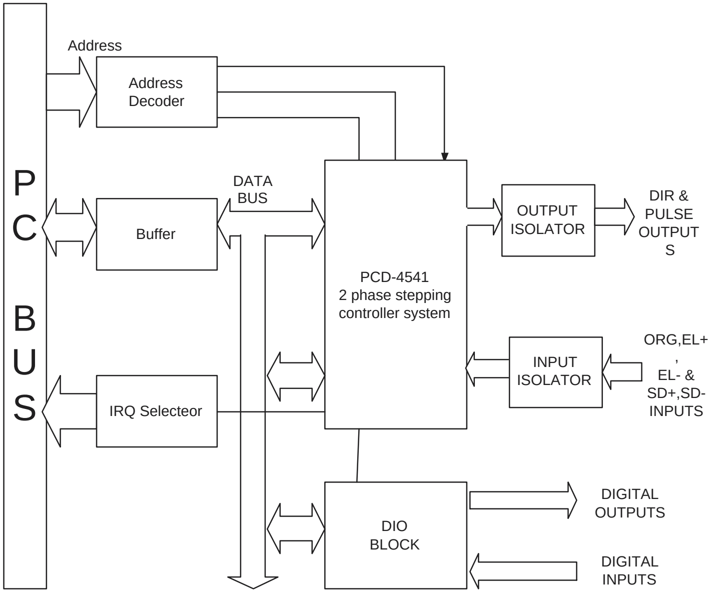
- Jumper and Switch Layout
- PCL-839+ Block Diagram
- Output Circuit Diagram

Appendix A Diagrams

A.1 Jumper and Switch Layout



A.2 PCL-839+ Block Diagram



PCL-839+ HIGH SPEED STEPPING MOTOR CONTROL CARD

A.3 Output Circuit Diagram