I-8091

2-axis stepping/servo motor control card

User's Manual

Version 2.0 04/2003 Edition

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I-8091 2-axis Stepping/Servo Motor Control Card

The I-8091 card is a 2-axis command-type stepping motor control card on I-8000 platform, it also can be used as servo motor control (pulse input type). This card has an embedded CPU which performs motion commands transfered from I-8000 main system to increase the system performance. A 2Kbytes-FIFO is introduced as command buffer. This buffer can provide over 700ms buffer time.

A system including I-8000(main system), I-8091(2-axis stepping/servo control card), I-8090(3-axis encoder card) can be implemented as a stand along motion controller system for low cost automatical machine.

Features

- I-8000 series.
- 2-axis independent, simultaneous stepping motor control / servo motor control (pulse input type).
- Maximum pulse rate: 1Mpps.
- Maximum step counts: $2^{32}-1$ steps.
- DOS driver.
- embedded CPU.
- command type interface.
- 2-axis linear, 2-axis circular interpolation.
- automatic trapezoidal acceleration / deceleration.
- output pulse modes : CW/CCW or pulse/direction.
- output polarity can be programmable.
- 2500Vrms optical isolated signal output.
- 3 optical isolated digital inputs per axis for limit switches.
- programmable limit switch initial condition as normal open(N.O.) or normal close(N.C.).

I-8091 Contents

1. Introduction

1.1 System Block Diagram

The I-8091 stepping motor control card is a micro-computer controlled, 2-axis pulse generation card. It includes a 2Kbytes-FIFO to receive motion command from host, a micro-computer for profile generation and protection, 2-axis DDA chip to execute DDA function when interpolation command is used, 2500Vrms optical isolation inserted for industrial application.

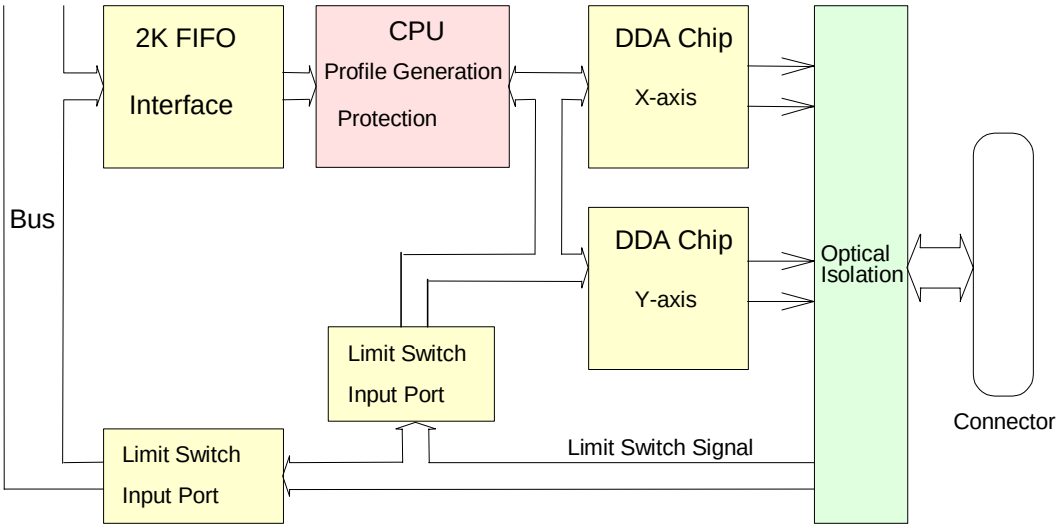


Fig.(1) block diagram of I-8091 card

1.2 DDA Technology

The DDA chip is the heart of I-8091 card, it will generate equal-space pulse train corresponding to specific pulse number during a DDA period. This mechanism is very useful to execute pulse generation and interpolation function. The DDA period can be determined by DDA cycle. Table(1) shows the relation among DDA cycle, DDA period and output pulse rate. When DDA cycle set to 1, the DDA period is equal to (1+1)x1.024ms = 2.048ms. The output pulse number can be set to 0~2047, therefore the maximum output pulse rate will be 1Mpps. The minimum output pulse rate is 3.83pps when set DDA cycle=254 (DDA period = (254+1)x1.024ms = 261.12ms).

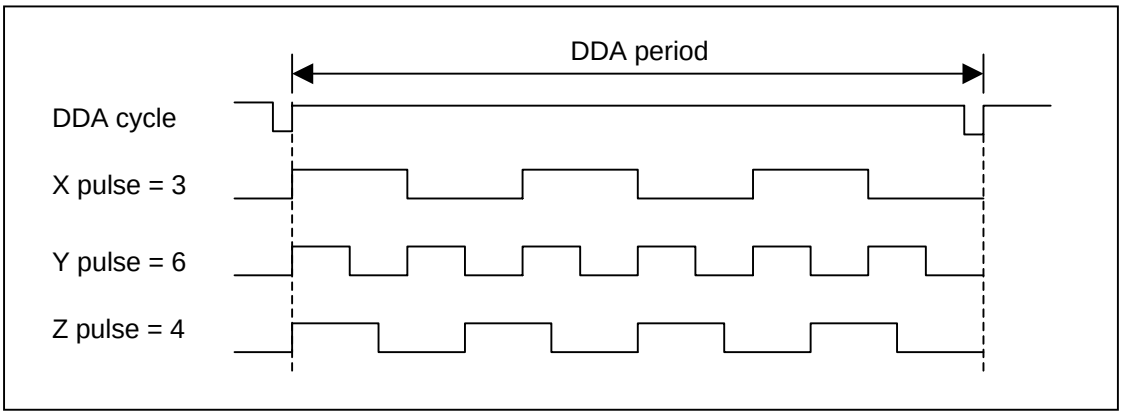


Fig.(2) DDA mechanism

Table(1) The Relation among DDA cycle, DDA period and output pulse rate.

DDA cycle	DDA period	Max. pulse rate(n=2047)	Min. pulse rate (n=1)
1	2.048ms	999511pps	488pps
2	3.072ms	666341pps	325pps
3	4.096ms	.	.
.	.	.	.
N	(N+1)*1.024ms	2047/(DDA period)	1/(DDA period)
.	.	.	.
254	261.12ms	7839pps	3.83pps

The DDA cycle can be set by i8091_SET_VAR() command which decribed in charpter 3. The selection criterion of DDA cycle was described as following.

(1) The required max. output pulse rate.

PRmax = Vmax*N/60

$$PRmax = \frac{2047}{(DDAcycle + 1) * 1.024ms}$$

PRmax : max. output pulse rate.
Vmax : max. speed (rpm).
N : the pulse number of stepping motor per revolution. (pulse/rev).

2. The required speed resolution.

The maximum output pulse number is Np(0~2047), therefore the speed resolution is Vmax(max. speed)/Np. The DDA cycle can be obtained by following equation.

$$PRmax = \frac{Np}{(DDAcycle + 1) * 1.024ms}$$

3. When choose large DDA cycle (DDA period), it will occur vibration between different pulse input which generally can be observed during acceleration or deceleration. So, the small DDA cycle , the smooth acceleration/deceleration curve as long as the speed resolution is acceptable.

Example: Stepping Motor

The specification of stepping motor is 500 pulse/rev, max. speed 500 rpm, speed resolution 2 rpm.

The required max. pulse rate

PRmax = 500 rpm*500/60 = 4166.67 pps

The maximum output pulse

Np = 500rpm/2rpm =250 pulse number

The DDA cycle can be calculated by follow equation

$$PRmax = \frac{Np}{(DDAcycle + 1) * 1.024ms}$$

$$4166.67 = \frac{250}{(DDAcycle + 1) * 1.024ms}$$

DDA cycle = 58

High Speed = 247 pulse (4166.67*58*0.001024)

The above results means that maximum speed is 500rpm when send command i8091_SET_VAR(0, 58, 2, 2, 247) to I-8091 card.

Example: Pulse type input Servo Motor

The specification of servo motor is 8000 pulse/rev, max. speed 3000 rpm, speed resolution 2 rpm.

The required max. pulse rate

PRmax = 3000 rpm*8000/60 = 400,000 pps

The maximum output pulse

Np = 3000rpm/2rpm =1500 pulse number

The DDA cycle can be calculated by follow equation

$$PRmax = \frac{Np}{(DDAcycle + 1) * 1.024ms}$$

$$400{,}000 = \frac{1500}{(DDAcycle + 1) * 1.024ms}$$

DDA cycle = 3

High Speed = 1638 pulse (400,000*4*0.001024)

The above results means that maximum speed is 3000rpm when send command i8091_SET_VAR(0, 3, 2, 2, 1638) to I-8091 card.

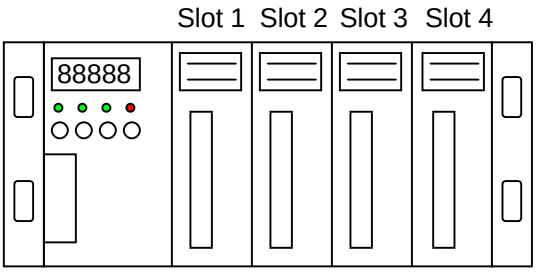
2 Hardware

2.1 I-8000 hardware address

The hardware address of I-8000 main system is fixed as following table. There are 4 slots I-8000 and 8 slots I-8000.

	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Slot 8
I-8000, 4 slot address	0x080	0x0A0	0x0C0	0x0E0	---	---	---	---
I-8000, 8 slot address	0x080	0x0A0	0x0C0	0x0E0	0x140	0x160	0x180	0x1A0

I-8000, 4 slots



I-8000, 8 slots

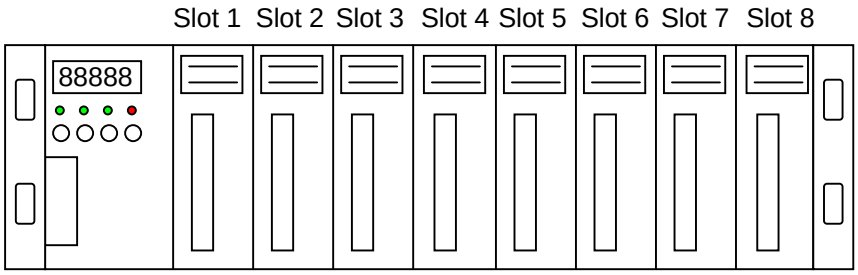


Fig.(3) I-8000 hardware address

2.2 Registers of I-8091 board

The I-8091 card's registers table as following.

Register	Add.	R/W	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ID	0x00	R	0x0E							
LIMIT1	0x01	R	/EMG	/FFFF	/FFEF	/LS14			/LS11	/ORG1
LIMIT2	0x02	R	/YSTOP	/XSTOP		/LS24			/LS21	/ORG2
WRFF	0x01	W	Command port							
RSTFF	0x02	W	Reset FIFO							

Register	Add.	R/W	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ID	0x00	R	0x0E							

The ID register is read only and its value is fixed as 0x0E. User can check this register to identify I-8091 card or not.

Register	Add.	R/W	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
LIMIT1	0x01	R	/EMG	/FFFF	/FFEF	/LS14			/LS11	/ORG1

/ORG1 : original point limit switch of X-axis.

/LS11, /LS14 : limit switches of X-axis, which must be configured as chapter 2.4.1.

/EMG : emergency switch.

/FFEF : active low, indicate FIFO is empty.

/FFFF : active low, indicate FIFO is full.

Register	Add.	R/W	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
LIMIT2	0x02	R	/YSTOP	/XSTOP		/LS24			/LS21	/ORG2

/ORG2 : original point switch of Y-axis.

/LS21, /LS24 : limit switches of Y-axis, which must be configured as chapter 2.4.1.

/XSTOP, /YSTOP : These signals indicate the operating situation of X, Y axis in CPU.

1 : busy, 0 : stop

The commands i8091_WAIT_X( ) and i8091_WAIT_Y( ) just to waiting for

'/XSTOP' or '/YSTOP' signal become to '0'.

Register	Add.	R/W	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
WRFF	0x01	W	Command port							

I-8091 driver will send motion command by way of this register. Please do not use this register to write any thing, or I-8091 will not operate properly.

Register	Add.	R/W	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
RSTFF	0x02	W	Reset FIFO							

This register is used to reset FIFO for clear all of commands pending in the FIFO buffer.

2.3 LED Indicator

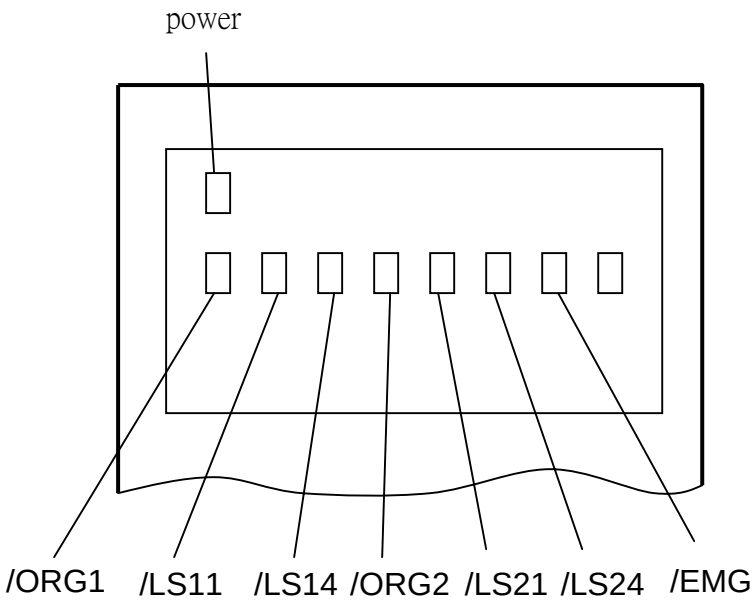


Fig.(4) I-8091 LED indicator

Where

/ORG1: X-axis's original limit switch for machine home position.

/LS11, /LS14 : X-axis's negative and positive limit switches.

/ORG2: Y-axis's original limit switch for machine home position.

/LS21, /LS24 : Y-axis's negative and positive limit switches.

/EMG : system's emergency signal input.

2.4 Hardware Configuration

2.4.1 Limit switch configuration

Because the profile generation and protection is executed by the CPU on I-8091 card, the limit switches must configure as following diagram. The motion command just can work properly.

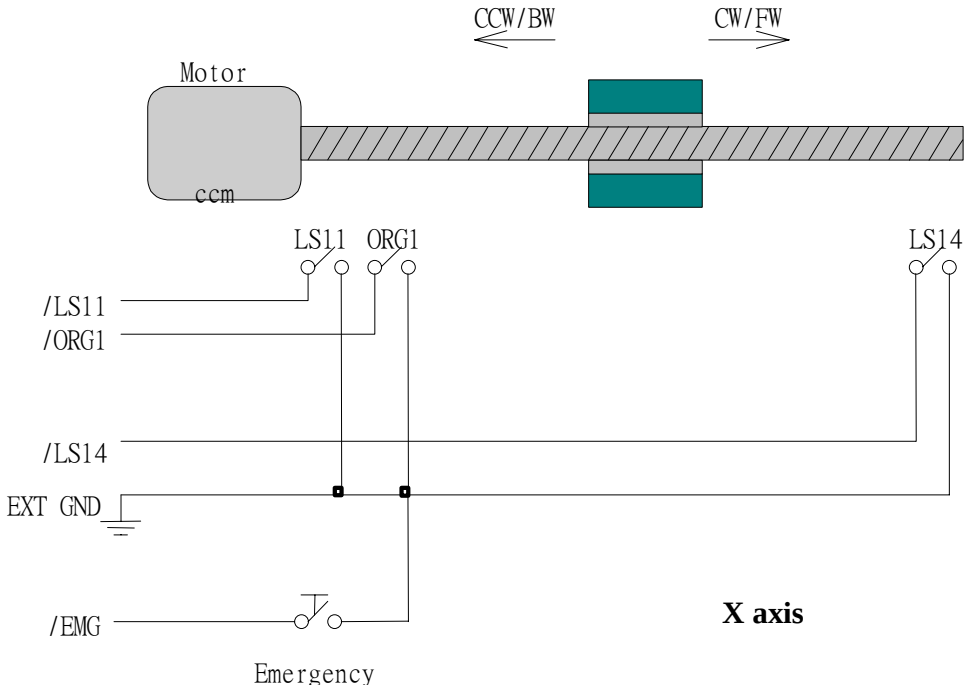


Fig.(5) Limit switch configuration of X axis

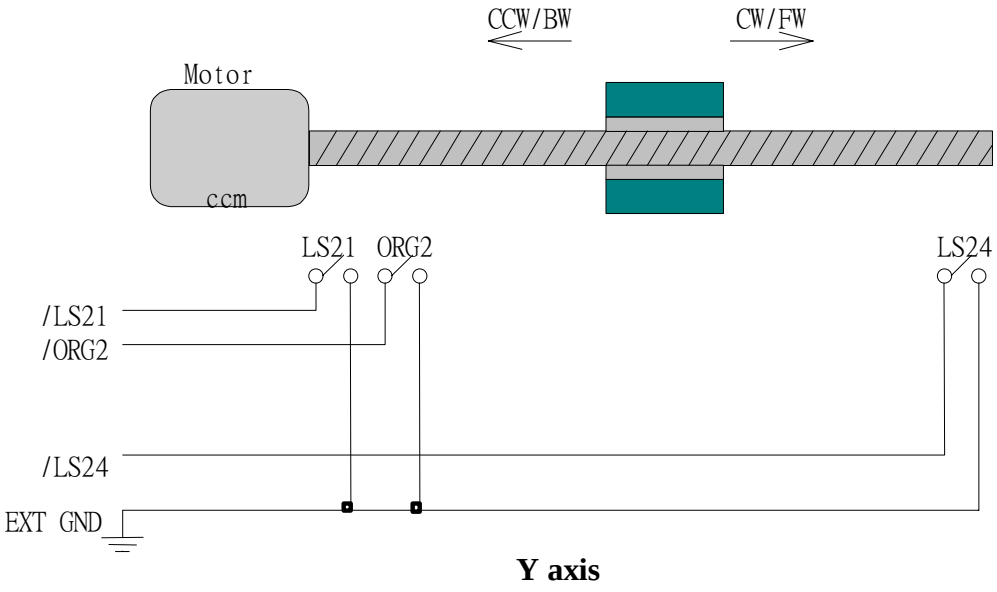


Fig.(6) Limit switch configuration of Y axis

2.4.2 Output pulse mode configuration

I-8091 card provide two kind output method.

(a) CW/CCW mode

(b) Pulse/Direction mode

The command i8091_SET_MODE(cardNo, modeX, modeY) provide parameters CW_CCW (0) and PULSE_DIR (1) to define output pulse mode.

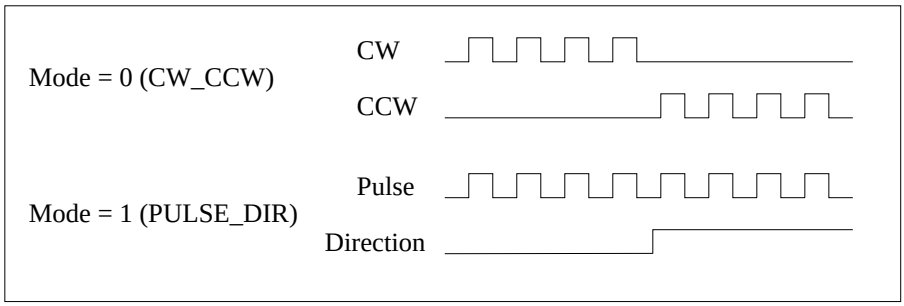


Fig.(7) Output pulse mode

2.4.3 Direction configuration

Sometimes, the output direction of X-axis, Y-axis is not in the desired direction due to the motor's connection or gear train. It is recommended to unify the output direction as shown in Figure(5)(6). The CW/FW direction is defined as toward outside from motor and the CCW/BW direction is defined as toward inside to motor. The i8091_SET_DEFDIR(cardNo, defdirX, defdirY) command provides parameters NORMAL_DIR (0) and REVERSE_DIR (1) to define the rotating direction of motor.

2.4.4 Turn Servo ON/OFF (Hold ON/OFF)

To turn servo motor into servo ON(OFF) state, or turn stepping motor into hold ON(OFF) state, the command i8091_SET_SERVO_ON(cardNo, sonX, sonY) provide parameters ON (1) and OFF (0) to turn ON or OFF.

2.4.5 Automatic protection

The I-8091 card has a automatic protected system.

(a) If X-aixs command is executing and moving toward CW/FW direction,

X-axis will immediately stop when LS14 is touched. To release this protection as long as X-axis move toward CCW/BW direction.

(b) If X-aixs command is executing and moving toward CCW/BW direction, X-axis will immediately stop when LS11 is touched. To release this protection as long as X-axis move toward CW/FW direction.

(c) If Y-aixs command is executing and moving toward CW/FW direction, Y-axis will immediately stop when LS24 is touched. To release this protection as long as Y-axis move toward CCW/BW direction.

(d) If Y-aixs command is executing and moving toward CCW/BW direction, Y-axis will immediately stop when LS21 is touched. To release this protection, as long as Y-axis move toward CW/FW direction.

(e) If the signal of the emergency limit switch /EMG was found in CPU firmware, all motion will be terminated and stop.

2.4.6 Set limit switch as normal close condition

The limit switches /EMG, /LS11, /LS14, /LS21, /LS24, /ORG1, /ORG2 is initially normal open condition, that is, these signal is active when connect it to ground. In industrial application, it might be recommended normal close condition, that is, these signal is active when open from ground.

The i8091_SET_NC(cardNo, sw) command can be set sw=0 (default), for normal open condition. When set sw=1, for normal close condition.

2.5 Connection

2.5.1 Pin assignment of connector CN2

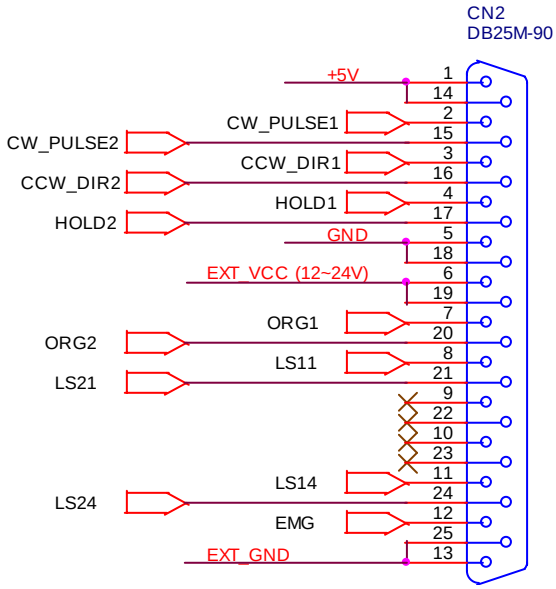


Fig.(8) CN2 connector

Table of CN2 connector's pin assignment

pin name	pin number	Description
+5V	1	Internal +5V power, Max. output current: 50mA
CW_PULSE1	2	X-axis CW (Pulse) output pin
CCW_DIR1	3	X-axis CCW (Direction) output pin
HOLD1	4	X-axis HOLD (servo on) output pin
GND	5	Signal ground of pin 2,3,4
EXT_VCC	6	External power(12~24V) for limit switches
/ORG1	7	X-axis original (home) limit switch
/LS11	8	X-axis limit switch
	9,10	No used
/LS14	11	X-axis limit switch
/EMG	12	Emergency input
EXT_GND	13	External ground for limit switch
+5V	14	Internal +5V power, Max. output current: 50mA
CW_PULSE2	15	Y-axis CW (Pulse) output pin
CCW_DIR2	16	Y-axis CCW (Direction) output pin
HOLD2	17	Y-axis HOLD (servo on) output pin
GND	18	Signal ground of pin 15,16,17

EXT_VCC	19	External power(12~24V) for limit switches
/ORG2	20	Y-axis original (home) limit switch
/LS21	21	Y-axis limit switch
	22,23	No used
/LS24	24	Y-axis limit switch
EXT_GND	25	External ground for limit switch

2.5.2 The internal circuit of CW_PULSE, CCW_DIR, HOLD

When output these signal as 1, it can source 15mA(max.).

When output these signal as 0, it can sink 50mA(max.)

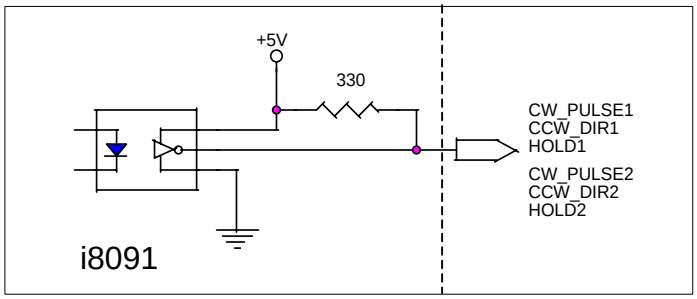


Fig.(9) internal circuit of pulse output pin

2.5.3 The internal circuit of limit switch input

Initially, the limit switch inputs of I-8091 board are normal open (N.O.), the I-8091 board will automatic protect when limit switch pin connect to EXT_GND. The user can use the command i8091_SET_NC (cardNo, YES) to let those limit switch input as normal close condition at the beginning of the user's program.

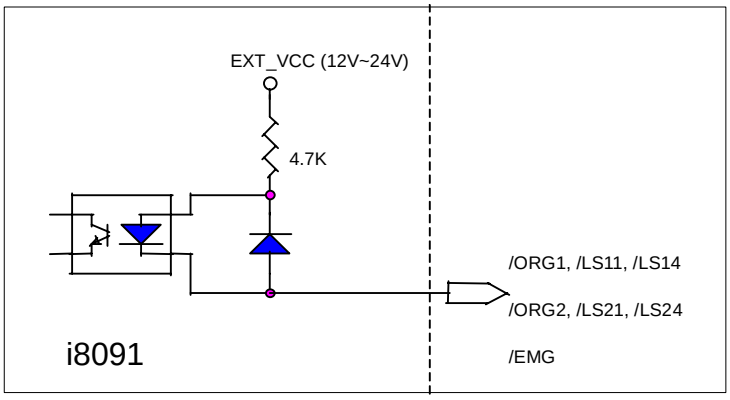


Fig.(10) internal circuit of limit switch input pin

2.5.4 Example of connection

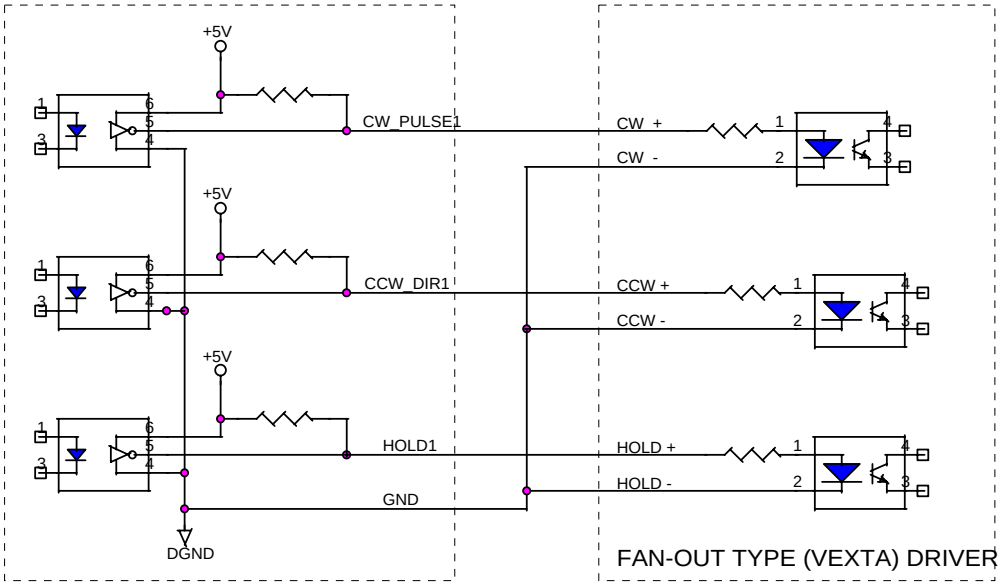


Fig.(11) fan-out type driver (VEXTA's motor driver)

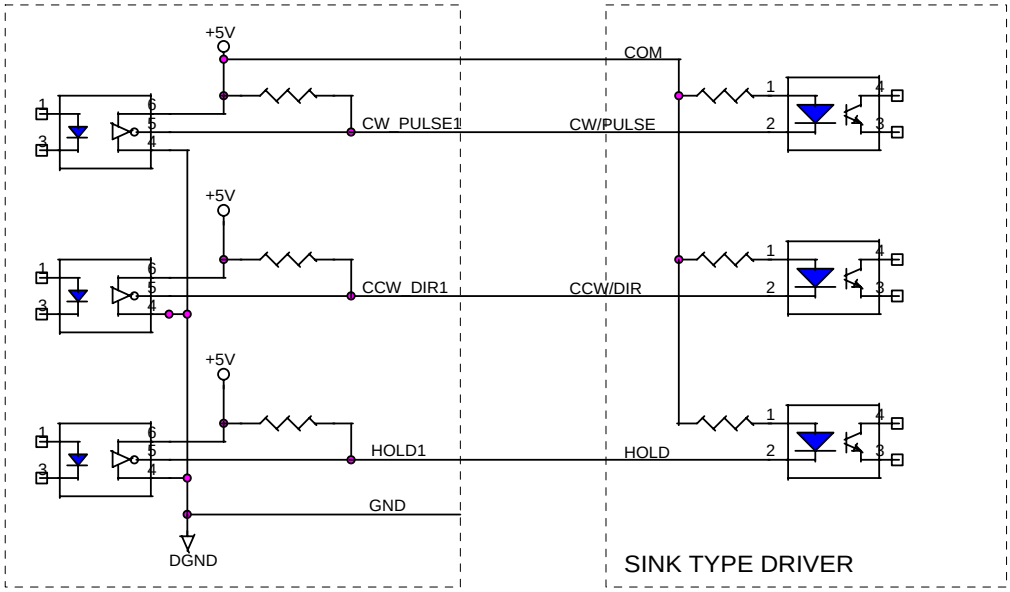


Fig.(12) Sink type driver

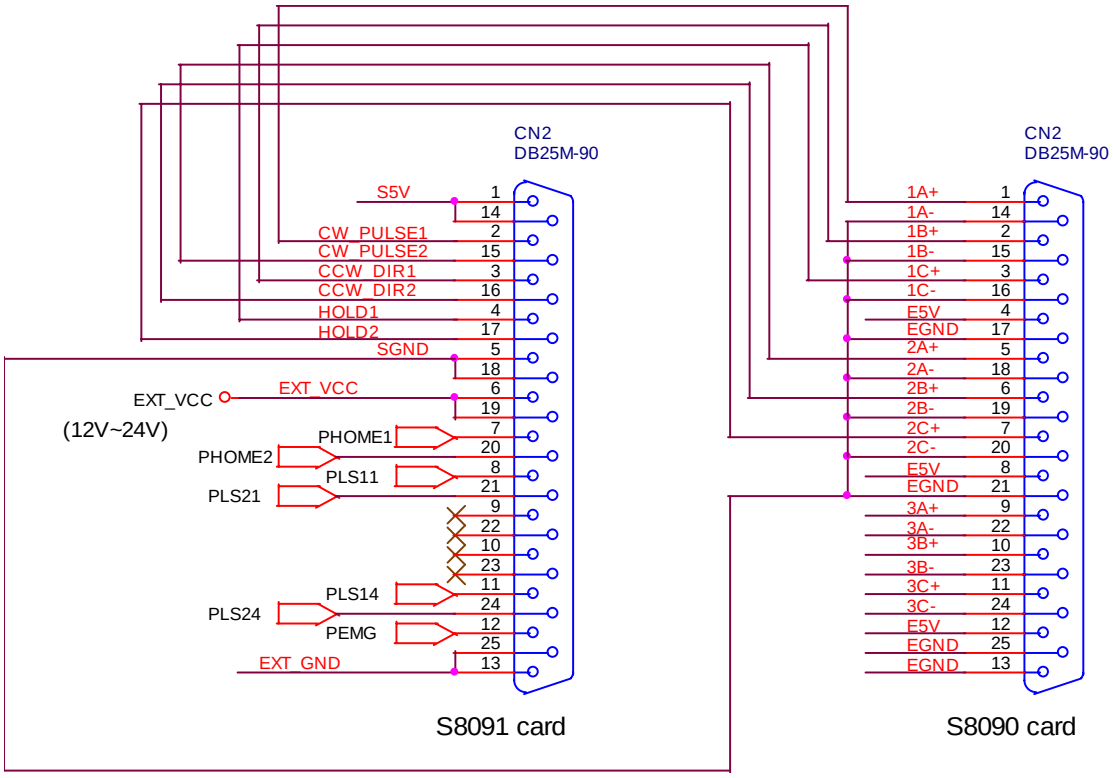


Fig.(13) The connection between I-8090 and I-8091 for function testing or pulse feedback by I-8090 encoder card.

3. Software

User's applications could be compiled under DOS Turbo/borland C/C++ environment. It should be include i8091.h and i8091.LIB to compile the target execution file. The execution files can be downloaded under I-8000 main system (execute 7188x.exe), and then run the target execution file as under PC system. About the I-8000's resource or environment, please refer to the manual of I-8000 system or its software programming guide.

The following section will introduce the I-8091's functions and examples.

3.1 Functions

Constants

```
#define i8091          0x0e
#define YES            1
#define NO             0
#define READY          0
#define BUSY           1
#define ON             1
#define OFF            0
#define CW_CCW         0
#define PULSE_DIR      1
#define NORMAL_DIR     0
#define REVERSE_DIR    1
#define FW             0
#define BW             1
#define CW             0
#define CCW            1
#define X_axis         1
#define Y_axis         2
#define Z_axis         3
```

I-8091 card is a automatic protected system.

(a) If X-aixs command is executing and moving toward CW/FW direction, X-axis will immediately stop when LS14 is touched. To release this protection as long as X-axis move toward CCW/BW direction.

(b) If X-aixs command is executing and moving toward CCW/BW direction, X-axis will immediately stop when LS11 is touched. To release this protection as long as X-axis move toward CW/FW direction.

(c) If Y-aixs command is executing and moving toward CW/FW direction, Y-axis will immediately stop when LS24 is touched. To release this protection as long as Y-axis move toward CCW/BW direction.

(d) If Y-aixs command is executing and moving toward CCW/BW direction, Y-axis will immediately stop when LS21 is touched. To release this protection, as long as Y-axis move toward CW/FW direction.

3.1.1 Setting commands

(1) unsigned char i8091_REGISTRATION(unsigned char cardNo, unsigned int address);

In order to distinguish more than one I-8091 card in I-8000 platform, the I-8091 cards should be registrated before using it. This command will assign a card number="cardNo" to I-8091 card address="address" . If there is not I-8091 at the given address, this command will return "NO".

cardNo : board number 0~19.

address : select the address as well as hardware selected in chapter 2.1.

return NO : board not exist

YES : board exist

Example:

```
i8091_REGISTRATION(1, 0x080);
```

(2) i8091_RESET_SYSTEM(unsigned char cardNo)

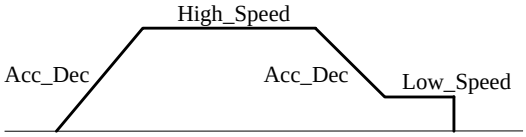
To reset I-8091 card, this command will terminate the running command in I-8091 card. User can use this command as software emergency stop. i8091_RESET_SYSTEM command also will clear all of setting, so, all I-8091 card's parameter should be set again.

cardNo : board number 0~19.

(3) i8091_SET_VAR(unsigned char cardNo,
unsigned char DDA_cycle,
unsigned char Acc_Dec,
unsigned int Low_Speed,
unsigned int High_Speed)

to set DDA cycle, accelerating/decelerating speed, low speed and high speed value.

cardNo : board number 0~19.



Restriction:

$1 \le DDA\_cycle \le 254$

$1 \le Acc\_Dec \le 200$

$1 \le Low\_Speed \le 200$

$Low\_Speed \le High\_Speed \le 2047$

$Low\_Speed >= Acc\_Dec$

default value

DDA_cycle = 10

Acc_Dec = 1

Low_Speed = 10

High_Speed = 100

Example:

i8091_SET_VAR(1, 5, 2, 10, 150);

where

DDA_cycle = 5	--> DDA period = (5+1)*1.024ms = 6.144ms
Acc_Dec = 2	--> Acc/Dec speed = 2/(6.144ms)^2 = 52981 p/s^2
Low_Speed = 10	--> low speed = 10/6.144ms = 1628pps
High_Speed = 150	--> high speed = 150/6.144ms = 24414pps

(4) i8091_SET_DEFDIR(unsigned char cardNo,
unsigned char defdirX,
unsigned char defdirY)

Sometimes, the output direction of X-axis, Y-axis is undesired direction due to the motor's connection or gear train. In oder to unify the output direction as shown in Fig.(5) and Fig.(6). Where CW/FW direction is defined as toward outside from motor, CCW/BW direction is defined as toward inside from motor. i8091_SET_DEFDIR( ) command provide parameters to define the rotating direction of motor.

cardNo : board number 0~19.

defdirX : X axis direction definition

defdirY : Y axis direction definition

0 : NORMAL_DIR

1 : REVERSE_DIR

(5) i8091_SET_MODE(unsigned char cardNo,
unsigned char modeX,
unsigned char modeY)

I-8091 card provide two kind output method.

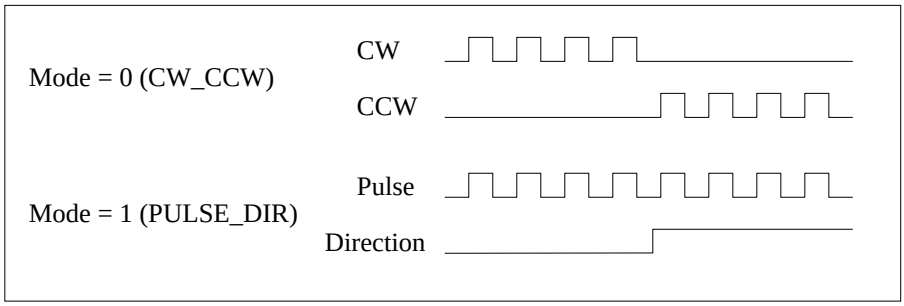
cardNo : board number 0~19.

modeX : X axis output mode

modeY : Y axis output mode

0 : CW_CCW CW/CCW mode

1 : PULSE_DIR Pulse/Direction mode



Example:

i8091_SET_MODE(1,CW_CCW, PULSE_DIR);

(6) i8091_SET_SERVO_ON(unsigned char cardNo,
unsigned char sonX, unsigned char sonY)

To turn servo motor into servo ON(OFF) state, or turn stepping motor into hold ON(OFF) state.

cardNo : board number 0~19.

sonX : X axis servo/hold on switch

sonY : Y axis servo/hold on switch

1 : ON

0 : OFF

(7) i8091_SET_NC(unsigned char cardNo, unsigned char sw);

To set all of the following limit switches as N.C.(normal close) or N.O.(normal open). If set as N.O., those limit switches are active low. If

set as N.C., those limit switches are active high. The auto-protection will automatically change the judgement whatever it is N.O. or N.C..

Limit switches: ORG1, LS11, LS14, ORG2, LS21, LS24, EMG.

cardNo : card number 0~19.

sw: 0(NO) normal open (default).

1(YES) normal close.

3.1.2 Stop Commands

(8) i8091_STOP_X(unsigned char cardNo)

to stop X axis.

cardNo : board number 0~19.

(9) i8091_STOP_Y(unsigned char cardNo)

to stop Y axis.

cardNo : board number 0~19.

(10) i8091_STOP_ALL(unsigned char cardNo)

to stop X, Y axis immediatly.

cardNo : board number 0~19.

This command will clear all of commands pending in the FIFO.

The i8091_RESET_SYSTEM can be used as software emergency stop.

The i8091_RESET_SYSTEM command will terminate the running command and clear all of setting, so, all I-8091 card's parameter should be set again after call i8091_RESET_SYSTEM command.

(11) i8091_EMG_STOP(unsigned char cardNo);

This function is the same as i8091_STOP_ALL(), but i8091_ EMG_STOP() only can be used in interrupt routine.

cardNo : card number 0~19.

This command will clear all of commands pending in the FIFO.

The i8091_RESET_SYSTEM can be used as software emergency stop.

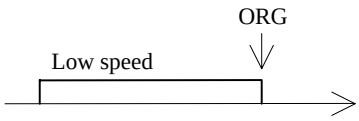
The i8091_RESET_SYSTEM command will terminate the running command and clear all of setting, so, all I-8091 card's parameter should be set again after call i8091_RESET_SYSTEM command.

3.1.3 Simple motion commands

(12) i8091_LSP_ORG(unsigned char cardNo,
unsigned char DIR, unsigned char AXIS)

Low speed move , and stop when **ORG1/ORG2** limit switch is touched.

cardNo : board number 0~19.



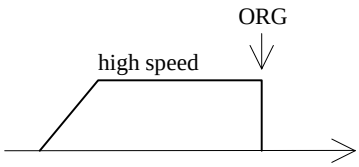
Example:

```
i8091_LSP_ORG(1, CCW, X_axis);
i8091_LSP_ORG(1, CCW, Y_axis);
```

(13) i8091_HSP_ORG(unsigned char cardNo, unsigned char DIR,
unsigned char AXIS)

High speed move , and stop when **ORG1/ORG2** limit switch is touched.

cardNo : board number 0~19.



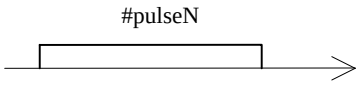
Example:

```
i8091_HSP_ORG(1, CCW, X_axis);
i8091_HSP_ORG(1, CCW, Y_axis);
```

(14) i8091_LSP_PULSE_MOVE(unsigned char cardNo,
unsigned char AXIS, long pulseN)

Low speed move #pulseN

cardNo : board number 0~19.



Example:

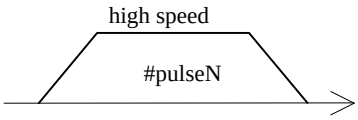
```
i8091_LSP_PULSE_MOVE(1, X_axis, 20000);
```

i8091_LSP_PULSE_MOVE(1, X_axis, -2000);
i8091_LSP_PULSE_MOVE(1, Y_axis, 20000);
i8091_LSP_PULSE_MOVE(1, Y_axis, -2000);

where
when pulseN>0, move toward CW/FW direction
when pulseN<0, move toward CCW/BW direction

(15) i8091_HSP_PULSE_MOVE(unsigned char cardNo, unsigned char AXIS, long pulseN, unsigned int speed)

move #pulseN. by speed
cardNo : board number 0~19.
speed : <2040

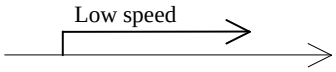


Example:
i8091_HSP_PULSE_MOVE(1, X_axis, 20000,50);
i8091_HSP_PULSE_MOVE(1, X_axis, -2000,70);
i8091_HSP_PULSE_MOVE(1, Y_axis, 20000,50);
i8091_HSP_PULSE_MOVE(1, Y_axis, -2000,60);

where
when pulseN>0, move toward CW/FW direction
when pulseN<0, move toward CCW/BW direction

(16) i8091_LSP_MOVE(unsigned char cardNo, unsigned char DIR, unsigned char AXIS)

Low speed move toward direction DIR. It can be stop by i8091_STOP_X or i8091_STOP_Y or i8091_STOP_ALL command.
cardNo : board number 0~19.



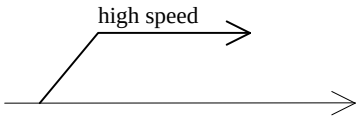
Example:

```
i8091_LSP_MOVE(1, CW, X_axis);
getch( );
i8091_STOP_X(1);
i8091_LSP_MOVE(1, CCW, Y_axis);
getch( );
i8091_STOP_Y(1);
```

(17) i8091_HSP_MOVE(unsigned char cardNo,
unsigned char DIR, unsigned char AXIS)

High speed move toward direction DIR. It can be stop by i8091_STOP_X or i8091_STOP_Y or i8091_STOP_ALL command.

cardNo : board number 0~19.



Example:

```
i8091_HSP_MOVE(1, CW, X_axis);
getch( );
i8091_STOP_X(1);
i8091_HSP_MOVE(1, CCW, Y_axis);
getch( );
i8091_STOP_Y(1);
```

(18) i8091_CSP_MOVE(unsigned char cardNo, unsigned char dir,
unsigned char axis, unsigned int move_speed)

This command will accelerate/decelerate the selected axis's motor to the "move_speed". This command can be continuously send to I-8091 to dynamicly change speed. The rotating motor can be stop by the

command i8091_STOP_X(), i8091_STOP_Y(), i8091_STOP_ALL(), or i8091_SLOW_STOP().

cardNo : board number 0~19.

axis : selected axis.

1 : X axis

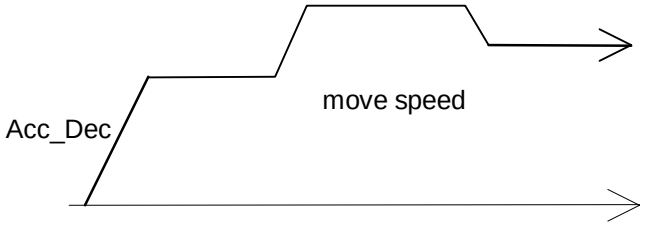
2 : Y axis

dir : moving direction.

0 : CW

1 : CCW

0 < move_speed <= 2040

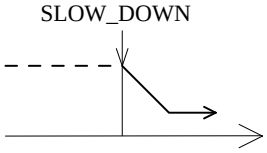


Example:

```
i8091_CSP_MOVE(1, CW, X_axis, 10);
delay(10000);
i8091_CSP_MOVE(1, CW, X_axis, 20);
delay(10000);
i8091_CSP_MOVE(1, CW, X_axis, 30);
delay(10000);
```

(19) i8091_SLOW_DOWN(unsigned char cardNo, unsigned char AXIS)

to decelerate to slow speed until i8091_STOP_X( ) or i8091_STOP_Y() or i8091_STOP_ALL is executed.



Example:

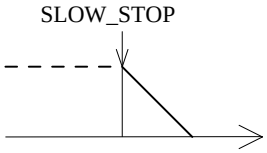
```
i8091_HSP_MOVE(1, CW, X_axis);
```

```
getch( );
i8091_SLOW_DOWN(1, X_axis);
getch( );
i8091_STOP_X(1);
```

(20) i8091_SLOW_STOP(unsigned char cardNo, unsigned char AXIS)

to decelerate to stop.

cardNo : board number 0~19.



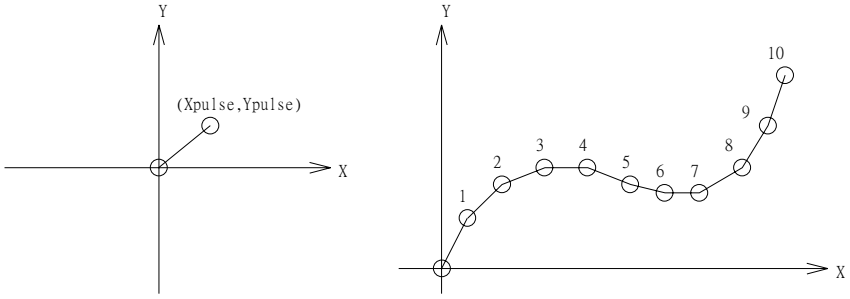
Example:

```
i8091_HSP_MOVE(1, CW, Y_axis);
getch( );
i8091_SLOW_STOP(1, Y_axis);
```

3.1.4 Interpolation commands

(21) i8091_INTP_PULSE(unsigned char cardNo, int Xpulse, int Ypulse)

This command will move a short distance (interpolation short line) in X-Y plane. This command provided a method for user to generate an arbitrary curve in X-Y plane.



cardNo : board number 0~19.

Restriction:

$$-2047 \le \#\ Xpulse \le 2047$$

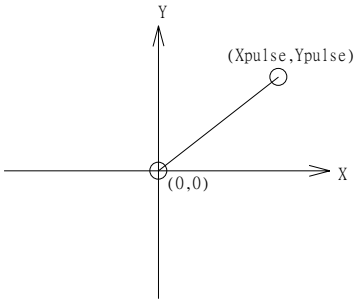
$$-2047 \le \#Ypulse \le 2047$$

Example:

```
i8091_INTP_PULSE(1,20,20);
i8091_INTP_PULSE(1,20,13);
i8091_INTP_PULSE(1,20,7);
i8091_INTP_PULSE(1,20,0);
i8091_INTP_PULSE(1,15,-5);
```

(22) i8091_INTP_LINE(unsigned char cardNo, long Xpulse, long Ypulse)

This command will move a long distance (interpolation line) in X-Y plane. The CPU on I-8091 card will generate a trapezoidal speed profile of X-axis and Y-axis, and execute interpolation by way of DDA chip.



cardNo : board number 0~19.

Restriction:

$$-524287 \le \#Xpulse \le 524287$$

$$-524287 \le \#Ypulse \le 524287$$

Example:

```
i8091_INTP_LINE(1,2000,-3000);
i8091_INTP_LINE(1,-500,200);
```

(23) i8091_INTP_LINE02(unsigned char cardNo, long x, long y
, unsigned int speed
, unsigned char acc_mode)

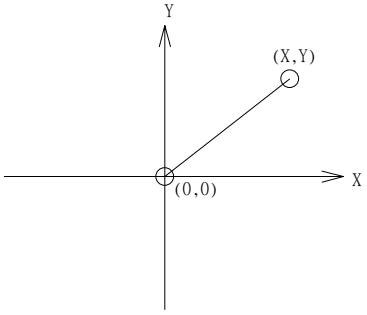
This command will move a long interpolation line in X-Y plane. Host will automaticly generate a trapezoidal speed profile of X-axis and Y-axis by state-machine-type calculation method. The **i8091_INTP_LINE02()** only set parameters into the driver. User can directly call the **do { } while (i8091_INTP_STOP( ) !=READY)** to execute the computing entity.

cardNo : board number 0~19.

speed : 0~2040

acc_mode: 0: enable acceleration and deceleration profile

1: disable acceleration and deceleration profile



Example:

```
i8091_INTP_LINE02(CARD1,1000,1000,100,0);
do { }  while( i8091_INTP_STOP()!=READY) ;  //call state machine
```

(24) i8091_INTP_CIRCLE02(unsigned char cardNo, long x, long y,
unsigned char dir, unsigned int speed,
unsigned char acc_mode)

This command will generate an interpolation circle in X-Y plane. Host will

automaticly generate a trapezoidal speed profile of X-axis and Y-axis by state-machine-type calculation method. The **i8091_INTP_CIRCLE02()** only set parameters into the driver. User can directly call the **do { } while (i8091_INTP_STOP( ) !=READY)** to execute the computing entity.

cardNo : board number 0~19.

x, y : center point of circle relate to present position.

dir : moving direction.

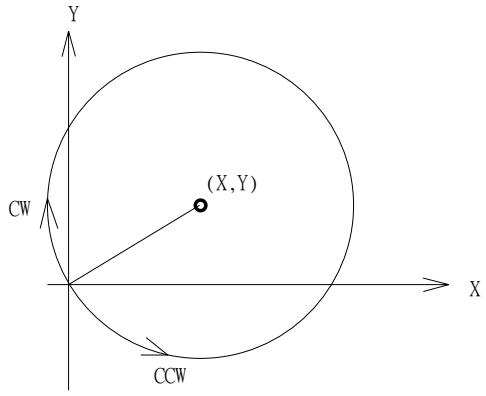
0 : CW

1 : CCW

speed : 0~2040

acc_mode: 0: enable acceleration and deceleration profile

1: disable acceleration and deceleration profile



where radius = sqrt(X^2 + Y^2)

Example:

```
i8091_INTP_CIRCLE02(CARD1,2000,2000,100,0);
do { }  while( i8091_INTP_STOP()!=READY) ;     //call state machine
```

(25) i8091_INTP_ARC02(unsigned char cardNo, long x, long y, long R, unsigned char dir, unsigned int speed, unsigned char acc_mode)

This command will generate an interpolation arc in X-Y plane. Host will automaticly generate a trapezoidal speed profile of X-axis and Y-axis by state-machine-type calculation method. The **i8091_INTP_ARC02()** only set parameters into the driver. User can directly call the **do { } while (i8091_INTP_STOP( ) !=READY)** to execute the computing entity.

cardNo : board number 0~19.

x, y : end point of arc relate to present position.

R : radius of arc.

if R>0 , the arc < 180degree

if R<0 , the arc > 180 degree

dir : moving direction.

0 : CW

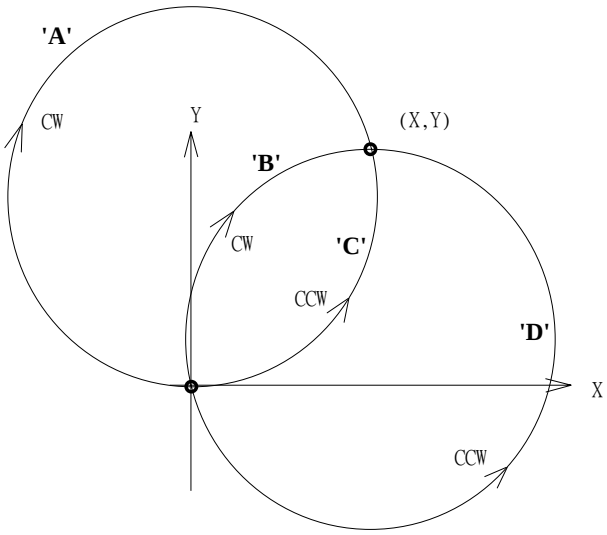
1 : CCW

R	dir	path of curve
R>0	CW	'B'
R>0	CCW	'C'
R<0	CW	'A'
R<0	CCW	'D'

speed : 0~2040

acc_mode: 0: enable acceleration and deceleration profile

1: disable acceleration and deceleration profile



Restriction:

$$-2^{32}+1 \le \#x \le 2^{32}-1$$

$$-2^{32}+1 \le \#y \le 2^{32}-1$$

$$-2^{32}+1 \le \#R \le 2^{32}-1$$

$$R \ge \frac{\sqrt{x^2+y^2}}{2}$$

Example:

```
i8091_INTP_ ARC02(1,2000,-2000,2000,CW,100,0);
do { }  while( i8091_INTP_STOP()!=READY) ;     //call state machine
```

(26) unsigned char i8091_INTP_STOP()

The above 3 state-machine-type interpolation commands **i8091_INTP_LINE02()**, **i8091_INTP_CIRCLE02()** and **i8091_INTP_ARC02()** must use **i8091_INTP_STOP()** simultaneously. The state-machine-type interpolation commands are only set parameters into the driver. The computing entity is in **i8091_INTP_STOP().**

This command will compute the interpolation profile. It will return READY(0) for interpolation command completed. And retrun BUSY(1) for not yet complete.

3.1.5 Others

(27) unsigned char i8091_LIMIT_X(unsigned char cardNo)

to request the condition of X-axis limit switches

cardNo : board number 0~19.

MSB 7	6	5	4	3	2	1	0 LSB
/EMG	/FFFF	/FFEF	/LS14	xx	xx	/LS11	/ORG1

/ORG1 : original point switch of X-axis, low active.

/LS11, /LS14 : limit switches of X-axis, low active, which must be configured as Fig.(5).

/EMG : emergency switch, low active.

/FFEF : active low, FIFO is empty

/FFFF : active low, FIFO is full

Example:

```
unsigned char limit1;
limit1 = i8091_LIMIT_X(1);
```

(28) unsigned char i8091_LIMIT_Y(unsigned char cardNo)

to request the condition of Y-axis limit switches

cardNo : board number 0~19.

MSB 7	6	5	4	3	2	1	0 LSB
ystop	xstop	xx	/LS24	xx	xx	/LS21	/ORG2

/ORG2 : original point switch of Y-axis, low active.

/LS21, /LS24 : limit switches of Y-axis, low active, which must be configured as Fig.(6).

xstop: 1:indicate X-axis is stop

ystop: 1:indicate Y-axis is stop

Example:

```
unsigned char limit2;
limit2 = i8091_LIMIT_Y(1);
```

(29) i8091_WAIT_X(unsigned char cardNo)

to wait X-axis going to STOP state.

cardNo : board number 0~19.

(30) i8091_WAIT_Y(unsigned char cardNo)

to wait Y-axis going to STOP state.

cardNo : board number 0~19.

(31) unsigned char i8091_IS_X_STOP(unsigned char cardNo)

To check whether X axis is STOP or not.

Return value 0 (NO) : not yet stop

1 (YES) : stop

(32) unsigned char i8091_IS_Y_STOP(unsigned char cardNo)

To check whether Y axis is STOP or not.

Return value 0 (NO) : not yet stop

1 (YES) : stop

3.2 Start up and end of program

Start up program

When you are going to use I-8091 card, there are some commands must be implement in previous.

i8091_REGISTRATION(CARD1,0x80)

set CARD1 address, (where CARD1=1)

i8091_RESET_SYSTEM(CARD1);

reset system

i8091_SET_VAR(CARD1, DDA, AD, LSP, HSP);

set DDA cycle, accelerating/decelerating speed, low speed and high speed value

i8091_SET_DEFDIR(CARD1, xdir, ydir);

define direction.

i8091_SET_MODE(CARD1, xmode, ymode);

define output mode.

i8091_SET_SERVO_ON(CARD1, xson, yson);

set servo ON/OFF.

define output mode.

i8091_SET_NC(CARD1, nc);

To config limit switch as N.C. or N.O.

end of program

i8091_RESET_SYSTEM(CARD1);

To reset system

Example

```
//---------------------------------------------------------------------------
-
#define CARD1     1
typedef struct {
  int           address;
  unsigned char DDA,AD;
  unsigned int  LSP,HSP;
  unsigned char xmode,ymode;
  unsigned char xdir,ydir;
  unsigned char xson,yson;
  unsigned char NCmode;
```

```
} i8091CardType;
i8091CardType card1;
//---------------------------------------------------------------------------
void main ()
{
    card1.address=PortAddress[i8091Slot];
    card1.DDA   = 10;
    card1.AD    = 5;
    card1.LSP   = 5;
    card1.HSP   = 100;
    card1.xmode = CW_CCW;
    card1.ymode = CW_CCW;
    card1.xdir  = NORMAL_DIR;
    card1.ydir  = NORMAL_DIR;
    card1.xson  = ON;
    card1.yson  = ON;
    card1.NCmode= OFF;
    i8091_REGISTRATION(CARD1, card1.address);
    i8091_RESET_SYSTEM(CARD1);
    i8091_SET_VAR(CARD1, card1.DDA, card1.AD, card1.LSP, card1.HSP);
    i8091_SET_DEFDIR(CARD1, card1.xdir, card1.ydir);
    i8091_SET_MODE(CARD1, card1.xmode, card1.ymode);
    i8091_SET_SERVO_ON(CARD1, card1.xson, card1.yson);
    i8091_SET_NC(CARD1, card1.NCmode);
    Delay(100);
            .
            .
//--- end of program ----------------------------
   i8091_RESET_SYSTEM(CARD1);
}
```

4. Example

4.1 Detect I-8091 card

```
//---------------------------------------------------
// detect i8090,i8091,i8092 card
//---------------------------------------------------
#include "8000.h"
#include "s8090.h"

#define i8090  0x0d
#define i8091  0x0e
#define i8092  0x0f
#define NOCARD 0x00
#define MAX_SLOT_NO  8
unsigned int PortAddress[8]={0x080, 0x0a0, 0x0c0, 0x0e0, 0x140, 0x160,
0x180, 0x1a0};
//---------------------------------------------------
void main ()
{
unsigned char slot,temp;

 for (slot=0; slot<MAX_SLOT_NO; slot++)
 {
  temp=inportb(PortAddress[slot]);
  switch (temp)
  {
    case i8090: //i8090 3-axis encoder card
          Print("Slot %d = i8090\r\n",SlotNum);
          return i8090;
    case i8091: //i8091 2-axis stepping card
          Print("Slot %d = i8091\r\n",SlotNum);
          return i8091;
    case i8092: //i8092
          Print("Slot %d = i8092\r\n",SlotNum);
```

```
            return i8092;
        default:
            Print("Slot %d = No Card\r\n",SlotNum);
            return NOCARD;
      };
      Delay(500);
    };
  }
```

4.2 Example: DEMO.cpp

```
//---------------------------------------------------------------------------
// demo.cpp for I-8091 card
//
// This program can test all of following command
// ----------------------I-8091 testing kit----------------------------------
// (0)Exit                 (A)i8091_IS_X_STOP       (K)i8091_CSP_MOVE
// (1)i8091_RESET_SYSTEM   (B)i8091_IS_Y_STOP       (L)i8091_SLOW_DOWN
// (2)i8091_SET_VAR        (C)i8091_LIMIT_X         (M)i8091_SLOW_STOP
// (3)i8091_SET_DEFDIR     (D)i8091_LIMIT_Y         (N)i8091_INTP_PULSE
// (4)i8091_SET_MODE       (E)i8091_LSP_ORG         (O)i8091_INTP_LINE
// (5)i8091_SET_SERVO_ON   (F)i8091_HSP_ORG         (P)i8091_INTP_LINE02
// (6)i8091_SET_NC         (G)i8091_LSP_PULSE_MOVE  (Q)i8091_CIRCLE02
// (7)i8091_STOP_X         (H)i8091_HSP_PULSE_MOVE  (R)i8091_ARC02
// (8)i8091_STOP_Y         (I)i8091_LSP_MOVE        (S)User Define Testing
// (9)i8091_STOP_ALL       (J)i8091_HSP_MOVE
//
//  The output pulse amount can be monitored from i8090 card. When directly
//  connect the CW/PULSE, CCW/DIR of i8091 to i8090. The encoder value
//  can be shown on the LED display. Its format as following.
//  ex:    0.2 1 2 8 : X-axis encoder value
//         5 3.4 0 2 : Y-axis encoder value
//         1 0 0.1 0 : Z-axis encoder value
//  the dot(.) stands for which axis.
//---------------------------------------------------------------------------
```

4.3 Example:DEMO1.cpp

```
//---------------------------------------------------------------------------
// demo1.cpp for I-8091 card
//
// This a simple program to test I-8091 command
//  i8091_INTP_LINE()
//  i8091_INTP_LINE02()
//---------------------------------------------------------------------------
```