RTU mode:

Command message:

Address	01H
Function	08H
Data address	00H
	00H
Data content	17H
	70H
CRC CHK Low	EEH
CRC CHK High	1FH

Response message:

Address	01H
Function	08H
Data address	00H
	00H
Data content	17H
	70H
CRC CHK Low	EEH
CRC CHK High	1FH

(4) 10H: write multiple registers (write multiple data to registers)

Example: Set the multi-step speed,

Pr.05.00=50.00 (1388H), Pr.05.01=40.00 (0FA0H). AC drive address is 01H.

ASCII Mode:

Command message:

STX	‘:’
Address 1	‘0’
Address 0	‘1’
Function 1	‘1’
Function 0	‘0’
Starting data address	‘0’
	‘5’
	‘0’
	‘0’
Number of data (count by word)	‘0’
	‘0’
	‘0’
	‘2’
Number of data (count by byte)	‘0’
	‘4’
The first data content	‘1’
	‘3’
	‘8’
	‘8’
The second data content	‘0’
	‘F’
	‘A’
	‘0’
LRC Check	‘9’
	‘A’
END	CR

Response message:

STX	‘:’
Address 1	‘0’
Address 0	‘1’
Function 1	‘1’
Function 0	‘0’
Starting data address	‘0’
	‘5’
	‘0’
	‘0’
Number of data (count by word)	‘0’
	‘0’
	‘0’
	‘2’
LRC Check	‘E’
	‘8’
END	CR
	LF

Command message:

	LF

Response message:

RTU mode:

Command message:

Address	01H
Function	10H
Starting data address	05H
	00H
Number of data (count by word)	00H'
	02H
Number of data (count by byte)	04
The first data content	13H
	88H
The second data content	0FH
	A0H
CRC Check Low	4DH
CRC Check High	D9H

Response message:

Address	01H
Function	10H
Starting data address	05H
	00H
Number of data (count by word)	00H
	02H
CRC Check Low	41H
CRC Check High	04H

3.4 Check sum

ASCII mode:

LRC (Longitudinal Redundancy Check) is calculated by summing up, module 256, the values of the bytes from ADR1 to last data character then calculating the hexadecimal representation of the 2's-complement negation of the sum.

For example, reading 1 word from address 0401H of the AC drive with address 01H.

STX	':'
Address 1	'0'
Address 0	'1'
Function 1	'0'
Function 0	'3'
Starting data address	'0'
	'4'
	'0'
	'1'
Number of data	'0'
	'0'
	'0'
	'1'
LRC Check 1	'F'
LRC Check 0	'6'
END 1	CR
END 0	LF

01H+03H+04H+01H+00H+01H=0AH, the 2's-complement negation of 0AH is F6H.

RTU mode:

Address	01H

Function	03H
Starting data address	21H
	02H
Number of data (count by word)	00H
	02H
CRC CHK Low	6FH
CRC CHK High	F7H

CRC (Cyclical Redundancy Check) is calculated by the following steps:

Step 1: Load a 16-bit register (called CRC register) with FFFFH.

Step 2: Exclusive OR the first 8-bit byte of the command message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.

Step 3: Examine the LSB of CRC register.

Step 4: If the LSB of CRC register is 0, shift the CRC register one bit to the right with MSB zero filling, then repeat step 3. If the LSB of CRC register is 1, shift the CRC register one bit to the right with MSB zero filling, Exclusive OR the CRC register with the polynomial value A001H, then repeat step 3.

Step 5: Repeat step 3 and 4 until eight shifts have been performed. When this is done, a complete 8-bit byte will have been processed.

Step 6: Repeat step 2 to 5 for the next 8-bit byte of the command message. Continue doing this until all bytes have been processed. The final contents of the CRC register are the CRC value. When transmitting the CRC value in the message, the upper and lower bytes of the CRC value must be swapped, i.e. the lower order byte will be transmitted first.

The following is an example of CRC generation using C language. The function takes two arguments:

Unsigned char* data ← a pointer to the message buffer

Unsigned char length ← the quantity of bytes in the message buffer

The function returns the CRC value as a type of unsigned integer.

```
Unsigned int crc_chk(unsigned char* data, unsigned char length){
  int j;
  unsigned int reg_crc=0xFFFF;
  while(length--){
    reg_crc ^= *data++;
    for(j=0;j<8;j++){
      if(reg_crc & 0x01){  /* LSB(b0)=1 */
        reg_crc=(reg_crc>>1) ^ 0xA001;
```


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```
    }else{
      reg_crc=reg_crc >>1;
    }
   }
  }
 return reg_crc;
}
```

3.5 Address list

The contents of available addresses are shown as below:

Content	Address	Function	
AC drive Parameters	GGnnH	GG means parameter group, nn means parameter number, for example, the address of Pr 04.01 is 0401H. Refer to chapter 5 for the function of each parameter. When reading parameter by command code 03H, only one parameter can be read at one time.	
Command Write only	2000H	Bit 0-1	00B: No function 01B: Stop 10B: Run 11B: Jog + Run
		Bit 2-3	Reserved
		Bit 4-5	00B: No function 01B: FWD 10B: REV 11B: Change direction
		Bit 6-7	00B: Comm. forced 1st accel/decel 01B: Comm. forced 2nd accel/decel
		Bit 8-15	Reserved
	2001H	Frequency command	
	2002H	Bit 0	1: EF (external fault) on
		Bit 1	1: Reset
		Bit 2-15	Reserved
Status monitor Read only	2100H	Error code:	
		0: No error occurred	
		1: Over-current (oc)	

Content	Address	Function
		2: Over-voltage (ov)
		3: IGBT Overheat (oH1)
		4: Power Board Overheat (oH2)
		5: Overload (oL)
		6: Overload1 (oL1)
		7: Overload2 (oL2)
		8: External fault (EF)
		9: Current exceeds 2 times rated current during accel (ocA)
		10: Current exceeds 2 times rated current during decel (ocd) Current exceeds 2 times rated current during decel (ocd)
		11: Current exceeds 2 times rated current during steady state operation (ocn)
		12: Ground Fault (GFF)
		13: Low voltage (Lv)
		14: PHL (Phase-Loss)
	2100H	15: Base Block
		16: Auto accel/decel failure (cFA)
		17: Software protection enabled (codE)
		18: Power Board CPU WRITE failure (CF1.0)
		19: Power Board CPU READ failure (CF2.0)
		20: CC, OC Hardware protection failure (HPF1)
		21: OV Hardware protection failure (HPF2)
		22: GFF Hardware protection failure (HPF3)
		23: OC Hardware protection failure (HPF4)
		24: U-phase error (cF3.0)
		25: V-phase error (cF3.1)
		26: W-phase error (cF3.2)
		27: DCBUS error (cF3.3)
		28: IGBT Overheat (cF3.4)
		29: Power Board Overheat (cF3.5)
		30: Control Board CPU WRITE failure (cF1.1)

Content	Address	Function	
		31: Control Board CPU WRITE failure (cF2.1)	
		32: ACI signal error (AErr)	
		33: Reserved	
		34: Motor PTC overheat protection (PtC1)	
		35: PG feedback signal error (PGEr)	
		36~39: Reserved	
		40: Communication time-out error of control board and power board (CP10)	
		41: dEb error	
		42: ACL (Abnormal Communication Loop)	
	2101H	Status of AC drive	
		Bit 0-1	00B: RUN LED is off, STOP LED is on (The AC motor Drive stops)
			01B: RUN LED blinks, STOP LED is on (When AC motor drive decelerates to stop)
			10B: RUN LED is on, STOP LED blinks (When AC motor drive is standby)
			11B: RUN LED is on, STOP LED is off (When AC motor drive runs)
		Bit 2	1: JOG command
		Bit 3-4	00B: FWD LED is on, REV LED is off (When AC motor drive runs forward)
			01B: FWD LED is on, REV LED blinks (When AC motor drive runs from reverse to forward)
			10B: FWD LED blinks, REV LED is on (When AC motor drive runs from forward to reverse)
			11B: FWD LED is off, REV LED is on (When AC motor drive runs reverse)
		Bit 5-7	Reserved
		Bit 8	1: Master frequency Controlled by communication interface
		Bit 9	1: Master frequency controlled by analog signal
		Bit 10	1: Operation command controlled by communication interface
		Bit 11-15	Reserved

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Content	Address	Function
	2102H	Frequency command (F)
	2103H	Output frequency (H)
	2104H	Output current (AXXX.X)
	2105H	Reserved
	2106H	Reserved
	2107H	Reserved
	2108H	DC-BUS Voltage (UXXX.X)
	2109H	Output voltage (EXXX.X)
	210AH	Display temperature of IGBT (°C)
	2116H	User defined (Low word)
	2117H	User defined (High word)

Note: 2116H is number display of Pr.00.04. High byte of 2117H is number of decimal places of 2116H. Low byte of 2117H is ASCII code of alphabet display of Pr.00.04.

3.6 Exception response:

The AC motor drive is expected to return a normal response after receiving command messages from the master device. The following depicts the conditions when no normal response is replied to the master device.

The AC motor drive does not receive the messages due to a communication error; thus, the AC motor drive has no response. The master device will eventually process a timeout condition.

The AC motor drive receives the messages without a communication error, but cannot handle them. An exception response will be returned to the master device and an error message "CExx" will be displayed on the keypad of AC motor drive. The xx of "CExx" is a decimal code equal to the exception code that is described below.

In the exception response, the most significant bit of the original command code is set to 1, and an exception code which explains the condition that caused the exception is returned.

Example of an exception response of command code 06H and exception code 02H:

ASCII mode:

STX	':'
Address Low	'0'
Address High	'1'

RTU mode:

Address	01H
Function	86H
Exception code	02H

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Function Low Function High	'8'
	'6'
Exception code	'0'
	'2'
LRC CHK Low LRC CHK High	'7'
	'7'
END 1 END 0	CR
	LF

CRC CHK Low	C3H
CRC CHK High	A1H

The explanation of exception codes:

Exception code	Explanation
01	Illegal function code: The function code received in the command message is not available for the AC motor drive.
02	Illegal data address: The data address received in the command message is not available for the AC motor drive.
03	Illegal data value: The data value received in the command message is not available for the AC drive.
04	Slave device failure: The AC motor drive is unable to perform the requested action.
10	Communication time-out: If Pr.09.03 is not equal to 0.0, Pr.09.02=0~2, and there is no communication on the bus during the Time Out detection period (set by Pr.09.03), "cE10" will be shown on the keypad.

3.7 Communication program of PC:

The following is a simple example of how to write a communication program for Modbus ASCII mode on a PC in C language.

```
#include<stdio.h>
#include<dos.h>
#include<conio.h>
#include<process.h>
#define PORT 0x03F8  /* the address of COM1 */
/* the address offset value relative to COM1 */
```


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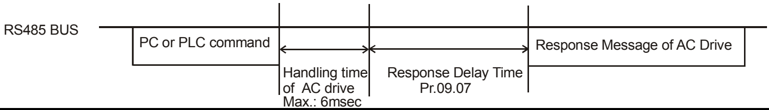
```
#define THR  0x0000
#define RDR  0x0000
#define BRDL  0x0000
#define IER  0x0001
#define BRDH 0x0001
#define LCR  0x0003
#define MCR  0x0004
#define LSR  0x0005
#define MSR  0x0006
unsigned char rdat[60];
/* read 2 data from address 2102H of AC drive with address 1 */
unsigned char tdat[60]={':','0','1','0','3','2','1','0','2', '0','0','0','2','D','7','\r','\n'};
void main(){
int i;
outportb(PORT+MCR,0x08);           /* interrupt enable */
outportb(PORT+IER,0x01);           /* interrupt as data in */
outportb(PORT+LCR,(inportb(PORT+LCR) | 0x80));
/* the BRDL/BRDH can be access as LCR.b7==1 */
outportb(PORT+BRDL,12);            /* set baudrate=9600, 12=115200/9600*/
outportb(PORT+BRDH,0x00);
outportb(PORT+LCR,0x06);           /* set protocol, <7,N,2>=06H, <7,E,1>=1AH,
<7,O,1>=0AH, <8,N,2>=07H, <8,E,1>=1BH, <8,O,1>=0BH   */
for(i=0;i<=16;i++){
while(!(inportb(PORT+LSR) & 0x20)); /* wait until THR empty */
outportb(PORT+THR,tdat[i]);      /* send data to THR */   }
i=0;
while(!kbhit()){
if(inportb(PORT+LSR) & 0x01){ /* b0==1, read data ready */
rdat[i++]=inportb(PORT+RDR); /* read data form RDR */
}   }    }
```

09.05	Reserved
09.06	Reserved

09.07	✔Response Delay Time		Unit: 2ms
	Settings	0 ~ 200 (400msec)	Factory Setting: 1

📖 This parameter is the response delay time after AC drive receives communication command as shown in the following. 1 unit = 2 msec.



09.08 ⚡Transmission Speed for USB Card

Factory Setting: 2

Settings	0	Baud rate 4800 bps
	1	Baud rate 9600 bps
	2	Baud rate 19200 bps
	3	Baud rate 38400 bps
	4	Baud rate 57600 bps

📖 This parameter is used to set the transmission speed for USB card.

09.09 ⚡Communication Protocol for USB Card

Factory Setting: 1

Settings	0	Modbus ASCII mode, protocol <7,N,2>
	1	Modbus ASCII mode, protocol <7,E,1>
	2	Modbus ASCII mode, protocol <7,O,1>
	3	Modbus RTU mode, protocol <8,N,2>
	4	Modbus RTU mode, protocol <8,E,1>
	5	Modbus RTU mode, protocol <8,O,1>
	6	Modbus RTU mode, protocol <8,N,1>
	7	Modbus RTU mode, protocol <8,E,2>
	8	Modbus RTU mode, protocol <8,O,2>
	9	Modbus ASCII mode, protocol <7,N,1>
	10	Modbus ASCII mode, protocol <7,E,2>
	11	Modbus ASCII mode, protocol <7,O,2>

09.10 ⚡Transmission Fault Treatment for USB Card

Factory Setting: 0

Settings	0	Warn and keep operating
	1	Warn and RAMP to stop
	2	Warn and COAST to stop
	3	No warning and keep operating

- This parameter is set to how to react when transmission errors occurs.
- Setting 0: when transmission errors occur, it will display warning message “cEXX” on the digital keypad and the motor will keep running. The warning message can be cleared after the communication is normal.
- Setting 1: when transmission errors occur, it will display warning message “cEXX” on the digital keypad and the motor will stop by the deceleration time (Pr.01.10/01.12). It needs to press “RESET” to clear the warning message.
- Setting 2: When transmission errors occur, it will display warning message “cEXX” on the digital keypad and the motor will free run to stop immediately. It needs to press “RESET” to clear the warning message.
- Setting 3: When transmission errors occur, it won’t display any warning message on the digital keypad and the motor will still keep running.
- See list of error messages below (see section 3.6 in Pr.09.04)

NOTE

The digital keypad is optional. Please refer to Appendix B for details. When using without this optional keypad, the FAULT LED will be ON once there is error messages or warning messages from the external terminals.

09.11	⚡Time-out Detection for USB Card		Unit: second
	Settings	0.0 to 120.0 sec	Factory Setting: 0.0
		0.0 Disable	

09.12	COM port for PLC Communication (NOT for VFD*E*C models)		
			Factory Setting: 0
	Settings	0 RS485	
		1 USB card	

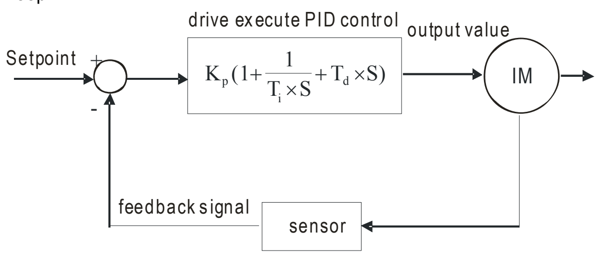
Group 10: PID Control

A. Common applications for PID control

1. Flow control: A flow sensor is used to feedback the flow data and perform accurate flow control.
2. Pressure control: A pressure sensor is used to feedback the pressure data and perform precise pressure control.
3. Air volume control: An air volume sensor is used to feedback the air volume data to have excellent air volume regulation.
4. Temperature control: A thermocouple or thermistor is used to feedback temperature data for comfortable temperature control.
5. Speed control: A speed sensor or encoder is used to feedback motor shaft speed or input another machines speed as a target value for closed loop speed control of master-slave operation.

Pr.10.00 sets the PID setpoint source (target value). PID control operates with the feedback signal as set by Pr.10.01 either 0~+10V voltage or 4-20mA current.

B. PID control loop:



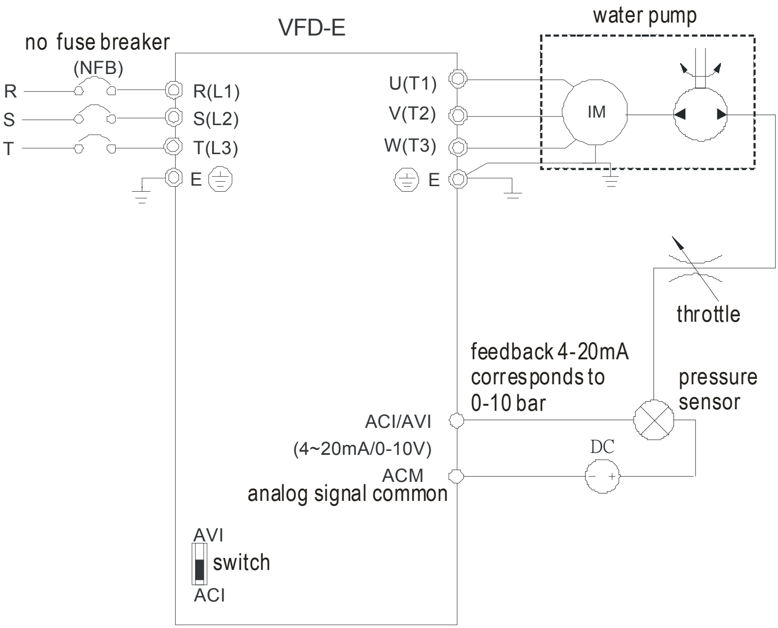
K_p: Proportional gain(P) T_i: Integral time(I) T_d: Derivative control(D) S: Operator

C. Concept of PID control

1. Proportional gain(P): the output is proportional to input. With only proportional gain control, there will always be a steady-state error.
2. Integral time(I): the controller output is proportional to the integral of the controller input. To eliminate the steady-state error, an “integral part” needs to be added to the controller. The integral time decides the relation between integral part and error. The integral part will be increased by time even if the error is small. It gradually increases the controller output to eliminate the error until it is 0. In this way a system can be stable without steady-state error by proportional gain control and integral time control.

3. Differential control(D): the controller output is proportional to the differential of the controller input. During elimination of the error, oscillation or instability may occur. The differential control can be used to suppress these effects by acting before the error. That is, when the error is near 0, the differential control should be 0. Proportional gain(P) + differential control(D) can be used to improve the system state during PID adjustment.

D. When PID control is used in a constant pressure pump feedback application:
Set the application's constant pressure value (bar) to be the setpoint of PID control. The pressure sensor will send the actual value as PID feedback value. After comparing the PID setpoint and PID feedback, there will be an error. Thus, the PID controller needs to calculate the output by using proportional gain(P), integral time(I) and differential time(D) to control the pump. It controls the drive to have different pump speed and achieves constant pressure control by using a 4-20mA signal corresponding to 0-10 bar as feedback to the drive.



1. Pr.00.04 is set to 5 (Display PID analog feedback signal value (b) (%))
2. Pr.01.09 Acceleration Time will be set as required

3. Pr.01.10 Deceleration Time will be set as required

4. Pr.02.01=1 to operate from the digital keypad

5. Pr.10.00=1, the setpoint is controlled by the digital keypad

6. Pr.10.01=3(Negative PID feedback from external terminal ACI (4 ~ 20mA)/ AVI2 (0 ~ +10VDC))

7. Pr.10.01-10.17 will be set as required

7.1 When there is no vibration in the system, increase Pr.10.02(Proportional Gain (P))

7.2 When there is no vibration in the system, reduce Pr.10.03(Integral Time (I))

7.3 When there is no vibration in the system, increase Pr.10.04(Differential Time(D))

8. Refer to Pr.10.00-10.17 for PID parameters settings.

10.00 PID Set Point Selection

Factory Setting: 0

Settings	0	Disable
	1	Digital keypad UP/DOWN keys
	2	AVI 0 ~ +10VDC
	3	ACI 4 ~ 20mA / AVI2 0 ~ +10VDC
	4	PID set point (Pr.10.11)

10.01 Input Terminal for PID Feedback

Factory Setting: 0

Settings	0	**Positive** PID feedback from external terminal AVI (0 ~ +10VDC).
	1	**Negative** PID feedback from external terminal AVI (0 ~ +10VDC).
	2	**Positive** PID feedback from external terminal ACI (4 ~ 20mA)/ AVI2 (0 ~ +10VDC).
	3	**Negative** PID feedback from external terminal ACI (4 ~ 20mA)/ AVI2 (0 ~ +10VDC).

📖 Note that the measured variable (feedback) controls the output frequency (Hz).

📖 When Pr.10.00=2 or 3, the set point (Master Frequency) for PID control is obtained from the AVI or ACI/AVI2 external terminal (0 to +10V or 4-20mA) or from multi-step speed. When Pr.10.00=1, the set point is obtained from the keypad.

📖 When Pr.10.01=1 or 3 (Negative feedback): Error (Err) = setpoin(SP) – feedback(FB). When the feedback will be increased by the increasing output frequency, please use this setting.

- When Pr.10.01= to 0 or 2 (Positive feedback): Error (Err) =feedback(FB)- setpoint(SP) When the feedback will be decreased by the increasing output frequency, please use this setting.
- Select input terminal accordingly. Make sure this parameter setting does not conflict with the setting for Pr.10.00 (Master Frequency).
- Related parameters: Pr.00.04 Content of Multi-function Display (set to 5 Display PID analog feedback signal value (b) (%)), Pr. 10.11(Source of PID Set point) and Pr.04.19(ACI/AVI2 Selection)

10.11	✓Source of PID Set point		Unit: Hz
	Settings	0.00 to 600.0Hz	Factory Setting: 0.00

- This parameter is used in conjunction with Pr.10.00 set 4 to input a set point in Hz.

10.02	✓Proportional Gain (P)		
	Settings	0.0 to 10.0	Factory Setting: 1.0

- It is used to eliminate the system error. It is usually used to decrease the error and get the faster response speed. But if setting too large value in Pr.10.02, it may cause the system oscillation and instability.
- It can be used to set the proportional gain to decide the responds speed. The larger value is set in Pr.10.02, the faster response it will get. The smaller value is set in Pr.10.02, the slower response it will get.
- If the other two gains (I and D) are set to zero, proportional control is the only one effective.
- Related parameters: Pr.10.03(Integral Time (I)) and Pr.10.04(Differential Control (D))

10.03	✓Integral Time (I)		Unit: second
	Settings	0.00 to 100.0 sec	Factory Setting: 1.00
		0.00 Disable	

- The integral controller is used to eliminate the error during stable system. The integral control doesn't stop working until error is 0. The integral is acted by the integral time. The smaller integral time is set, the stronger integral action will be. It is helpful to reduce overshoot and oscillation to make a stable system. At this moment, the decreasing error will be slow. The integral control is often used with other two controls to become PI controller or PID controller.
- This parameter is used to set the integral time of I controller. When the integral time is long, it will have small gain of I controller, the slower response and bad external control. When the

integral time is short, it will have large gain of I controller, the faster response and rapid external control.

- When the integral time is too small, it may cause system oscillation.
- When it is set to 0.0, the integral function is disabled.
- Related parameter: Pr.10.05(Upper Bound for Integral Control)

10.04	⁄Differential Control (D)		Unit: second
	Settings	0.00 to 1.00 sec	Factory Setting: 0.00

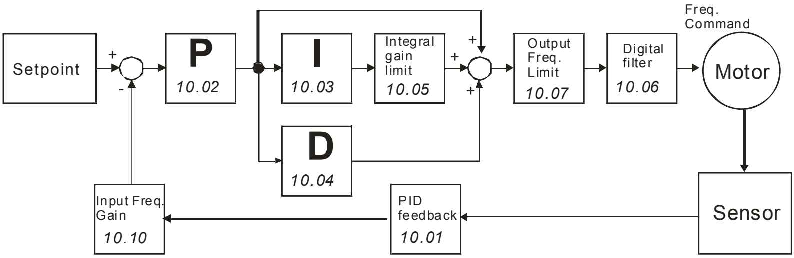
- The differential controller is used to show the change of system error and it is helpful to preview the change of error. So the differential controller can be used to eliminate the error to improve system state. With the suitable differential time, it can reduce overshoot and shorten adjustment time. However, the differential operation will increase the noise interference. Please note that too large differential will cause big noise interference. Besides, the differential shows the change and the output of the differential will be 0 when there is no change. Therefore, the differential control can't be used independently. It needs to be used with other two controllers to make a PD controller or PID controller.
- This parameter can be used to set the gain of D controller to decide the response of error change. The suitable differential time can reduce the overshoot of P and I controller to decrease the oscillation and have a stable system. But too long differential time may cause system oscillation.
- The differential controller acts for the change of error and can't reduce the interference. It is not recommended to use this function in the serious interference.

10.05	Upper Bound for Integral Control		Unit: %
	Settings	0 to 100 %	Factory Setting: 100

- This parameter defines an upper bound or limit for the integral gain (I) and therefore limits the Master Frequency. The formula is: Integral upper bound = Maximum Output Frequency (Pr.01.00) x (Pr.10.05).
- Too large integral value will make the slow response due to sudden load change. In this way, it may cause motor stall or machine damage.
- Related parameter: Pr.01.00(Maximum Output Frequency (Fmax))

10.06	Primary Delay Filter Time	Unit: second
Settings	0.0 to 2.5 sec	Factory Setting: 0.0

- It is used to set the time that required for the low-pass filter of PID output. Increasing the setting, it may affect the drive's response speed.
- The frequency output of PID controller will filter after primary delay filter time. It can smooth the change of the frequency output. The longer primary delay filter time is set, the slower response time it will be.
- The unsuitable primary delay filter time may cause system oscillation.
- PID control can be used for speed, pressure and flow control. It needs to use with the relevant equipment of sensor feedback for PID control. Refer to the following for the closed-loop control diagram.



10.07	PID Output Frequency Limit	Unit: %
Settings	0 to 110 %	Factory Setting: 100

- This parameter defines the percentage of output frequency limit during the PID control. The formula is Output Frequency Limit = Maximum Output Frequency (Pr.01.00) X Pr.10.07 %. This parameter will limit the Maximum Output Frequency. An overall limit for the output frequency can be set in Pr.01.07.
- Related parameter: Pr.01.00(Maximum Output Frequency (Fmax))

10.08	PID Feedback Signal Detection Time	Unit: second
Settings	0.0 to d 3600 sec	Factory Setting: 60.0

- This parameter defines the time during which the PID feedback must be abnormal before a warning (see Pr.10.09) is given. It also can be modified according to the system feedback signal time.
- If this parameter is set to 0.0, the system would not detect any abnormality signal.

- If it doesn't receive PID feedback signal over Pr.10.08 setting, the feedback signal fault will occur and please refer to Pr.10.09 for the fault treatment.
- Related parameter: Pr.10.09(Treatment of the Erroneous PID Feedback Signals)

10.09	Treatment of the Erroneous Feedback Signals (for PID feedback error)	
		Factory Setting: 0
Settings	0	Warning and RAMP to stop
	1	Warning and COAST to stop
	2	Warning and keep operating

- AC motor drive action when the feedback signals (analog PID feedback) are abnormal according to Pr.10.16.
- Setting Pr.10.09 to 0: When the feedback signal fault occurs, it will display "FbE" on the digital keypad and the motor will stop to 0Hz by Pr.01.10/Pr.01.12 setting. It needs to clear "RESET" to clear the warning message.
- Setting Pr.10.09 to 1: When the feedback signal fault occurs, it will display "FbE" on the digital keypad and the motor will free run to stop. It needs to press "RESET" to clear the warning message.
- Setting Pr.10.09 to 2: When the feedback signal fault occurs, it will display "FbE" on the digital keypad and the motor will keep running. The warning message can be cleared after the feedback signal is normal.
- Related parameters" Pr.10.00(PID Set Point Selection), Pr.10.01(Input Terminal for PID Feedback), Pr.10.12(PID Offset Level) and Pr.10.13(Detection Time of PID Offset)

NOTE

The digital keypad is optional. Please refer to Appendix B for details. When using without this optional keypad, the FAULT LED will be ON once there is error messages or warning messages from the external terminals.

10.10	Gain Over the PID Detection Value	
Settings	0.0 to 10.0	Factory Setting: 1.0

- This is the gain adjustment over the feedback detection value.

- This parameter will affect Pr.00.04(setting 5) directly. That is Pr.00.04(setting 5) Display PID analog feedback signal value (b) (%)= PID detection value X Gain Over the PID Detection Value.
- Related parameters: Pr.00.04(Content of Multi-function Display) and Pr.10.01(Input Terminal for PID Feedback)

10.12	PID Offset Level		Unit: %
	Settings	1.0 to 50.0%	Factory Setting: 10.0

- This parameter is used to set max. allowable value of PID error.

10.13	Detection Time of PID Offset		Unit: second
	Settings	0.1 to 300.0 sec	Factory Setting: 5.0

- This parameter is used to set detection of the offset between set point and feedback.
- When the offset is higher than the setting of Pr.10.12 for a time exceeding the setting of Pr.10.13, PID feedback signal fault occurs and operates by the treatment set in Pr.10.09.
- Related parameters: Pr.10.00(PID Set Point Selection), Pr.10.01(Input Terminal for PID Feedback), Pr.10.09(Treatment of the Erroneous PID Feedback Signals) and Pr.10.12(PID Offset Level)

10.17	Minimum PID Output Frequency Selection		
			Factory Setting: 0
	Settings	0	By PID control
		1	By Minimum output frequency (Pr.01.05)

- This is the source selection of minimum output frequency when control is by PID.
- The output of the AC motor drive will refer to this parameter setting. When this parameter is set to 0, the output frequency will output by the calculation of PID. When this parameter is set to 1 and Pr.01.08 is not set to 0, the output frequency=Pr.01.08 setting. Otherwise, the output frequency=Pr.01.05 setting.
- Related parameters: Pr.01.05(Minimum Output Frequency (Fmin) (Motor 0)) and Pr.01.08(Output Frequency Lower Limit)

10.14	Sleep/Wake Up Detection Time		Unit: second
	Settings	0.0 to 6550 sec	Factory Setting: 0.0

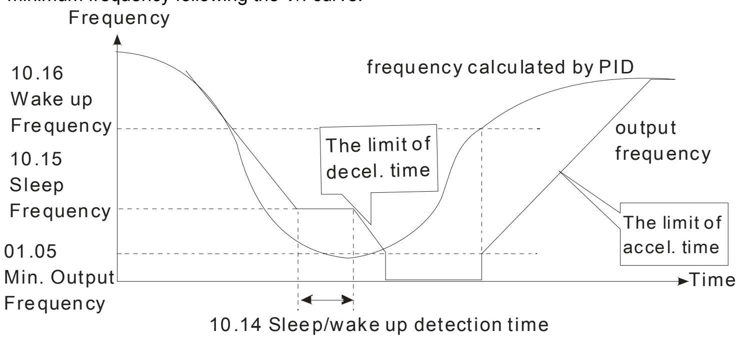
- If PID frequency is less than the sleep frequency when the drive starts running, the drive will be in sleep mode immediately and won't limit by this parameter.
- Related parameters: Pr.10.15(Sleep Frequency) and Pr.10.16(Wakeup Frequency)

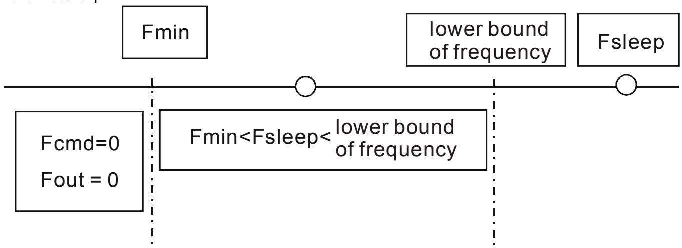
10.15	Sleep Frequency		Unit: Hz
	Settings	0.00 to 600.0 Hz	Factory Setting: 0.00

- This parameter set the frequency for the AC motor drive to be in sleep mode.
- The AC motor drive will stop outputting after being sleep mode, but PID controller keep operating.

10.16	Wakeup Frequency		Unit: Hz
	Settings	0.00 to 600.0 Hz	Factory Setting: 0.00

- This parameter is used to set the wakeup frequency to restart the AC motor drive after sleep mode.
- The wake up frequency must be higher than sleep frequency.
- When the actual output frequency ≤ Pr.10.15 and the time exceeds the setting of Pr.10.14, the AC motor drive will be in sleep mode and the motor will decelerate to stop by Pr.01.10/01.12 setting.
- When the actual frequency command > Pr.10.16 and the time exceeds the setting of Pr.10.14, the AC motor drive will restart.
- When the AC motor drive is in sleep mode, frequency command is still calculated by PID. When frequency reaches wake up frequency, AC motor drive will accelerate from Pr.01.05 minimum frequency following the V/f curve.





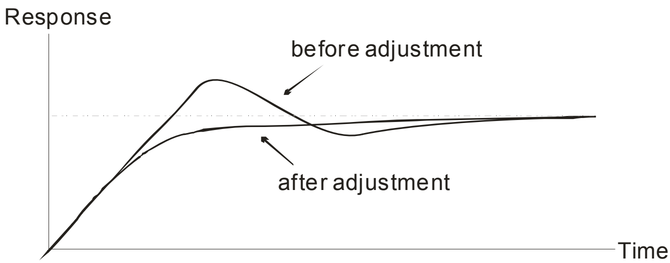
When Pr. 01.05min. output frequency ≦ PID frequency (H) ≦ Pr.01.08 lower bound of frequency and sleep function is enabled (output frequency (H) < Pr.10.15 sleep frequency and time > Pr.10.14 detection time), frequency will be 0 (in sleep mode). If sleep function is disabled, output frequency(H) = Pr.01.08 lower bound frequency.

NOTE

The common adjustments of PID control are shown as follows:

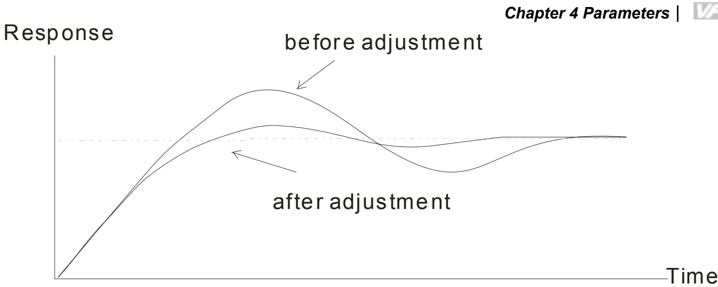
Example 1: how to have stable control as soon as possible?

Please shorten Pr.10.03 (Integral Time (I)) setting and increase Pr,10.04(Differential Control (D)) setting.



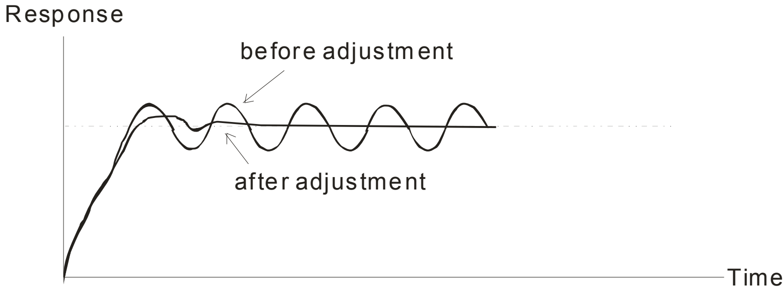
Example 2: How to suppress the oscillation of the wave with long cycle?

If it is oscillation when the wave cycle is longer than integral time, it needs to increase Pr.10.03 setting to suppress the oscillation.



Example 3: How to suppress the oscillation of the wave with short cycle?

When the cycle of oscillation is short and almost equal Differential time setting, it needs to shorten the differential time setting to suppress the oscillation. If Differential time(I) = 0.0, it can not suppress the oscillation. Please reduce Pr.10.02 setting or increase Pr.10.06 setting.



Group 11: Multi-function Input/Output Parameters for Extension Card

Make sure that the extension card is installed on the AC motor drive correctly before using group 11 parameters. See Appendix B for details.

11.00	Multi-function Output Terminal MO2/RA2
11.01	Multi-function Output Terminal MO3/RA3
11.02	Multi-function Output Terminal MO4/RA4
11.03	Multi-function Output Terminal MO5/RA5
11.04	Multi-function Output Terminal MO6/RA6
11.05	Multi-function Output Terminal MO7/RA7

Settings 0 to 21 Factory Setting: 0

Settings	Function	Description
0	No Function	
1	AC Drive Operational	Active when the drive is ready or RUN command is “ON”.
2	Master Frequency Attained	Active when the AC motor drive reaches the output frequency setting.
3	Zero Speed	Active when Command Frequency is lower than the Minimum Output Frequency.
4	Over-Torque Detection	Active as long as over-torque is detected. (Refer to Pr.06.03 ~ Pr.06.05)
5	Baseblock (B.B.) Indication	Active when the output of the AC motor drive is shut off during baseblock. Base block can be forced by Multi-function input (setting 09).
6	Low-Voltage Indication	Active when low voltage (Lv) is detected.
7	Operation Mode Indication	Active when operation command is controlled by external terminal.
8	Fault Indication	Active when a fault occurs (oc, ov, oH, oL, oL1, EF, cF3, HPF, ocA, ocd, ocn, GFF).

Settings	Function	Description
9	Desired Frequency Attained	Active when the desired frequency (Pr.03.02) is attained.
10	Terminal Count Value Attained	Active when the counter reaches Terminal Count Value.
11	Preliminary Count Value Attained	Active when the counter reaches Preliminary Count Value.
12	Over Voltage Stall supervision	Active when the Over Voltage Stall function operating
13	Over Current Stall supervision	Active when the Over Current Stall function operating
14	Heat Sink Overheat Warning	When heatsink overheats, it will signal to prevent OH turn off the drive. When it is higher than 85oC (185oF), it will be ON.
15	Over Voltage supervision	Active when the DC-BUS voltage exceeds level
16	PID supervision	Active when the PID function is operating
17	Forward command	Active when the direction command is FWD
18	Reverse command	Active when the direction command is REV
19	Zero Speed Output Signal	Active unless there is an output frequency present at terminals U/T1, V/T2, and W/T3.
20	Communication Warning (FbE,Cexx, AoL2, AUE, SAvE)	Active when there is a Communication Warning
21	Brake Control (Desired Frequency Attained)	Active when output frequency ≥Pr.03.14. Deactivated when output frequency ≤Pr.03.15 after STOP command.

11.06	Multi-function Input Terminal (MI7)
11.07	Multi-function Input Terminal (MI8)
11.08	Multi-function Input Terminal (MI9)
11.09	Multi-function Input Terminal (MI10)

11.10	Multi-function Input Terminal (MI11)
11.11	Multi-function Input Terminal (MI12)
	Settings 0 to 23 Factory Setting: 0

📖 Refer to the table below Pr.04.08 for setting the multifunction input terminals.

📖 Set the corresponding parameter according to the terminal labeled on the extension card.

Group 12: Analog Input/Output Parameters for Extension Card

Make sure that the extension card is installed on the AC motor drive correctly before using group 12 parameters. See Appendix B for details.

12.00	AI1 Function Selection

Factory Setting: 0

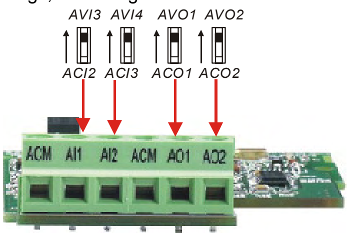
Settings		
	0	Disabled
	1	Source of the 1st frequency
	2	Source of the 2nd frequency
	3	PID Set Point (PID enable)
	4	Positive PID feedback
	5	Negative PID feedback

12.01	AI1 Analog Signal Mode

Factory Setting: 1

Settings		
	0	ACI2 analog current (0.0 ~ 20.0mA)
	1	AVI3 analog voltage (0.0 ~ 10.0V)

📖 Besides parameters settings, the voltage/current mode should be used with the switch.



12.02	Min. AVI3 Input Voltage	Unit: V
	Settings 0.0 to 10.0V	Factory Setting: 0.0

12.03	Min. AVI3 Scale Percentage	Unit: %
	Settings 0.0 to 100.0%	Factory Setting: 0.0

12.04	Max. AVI3 Input Voltage	Unit: V
	Settings 0.0 to 10.0V	Factory Setting: 10.0

12.05	Max. AVI3 Scale Percentage	Unit: %
Settings	0.0 to 100.0%	Factory Setting: 100.0

12.06	Min. ACI2 Input Current	Unit: mA
Settings	0.0 to 20.0mA	Factory Setting: 4.0

12.07	Min. ACI2 Scale Percentage	Unit: %
Settings	0.0 to 100.0%	Factory Setting: 0.0

12.08	Max. ACI2 Input Current	Unit: mA
Settings	0.0 to 20.0mA	Factory Setting: 20.0

12.09	Max. ACI2 Scale Percentage	Unit: %
Settings	0.0 to 100.0%	Factory Setting: 100.0

12.10 AI2 Function Selection

Factory Setting: 0

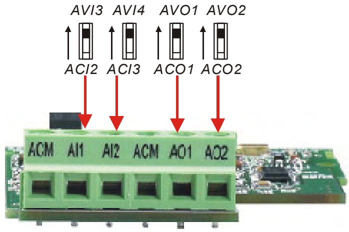
Settings		
Settings	0	Disabled
	1	Source of the 1st frequency
	2	Source of the 2nd frequency
	3	PID Set Point (PID enable)
	4	Positive PID feedback
	5	Negative PID feedback

12.11 AI2 Analog Signal Mode

Factory Setting: 1

Settings	0	ACI3 analog current (0.0 ~ 20.0mA)
	1	AVI4 analog voltage (0.0 ~ 10.0V)

📖 Besides parameters settings, the voltage/current mode should be used with the switch.



12.12	Min. AVI4 Input Voltage	Unit: V
	Settings 0.0 to 10.0V	Factory Setting: 0.0

12.13	Min. AVI4 Scale Percentage	Unit: %
	Settings 0.0 to 100.0%	Factory Setting: 0.0

12.14	Max. AVI4 Input Voltage	Unit: V
	Settings 0.0 to 10.0V	Factory Setting: 10.0

12.15	Max. AVI4 Scale Percentage	Unit: %
	Settings 0.0 to 100.0%	Factory Setting: 100.0

12.16	Min. ACI3 Input Current	Unit: mA
	Settings 0.0 to 20.0mA	Factory Setting: 4.0

12.17	Min. ACI3 Scale Percentage	Unit: %
	Settings 0.0 to 100.0%	Factory Setting: 0.0

12.18	Max. ACI3 Input Current	Unit: mA
	Settings 0.0 to 20.0mA	Factory Setting: 20.0

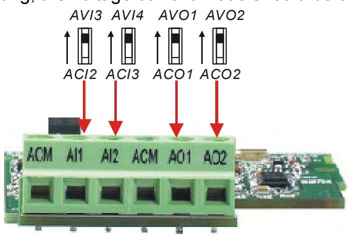
12.19	Max. ACI3 Scale Percentage	Unit: %
	Settings 0.0 to 100.0%	Factory Setting: 100.0

12.20 AO1 Terminal Analog Signal Mode

Factory Setting: 0

Settings	0	AVO1
	1	ACO1 (analog current 0.0 to 20.0mA)
	2	ACO1 (analog current 4.0 to 20.0mA)

📖 Besides parameter setting, the voltage/current mode should be used with the switch.



12.21 AO1 Analog Output Signal

Factory Setting: 0

Settings	0	Analog Frequency
	1	Analog Current (0 to 250% rated current)

📖 This parameter is used to choose analog frequency (0-+10Vdc) or analog current (4-20mA) to correspond to the AC motor drive’s output frequency or current.

12.22 AO1 Analog Output Gain — Unit: %

Settings 1 to 200% — Factory Setting: 100

📖 This parameter is used to set the analog output voltage range.

📖 When Pr.12.21 is set to 0, analog output voltage corresponds to the AC motor drive’s output frequency. When Pr.12.22 is set to 100, the max. output frequency (Pr.01.00) setting corresponds to the AFM output (+10VDC or 20mA)

📖 When Pr.12.21 is set to 1, analog output voltage corresponds to the AC motor drive’s output current. When Pr.12.22 is set to 100, the 2.5 X rated current corresponds to the AFM output (+10VDC or 20mA)

NOTE

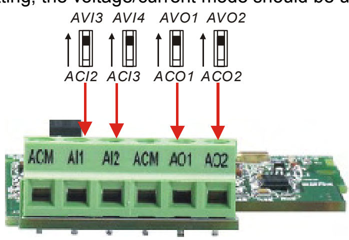
If the scale of the voltmeter is less than 10V, refer to following formula to set Pr.12.22:

Pr.12.22 = [(full scale voltage)/10]*100%.

Example: When using voltmeter with full scale (5V), Pr.12.22 should be set to 5/10*100%=50%. If Pr.12.21 is set to 0, the output voltage will correspond to the max. output frequency.

12.23	AO2Terminal Analog Signal Mode	
		Factory Setting: 0
Settings	0	AVO2
	1	ACO2 (analog current 0.0 to 20.0mA)
	2	ACO2 (analog current 4.0 to 20.0mA)

📖 Besides parameter setting, the voltage/current mode should be used with the switch.



12.24	AO2 Analog Output Signal	
		Factory Setting: 0
Settings	0	Analog Frequency
	1	Analog Current (0 to 250% rated current)

12.25	AO2 Analog Output Gain	Unit: %
Settings	1 to 200%	Factory Setting: 100

📖 Setting method for the AO2 is the same as the AO1.

12.26	AUI Analog Input Selection	
		Factory Setting: 0
Settings	0	No function
	1	Source of the 1st frequency
	2	Source of the 2nd frequency

12.27	✗AUI Analog Input Bias	Unit: %
	Settings 0.00 to 200.00%	Factory Setting: 0.00

12.28	AUI Bias Polarity	
		Factory Setting: 0
	Settings 0 Positive bias	
	1 Negative bias	

12.29	✗AUI Analog Gain	Unit: %
	Settings 1 to 200%	Factory Setting: 100

12.30	AUI Negative Bias, Reverse Motion Enable/Disable	
		Factory Setting: 0
	Settings 0 No AUI Negative Bias Command	
	1 Negative Bias: REV Motion Enabled	
	2 Negative Bias: REV Motion Disabled	

12.31	AUI Analog Input Delay	Unit: 2ms
	Settings 0 to 9999	Factory Setting: 50

- In a noisy environment, it is advantageous to use negative bias to provide a noise margin. It is recommended NOT to use less than 1V to set the operation frequency.
- Pr.12-26 to Pr.12-31 can be used to set the frequency command by adjusting analog input voltage -10V to +10V. Refer to Pr.04-00 to 04-03 for details.

Group 13: PG function Parameters for Extension Card

Pulse generator card (PG card) is mainly applied in the detection components of speed control or position control. It usually makes a closed-loop speed control system with encoder. The AC motor drive is used with encoder and PG card to have a complete speed control and position detection system.

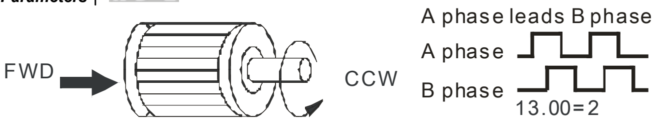
Please make sure that the extension card is installed on the AC motor drive correctly before using group 12 parameters. See Appendix B for details.

13.00	PG Input

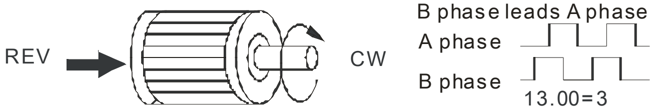
Factory Setting: 0

Settings	0	Disable PG
	1	Single phase
	2	Forward/Counterclockwise rotation
	3	Reverse/Clockwise rotation

- There are two outputs, 1-phase and 2-phase output, for the encoder output. For the 1-phase output, the encoder output is a group of pulse signal. For the 2-phase output, the encoder can output A and B pulse signals with 90^{o} phase difference. The encoder is defined by the timing of A and B pulses as the following figure. It can not only measure the speed but distinguish motor rotation direction by A and B pulse signals.
- PG card receives A and B pulses from encoder output and sends this feedback signal to the AC motor drive for speed or position control.
- Setting 0: disable PG function.
- Setting 1: for speed/position control but can't distinguish motor rotation direction.
- Setting 2: both for speed control and distinguish motor rotation direction. A phase leads B phase as shown in the following diagram and motor is forward running.
- Setting 3: both for speed control and distinguish motor rotation direction. B phase leads A phase as shown in the following diagram and motor is reverse running.
- Related parameter: Pr.13.01(PG Pulse Range)



When receiving a forward command, motor will rotate in counterclockwise direction (see from output side).



When receiving a reverse command, motor will rotate in clockwise direction (see from output side).

When encoder rotates in clockwise direction (see from input side). At this moment, A phase leads B phase.

13.01	PG Pulse Range	
	Settings 1 to 20000	Factory Setting: 600

📖 A Pulse Generator (PG) is used as a sensor that provides a feedback signal of the motor speed. This parameter defines the number of pulses for each cycle of the PG control.

📖 This parameter setting is the resolution of encoder. With the higher resolution, the speed control will be more precise.

13.02	Motor Pole Number (Motor 0)	Unit: 1
	Settings 2 to 10	Factory Setting: 4

📖 The pole number should be even (can't be odd).

13.03	⚡Proportional Gain (P)	Unit: 0.01
	Settings 0.0 to 10.0	Factory Setting: 1.0

📖 This parameter is used to set the gain (P) when using PG for the closed-loop speed control.

📖 The proportional gain is mainly used to eliminate the error. The large proportional gain(P) will get the faster response to decrease the error. Too large proportional gain will cause large overshoot and oscillation and decrease the stable.

📖 This parameter can be used to set the proportional gain (P) to decide the response speed. With large proportional gain, it will get faster response. Too large proportional gain may cause system oscillation. With small proportional gain, it will get slower response.

13.04	✓Integral Gain (I)	Unit: 0.01
	Settings 0.00 to 100.00 sec	Factory Setting: 1.00
	0.00 Disable	

📖 The integral controller is used to eliminate the error during stable system. The integral control doesn't stop working until error is 0. The integral is acted by the integral time. The smaller integral time is set, the stronger integral action will be. It is helpful to reduce overshoot and oscillation to make a stable system. At this moment, the decreasing error will be slow. The integral control is often used with other two controls to become PI controller or PID controller.

📖 This parameter is used to set the integral time of I controller. When the integral time is long, it will have small gain of I controller, the slower response and bad external control. When the integral time is short, it will have large gain of I controller, the faster response and rapid external control.

📖 When the integral time is too small, it may cause system oscillation.

📖 When it is set to 0.0, the integral function is disabled.

13.05	✓Speed Control Output Frequency Limit	Unit: Hz
	Settings 0.00 to 100.00Hz	Factory Setting: 10.00

📖 This parameter is used to limit the max. output frequency.

📖 From the following PG speed diagram, output frequency (H) = frequency command (F) + speed detection value via PG feedback. With the speed change of motor load, the speed change will be sent to drive via PG card to change the output frequency. So this parameter can be used to decrease the speed change of motor load.

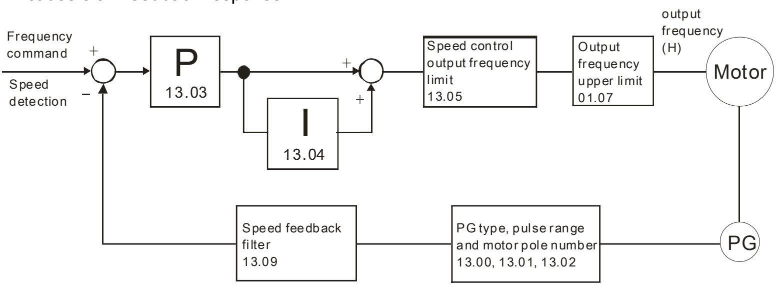
13.06	✓Speed Feedback Display Filter	Unit: 2ms
	Settings 0 to 9999 (*2ms)	Factory Setting: 500

📖 When Pr.0.04 is set to 14, its display will be updated regularly. This update time is set by Pr.13.06.

- With the large setting in Pr.13.06, it can slow the response speed to prevent the blinking of digital number on the digital keypad. Too large setting may cause the delay of RPM value via PG card.
- Related parameter: Pr.00.04(Content of Multi-function Display)

13.09	✓Speed Feedback Filter		Unit: 2ms
	Settings	0 to 9999 (*2ms)	Factory Setting: 16

- This parameter is the filter time from the speed feedback to the PG card. Too large setting may cause slow feedback response.



PG feedback speed control

13.07	✓Time for Feedback Signal Fault		Unit: second
	Settings	0.1 to 10.0 sec	Factory Setting: 1.0
		0.0 Disabled	

- This parameter defines the time during which the PID feedback must be abnormal before a warning (see Pr.13.08) is given. It also can be modified according to the system feedback signal time.
- If this parameter is set to 0.0, the system would not detect any abnormality signal.
- Related parameter: Pr.13.08(Treatment of the Feedback Signal Fault)

13.08	✗Treatment of the Feedback Signal Fault

Factory Setting: 1

Settings	0	Warn and RAMP to stop
	1	Warn and COAST to stop
	2	Warn and keep operating

- AC motor drive action when the feedback signals (analog PID feedback or PG (encoder) feedback) are abnormal.
- Setting Pr.13.08 to 0: When the feedback signal fault occurs, it will display “PGEr” on the digital keypad and the stop to 0Hz by Pr.01.10/Pr.01.12 setting.
- Setting Pr.13.08 to 1: When the feedback signal fault occurs, it will display “PGEr” on the digital keypad and the motor will free run to stop.
- Setting Pr.13.08 to 2: When the feedback signal fault occurs, it will display “PGEr” on the digital keypad and the motor will keep running.
- It needs to press “RESET” to clear the warning message “PGEr” displayed on the keypad.

NOTE

The digital keypad is optional. Please refer to Appendix B for details. When using without this optional keypad, the FAULT LED will be ON once there is error messages or warning messages from the external terminals.

13.10	Source of the High-speed Counter (NOT for VFD*E*C models)

Factory Display: 0 (Read only)

Settings	0	PG card
	1	PLC

- This parameter reads the high-speed counter of the drive to use on PG card or PLC.

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4.4 Different Parameters for VFD*E*C Models

The content of this instruction sheet may be revised without prior notice. Please consult our distributors or download the most updated version at http://www.delta.com.tw/industrialautomation

Software version for VFD*E*C is power board: V1.00 and control board: V2.00.

⺈: The parameter can be set during operation.

Group 0 User Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
00.02	Parameter Reset	0: Parameter can be read/written 1: All parameters are read only 6: Clear PLC program (NOT for VFD*E*C models) 9: All parameters are reset to factory settings (50Hz, 230V/400V or 220V/380V depends on Pr.00.12) 10: All parameters are reset to factory settings (60Hz, 220V/440V)	0	
⺈00.03	Start-up Display Selection	0: Display the frequency command value (Fxxx) 1: Display the actual output frequency (Hxxx) 2: Display the content of user-defined unit (Uxxx) 3: Multifunction display, see Pr.00.04 4: FWD/REV command 5: PLCx (PLC selections: PLC0/PLC1/PLC2) (NOT for VFD*E*C models)	0	
⺈00.04	Content of Multi-function Display	0: Display the content of user-defined unit (Uxxx) 1: Display the counter value (c) 2: Display PLC D1043 value (C) (NOT for VFD*E*C models) 3: Display DC-BUS voltage (u) 4: Display output voltage (E)	0	

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Parameter	Explanation	Settings	Factory Setting	Customer
		5: Display PID analog feedback signal value (b) (%) 6: Output power factor angle (n) 7: Display output power (P)		
		8: Display the estimated value of torque as it relates to current (t) 9: Display AVI (I) (V) 10: Display ACI / AVI2 (i) (mA/V) 11: Display the temperature of IGBT (h) (°C) 12: Display AVI3/ACI2 level (I.) 13: Display AVI4/ACI3 level (i.) 14: Display PG speed in RPM (G) 15: Display motor number (M)		

Group 1 Basic Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
⁄⁄01.11	Accel Time 2	0.1 to 600.0 / 0.01 to 600.0 sec	1.0	
⁄⁄01.12	Decel Time 2	0.1 to 600.0 / 0.01 to 600.0 sec	1.0	

Group 2 Operation Method Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
⁄⁄02.00	Source of First Master Frequency Command	0: Digital keypad UP/DOWN keys or Multi-function Inputs UP/DOWN. Last used frequency saved. 1: 0 to +10V from AVI 2: 4 to 20mA from ACI or 0 to +10V from AVI2 3: RS-485 (RJ-45)/USB communication 4: Digital keypad potentiometer 5: CANopen communication	5	

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Parameter	Explanation	Settings	Factory Setting	Customer
✐02.01	Source of First Operation Command	0: Digital keypad 1: External terminals. Keypad STOP/RESET enabled. 2: External terminals. Keypad STOP/RESET disabled. 3: RS-485 (RJ-45)/USB communication. Keypad STOP/RESET enabled. 4: RS-485 (RJ-45)/USB communication. Keypad STOP/RESET disabled. 5: CANopen communication. Keypad STOP/RESET disabled.	5	
✐02.09	Source of Second Frequency Command	0: Digital keypad UP/DOWN keys or Multi-function Inputs UP/DOWN. Last used frequency saved. 1: 0 to +10V from AVI 2: 4 to 20mA from ACI or 0 to +10V from AVI2 3: RS-485 (RJ-45)/USB communication 4: Digital keypad potentiometer 5: CANopen communication	0	
02.16	Display the Master Freq Command Source	Read Only Bit0=1: by First Freq Source (Pr.02.00) Bit1=1: by Second Freq Source (Pr.02.09) Bit2=1: by Multi-input function Bit3=1: by PLC Freq command (NOT for VFD*E*C models)	##	
02.17	Display the Operation Command Source	Read Only Bit0=1: by Digital Keypad Bit1=1: by RS485 communication Bit2=1: by External Terminal 2/3 wire mode Bit3=1: by Multi-input function Bit5=1: by CANopen communication	##	

Group 3 Output Function Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
03.09	Reserved			
03.10	Reserved			

Group 4 Input Function Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
04.05	Multi-function Input Terminal (MI3)	0: No function	1	
		1: Multi-Step speed command 1		
		2: Multi-Step speed command 2		
04.06	Multi-function Input Terminal (MI4)	3: Multi-Step speed command 3	2	
		4: Multi-Step speed command 4		
		5: External reset		
04.07	Multi-function Input Terminal (MI5)	6: Accel/Decel inhibit	3	
		7: Accel/Decel time selection command		
		8: Jog Operation		
04.08	Multi-function Input Terminal (MI6)	9: External base block	23	
		10: Up: Increment master frequency		
		11: Down: Decrement master frequency		
		12: Counter Trigger Signal		
		13: Counter reset		
		14: E.F. External Fault Input		
		15: PID function disabled		
		16: Output shutoff stop		
		17: Parameter lock enable		
		18: Operation command selection (external terminals)		
		19: Operation command selection(keypad)		
		20: Operation command selection (communication)		
		21: FWD/REV command		
		22: Source of second frequency command		
		23: Quick Stop (Only for VFD*E*C models)		
		24: Download/execute/monitor PLC Program (PLC2) (NOT for VFD*E*C models)		
		25: Simple position function		
		26: OOB (Out of Balance Detection)		

Parameter	Explanation	Settings	Factory Setting	Customer
		27: Motor selection (bit 0) 28: Motor selection (bit 1)		
04.24	Reserved			
04.25	Reserved			

Group 7 Motor Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
07.08	Torque Compensation Time Constant	0.01 ~10.00 Sec	0.30	

Group 9 Communication Parameters

Parameter	Explanation	Settings	Factory Setting	Customer
09.12~ 09.19	Reserved			
09.20	CANopen Communication Address	0: disable 1: 1 to 127	1	
09.21	CANbus Baud Rate	0: 1M 1: 500K 2: 250K 3: 125K 4: 100K 5: 50K	0	
09.22	Gain of CANbus Frequency	0.00~2.00	1.00	
09.23	CANbus Warning	bit 0 : CANopen Guarding Time out bit 1 : CANopen Heartbeat Time out bit 2 : CANopen SYNC Time out bit 3 : CANopen SDO Time out bit 4 : CANopen SDO buffer overflow bit 5 : CANbus Off bit 6 : Error protocol of CANopen bit 7 : CANopen boot up fault	Read-only	

Parameter	Explanation	Settings	Factory Setting	Customer
09.24	DS402 Protocol	0: Disable (By Delta rule) 1: Enable (By DS402)	1	

Group 11 Parameters for Extension Card

Parameter	Explanation	Settings	Factory Setting	Customer
11.06	Multi-function Input Terminal (MI7)	0: No function 1: Multi-Step speed command 1 2: Multi-Step speed command 2	0	
11.07	Multi-function Input Terminal (MI8)	3: Multi-Step speed command 3 4: Multi-Step speed command 4 5: External reset	0	
11.08	Multi-function Input Terminal (MI9)	6: Accel/Decel inhibit 7: Accel/Decel time selection command 8: Jog Operation	0	
11.09	Multi-function Input Terminal (MI10)	9: External base block 10: Up: Increment master frequency 11: Down: Decrement master frequency	0	
11.10	Multi-function Input Terminal (MI11)	12: Counter Trigger Signal 13: Counter reset 14: E.F. External Fault Input 15: PID function disabled	0	
11.11	Multi-function Input Terminal (MI12)	16: Output shutoff stop 17: Parameter lock enable 18: Operation command selection (external terminals) 19: Operation command selection (keypad) 20: Operation command selection (communication) 21: FWD/REV command 22: Source of second frequency command 23: Quick Stop (Only for VFD*E*C models)	0	

Parameter	Explanation	Settings	Factory Setting	Customer
		24: Download/execute/monitor PLC Program (PLC2) (NOT for VFD*E*C models) 25: Simple position function 26: OOB (Out of Balance Detection) 27: Motor selection (bit 0) 28: Motor selection (bit 1)		

Group 13: PG function Parameters for Extension Card

Parameter	Explanation	Settings	Factory Setting	Customer
13.10	Reserved			

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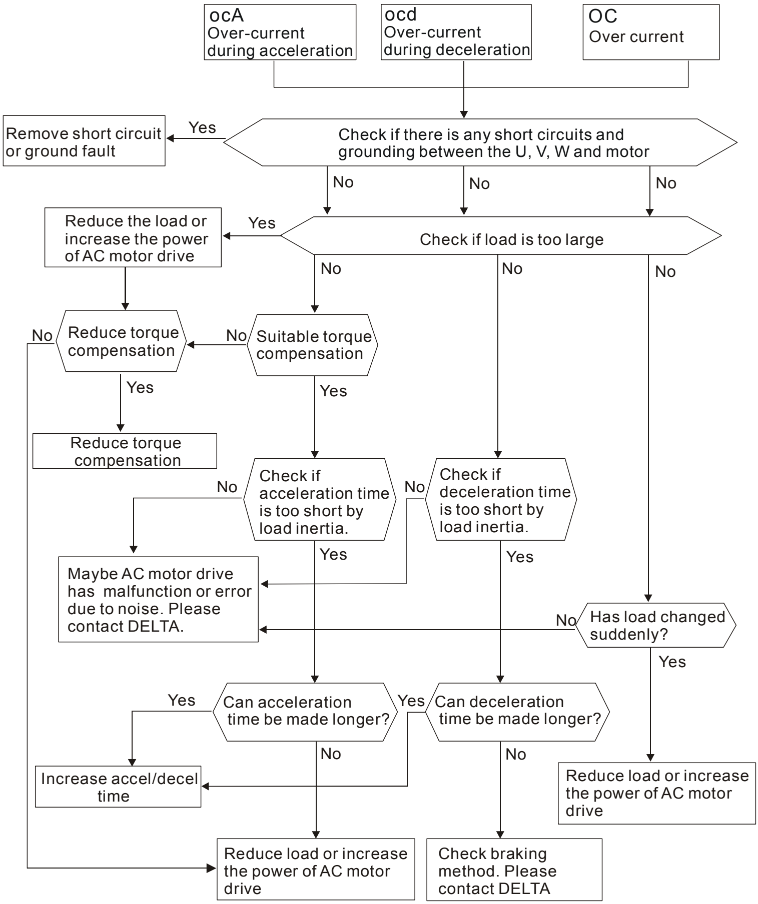
Chapter 5 Troubleshooting

5.1 Over Current (OC)



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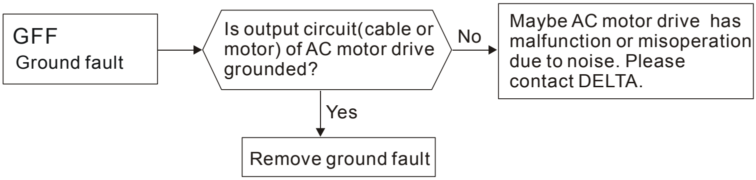
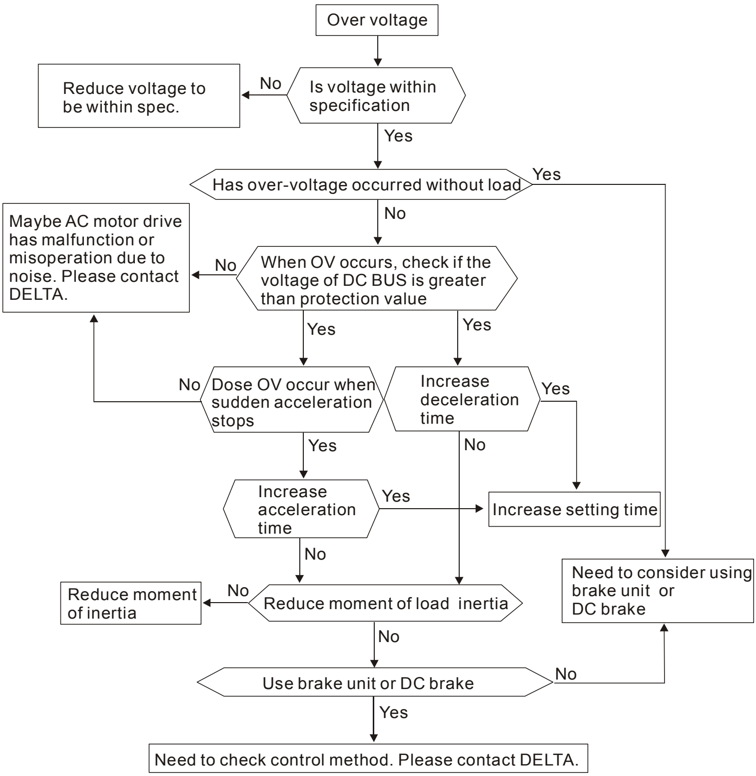
5.2 Ground Fault



5.3 Over Voltage (OV)



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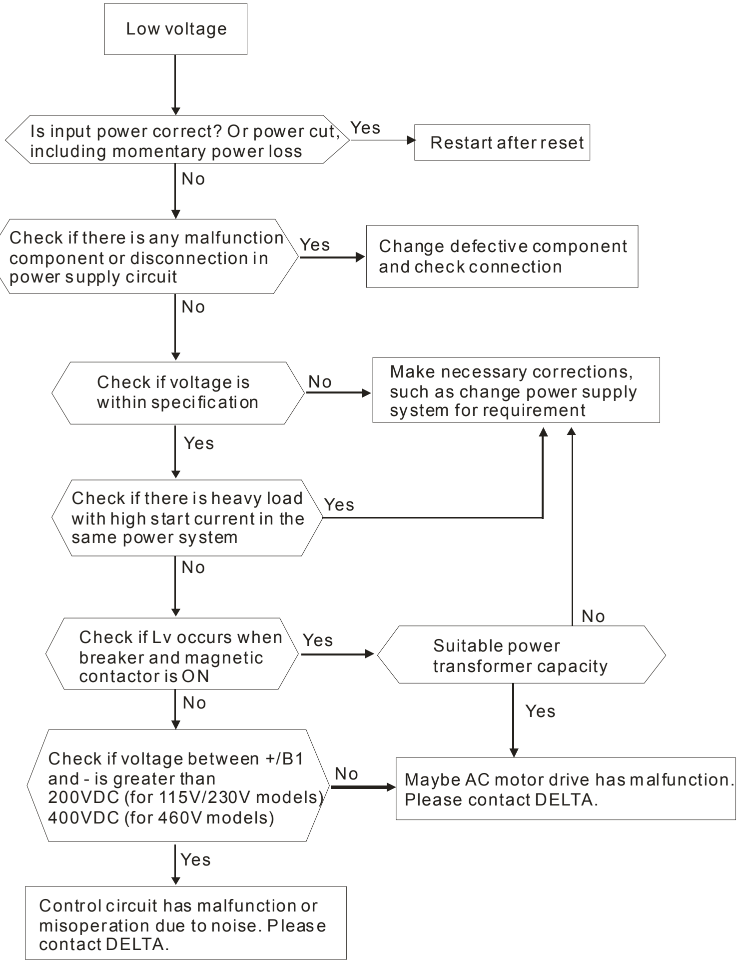
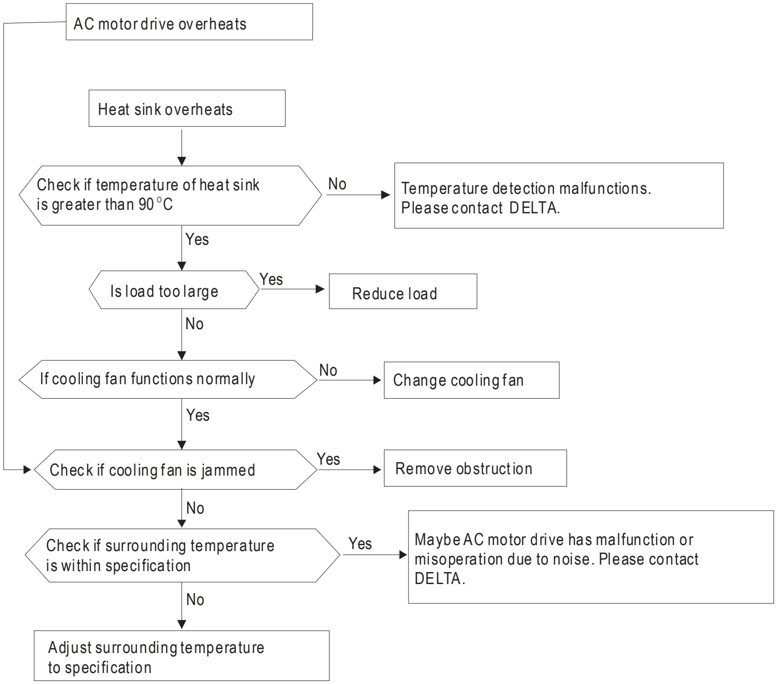
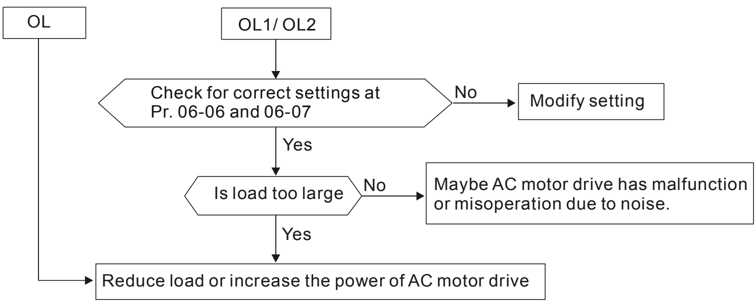
5.4 Low Voltage (Lv)



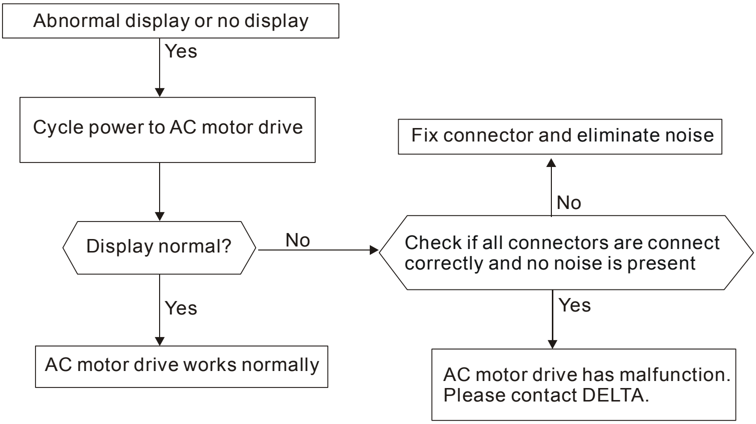
5.5 Over Heat (OH)



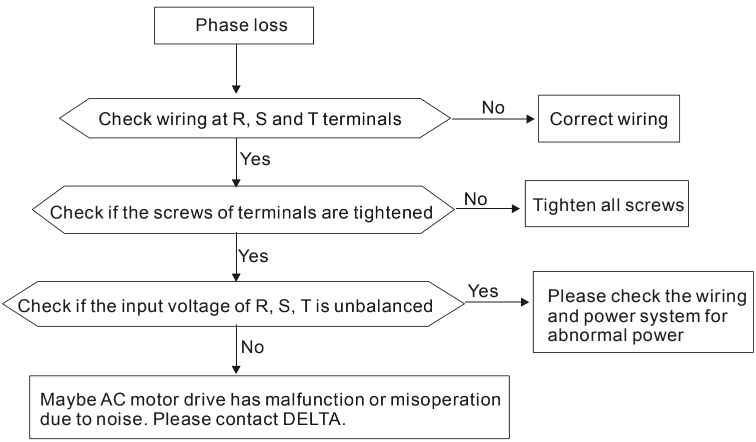
5.6 Overload



5.7 Keypad Display is Abnormal



5.8 Phase Loss (PHL)



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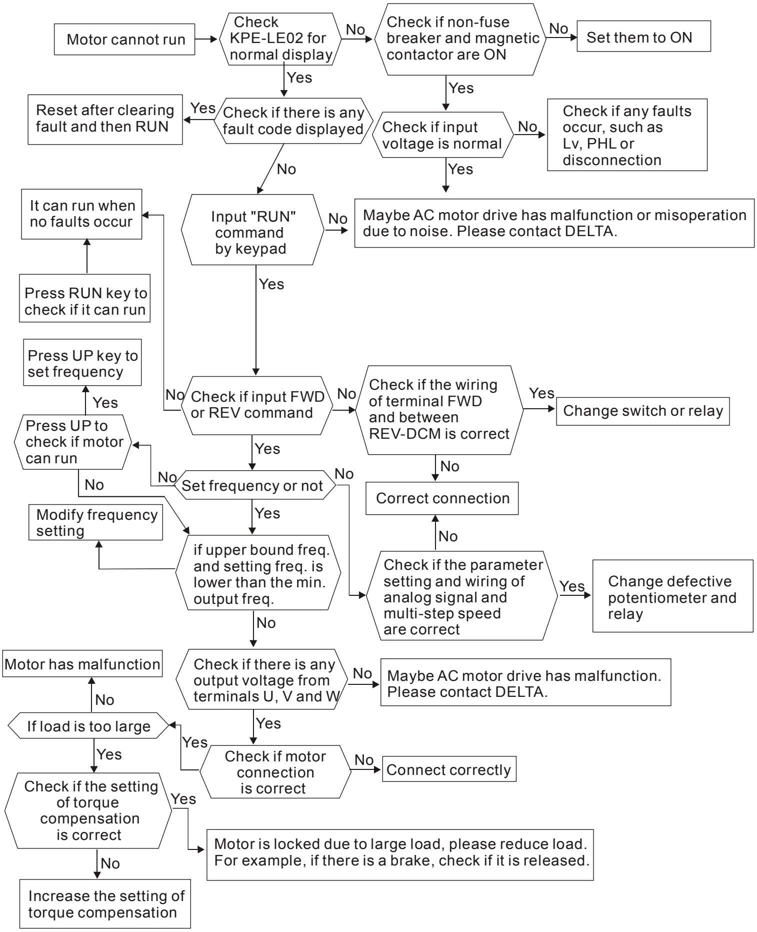
5.9 Motor cannot Run



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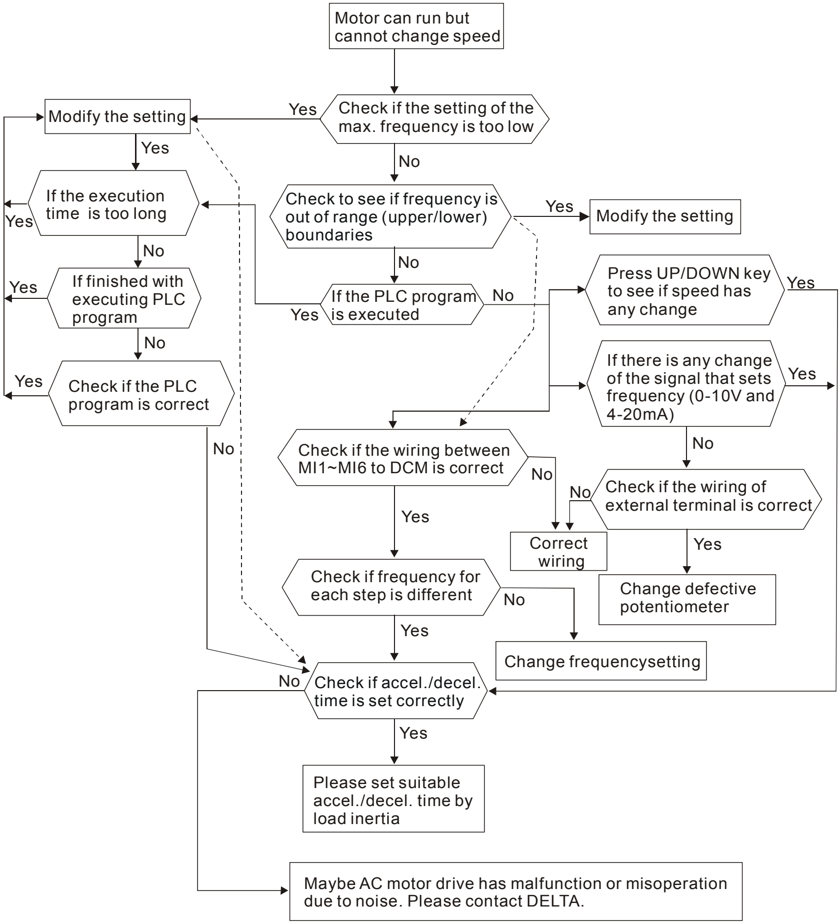
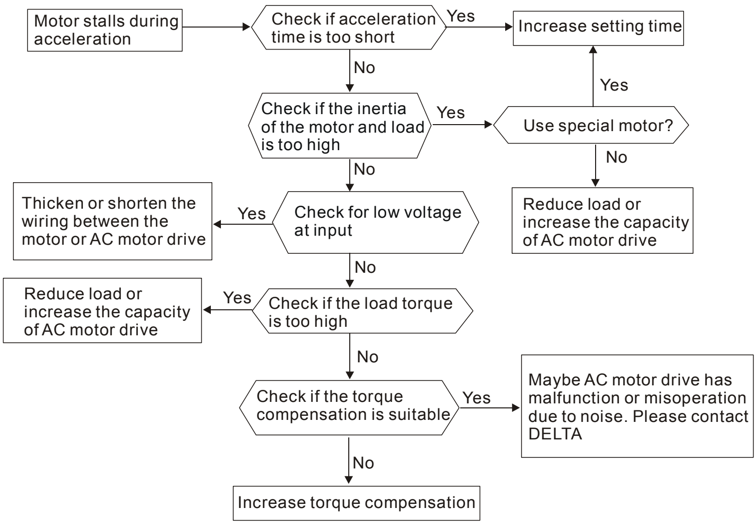
5.10 Motor Speed cannot be Changed

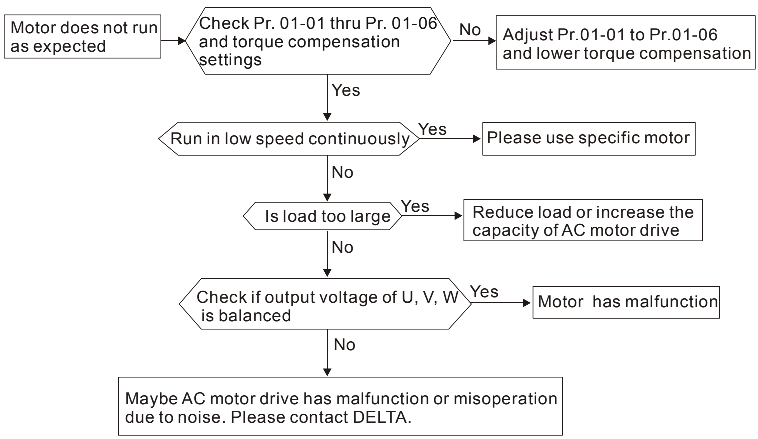
For VFD*E*C models, no PLC function is supported. Please follow the dashed line to skip the PLC parts.



5.11 Motor Stalls during Acceleration



5.12 The Motor does not Run as Expected



5.13 Electromagnetic/Induction Noise

Many sources of noise surround AC motor drives and penetrate it by radiation or conduction. It may cause malfunctioning of the control circuits and even damage the AC motor drive. Of course, there are solutions to increase the noise tolerance of an AC motor drive. But this has its limits. Therefore, solving it from the outside as follows will be the best.

1. Add surge suppressor on the relays and contacts to suppress switching surges.
2. Shorten the wiring length of the control circuit or serial communication and keep them separated from the power circuit wiring.
3. Comply with the wiring regulations by using shielded wires and isolation amplifiers for long length.
4. The grounding terminal should comply with the local regulations and be grounded independently, i.e. not to have common ground with electric welding machines and other power equipment.
5. Connect a noise filter at the mains input terminal of the AC motor drive to filter noise from the power circuit.

In short, solutions for electromagnetic noise exist of “no product”(disconnect disturbing equipment), “no spread”(limit emission for disturbing equipment) and “no receive”(enhance immunity).

5.14 Environmental Condition

Since the AC motor drive is an electronic device, you should comply with the environmental conditions. Here are some remedial measures if necessary.

1. To prevent vibration, the use of anti-vibration dampers is the last choice. Vibrations must be within the specification. Vibration causes mechanical stress and it should not occur frequently, continuously or repeatedly to prevent damage to the AC motor drive.
2. Store the AC motor drive in a clean and dry location, free from corrosive fumes/dust to prevent corrosion and poor contacts. Poor insulation in a humid location can cause short-circuits. If necessary, install the AC motor drive in a dust-proof and painted enclosure and in particular situations, use a completely sealed enclosure.
3. The ambient temperature should be within the specification. Too high or too low temperature will affect the lifetime and reliability. For semiconductor components, damage will occur once any specification is out of range. Therefore, it is necessary to periodically check air quality and the cooling fan and provide extra cooling of necessary. In addition, the microcomputer may not work in extremely low temperatures, making cabinet heating necessary.

4. Store within a relative humidity range of 0% to 90% and non-condensing environment. Use an air conditioner and/or exsiccator.

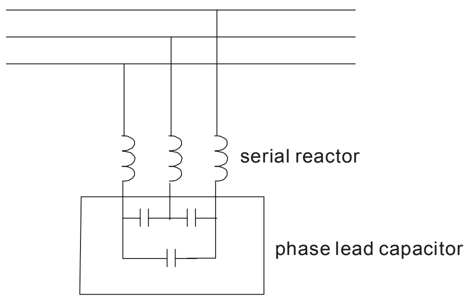
5.15 Affecting Other Machines

An AC motor drive may affect the operation of other machines due to many reasons. Some solutions are:

- High Harmonics at Power Side

High harmonics at power side during running can be improved by:

1. Separate the power system: use a transformer for AC motor drive.
2. Use a reactor at the power input terminal of the AC motor drive.
3. If phase lead capacitors are used (never on the AC motor drive output!!), use serial reactors to prevent damage to the capacitors damage from high harmonics.



- Motor Temperature Rises

When the motor is a standard induction motor with fan, the cooling will be bad at low speeds, causing the motor to overheat. Besides, high harmonics at the output increases copper and core losses. The following measures should be used depending on load and operation range.

1. Use a motor with independent ventilation (forced external cooling) or increase the motor rated power.
2. Use a special inverter duty motor.
3. Do NOT run at low speeds for long time.

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Chapter 6 Fault Code Information and Maintenance

6.1 Fault Code Information

The AC motor drive has a comprehensive fault diagnostic system that includes several different alarms and fault messages. Once a fault is detected, the corresponding protective functions will be activated. The following faults are displayed as shown on the AC motor drive digital keypad display. The five most recent faults can be read from the digital keypad or communication.

NOTE

Wait 5 seconds after a fault has been cleared before performing reset via keypad of input terminal.

6.1.1 Common Problems and Solutions

Fault Name	Fault Descriptions	Corrective Actions
oc	**Over current** Abnormal increase in current.	1. Check if motor power corresponds with the AC motor drive output power. 2. Check the wiring connections to U/T1, V/T2, W/T3 for possible short circuits. 3. Check the wiring connections between the AC motor drive and motor for possible short circuits, also to ground. 4. Check for loose contacts between AC motor drive and motor. 5. Increase the Acceleration Time. 6. Check for possible excessive loading conditions at the motor. 7. If there are still any abnormal conditions when operating the AC motor drive after a short-circuit is removed and the other points above are checked, it should be sent back to manufacturer.
ou	**Over voltage** The DC bus voltage has exceeded its maximum allowable value.	1. Check if the input voltage falls within the rated AC motor drive input voltage range. 2. Check for possible voltage transients. 3. DC-bus over-voltage may also be caused by motor regeneration. Either increase the Decel. Time or add an optional brake resistor (and brake unit). 4. Check whether the required brake power is within the specified limits.

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Fault Name	Fault Descriptions	Corrective Actions
oH1 oH2	**Overheating** Heat sink temperature too high	1. Ensure that the ambient temperature falls within the specified temperature range. 2. Make sure that the ventilation holes are not obstructed. 3. Remove any foreign objects from the heatsinks and check for possible dirty heat sink fins. 4. Check the fan and clean it. 5. Provide enough spacing for adequate ventilation. (See chapter 1)
Lv	**Low voltage** The AC motor drive detects that the DC bus voltage has fallen below its minimum value.	1. Check whether the input voltage falls within the AC motor drive rated input voltage range. 2. Check for abnormal load in motor. 3. Check for correct wiring of input power to R-S-T (for 3-phase models) without phase loss.
oL	**Overload** The AC motor drive detects excessive drive output current. **NOTE: The AC motor drive can withstand up to 150% of the rated current for a maximum of 60 seconds.**	1. Check whether the motor is overloaded. 2. Reduce torque compensation setting in Pr.07.02. 3. Use the next higher power AC motor drive model.
oL1	**Overload 1** Internal electronic overload trip	1. Check for possible motor overload. 2. Check electronic thermal overload setting. 3. Use a higher power motor. 4. Reduce the current level so that the drive output current does not exceed the value set by the Motor Rated Current Pr.07.00.
oL2	**Overload 2** Motor overload.	1. Reduce the motor load. 2. Adjust the over-torque detection setting to an appropriate setting (Pr.06.03 to Pr.06.05).
HPF1	**CC (current clamp)**	Return to the factory.
HPF2	**OV hardware error**	
HPF3	**GFF hardware error**	
HPF4	**OC hardware error**	
bb	**External Base Block.** (Refer to Pr. 08.07)	1. When the external input terminal (B.B) is active, the AC motor drive output will be turned off. 2. Deactivate the external input terminal (B.B) to operate the AC motor drive again.

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Fault Name	Fault Descriptions	Corrective Actions
ocA	**Over-current during acceleration**	1. Short-circuit at motor output: Check for possible poor insulation at the output lines. 2. Torque boost too high: Decrease the torque compensation setting in Pr.07.02. 3. Acceleration Time too short: Increase the Acceleration Time. 4. AC motor drive output power is too small: Replace the AC motor drive with the next higher power model.
ocd	**Over-current during deceleration**	1. Short-circuit at motor output: Check for possible poor insulation at the output line. 2. Deceleration Time too short: Increase the Deceleration Time. 3. AC motor drive output power is too small: Replace the AC motor drive with the next higher power model.
ocn	**Over-current during constant speed operation**	1. Short-circuit at motor output: Check for possible poor insulation at the output line. 2. Sudden increase in motor loading: Check for possible motor stall. 3. AC motor drive output power is too small: Replace the AC motor drive with the next higher power model.
EF	**External Fault**	1. When multi-function input terminals (MI3-MI9) are set to external fault, the AC motor drive stops output U, V and W. 2. Give RESET command after fault has been cleared.
cF1.0	**Internal EEPROM can not be programmed.**	Return to the factory.
cF1.1	**Internal EEPROM can not be programmed.**	Return to the factory.
cF2.0	**Internal EEPROM can not be read.**	1. Press RESET key to set all parameters to factory setting. 2. Return to the factory.
cF2.1	**Internal EEPROM can not be read.**	1. Press RESET key to set all parameters to factory setting. 2. Return to the factory.
cF3.0	**U-phase error**	Return to the factory.
cF3.1	**V-phase error**	
cF3.2	**W-phase error**	
cF3.3	**OV or LV**	
cF3.4 cF3.5	**Temperature sensor error**	

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Fault Name	Fault Descriptions	Corrective Actions
GFF	**Ground fault**	When (one of) the output terminal(s) is grounded, short circuit current is more than 50% of AC motor drive rated current, the AC motor drive power module may be damaged. **NOTE: The short circuit protection is provided for AC motor drive protection, not for protection of the user.** 1. Check whether the IGBT power module is damaged. 2. Check for possible poor insulation at the output line.
cFA	**Auto accel/decel failure**	1. Check if the motor is suitable for operation by AC motor drive. 2. Check if the regenerative energy is too large. 3. Load may have changed suddenly.
cE--	**Communication Error**	1. Check the RS485 connection between the AC motor drive and RS485 master for loose wires and wiring to correct pins. 2. Check if the communication protocol, address, transmission speed, etc. are properly set. 3. Use the correct checksum calculation. 4. Please refer to group 9 in the chapter 5 for detail information.
codE	**Software protection failure**	Return to the factory.
AErr	**Analog signal error**	Check the wiring of ACI
FbE	**PID feedback signal error**	1. Check parameter settings (Pr.10.01) and AVI/ACI wiring. 2. Check for possible fault between system response time and the PID feedback signal detection time (Pr.10.08)
PHL	**Phase Loss**	Check input phase wiring for loose contacts.
AUE	**Auto Tuning Error**	1. Check cabling between drive and motor 2. Retry again
CP10	**Communication time-out error on the control board or power board**	1. Press RESET key to set all parameters to factory setting. 2. Return to the factory.
PtC1 PtC2	**Motor overheat protection**	1. Check if the motor is overheat 2. Check Pr.07.12 to Pr.07.17 settings
PGEr	**PG signal error**	1. Check the wiring of PG card 2. Try another PG card
CGUd	CANopen Guarding Time out （Only for VFDxxxExxC）	Connect to CAN bus again and reset CAN bus

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Fault Name	Fault Descriptions	Corrective Actions
CHbt	CANopen Heartbeat Time out（Only for VFDxxxExxC）	Connect to CAN bus again and reset CAN bus
CSYc	CANopen SYNC Time out（Only for VFDxxxExxC）	Check if CANopen synchronous message is abnormal
CSdo	CANopen SDO Time out（Only for VFDxxxExxC）	Check if command channels are full
CSbF	CANopen SDO buffer overflow（Only for VFDxxxExxC）	1. Too short time between commands, please check SDO message sent from the master 2. Reset CAN bus
CbSF	CAN bus off（Only for VFDxxxExxC）	1. Check if it connects to terminal resistor 2. Check if the signal is abnormal 3. Check if the master is connected
CbtU	CAN Boot up fault（Only for VFDxxxExxC）	1. Check if the master is connected 2. Reset CAN bus
CPto	Error communication protocol of CANopen （Only for VFDxxxExxC）	Check if the communication protocol is correct
dEb	It will be displayed during deceleration when Pr.08-24 is not set to 0 and unexpected power off occurs, such as momentary power loss.	1. Set Pr.08-24 to 0 2. Check if the input power is stable
AcL	Abnormal Communication Loop	1. Check if the communication wiring is correct 2. Return to the factory

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6.1.2 Reset

There are three methods to reset the AC motor drive after solving the fault:

1. Press STOP/RESET key on keypad.
2. Set external terminal to "RESET" (set one of Pr.04.05~Pr.04.08 to 05) and then set to be ON.
3. Send "RESET" command by communication.

NOTE

Make sure that RUN command or signal is OFF before executing RESET to prevent damage or personal injury due to immediate operation.

6.2 Maintenance and Inspections

Modern AC motor drives are based on solid-state electronics technology. Preventive maintenance is required to keep the AC motor drive in its optimal condition, and to ensure a long life. It is recommended to have a qualified technician perform a check-up of the AC motor drive regularly.

Daily Inspection:

Basic check-up items to detect if there were any abnormalities during operation are:

1. Whether the motors are operating as expected.
2. Whether the installation environment is abnormal.
3. Whether the cooling system is operating as expected.
4. Whether any irregular vibration or sound occurred during operation.
5. Whether the motors are overheating during operation.
6. Always check the input voltage of the AC drive with a Voltmeter.

Periodic Inspection:

Before the check-up, always turn off the AC input power and remove the cover. Wait at least 10 minutes after all display lamps have gone out, and then confirm that the capacitors have fully discharged by measuring the voltage between ⊕ ~ ⊖. It should be less than 25VDC.

DANGER!

1. Disconnect AC power before processing!
2. Only qualified personnel can install, wire and maintain AC motor drives. Please take off any metal objects, such as watches and rings, before operation. And only insulated tools are allowed.
3. Never reassemble internal components or wiring.
4. Prevent static electricity.

Periodical Maintenance

Ambient environment

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check the ambient temperature, humidity, vibration and see if there are any dust, gas, oil or water drops	Visual inspection and measurement with equipment with standard specification	○		
Check if there are any dangerous objects in the environment	Visual inspection	○		

Voltage

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check if the voltage of main circuit and control circuit is correct	Measure with multimeter with standard specification	○		

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Keypad

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Is the display clear for reading?	Visual inspection	○		
Any missing characters?	Visual inspection	○		

Mechanical parts

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual and aural inspection		○	
If there are any loose screws	Tighten the screws		○	
If any part is deformed or damaged	Visual inspection		○	
If there is any color change by overheating	Visual inspection		○	
If there is any dust or dirt	Visual inspection		○	

Main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose or missing screws	Tighten or replace the screw	○		
If machine or insulator is deformed, cracked, damaged or with changed color change due to overheating or ageing	Visual inspection **NOTE: Please ignore the color change of copper plate**		○	
If there is any dust or dirt	Visual inspection		○	

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Terminals and wiring of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If the wiring shows change of color change or deformation due to overheat	Visual inspection		○	
If the insulation of wiring is damaged or the color has changed	Visual inspection		○	
If there is any damage	Visual inspection		○	

DC capacity of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any leakage of liquid, change of color, cracks or deformation	Visual inspection	○		
Measure static capacity when required	Static capacity $\geq$ initial value X 0.85		○	

Resistor of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any peculiar smell or insulator cracks due to overheating	Visual inspection, smell		○	
If there is any disconnection	Visual inspection or measure with multimeter after removing wiring between +/B1 ~ - Resistor value should be within $\pm$ 10%		○	

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Transformer and reactor of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal vibration or peculiar smell	Visual, aural inspection and smell	○		

Magnetic contactor and relay of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws	Visual and aural inspection. Tighten screw if necessary.	○		
If the contact works correctly	Visual inspection	○		

Printed circuit board and connector of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws and connectors	Tighten the screws and press the connectors firmly in place.		○	
If there is any peculiar smell and color change	Visual inspection and smell		○	
If there is any crack, damage, deformation or corrosion	Visual inspection		○	
If there is any leaked liquid or deformation in capacitors	Visual inspection		○	

Cooling fan of cooling system

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual, aural inspection and turn the fan with hand (turn off the power before operation) to see if it rotates smoothly			○
If there is any loose screw	Tighten the screw			○
If there is any change of color due to overheating	Change fan			○

Ventilation channel of cooling system

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any obstruction in the heat sink, air intake or air outlet	Visual inspection		○	

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Appendix A Specifications

There are 115V, 230V and 460V models in the VFD-E series. For 115V models, it is 1-phase models. For 0.25 to 3HP of the 230V models, there are 1-phase/3-phase models. Refer to following specifications for details.

Voltage Class		115V Class		
Model Number VFD-XXXE		002	004	007
Max. Applicable Motor Output (kW)		0.2	0.4	0.75
Max. Applicable Motor Output (hp)		0.25	0.5	1.0
Output Rating	Rated Output Capacity (kVA)	0.6	1.0	1.6
	Rated Output Current (A)	1.6	2.5	4.2
	Maximum Output Voltage (V)	3-Phase Proportional to Twice the Input Voltage		
	Output Frequency (Hz)	0.1~600 Hz		
	Carrier Frequency (kHz)	1-15		
Input Rating	Rated Input Current (A)	Single-phase		
		6	9	18
	Rated Voltage/Frequency	Single phase, 100-120V, 50/60Hz		
	Voltage Tolerance	± 10%(90~132 V)		
	Frequency Tolerance	± 5%(47~63 Hz)		
Cooling Method		Natural Cooling		Fan Cooling
Weight (kg)		1.2	1.2	1.2

Voltage Class		230V Class									
Model Number VFD-XXXE		002	004	007	015	022	037	055	075	110	150
Max. Applicable Motor Output (kW)		0.2	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15
Max. Applicable Motor Output (hp)		0.25	0.5	1.0	2.0	3.0	5.0	7.5	10	15	20
Output Rating	Rated Output Capacity (kVA)	0.6	1.0	1.6	2.9	4.2	6.5	9.5	12.5	17.1	25
	Rated Output Current (A)	1.6	2.5	4.2	7.5	11.0	17	25	33	45	65
	Maximum Output Voltage (V)	3-Phase Proportional to Input Voltage									
	Output Frequency (Hz)	0.1~600 Hz									
	Carrier Frequency (kHz)	1-15									
Input Rating	Rated Input Current (A)	Single/3-phase					3-phase				
		4.9/1.9	6.5/2.7	9.5/5.1	15.7/9	24/15	20.6	26	34	48	70
	Rated Voltage/Frequency	Single/3-phase 200-240 V, 50/60Hz					3-phase 200-240V, 50/60Hz				
	Voltage Tolerance	± 10%(180~264 V)									
	Frequency Tolerance	± 5%(47~63 Hz)									
Cooling Method		Natural Cooling			Fan Cooling						
Weight (kg)		1.1	1.1	1.1	*1.2/1.9	1.9	1.9	3.5	3.5	3.57	6.6

*NOTE: the weight for VFD015E23P is 1.2kg.

Voltage Class		460V Class										
Model Number VFD-XXXE		004	007	015	022	037	055	075	110	150	185	220
Max. Applicable Motor Output (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22
Max. Applicable Motor Output (hp)		0.5	1.0	2.0	3.0	5.0	7.5	10	15	20	25	30
Output Rating	Rated Output Capacity (kVA)	1.2	2.0	3.3	4.4	6.8	9.9	13.7	18.3	24	29	34
	Rated Output Current (A)	1.5	2.5	4.2	5.5	8.2	13	18	24	32	38	45
	Maximum Output Voltage (V)	3-Phase Proportional to Input Voltage										
	Output Frequency (Hz)	0.1~600 Hz										
	Carrier Frequency (kHz)	1-15										
Input Rating	Rated Input Current (A)	3-phase										
		1.9	3.2	4.3	7.1	11.2	14	19	26	35	41	49
	Rated Voltage/Frequency	3-phase, 380-480V, 50/60Hz										
	Voltage Tolerance	±10%(342~528V)										
	Frequency Tolerance	±5%(47~63Hz)										
Cooling Method		Natural Cooling		Fan Cooling								
Weight (kg)		1.2	1.2	1.2	1.9	1.9	4.2	4.2	4.2	7.47	7.47	7.47

General Specifications			
Control Characteristics	Control System		SPWM(Sinusoidal Pulse Width Modulation) control (V/f or sensorless vector control)
	Frequency Setting Resolution		0.01Hz
	Output Frequency Resolution		0.01Hz
	Torque Characteristics		Including the auto-torque/auto-slip compensation; starting torque can be 150% at 3.0Hz
	Overload Endurance		150% of rated current for 1 minute
	Skip Frequency		Three zones, setting range 0.1-600Hz
	Accel/Decel Time		0.1 to 600 seconds (2 Independent settings for Accel/Decel time)
	Stall Prevention Level		Setting 20 to 250% of rated current
	DC Brake		Operation frequency 0.1-600.0Hz, output 0-100% rated current Start time 0-60 seconds, stop time 0-60 seconds
	Regenerated Brake Torque		Approx. 20% (up to 125% possible with optional brake resistor or externally mounted brake unit, 1-15hp (0.75-11kW) models have brake chopper built-in)
	V/f Pattern		4-point adjustable V/f pattern
Operating Characteristics	Frequency Setting	Keypad	Setting by ▲ ▼
		External Signal	Potentiometer-5kΩ/0.5W, 0 to +10VDC, 4 to 20mA, RS-485 interface; Multi-function Inputs 3 to 9 (15 steps, Jog, up/down)
	Operation Setting Signal	Keypad	Set by RUN and STOP
		External Signal	2 wires/3 wires (MI1, MI2, MI3), JOG operation, RS-485 serial interface (MODBUS), programmable logic controller
	Multi-function Input Signal		Multi-step selection 0 to 15, Jog, accel/decel inhibit, 2 accel/decel switches, counter, external Base Block, ACI/AVI selections, driver reset, UP/DOWN key settings, NPN/PNP input selection

General Specifications		
	Multi-function Output Indication	AC drive operating, frequency attained, zero speed, Base Block, fault indication, overheat alarm, emergency stop and status selections of input terminals
	Analog Output Signal	Output frequency/current
Alarm Output Contact		Contact will be On when drive malfunctions (1 Form C/change-over contact and 1 open collector output) for standard type)
Operation Functions		Built-in PLC(NOT for CANopen models), AVR, accel/decel S-Curve, over-voltage/over-current stall prevention, 5 fault records, reverse inhibition, momentary power loss restart, DC brake, auto torque/slip compensation, auto tuning, adjustable carrier frequency, output frequency limits, parameter lock/reset, vector control, PID control, external counter, MODBUS communication, abnormal reset, abnormal re-start, power-saving, fan control, sleep/wake frequency, 1st/2nd frequency source selections, 1st/2nd frequency source combination, NPN/PNP selection, parameters for motor 0 to motor 3, DEB and OOB (Out Of Balance Detection)(for washing machine)
Protection Functions		Over voltage, over current, under voltage, external fault, overload, ground fault, overheating, electronic thermal, IGBT short circuit, PTC
Display Keypad (optional)		6-key, 7-segment LED with 4-digit, 5 status LEDs, master frequency, output frequency, output current, custom units, parameter values for setup and lock, faults, RUN, STOP, RESET, FWD/REV, PLC
Built-in Brake Chopper		VFD002E11T/21T/23T, VFD004E11T/21T/23T/43T, VFD007E21T/23T/43T, VFD015E23T/43T, VFD007E11A/11C, VFD015E21A/21C, VFD022E21A/21C/23A/23C/43A/43C, VFD037E23A/23C/43A/43C, VFD055E23A/23C/43A/43C, VFD075E23A/23C/43A/43C, VFD110E23A/23C/43A/43C, VFD150E23A/23C/43A/43C, VFD185E43A/43C, VFD220E43A/43C
Built-in EMI Filter		For 230V 1-phase and 460V 3-phase models.
Environmental Conditions	Enclosure Rating	IP20
	Pollution Degree	2
	Installation Location	Altitude 1,000 m or lower, keep from corrosive gasses, liquid and dust
	Ambient Temperature	-10^{o}C to 50^{o}C (40^{o}C for side-by-side mounting) Non-Condensing and not frozen
	Storage/ Transportation Temperature	-20 ^{o}C to 60 ^{o}C
	Ambient Humidity	Below 90% RH (non-condensing)
	Vibration	9.80665m/s^2 (1G) less than 20Hz, 5.88m/s^2 (0.6G) at 20 to 50Hz
Approvals		CE cULus C-tick

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Appendix B Accessories

B.1 All Brake Resistors & Brake Units Used in AC Motor Drives

Note: Please only use DELTA resistors and recommended values. Other resistors and values will void Delta's warranty. Please contact your nearest Delta representative for use of special resistors. The brake unit should be at least 10 cm away from AC motor drive to avoid possible interference. Refer to the "Brake unit Module User Manual" for further details.

Voltage	Applicable Motor		AC Drive Part No.	Full Load Torque KG-M	Equivalent Resistor Value (recommended)	Brake Unit Part No. and Quantity		Brake Resistors Part No. and Quantity		Brake Torque 10%ED	Min. Equivalent Resistor Value for each AC Motor Drive
	hp	kW									
115V Series	0.25	0.2	VFD002E11A/11C/11P	0.110	200W 250Ω	BUE-20015	1	BR200W250	1	320	200Ω
			VFD002E11T		200W 250Ω			BR200W250	1	320	200Ω
	0.5	0.4	VFD004E11A/11C/11P	0.216	200W 250Ω	BUE-20015	1	BR200W250	1	170	100Ω
			VFD004E11T		200W 250Ω			BR200W250	1	170	100Ω
	1	0.75	VFD007E11A/11C/11P	0.427	200W 150Ω			BR200W150	1	140	80Ω
230V Series	0.25	0.2	VFD002E21A/21C/21P/23A 23C/23P	0.110	200W 250Ω	BUE-20015	1	BR200W250	1	320	200Ω
			VFD002E21T/23T		200W 250Ω			BR200W250	1	320	200Ω
	0.5	0.4	VFD004E21A/21C/21P/23A /23C/23P	0.216	200W 250Ω	BUE-20015	1	BR200W250	1	170	100Ω
			VFD004E21T/23T		200W 250Ω			BR200W250	1	170	100Ω
	1	0.75	VFD007E21A/21C/21P/23A /23C/23P	0.427	200W 150Ω	BUE-20015	1	BR200W150	1	140	80Ω
			VFD007E21T/23T		200W 150Ω			BR200W150	1	140	80Ω
	2	1.5	VFD015E21A/21C	0.849	300W 85Ω			-		125	40Ω
			VFD015E23T		300W 85Ω			-		125	80Ω
			VFD015E23A/23C/23P		300W 85Ω	BUE-20015	1	-		125	80Ω
	3	2.2	VFD022E21A/21C/23A/23C	1.262	600W 50Ω			-		120	40Ω
	5	3.7	VFD037E23A/23C	2.080	600W 50Ω			-		107	40Ω
	7.5	5.5	VFD055E23A/23C	3.111	800W 37.5Ω			-		85	34Ω
	10	7.5	VFD075E23A/23C	4.148	1200W 25Ω			-		90	24Ω
	15	11	VFD110E23A/23C	6.186	1200W 8Ω			BR1K2W008	2	100	8Ω
	20	15	VFD150E23A/23C	8.248	3000W 10Ω			BR1K5W005	2	119	10Ω
460V Series	0.5	0.4	VFD004E43A/43C/43P	0.216	300W 400Ω	BUE-40015	1	BR300W400	1	400	400Ω
			VFD004E43T		300W 400Ω			BR300W400	1	400	400Ω
	1	0.75	VFD007E43A/43C/43P	0.427	300W 400Ω	BUE-40015	1	BR300W400	1	200	200Ω
			VFD007E43T		300W 400Ω			BR300W400	1	200	200Ω
	2	1.5	VFD015E43A/43C/43P	0.849	400W 300Ω	BUE-40015	1	BR200W150	2	140	160Ω
			VFD015E43T		400W 300Ω			BR200W150	2	140	160Ω
	3	2.2	VFD022E43A/43C	1.262	600W 200Ω			BR300W400	2	140	140Ω
	5	3.7	VFD037E43A/43C	2.080	750W 140Ω			-		125	96Ω
	7.5	5.5	VFD055E43A/43C	3.111	1100W 96Ω			-		120	96Ω
	10	7.5	VFD075E43A/43C	4.148	1500W 69Ω			-		125	69Ω
	15	11	VFD110E43A/43C	6.186	2000W 53Ω			-		108	53Ω
	20	15	VFD150E43A/43C	8.248	4800W 32Ω			BR1K2W008	4	151	31Ω
	25	18.5	VFD185E43A/43C	10.281	4800W 32Ω			BR1K2W008	4	121	31Ω
	30	22	VFD220E43A/43C	12.338	4800W 32Ω			BR1K2W008	4	100	31Ω

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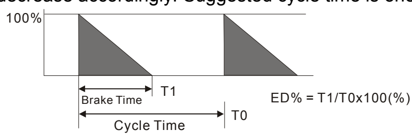
NOTE

1. Please select the brake unit and/or brake resistor according to the table. “-“ means no Delta product. Please use the brake unit according to the Equivalent Resistor Value.
2. If damage to the drive or other equipment is due to the fact that the brake resistors and the brake modules in use are not provided by Delta, the warranty will be void.
3. Take into consideration the safety of the environment when installing the brake resistors.
4. If the minimum resistance value is to be utilized, consult local dealers for the calculation of the power in Watt.
5. Please select thermal relay trip contact to prevent resistor over load. Use the contact to switch power off to the AC motor drive!
6. When using more than 2 brake units, equivalent resistor value of parallel brake unit can’t be less than the value in the column “Minimum Equivalent Resistor Value for Each AC Drive” (the right-most column in the table).
7. Please read the wiring information in the user manual of the brake unit thoroughly prior to installation and operation.
8. When using with the brake resistor or brake unit, it needs to disable over-voltage stall prevention function (set Pr.06.00 to 0). It is recommended to disable AVR (auto voltage regulation) function (set Pr.08.18 to 1).
9. Definition for Brake Usage ED%

   Explanation: The definition of the barking usage ED(%) is for assurance of enough time for the brake unit and brake resistor to dissipate away heat generated by braking. When the brake resistor heats up, the resistance would increase with temperature, and brake torque would decrease accordingly. Suggested cycle time is one minute



10. For safety reasons, install a thermal overload relay between brake unit and brake resistor. Together with the magnetic contactor (MC) in the mains supply circuit to the drive it offers protection in case of any malfunctioning. The purpose of installing the thermal overload relay is to protect the brake resistor against damage due to frequent brake or in case the brake unit is continuously on due to unusual high input voltage. Under these circumstances the thermal overload relay switches off the power to the drive. Never let the thermal overload relay switch off only the brake resistor as this will cause serious damage to the AC Motor Drive.

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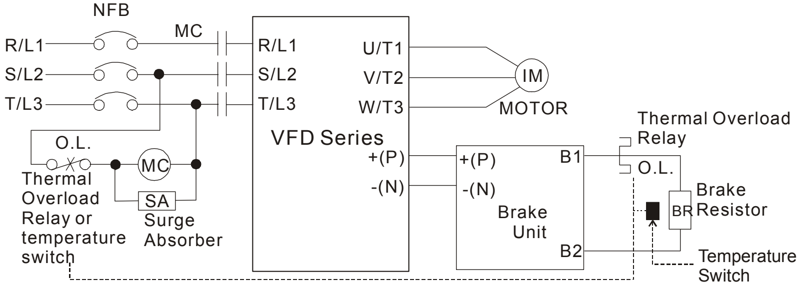


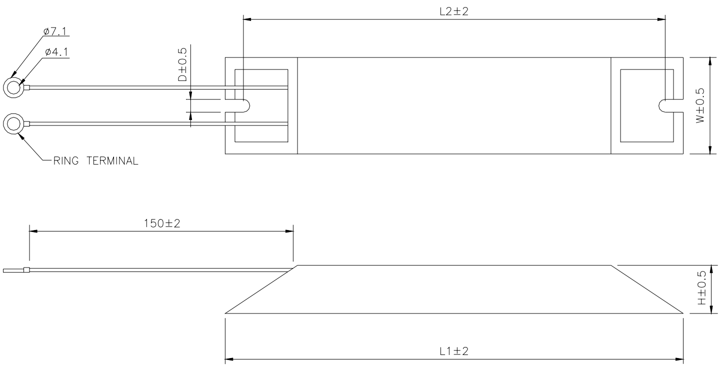
Note1: When using the AC drive with DC reactor, please refer to wiring diagram in the AC drive user manual for the wiring of terminal +(P) of Brake unit.

Note2: **Do NOT** wire terminal -(N) to the neutral point of power system.

B.1.1 Dimensions and Weights for Brake Resistors

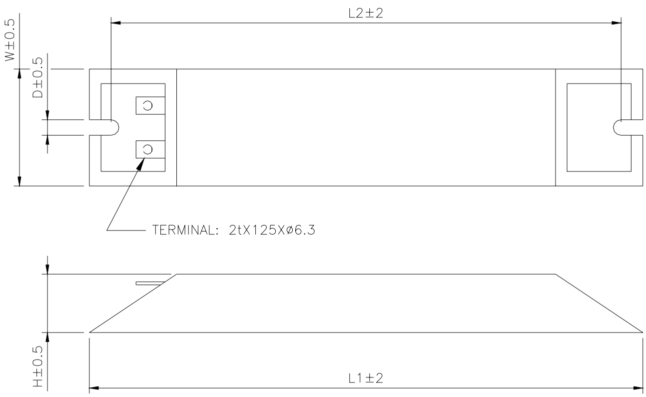
(Dimensions are in millimeter)

Order P/N: BR080W200, BR080W750, BR300W100, BR300W250, BR300W400, BR400W150, BR400W040



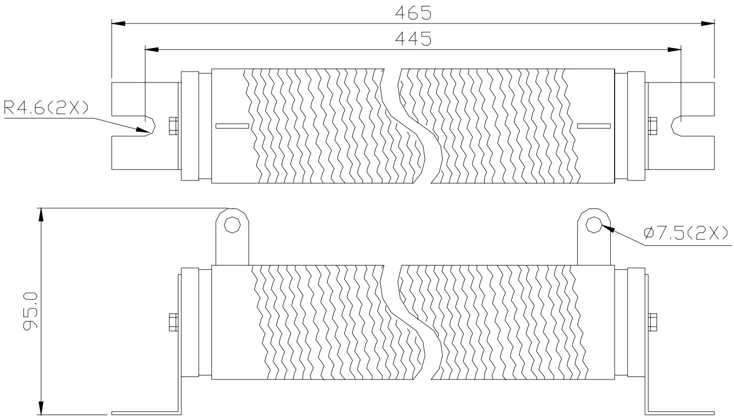
Model no.	L1	L2	H	D	W	Max. Weight (g)
BR080W200	140	125	20	5.3	60	160
BR080W750						
BR300W100	215	200	30	5.3	60	750
BR300W250						
BR300W400						
BR400W150	265	250	30	5.3	60	930
BR400W040						

Order P/N: BR500W030, BR500W100, BR1KW020, BR1KW075

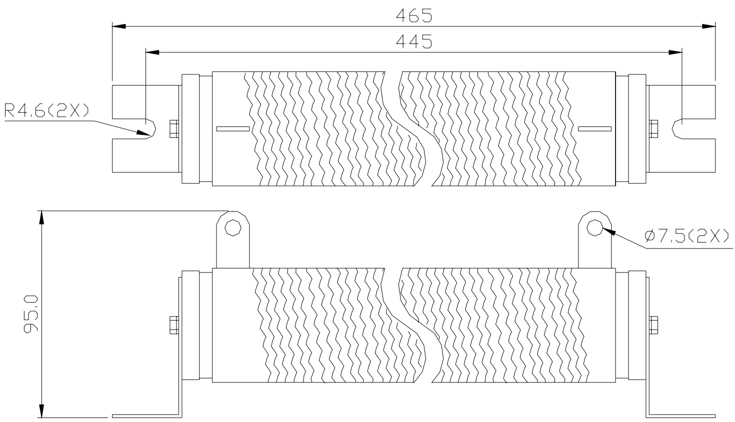


Model no.	L1	L2	H	D	W	Max. Weight (g)
BR500W030	335	320	30	5.3	60	1100
BR500W100						
BR1KW020	400	385	50	5.3	100	2800
BR1KW075						

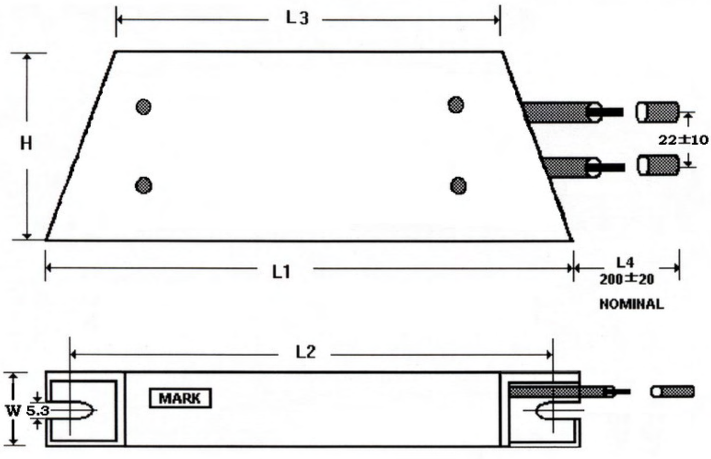
Order P/N: BR1K0W050



Order P/N: BR1K0W050, BR1K2W008, BR1K2W6P8, BR1K5W005, BR1K5W040



Order P/N: BR200W150, BR200W250



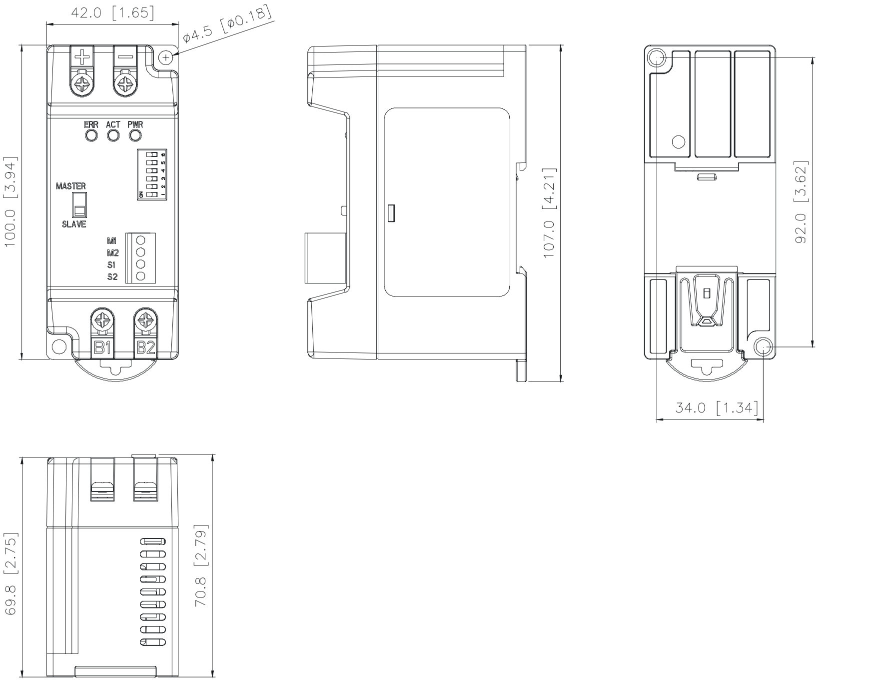
Model no.	L1±2	L2±2	L3±2	W±1	H±1
BR200W150	165	150	110	30	60
BR200W250					

B.1.2 Specifications for Brake Unit

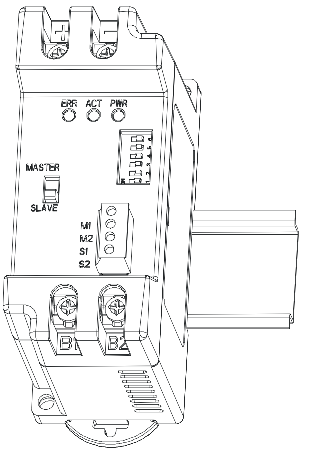
		230V Series		460V Series	
Model Name BUE-XXXXX		20015	20037	40015	40037
Max. Motor Power (kW)		1.5	3.7	30	45
Output Rating	Max. Peak Discharge Current (A) 10%ED	3.6	3.7	1.5	3.7
	Brake Start-up Voltage (DC)	328/345/362/380/400±3V		656/690/725/760/800±6V	
Power	DC Voltage	200~400VDC		400~800VDC	
Protection	Heat Sink Overheat	Temperature over +100°C (212°F)			
	Power Charge Display	Blackout until bus (P~N) voltage is below 50VDC			
Environment	Installation Location	Indoor (no corrosive gases, metallic dust)			
	Operating Temperature	-10°C ~ +50°C (14°F to 122°F)			
	Storage Temperature	-20°C ~ +60°C (-4°F to 140°F)			
	Humidity	90% Non-condensing			
	Vibration	9.8m/s^2 (1G) under 20Hz, 2m/s^2 (0.2G) at 20~50Hz			
Wall-mounted Enclosed Type		IP20			

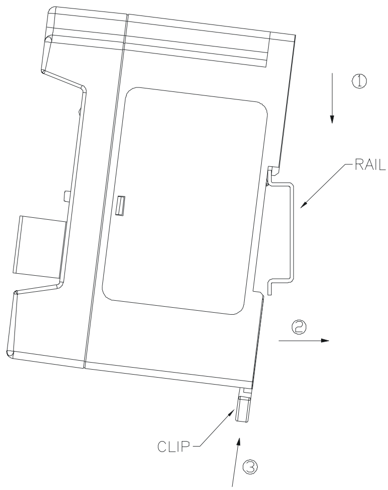
B.1.3 Dimensions for Brake Unit

(Dimensions are in millimeter[inch])



B.1.4 DIN Rail Installation





B.2 No-fuse Circuit Breaker Chart

For 1-phase/3-phase drives, the current rating of the breaker shall be within 2-4 times rated input current.

1-phase		3-phase	
Model	**Recommended no-fuse breaker (A)**	**Model**	**Recommended no-fuse breaker (A)**
VFD002E11A/11T/11C/ 11P	15	VFD002E23A/23C/23T/ 23P	5
VFD002E21A/21T/21C/ 21P	10	VFD004E23A/23C/23T/ 23P	5
VFD004E11A/11C/11T/ 11P	20	VFD004E43A/43C/43T/ 43P	5
VFD004E21A/21C/21T/ 21P	15	VFD007E23A/23C/23T/ 23P	10
VFD007E11A/11C	30	VFD007E43A/43C/43T/ 43P	5
VFD007E21A/21C/21T/ 21P	20	VFD015E23A/23C/23T/ 23P	20
VFD015E21A/21C	30	VFD015E43A/43C/43T/ 43P	10
VFD022E21A/21C	50	VFD022E23A/23C	30
		VFD022E43A/43C	15
		VFD037E23A/23C	40
		VFD037E43A/43C	20
		VFD055E23A/23C	50
		VFD055E43A/43C	30
		VFD075E23A/23C	60
		VFD075E43A/43C	40
		VFD110E23A/23C	100
		VFD110E43A/43C	50
		VFD150E23A/23C	150
		VFD150E43A/43C	70
		VFD185E43A/43C	80
		VFD220E43A/43C	100

B.3 Fuse Specification Chart

Smaller fuses than those shown in the table are permitted.

Model	I (A) Input	I (A) Output	Line Fuse	
			I (A)	Bussmann P/N
VFD002E11A/11T/11C/11P	6	1.6	15	JJN-15
VFD002E21A/21T/21C/21P	4.9	1.6	10	JJN-10
VFD002E23A/23C/23T/23P	1.9	1.6	5	JJN-6
VFD004E11A/11C/11T/11P	9	2.5	20	JJN-20
VFD004E21A/21C/21T/21P	6.5	2.5	15	JJN-15
VFD004E23A/23C/23T/23P	2.7	2.5	5	JJN-6
VFD004E43A/43C/43T/43P	1.9	1.5	5	JJS-6
VFD007E11A/11C	18	4.2	30	JJN-30
VFD007E21A/21C/21T/21P	9.7	4.2	20	JJN-20
VFD007E23A/23C/23T/23P	5.1	4.2	10	JJN-10
VFD007E43A/43C/43T/43P	3.2	2.5	5	JJS-6
VFD015E21A/21C	15.7	7.5	30	JJN-30
VFD015E23A/23C/23T/23P	9	7.5	20	JJN-20
VFD015E43A/43C/43T/43P	4.3	4.2	10	JJS-10
VFD022E21A/21C	24	11	50	JJN-50
VFD022E23A/23C	15	11	30	JJN-30
VFD022E43A/43C	7.1	5.5	15	JJS-15
VFD037E23A/23C	20.6	17	40	JJN-40
VFD037E43A/43C	11.2	8.2	20	JJS-20
VFD055E23A/23C	26	25	50	JJN-50

Model	I (A) Input	I (A) Output	Line Fuse	
			I (A)	Bussmann P/N
VFD055E43A/43C	14	13	30	JJS-30
VFD075E23A/23C	34	33	60	JJN-60
VFD075E43A/43C	19	18	40	JJS-40
VFD110E23A/23C	48	45	100	JJN-100
VFD110E43A/43C	26	24	50	JJS-50
VFD150E23A/23C	70	65	150	JJN-150
VFD150E43A/43C	35	32	70	JJN-70
VFD185E43A/43C	41	38	80	JJN-80
VFD220E43A/43C	49	45	100	JJN-100

B.4 AC Reactor

B.4.1 AC Input Reactor Recommended Value

230V, 50/60Hz, 1-Phase

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)
				3~5% impedance
0.2	1/4	4	6	6.5
0.4	1/2	5	7.5	3
0.75	1	8	12	1.5
1.5	2	12	18	1.25
2.2	3	18	27	0.8

230V, 50/60Hz, 3-Phase

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
0.2	1/4	2	3	9	20
0.4	1/2	2	3	6.5	12
0.75	1	4	6	3	6.5
1.5	2	8	12	1.5	3

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
2.2	3	12	18	1.25	2.5
3.7	5	18	27	0.8	1.5
5.5	7.5	25	37.5	0.5	1.2
7.5	10	35	52.5	0.4	0.8
11	15	45	67.5	0.3	0.5

460V, 50/60Hz, 3-Phase

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
0.4	1/2	2	3	20	32
0.75	1	4	6	9	12
1.5	2	4	6	6.5	9
2.2	3	8	12	5	7.5
3.7	5	8	12	3	5
5.5	7.5	12	18	2.5	4.2
7.5	10	18	27	1.5	2.5
11	15	25	37.5	1.2	2
15	20	35	52.5	0.8	1.2
18.5	25	35	52.5	0.8	1.2
22	30	45	67.5	0.7	1.2

B.4.2 AC Output Reactor Recommended Value

115V/230V, 50/60Hz, 3-Phase

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
0.2	1/4	4	4	9	12
0.4	1/2	6	6	6.5	9
0.75	1	8	12	3	5
1.5	2	8	12	1.5	3
2.2	3	12	18	1.25	2.5
3.7	5	18	27	0.8	1.5

kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
5.5	7.5	25	37.5	0.5	1.2
7.5	10	35	52.5	0.4	0.8
11	15	55	82.5	0.25	0.5
15	20	80	120	0.2	0.4

460V, 50/60Hz, 3-Phase

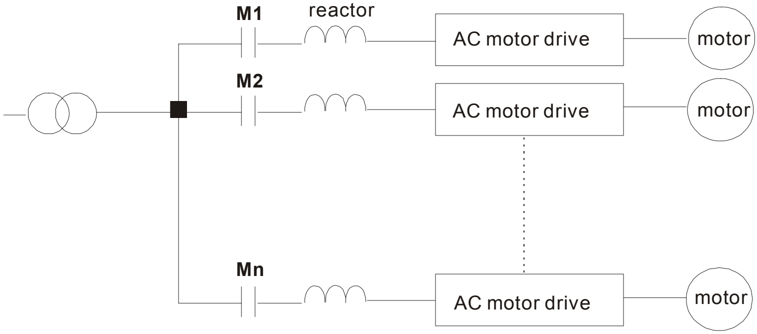
kW	HP	Fundamental Amps	Max. continuous Amps	Inductance (mH)	
				3% impedance	**5% impedance**
0.4	1/2	2	3	20	32
0.75	1	4	6	9	12
1.5	2	4	6	6.5	9
2.2	3	8	12	5	7.5
3.7	5	12	18	2.5	4.2
5.5	7.5	18	27	1.5	2.5
7.5	10	18	27	1.5	2.5
11	15	25	37.5	1.2	2
15	20	35	52.5	0.8	1.2
18.5	25	45	67.5	0.7	1.2
22	30	45	67.5	0.7	1.2

B.4.3 Applications

Connected in input circuit

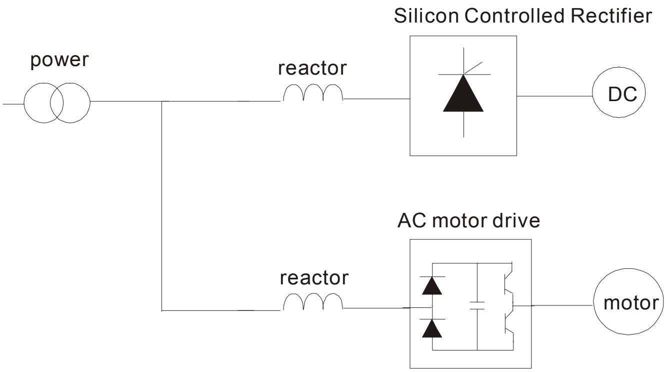
Application 1	Question
When more than one AC motor drive is connected to the same mains power, and one of them is ON during operation.	When applying power to one of the AC motor drive, the charge current of the capacitors may cause voltage dip. The AC motor drive may be damaged when over current occurs during operation.

Correct wiring



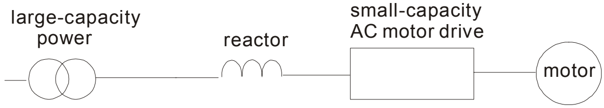
Application 2	Question
Silicon rectifier and AC motor drive are connected to the same power.	Switching spikes will be generated when the silicon rectifier switches on/off. These spikes may damage the mains circuit.

Correct wiring



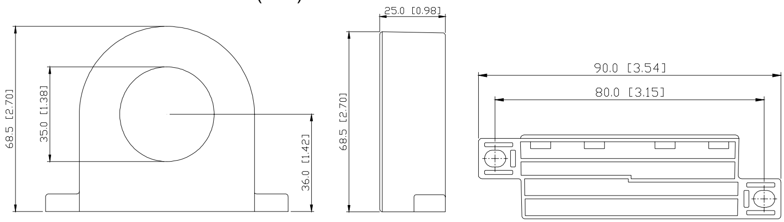
Application 3	Question
Used to improve the input power factor, to reduce harmonics and provide protection from AC line disturbances. (surges, switching spikes, short interruptions, etc.). The AC line reactor should be installed when the power supply capacity is 500kVA or more and exceeds 6 times the inverter capacity, or the mains wiring distance ≤10m.	When the mains power capacity is too large, line impedance will be small and the charge current will be too high. This may damage AC motor drive due to higher rectifier temperature.

Correct wiring



B.5 Zero Phase Reactor (RF220X00A)

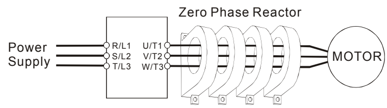
Dimensions are in millimeter and (inch)



Cable type (**Note**)	Recommended Wire Size			Qty.	Wiring Method
	AWG	mm^2	Nominal (mm^2)		
Single-core	≦10	≦5.3	≦5.5	1	Diagram A
	≦2	≦33.6	≦38	4	Diagram B
Three-core	≦12	≦3.3	≦3.5	1	Diagram A
	≦1	≦42.4	≦50	4	Diagram B

Note: 600V Insulated unshielded Cable.

Diagram B
Please put all wires through 4 cores in series without winding.

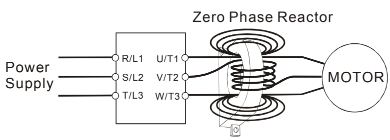


Note 1: The table above gives approximate wire size for the zero phase reactors but the selection is ultimately governed by the type and diameter of cable fitted i.e. the cable must fit through the center hole of zero phase reactors.

Note 2: Only the phase conductors should pass through, not the earth core or screen.

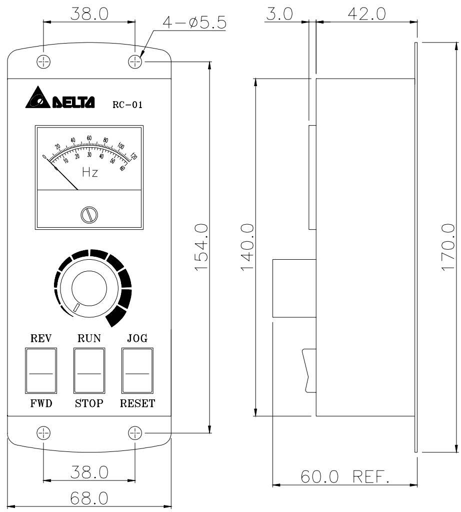
Note 3: When long motor output cables are used an output zero phase reactor may be required to reduce radiated emissions from the cable.

Diagram A
Please wind each wire 4 times around the core. The reactor must be put at inverter output as close as possible.



B.6 Remote Controller RC-01

Dimensions are in millimeter



8	6	5	4	16	15	14	13	11	← RC-01Terminal block
↕	↕	↕	↕	↕	↕	↕	↕	↕	(Wiring connections)
AFM	ACM	AVI	+10V	DCM	MI5	MI1	MI2	MI6	← VFD-E I/O block

VFD-E Programming:

Pr.02.00 set to 2

Pr.02.01 set to 1 (external controls)

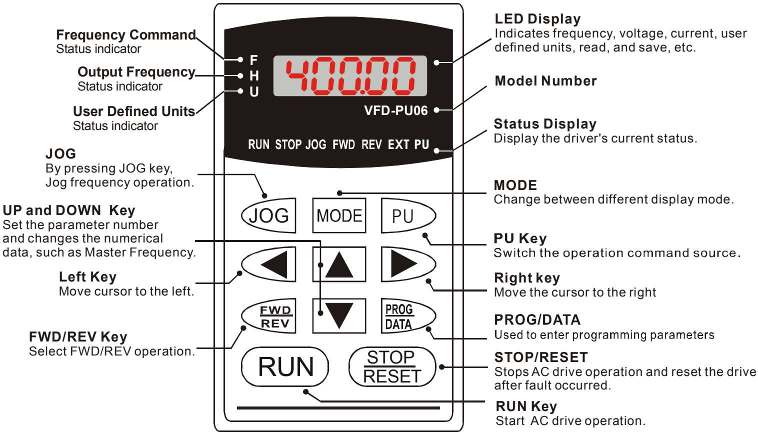
Pr.04.04 set to 1 (setting Run/Stop and Fwd/Rev controls)

Pr.04.07 (MI5) set to 5 (External reset)

Pr.04.08 (MI6) set to 8 (JOG operation)

B.7 PU06

B.7.1 Description of the Digital Keypad VFD-PU06



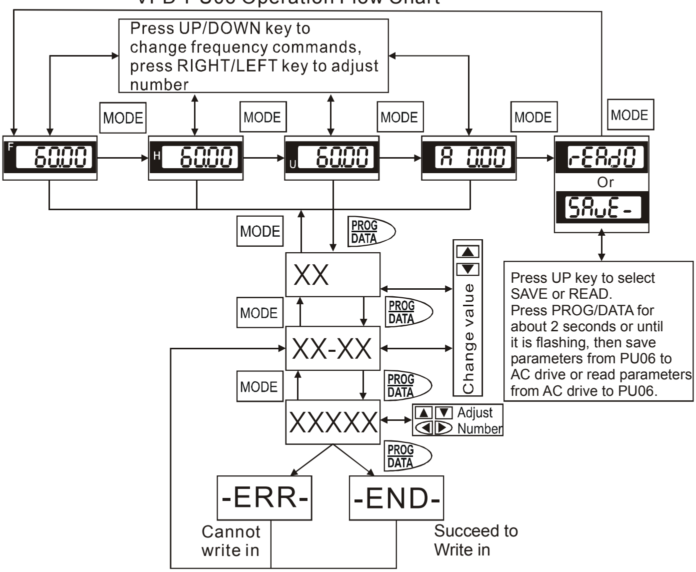
B.7.2 Explanation of Display Message

Display Message	Descriptions
	The AC motor drive Master Frequency Command.
	The Actual Operation Frequency present at terminals U, V, and W.
	The custom unit (u)
	The output current present at terminals U, V, and W.
	Press ▲ to change the mode to READ. Press PROG/DATA for about 2 sec or until it's flashing, read the parameters of AC drive to the digital keypad PU06. It can read 4 groups of parameters to PU06. (read 0 – read 3)
	Press ▲ to change the mode to SAVE. Press PROG/DATA for about 2 sec or until it's flashing, then write the parameters from the digital keypad PU06 to AC drive. If it has saved, it will show the type of AC motor drive.

Display Message	Descriptions
06-00	The specified parameter setting.
10	The actual value stored in the specified parameter.
E.F.	External Fault
-End-	"End" displays for approximately 1 second if the entered input data have been accepted. After a parameter value has been set, the new value is automatically stored in memory. To modify an entry, use the ▲ or ▼ keys.
-Err-	"Err" displays if the input is invalid.
CE-10	Communication Error. Please check the AC motor drive user manual (Chapter 5, Group 9 Communication Parameter) for more details.

B.7.3 Operation Flow Chart

VFD-PU06 Operation Flow Chart



B.8 KPE-LE02

B.8.1 Description of the Digital Keypad KPE-LE02

❶ **Status Display**
Display the driver's current status.

❷ **LED Display**
Indicates frequency, voltage, current, user defined units and etc.

❸ **Potentiometer**
For master Frequency setting.

❹ **RUN Key**
Start AC drive operation.

❺ **UP and DOWN Key**
Set the parameter number and changes the numerical data, such as Master Frequency.

❻ **MODE**
Change between different display mode.

❼ **STOP/RESET**
Stops AC drive operation and reset the drive after fault occurred.

❽ **ENTER**
Used to enter/modify programming parameters

Display Message	Descriptions
F 60.0	Displays the AC drive Master Frequency.
H 50.0	Displays the actual output frequency at terminals U/T1, V/T2, and W/T3.
U 180	User defined unit (where U = F x Pr.00.05)
A 5.0	Displays the output current at terminals U/T1, V/T2, and W/T3.
Frd	Displays the AC motor drive forward run status.
rEv	Displays the AC motor drive reverse run status.
c 20	The counter value (C).
06.00	Displays the selected parameter.

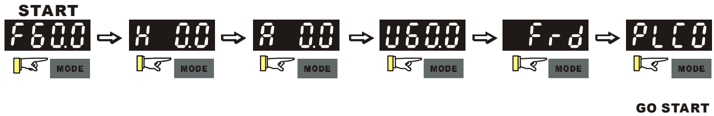
Display Message	Descriptions
	Displays the actual stored value of the selected parameter.
	External Fault.
	Display "End" for approximately 1 second if input has been accepted by pressing ENTER key. After a parameter value has been set, the new value is automatically stored in memory. To modify an entry, use the ▲ and ▼ keys.
	Display "Err", if the input is invalid.

NOTE

When the setting exceeds 99.99 for those numbers with 2 decimals (i.e. unit is 0.01), it will only display 1 decimal due to 4-digital display.

B.8.2 How to Operate the Digital Keypad

Setting Mode

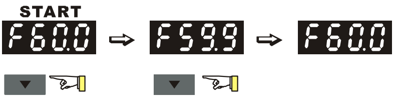


NOTE: In the selection mode, press ENTER to set the parameters.

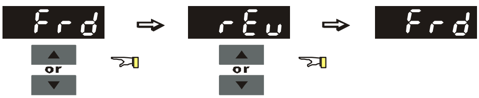
Setting parameters

NOTE :In the parameter setting mode, you can press ENTER to return the selecting mode.

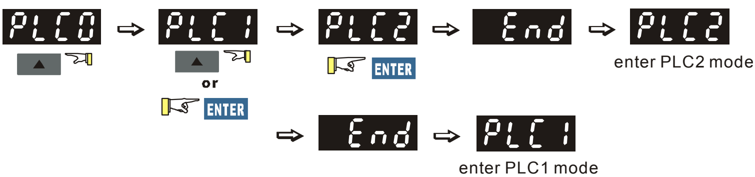
To shift data



Setting direction (When operation source is digital keypad)



Setting PLC Mode

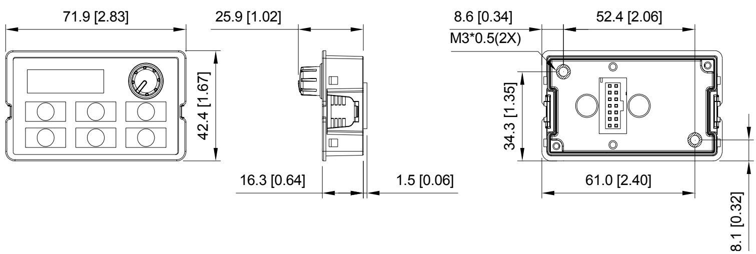


B.8.3 Reference Table for the 7-segment LED Display of the Digital Keypad

Digit	0	1	2	3	4	5	6	7	8	9
LED Display	0	1	2	3	4	5	6	7	8	9
English alphabet	A	a	B	C	c	D	d	E	e	F
LED Display	A	—	—	C	c	—	d	E	—	F
English alphabet	f	G	g	H	h	I	i	J	j	K
LED Display	—	G	—	H	h	I	i	J	j	K
English alphabet	k	L	l	M	m	N	n	O	o	P
LED Display	—	L	—	M	—	—	n	O	o	P
English alphabet	p	Q	q	R	r	S	s	T	t	U
LED Display	—	—	q	—	r	S	—	T	t	U
English alphabet	u	V	v	W	w	X	x	Y	y	Z
LED Display	—	—	v	—	—	—	—	Y	—	Z
English alphabet	z									
LED Display	—									

B.8.4 Keypad Dimensions

(Dimensions are in millimeter[inch])

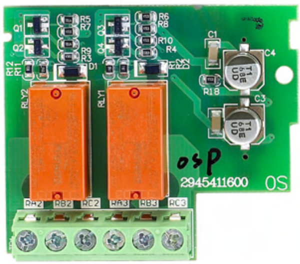
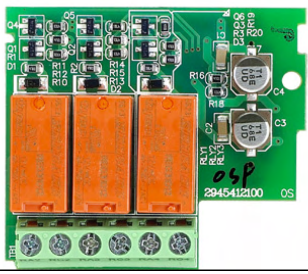


B.9 Extension Card

For details, please refer to the separate instruction shipped with these optional cards or download from our website http://www.delta.com.tw/industrialautomation/.

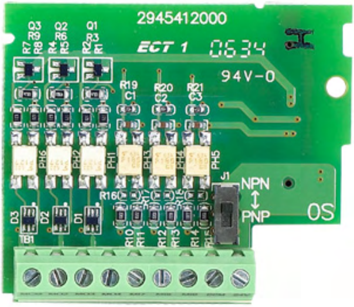
Installation method

B.9.1 Relay Card

EME-R2CA	Relay Output
	
EME-R3AA	**Relay Output**
	

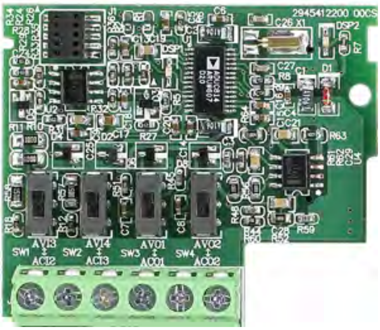
B.9.2 Digital I/O Card

EME-D33A



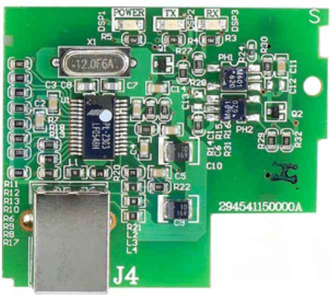
B.9.3 Analog I/O Card

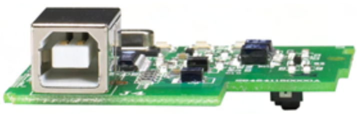
EME-A22A



B.9.4 Communication Card

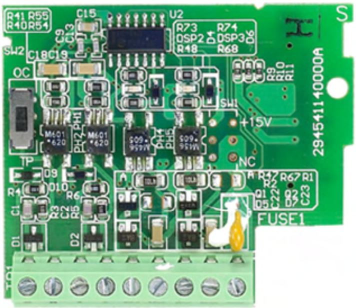
CME-USB01





B.9.5 Speed Feedback Card

EME-PG01

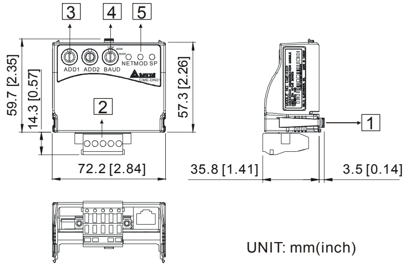


B.10 Fieldbus Modules

B.10.1 DeviceNet Communication Module (CME-DN01)

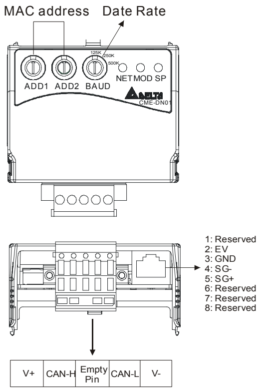
B.10.1.1 Panel Appearance and Dimensions

1. For RS-485 connection to VFD-E 2. Communication port for connecting DeviceNet network 3. Address selector 4. Baud rate selector 5. Three LED status indicators for monitor. (Refer to the figure below)

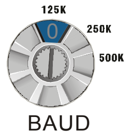


B.10.1.2 Wiring and Settings

Refer to following diagram for details.

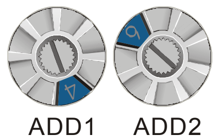


Setting baud rate



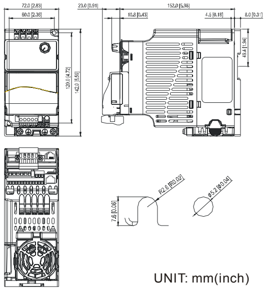
Switch Value	Baud Rate
0	125K
1	250K
2	500K
Other	AUTO

Setting MAC addresses: use decimal system.



B.10.1.3 Mounting Method

Step1 and step2 show how to mount this communication module onto VFD-E. The dimension on the left hand side is for your reference.

Dimensions	STEP 1	STEP 2
 UNIT: mm(inch)		

B.10.1.4 Power Supply

No external power is needed. Power is supplied via RS-485 port that is connected to VFD-E. An 8 pins RJ-45 cable, which is packed together with this communication module, is used to connect the RS-485 port between VFD-E and this communication module for power. This communication module will perform the function once it is connected. Refer to the following paragraph for LED indications.

B.10.1.5 LEDs Display

1. **SP:** Green LED means in normal condition, Red LED means abnormal condition.
2. **Module:** Green blinking LED means no I/O data transmission, Green steady LED means I/O data transmission OK.

   Red LED blinking or steady LED means module communication is abnormal.
3. **Network:** Green LED means DeviceNet communication is normal, Red LED means abnormal

NOTE

Refer to user manual for detail information-- *Chapter 5 Troubleshooting*.

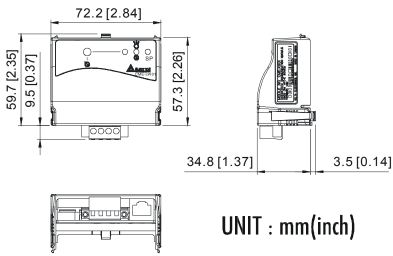
B.10.2 LonWorks Communication Module (CME-LW01)

B.10.2.1 Introduction

Device CME-LW01 is used for communication interface between Modbus and LonTalk. CME-LW01 needs be configured via LonWorks network tool first, so that it can perform the function on LonWorks network. No need to set CME-LW01 address.

This manual provides instructions for the installation and setup for CME-LW01 that is used to communicate with Delta VFD-E (firmware version of VFD-E should conform with CME-LW01 according to the table below) via LonWorks Network.

B.10.2.2 Dimensions

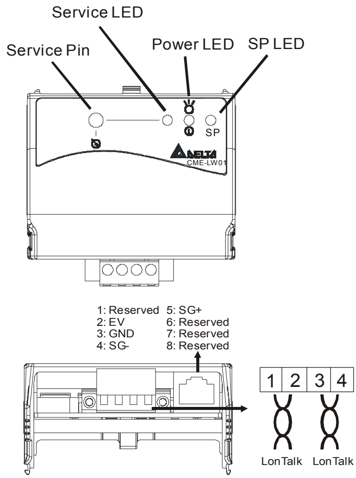


B.10.2.3 Specifications

Power supply:	16-30VDC, 750mW
Communication:	Modbus in ASCII format, protocol: 9600, 7, N, 2
LonTalk:	free topology with FTT-10A 78 Kbps.
LonTalk terminal:	4-pin terminals, wire gauge: 28-12 AWG, wire strip length: 7-8mm

RS-485 port: 8 pins with RJ-45

B.10.2.4 Wiring



■ Terminal definition for LonTalk system

Terminal	Symbol	Function
1		These are twisted pair cables to connect to LonTalk system. Terminals 1 and 2 should be used as one group, and the same for terminals 3 and 4.
2		
3		
4		

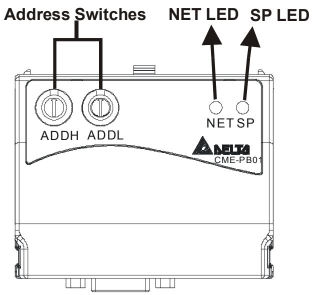
B.10.2.5 LED Indications

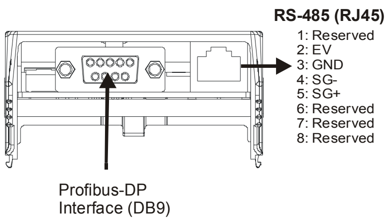
There are three LEDs in front panel of CME-LW01. If the communication is normal, power LED, SP LED should be green (red LED means abnormal communication) and service LED should be OFF. If LEDs display do not match, refer to user manual for details.

B.10.3 Profibus Communication Module (CME-PD01)

Call 1(800)985-6929 for Sales deltaacdrives.com sales@deltaacdrives.com

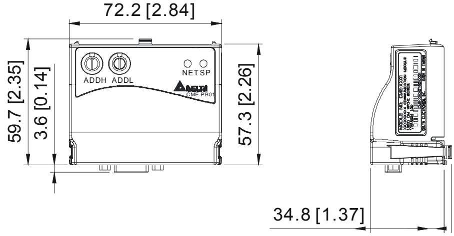
B.10.3.1 Panel Appearance

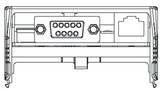




1. SP LED: Indicating the connection status between VFD-E and CME-PD01.
2. NET LED: Indicating the connection status between CME-PD01 and PROFIBUS-DP.
3. Address Switches: Setting the address of CME-PD01 on PROFIBUS- DP network.
4. RS-485 Interface (RJ45): Connecting to VFD-E, and supply power to CME-PD01.
5. PROFIBUS-DP Interface (DB9): 9-PIN connector that connects to PROFIBUS-DP network.
6. Extended Socket: 4-PIN socket that connects to PROFIBUS-DP network.

B.10.3.2 Dimensions





UNIT: mm(inch)

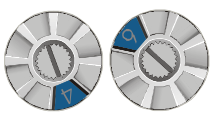
B.10.3.3 Parameters Settings in VFD-E

	VFD-E
Baud Rate 9600	Pr.09.01=1
RTU 8, N, 2	Pr.09.04=3
Freq. Source	Pr.02.00=4
Command Source	Pr.02.01=3

B.10.3.4 Power Supply

The power of CME-PD01 is supplied from VFD-E. Please connect VFD-E to CME-PD01 by using 8 pins RJ-45 cable, which is packed together with CME-PD01. After connection is completed, CME-PD01 is powered whenever power is applied to VFD-E.

B.10.3.5 PROFIBUS Address



ADDH ADDL

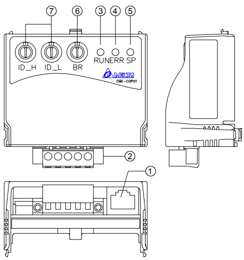
CME-PD01 has two rotary switches for the user to select the PROFIBUS address. The set value via 2 address switches, ADDH and ADDL, is in HEX format. ADDH sets the upper 4 bits, and ADDL sets the lower 4 bits of the PROFIBUS address.

Address	Meaning
1..0x7D	Valid PROFIBUS address
0 or 0x7E..0xFE	Invalid PROFIBUS address

B.10.4 CME-COP01 (CANopen)

CME-COP01 CANopen communication module is specifically for connecting to CANopen communication module of Delta VFD-E AC motor drive.

B.10.4.1 Product Profile



Unit: mm

①	COM port
②	CANopen connection port
③	RUN indicator
④	ERROR indicator
⑤	SP (Scan Port) indicator
⑥	Baud rate switch
⑦	Address switch

B.10.4.2 Specifications

CANopen Connection

Interface	Pluggable connector (5.08mm)
Transmission method	CAN
Transmission cable	2-wire twisted shielded cable
Electrical isolation	500V DC

Communication

Message type	Process Data Objects (PDO)	Baud rate	10 Kbps
	Service Data Object (SDO)		20 Kbps
	Synchronization (SYNC)		50 Kbps
	Emergency (EMCY)		125 Kbps
	Network Management (NMT)		250 Kbps
			500 Kbps
			800 Kbps
			1 Mbps
Product code	Delta VFD-E AC motor drive 22		
Device type	402		
Vendor ID	477		

Environmental Specifications

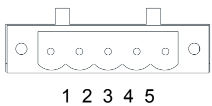
Noise Immunity	ESD(IEC 61131-2, IEC 61000-4-2): 8KV Air Discharge EFT(IEC 61131-2, IEC 61000-4-4): Power Line: 2KV, Digital I/O: 1KV, Analog & Communication I/O: 1KV Damped-Oscillatory Wave: Power Line: 1KV, Digital I/O: 1KV RS(IEC 61131-2, IEC 61000-4-3): 26MHz ~ 1GHz, 10V/m
Environment	Operation: 0°C ~ 55°C (Temperature), 50 ~ 95% (Humidity), Pollution degree 2; Storage: -40°C ~ 70°C (Temperature), 5 ~ 95% (Humidity)
Vibration / Shock Resistance	Standard: IEC1131-2, IEC 68-2-6（TEST Fc/IEC1131-2 & IEC 68-2-27 (TEST Ea)
Certifications	Standard: IEC 61131-2,UL508

B.10.4.3 Components

Pin Definition on CANopen Connection Port

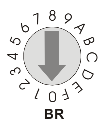
To connect with CANopen, use the connector enclosed with CME-COP01 or any connectors you can buy in the store for wiring.

Pin	Signal	Content
1	CAN_GND	Ground / 0 V / V-
2	CAN_L	Signal-
3	SHIELD	Shield
4	CAN_H	Signal+
5	-	Reserved



Baud Rate Setting

Rotary switch (BR) sets up the communication speed on CANopen network in hex. Setup range: 0 ~ 7 (8 ~F are forbidden)



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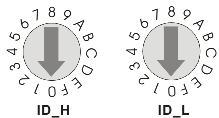
Example: If you need to set up the communication speed of CME-COP01 as 500K, simply switch BR to “5”.

BR Value	Baud rate	BR Value	Baud rate
0	10K	4	250K
1	20K	5	500K
2	50K	6	800K
3	125K	7	1M

MAC ID Setting

Rotary switches (ID_L and ID_H) set up the Node-ID on CANopen network in hex. Setup range: 00 ~ 7F (80 ~FF are forbidden)



Example: If you need to set up the communication address of CME-COP01 as 26(1AH), simply switch ID_H to “1” and ID_L to “A”.

Switch Setting	Content
0 … 7F	Valid CANopen MAC ID setting
Other	Invalid CANopen MAC ID setting

B.10.4.4 LED Indicator Explanation & Troubleshooting

There are 3 LED indicators, RUN, ERROR and SP, on CME-COP01 to indicate the communication status of CME-COP01.

RUN LED

LED Status	State	Indication
OFF	No power	No power on CME-COP01 card
Single Flash (Green)	STOPPED	CME-COP01 is in STOPPED state
Blinking (Green)	PRE-OPERATIONAL	CME-COP01 is in the PRE-OPERATIONAL state
Green ON	OPERATIONAL	CME-COP01 is in the OPERATIONAL state
Red ON	Configuration error	Node-ID or Baud rate setting error

ERROR LED

LED Status	State	Indication
OFF	No error	CME-COP01 is working condition
Single Flash (Red)	Warning limit reached	At least one of error counter of the CANopen controller has reached or exceeded the warning level (too many error frames)
Double Flash (Red)	Error control event	A guard event or heartbeat event has occurred
Red ON	Bus-off	The CANopen controller is bus-off

SP LED

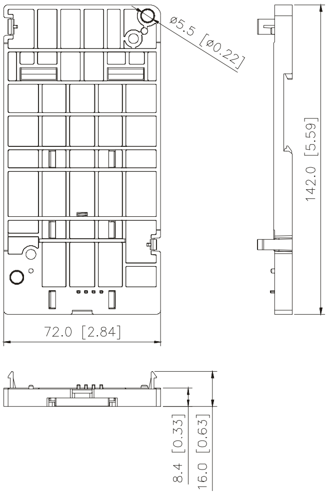
LED Status	State	Indication
OFF	No Power	No power on CME-COP01 card
LED Blinking (Red)	CRC check error	Check your communication setting in VFD-E drives (19200,<8,N,2>,RTU)
Red ON	Connection failure/No connection	1. Check the connection between VFD-E drive and CME-COP01 card is correct 2. Re-wire the VFD-E connection and ensure that the wire specification is correct
LED Blinking (Green)	CME-COP01 returns error code	Check the PLC program, ensure the index and sub-index is correct
Green ON	Normal	Communication is normal

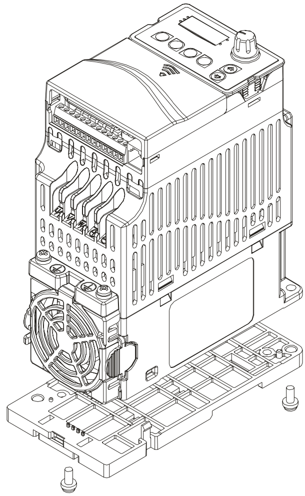
LED Descriptions

State	Description
LED ON	Constantly on
LED OFF	Constantly off
LED blinking	Flash, on for 0.2s and off for 0.2s
LED single flash	On for 0.2s and off for 1s
LED double flash	On for 0.2s off for 0.2s, on for 0.2s and off for 1s

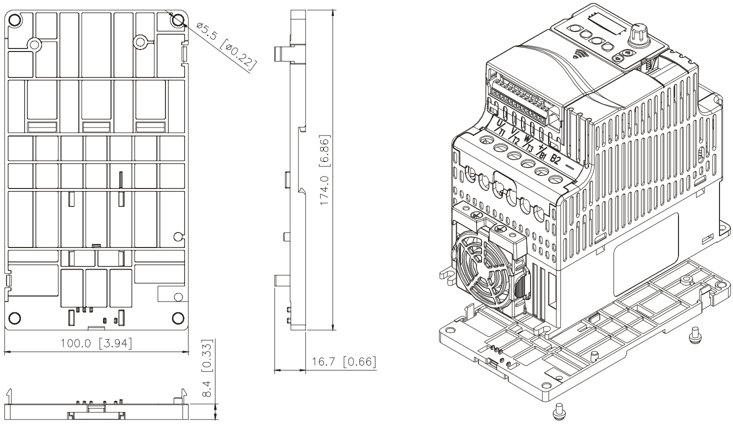
B.11 DIN Rail

B.11.1 MKE-DRA



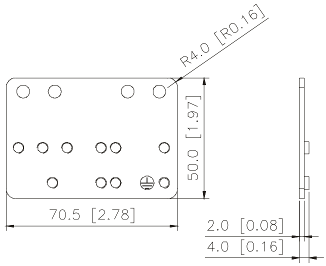


B.11.2 MKE-DRB

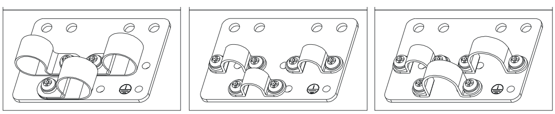


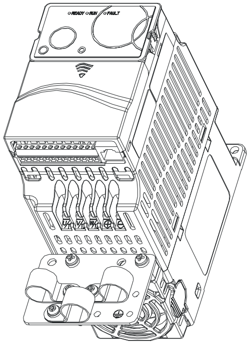
B.11.3 MKE-EP

EMC earthing plate for Shielding Cable



C CLAMP | TWO HOLE STRAP 1 | TWO HOLE STRAP 2





B.12 EMI Filter

To meet EN61800-3 variable speed drive system- part 3: EMC requirements and specific test methods, category C1, C2 and C3. Users can choose the suitable filter by the following table.

1-phase/ 3-phase	Voltage	HP	AC Motor Drive	Frame	Deltron Filter	C3	C2	C1
1-phase	230V	0.25	VFD002E21A	A	MDF16	50m	50m	50m
		0.5	VFD004E21A	A				
		1	VFD007E21A	A				
		2	VFD015E21A	B	MDF25	50m	50m	Fail*
		3	VFD022E21A	B				
3-phase	460V	0.5	VFD004E43A	A	KMF306A	50m	50m	50m
		1	VFD007E43A	A				
		2	VFD015E43A	A				
		3	VFD022E43A	B	KMF318A	50m	50m	50m
		5	VFD037E43A	B				
		7.5	VFD055E43A	C	KMF325A	75m	50m	50m
		10	VFD075E43A	C				
		15	VFD110E43A	C				

NOTE: For model VFD022E21A, please use MIF filter to meet Category C1.

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Installation

All electrical equipment, including AC motor drives, will generate high-frequency/low-frequency noise and will interfere with peripheral equipment by radiation or conduction when in operation. By using an EMI filter with correct installation, much interference can be eliminated. It is recommended to use DELTA EMI filter to have the best interference elimination performance.

We assure that it can comply with following rules when AC motor drive and EMI filter are installed and wired according to user manual:

EN61000-6-4

EN61800-3: 1996

EN55011 (1991) Class A Group 1

General precaution

1. EMI filter and AC motor drive should be installed on the same metal plate.
2. Please install AC motor drive on footprint EMI filter or install EMI filter as close as possible to the AC motor drive.
3. Please wire as short as possible.
4. Metal plate should be grounded.
5. The cover of EMI filter and AC motor drive or grounding should be fixed on the metal plate and the contact area should be as large as possible.

Choose suitable motor cable and precautions

Improper installation and choice of motor cable will affect the performance of EMI filter. Be sure to observe the following precautions when selecting motor cable.

1. Use the cable with shielding (double shielding is the best).
2. The shielding on both ends of the motor cable should be grounded with the minimum length and maximum contact area.
3. Remove any paint on metal saddle for good ground contact with the plate and shielding.

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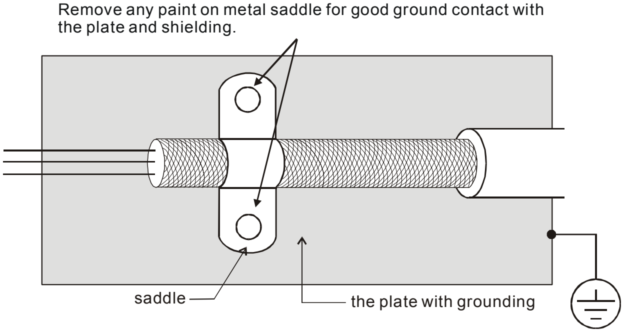
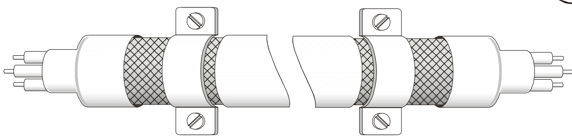
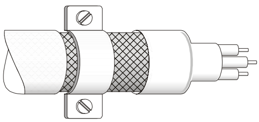




Saddle on both ends



Saddle on one end

The length of motor cable

When motor is driven by an AC motor drive of PWM type, the motor terminals will experience surge voltages easily due to components conversion of AC motor drive and cable capacitance. When the motor cable is very long (especially for the 460V series), surge voltages may reduce insulation quality. To prevent this situation, please follow the rules below:

- Use a motor with enhanced insulation.
- Connect an output reactor (optional) to the output terminals of the AC motor drive
- The length of the cable between AC motor drive and motor should be as short as possible (10 to 20 m or less)
- For models 7.5hp/5.5kW and above:

Insulation level of motor	1000V	1300V	1600V
460VAC input voltage	66 ft (20m)	328 ft (100m)	1312 ft (400m)
230VAC input voltage	1312 ft (400m)	1312 ft (400m)	1312 ft (400m)

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NOTE

When a thermal O/L relay protected by motor is used between AC motor drive and motor, it may malfunction (especially for 460V series), even if the length of motor cable is only 165 ft (50m) or less. To prevent it, please use AC reactor and/or lower the carrier frequency (Pr. 02.03 PWM carrier frequency).

NOTE

Never connect phase lead capacitors or surge absorbers to the output terminals of the AC motor drive.

- If the length is too long, the stray capacitance between cables will increase and may cause leakage current. It will activate the protection of over current, increase leakage current or not insure the correction of current display. The worst case is that AC motor drive may damage.
- If more than one motor is connected to the AC motor drive, the total wiring length is the sum of the wiring length from AC motor drive to each motor.

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Appendix C How to Select the Right AC Motor Drive

The choice of the right AC motor drive for the application is very important and has great influence on its lifetime. If the capacity of AC motor drive is too large, it cannot offer complete protection to the motor and motor maybe damaged. If the capacity of AC motor drive is too small, it cannot offer the required performance and the AC motor drive maybe damaged due to overloading.

But by simply selecting the AC motor drive of the same capacity as the motor, user application requirements cannot be met completely. Therefore, a designer should consider all the conditions, including load type, load speed, load characteristic, operation method, rated output, rated speed, power and the change of load capacity. The following table lists the factors you need to consider, depending on your requirements.

Item		Related Specification			
		Speed and torque characteristics	Time ratings	Overload capacity	Starting torque
Load type	Friction load and weight load Liquid (viscous) load Inertia load Load with power transmission	●			●
Load speed and torque characteristics	Constant torque Constant output Decreasing torque Decreasing output	●	●		
Load characteristics	Constant load Shock load Repetitive load High starting torque Low starting torque	●	●	●	●
Continuous operation, Short-time operation Long-time operation at medium/low speeds			●	●	
Maximum output current (instantaneous) Constant output current (continuous)		●		●	
Maximum frequency, Base frequency		●			
Power supply transformer capacity or percentage impedance Voltage fluctuations and unbalance Number of phases, single phase protection Frequency				●	●
Mechanical friction, losses in wiring				●	●
Duty cycle modification			●		

C.1 Capacity Formulas

1. When one AC motor drive operates one motor

The starting capacity should be less than 1.5x rated capacity of AC motor drive

The starting capacity=

$$\frac{k \times N}{973 \times \eta \times \cos\varphi}\left(T_L + \frac{GD^2}{375} \times \frac{N}{t_A}\right) \le 1.5 \times the\_capacity\_of\_AC\_motor\_drive(kVA)$$

2. When one AC motor drive operates more than one motor

2.1 The starting capacity should be less than the rated capacity of AC motor drive

■ Acceleration time ≦60 seconds

The starting capacity=

$$\frac{k \times N}{\eta \times \cos\varphi}\left[n_T + n_s(k_s - 1)\right] = P_{C1}\left[1 + \frac{n_s}{n_T}(k_s - 1)\right] \le 1.5 \times the\_capacity\_of\_AC\_motor\_drive(kVA)$$

■ Acceleration time ≧60 seconds

The starting capacity=

$$\frac{k \times N}{\eta \times \cos\varphi}\left[n_T + n_s(k_s - 1)\right] = P_{C1}\left[1 + \frac{n_s}{n_T}(k_s - 1)\right] \le the\_capacity\_of\_AC\_motor\_drive(kVA)$$

2.2 The current should be less than the rated current of AC motor drive(A)

■ Acceleration time ≦60 seconds

$$n_T + I_M\left[1 + \frac{n_S}{n_T}(k_S - 1)\right] \le 1.5 \times the\_rated\_current\_of\_AC\_motor\_drive(A)$$

■ Acceleration time ≧60 seconds

$$n_T + I_M\left[1 + \frac{n_S}{n_T}(k_S - 1)\right] \le the\_rated\_current\_of\_AC\_motor\_drive(A)$$

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2.3 When it is running continuously

- The requirement of load capacity should be less than the capacity of AC motor drive(kVA)
  The requirement of load capacity=

$$\frac{k \times P_M}{\eta \times \cos\varphi} \le the\_capacity\_of\_AC\_motor\_drive(kVA)$$

- The motor capacity should be less than the capacity of AC motor drive

$$k \times \sqrt{3} \times V_M \times I_M \times 10^{-3} \le the\_capacity\_of\_AC\_motor\_drive(kVA)$$

- The current should be less than the rated current of AC motor drive(A)

$$k \times I_M \le the\_rated\_current\_of\_AC\_motor\_drive(A)$$

Symbol explanation

P_M : Motor shaft output for load (kW)

η : Motor efficiency (normally, approx. 0.85)

$\cos\varphi$: Motor power factor (normally, approx. 0.75)

V_M : Motor rated voltage(V)

I_M : Motor rated current(A), for commercial power

k : Correction factor calculated from current distortion factor (1.05-1.1, depending on PWM method)

P_{C1} : Continuous motor capacity (kVA)

k_S : Starting current/rated current of motor

n_T : Number of motors in parallel

n_S : Number of simultaneously started motors

GD^2 : Total inertia (GD^2) calculated back to motor shaft (kg m^2)

T_L : Load torque

t_A : Motor acceleration time

N : Motor speed

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C.2 General Precaution

Selection Note

1. When the AC Motor Drive is connected directly to a large-capacity power transformer (600kVA or above) or when a phase lead capacitor is switched, excess peak currents may occur in the power input circuit and the converter section may be damaged. To avoid this, use an AC input reactor (optional) before AC Motor Drive mains input to reduce the current and improve the input power efficiency.
2. When a special motor is used or more than one motor is driven in parallel with a single AC Motor Drive, select the AC Motor Drive current ≥1.25x(Sum of the motor rated currents).
3. The starting and accel./decel. characteristics of a motor are limited by the rated current and the overload protection of the AC Motor Drive. Compared to running the motor D.O.L. (Direct On-Line), a lower starting torque output with AC Motor Drive can be expected. If higher starting torque is required (such as for elevators, mixers, tooling machines, etc.) use an AC Motor Drive of higher capacity or increase the capacities for both the motor and the AC Motor Drive.
4. When an error occurs on the drive, a protective circuit will be activated and the AC Motor Drive output is turned off. Then the motor will coast to stop. For an emergency stop, an external mechanical brake is needed to quickly stop the motor.

Parameter Settings Note

1. The AC Motor Drive can be driven at an output frequency up to 400Hz (less for some models) with the digital keypad. Setting errors may create a dangerous situation. For safety, the use of the upper limit frequency function is strongly recommended.
2. High DC brake operating voltages and long operation time (at low frequencies) may cause overheating of the motor. In that case, forced external motor cooling is recommended.
3. Motor accel./decel. time is determined by motor rated torque, load torque, and load inertia.
4. If the stall prevention function is activated, the accel./decel. time is automatically extended to a length that the AC Motor Drive can handle. If the motor needs to decelerate within a certain time with high load inertia that can't be handled by the AC Motor Drive in the

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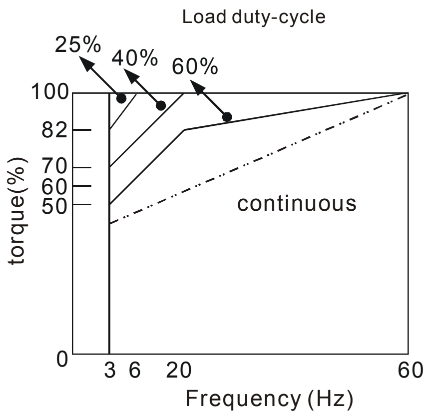
required time, either use an external brake resistor and/or brake unit, depending on the model, (to shorten deceleration time only) or increase the capacity for both the motor and the AC Motor Drive.

C.3 How to Choose a Suitable Motor

Standard motor

When using the AC Motor Drive to operate a standard 3-phase induction motor, take the following precautions:

1. The energy loss is greater than for an inverter duty motor.
2. Avoid running motor at low speed for a long time. Under this condition, the motor temperature may rise above the motor rating due to limited airflow produced by the motor's fan. Consider external forced motor cooling.
3. When the standard motor operates at low speed for long time, the output load must be decreased.
4. The load tolerance of a standard motor is as follows:



5. If 100% continuous torque is required at low speed, it may be necessary to use a special inverter duty motor.
6. Motor dynamic balance and rotor endurance should be considered once the operating speed exceeds the rated speed (60Hz) of a standard motor.

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7. Motor torque characteristics vary when an AC Motor Drive instead of commercial power supply drives the motor. Check the load torque characteristics of the machine to be connected.

8. Because of the high carrier frequency PWM control of the VFD series, pay attention to the following motor vibration problems:

- Resonant mechanical vibration: anti-vibration (damping) rubbers should be used to mount equipment that runs at varying speed.
- Motor imbalance: special care is required for operation at 50 or 60 Hz and higher frequency.
- To avoid resonances, use the Skip frequencies.

9. The motor fan will be very noisy when the motor speed exceeds 50 or 60Hz.

Special motors:

1. Pole-changing (Dahlander) motor:
   The rated current is differs from that of a standard motor. Please check before operation and select the capacity of the AC motor drive carefully. When changing the pole number the motor needs to be stopped first. If over current occurs during operation or regenerative voltage is too high, please let the motor free run to stop (coast).
2. Submersible motor:
   The rated current is higher than that of a standard motor. Please check before operation and choose the capacity of the AC motor drive carefully. With long motor cable between AC motor drive and motor, available motor torque is reduced.
3. Explosion-proof (Ex) motor:
   Needs to be installed in a safe place and the wiring should comply with the (Ex) requirements. Delta AC Motor Drives are not suitable for (Ex) areas with special precautions.
4. Gear reduction motor:
   The lubricating method of reduction gearbox and speed range for continuous operation will be different and depending on brand. The lubricating function for operating long time at low speed and for high-speed operation needs to be considered carefully.
5. Synchronous motor:
   The rated current and starting current are higher than for standard motors. Please check before operation and choose the capacity of the AC motor drive carefully. When the AC

motor drive operates more than one motor, please pay attention to starting and changing the motor.

Power Transmission Mechanism

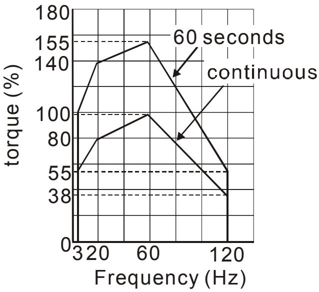
Pay attention to reduced lubrication when operating gear reduction motors, gearboxes, belts and chains, etc. over longer periods at low speeds. At high speeds of 50/60Hz and above, lifetime reducing noises and vibrations may occur.

Motor torque

The torque characteristics of a motor operated by an AC motor drive and commercial mains power are different.

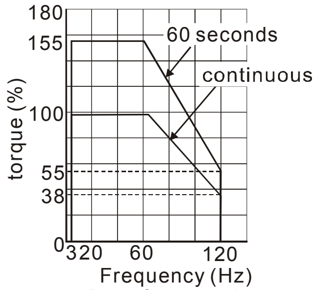
Below you'll find the torque-speed characteristics of a standard motor (4-pole, 15kW):

AC motor drive

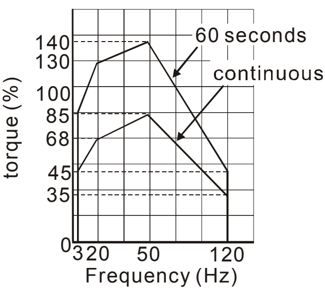


Base freq.: 60Hz
V/F for 220V/60Hz

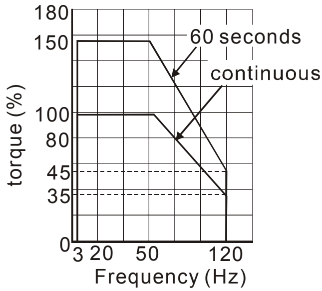
Motor



Base freq.: 60Hz
V/F for 220V/60Hz



Base freq.: 50Hz
V/F for 220V/50Hz



Base freq.: 50Hz
V/F for 220V/50Hz

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Appendix D How to Use PLC Function

※ **This function is NOT for VFD*E*C models.**

D.1 PLC Overview

D.1.1 Introduction

The PLC function built in the VFD-E provides following commands: WPLSoft, basic commands and application commands. The operation methods are the same as Delta DVP-PLC series.

D.1.2 Ladder Diagram Editor – WPLSoft

WPLSoft is a program editor of Delta DVP-PLC series and VFD-E series for WINDOWS. Besides general PLC program planning and general WINDOWS editing functions, such as cut, paste, copy, multi-windows, WPLSoft also provides various Chinese/English comment editing and other special functions (e.g. register editing, settings, the data readout, the file saving, and contacts monitor and set, etc.).

Following is the system requirement for WPLSoft:

Item	System Requirement
Operation System	Windows 95/98/2000/NT/ME/XP
CPU	Pentium 90 and above
Memory	16MB and above (32MB and above is recommended)
Hard Disk	Capacity: 50MB and above CD-ROM (for installing WPLSoft)
Monitor	Resolution: 640×480, 16 colors and above, It is recommended to set display setting of Windows to 800×600.
Mouse	General mouse or the device compatible with Windows
Printer	Printer with Windows driver
RS-232 port	At least one of COM1 to COM8 can be connected to PLC
Applicable Models	All Delta DVP-PLC series and VFD-E series

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D.2 Start-up

D.2.1 The Steps for PLC Execution

Please operate PLC function by the following five steps.

1. Switch the mode to PLC2 for program download/upload:

   A. Go to “PLC0” page by pressing the MODE key

   B. Change to “PLC2” by pressing the “UP” key and then press the “ENTER” key after confirmation

   C. If succeeded, “END” is displayed and back to “PLC2” after one or two seconds.

Disable | Run PLC | Read/write PLC program into AC drives

NOTE

You don’t need to care about the PLC warning, such as PLod, PLSv and PldA, before downloading a program to VFD-E.

2. Connection: Please connect RJ-45 of AC motor drive to computer via RS485-to-RS232 converter.

3. Run the program. The PLC status will always be PLC2, even if the AC motor drive is switched off.

   There are three ways to operate PLC:

   A. In “PLC1” page: execute PLC program.

   B. In “PLC2” page: execute/stop PLC program by using WPL software.

   C. After setting multi-function input terminals (MI3 to MI9) to 23 (RUN/STOP PLC), it will display “PLC1” for executing PLC when the terminal is ON. It will display “PLC0” to stop PLC program when terminals are OFF.

NOTE

When external terminals are set to 23 and the terminal is ON, it cannot use keypad to change PLC mode. Moreover, when it is PLC2, you cannot execute PLC program by external terminals.

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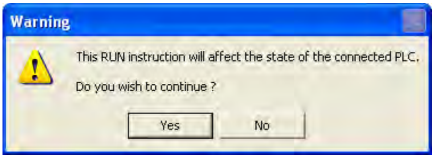
NOTE

When power on after power off, the PLC status will be in “PLC1”.



4. When you are in “PLC2”, please remember to change to “PLC1” when finished to prevent anyone modifying PLC program.

NOTE

When output/input terminals (MI1~MI9, Relay1~Relay 4, MO1~MO4) are used in PLC program, they cannot be used in other places. For example, When Y0 in PLC program is activated, the corresponding output terminals Relay (RA/RB/RC) will be used. At this moment, parameter 03.00 setting will be invalid. Because the terminal has been used by PLC.

NOTE

The PLC corresponding input points for MI1 to MI6 are X0 to X5. When extension card are added, the extension input points will be numbered from X06 and output points will start from Y2 as shown in chapter D.2.2.

D.2.2 Device Reference Table

Device	X								
ID	0	1	2	3	4	5	6	7	10
Terminals of AC Drives	MI1	MI2	MI3	MI4	MI5	MI6	--	--	--
3IN/3OUT Card (EME-D33A)	--	--	--	--	--	--	MI7	MI8	MI9

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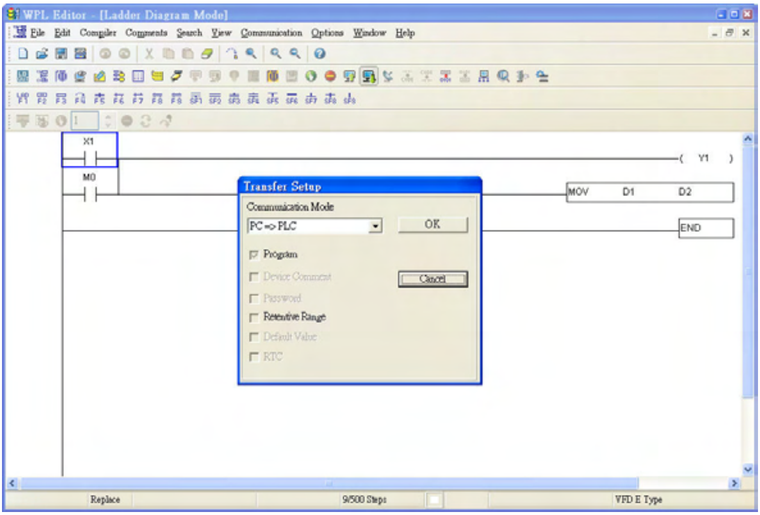
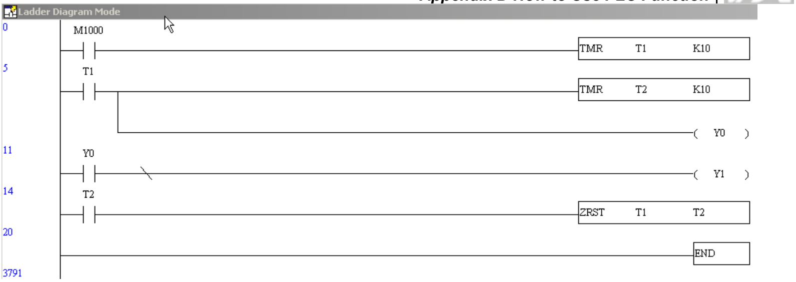
Device	Y				
ID	0	1	2	3	4
Terminals of AC Drives	RY	MO1	--	--	--
Relay Card-2C (EME-DR2CA)	--	--	RY2	RY3	--
Relay Card-3A (EME-R3AA)	--	--	RY2	RY3	RY4
3IN/3OUT Card (EME-D33A)	--	--	MO2	MO3	MO4

D.2.3 WPLSoft Installation

Download PLC program to AC drive: Refer to D.3 to D.7 for writing program and download the editor (WPLSoft V2.09) at DELTA website http://www.delta.com.tw/product/em/plc/plc_software.asp.



D.2.4 Program Input



D.2.5 Program Download

Please do following steps for program download.

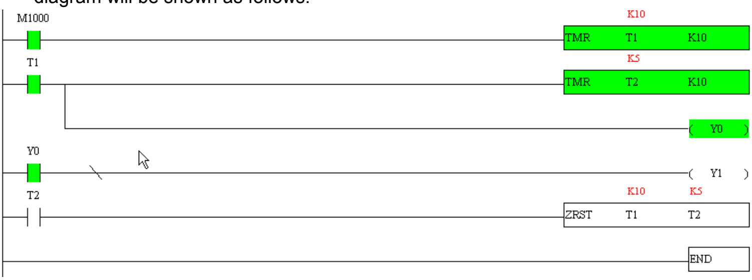
Step 1. Press button  for compiler after inputting program in WPLSoft.

Step 2. After finishing compiler, choose the item “Write to PLC” in the communication items.

After finishing Step 2, the program will be downloaded from WPLSoft to the AC motor drive by the communication format.

D.2.6 Program Monitor

If you execute “start monitor” in the communication item during executing PLC, the ladder diagram will be shown as follows.



D.2.7 The Limit of PLC

1. The protocol of PLC is 7,E,1
2. Make sure that the AC drive is stop and stop PLC before program upload/download.
3. The priority of commands WPR and FREQ is FREQ > WPR.
4. When setting P 00.04 to 2, the display will be the value in PLC register D1043.
   A. 0 ~ 999 display:

B. 1000 ~ 9999 display: It will only display the first 3 digits. The LED at the bottom-right corner will light to indicate 10 times of the display value. For example, the actual value for the following figure is 100X10=1000.

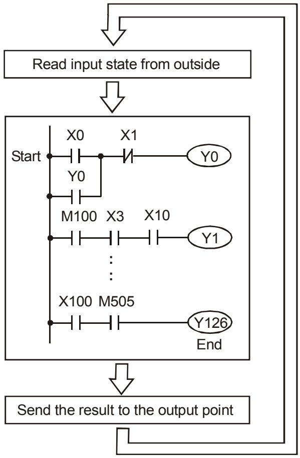
C. 10000~65535 display: It will only display the first 3 digits. The LED at the bottom-right corner and the single decimal point between the middle and the right-most numbers will light to indicate 100 times of the display value. For example, the actual value for the following figure is 100X100=10000.

5. When it is changed to “PLC2”, RS-485 will be used by PLC.
6. When it is in PLC1 and PLC2 mode, the function to reset all parameters to factory setting is disabled (i.e. Pr.00.02 can’t be set to 9 or 10).

D.3 Ladder Diagram

D.3.1 Program Scan Chart of the PLC Ladder Diagram

Calculate the result by ladder diagram algorithm (it doesn't sent to the outer output point but the inner equipment will output immediately.)



Execute in cycles

D.3.2 Introduction

Ladder diagram is a diagram language that applied on the automatic control and it is also a diagram that made up of the symbols of electric control circuit. PLC procedures are finished after ladder diagram editor edits the ladder diagram. It is easy to understand the control flow that indicated with diagram and also accept by technical staff of electric control circuit. Many basic symbols and motions of ladder diagram are the same as mechanical and electrical equipments of traditional automatic power panel, such as button, switch, relay, timer, counter and etc.

The kinds and amounts of PLC internal equipment will be different with brands. Although internal equipment has the name of traditional electric control circuit, such as relay, coil and contact. It doesn't have the real components in it. In PLC, it just has a basic unit of internal memory. If this bit is 1, it means the coil is ON and if this bit is 0, it means the coil is OFF. You should read the corresponding value of that bit when using contact (Normally Open, NO or contact a). Otherwise, you should read the opposite sate of corresponding value of that bit when using contact (Normally Closed, NC or contact b). Many relays will need many bits, such as 8-bits makes up a byte. 2 bytes can make up a word. 2 words makes up double word. When using many relays to do calculation, such as add/subtraction or shift, you could use byte, word or double word. Furthermore, the two equipments, timer and counter, in PLC not only have coil but also value of counting time and times.

In conclusion, each internal storage unit occupies fixed storage unit. When using these equipments, the corresponding content will be read by bit, byte or word.

Basic introduction of the inner equipment of PLC:

Input relay	Input relay is the basic storage unit of internal memory that corresponds to external input point (it is the terminal that used to connect to external input switch and receive external input signal). Input signal from external will decide it to display 0 or 1. You couldn't change the state of input relay by program design or forced ON/OFF via WPLSoft. The contacts (contact a, b) can be used unlimitedly. If there is no input signal, the corresponding input relay could be empty and can't be used with other functions. ☞ Equipment indication method: X0, X1,…X7, X10, X11,…. The symbol of equipment is X and the number uses octal.
Output relay	Output relay is the basic storage unit of internal memory that corresponds to external output point (it is used to connect to external load). It can be driven by input relay contact, the contact of other internal equipment and itself contact. It uses a normally open contact to connect to external load and other contacts can be used unlimitedly as input contacts. It doesn't have the corresponding output relay, if need, it can be used as internal relay. ☞ Equipment indication: Y0, Y1,…Y7, Y10, Y11,…. . The symbol of equipment is Y and the number uses octal.
Internal relay	The internal relay doesn't connect directly to outside. It is an auxiliary relay in PLC. Its function is the same as the auxiliary relay in electric control circuit. Each auxiliary relay has the corresponding basic unit. It can be driven by the contact of input relay, output relay or other internal equipment. Its contacts can be used unlimitedly. Internal auxiliary relay can't output directly, it should output with output point. ☞ Equipment indication: M0, M1,…, M4, M159. The symbol of equipment is M and the number uses decimal number system.
Timer	Timer is used to control time. There are coil, contact and timer storage. When coil is ON, its contact will act (contact a is close, contact b is open) when attaining desired time. The time value of timer is set by settings and each timer has its regular period. User sets the timer value and each timer has its timing period. Once the coil is OFF, the contact won't act (contact a is open and contact b is close) and the timer will be set to zero. ☞ Equipment indication: T0, T1,…,T15. The symbol of equipment is T and the number uses decimal system. The different number range corresponds with the different timing period.
Counter	Counter is used to count. It needs to set counter before using counter (i.e. the pulse of counter). There are coil, contacts and storage unit of counter in counter. When coil is from OFF to ON, that means input a pulse in counter and the counter should add 1. There are 16-bit, 32-bit and high-speed counter for user to use. ☞ Equipment indication: C0, C1,…,C7. The symbol of equipment is C and the number uses decimal.
Data register	PLC needs to handle data and operation when controlling each order, timer value and counter value. The data register is used to store data or parameters. It stores

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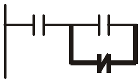
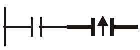
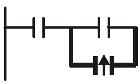
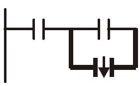
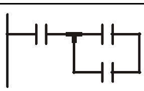
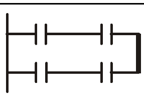
	16-bit binary number, i.e. a word, in each register. It uses two continuous number of data register to store double words. ☞ Equipment indication: D0, D1,…,D29. The symbol of equipment is D and the number uses decimal.

The structure and explanation of ladder diagram:

Ladder Diagram Structure	Explanation	Command	Equipment
	Normally open, contact a	LD	X, Y, M, T, C
	Normally closed, contact b	LDI	X, Y, M, T, C
	Serial normally open	AND	X, Y, M, T, C
	Parallel normally open	OR	X, Y, M, T, C
	Parallel normally closed	ORI	X, Y, M, T, C
	Rising-edge trigger switch	LDP	X, Y, M, T, C
	Falling-edge trigger switch	LDF	X, Y, M, T, C
	Rising-edge trigger in serial	ANDP	X, Y, M, T, C
	Falling-edge trigger in serial	ANDF	X, Y, M, T, C
	Rising-edge trigger in parallel	ORP	X, Y, M, T, C
	Falling-edge trigger in parallel	ORF	X, Y, M, T, C
	Block in serial	ANB	none
	Block in parallel	ORB	none

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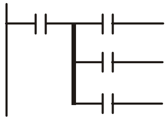
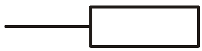
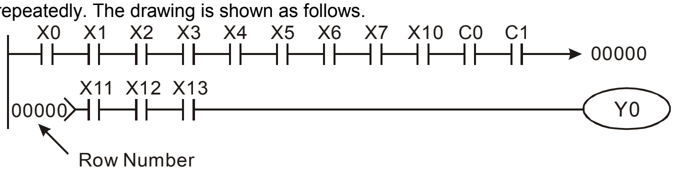
Ladder Diagram Structure	Explanation	Command	Equipment
	Multiple output	MPS MRD MPP	none
	Output command of coil drive	OUT	Y, M, S
	Basic command, Application command	Application command	Please refer to basic command and application command
	Inverse logic	INV	none

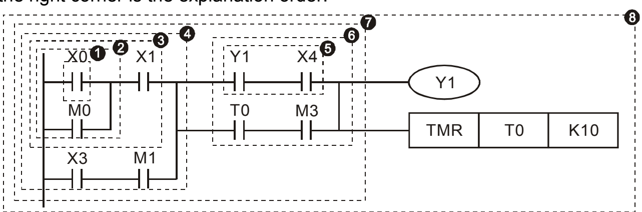
D.3.3 The Edition of PLC Ladder Diagram

The program edited method is from left power line to right power line. (the right power line will be omitted during the edited of WPLSoft.) After editing a row, go to editing the next row. The maximum contacts in a row are 11 contacts. If you need more than 11 contacts, you could have the new row and start with continuous line to continue more input devices. The continuous number will be produced automatically and the same input point can be used repeatedly. The drawing is shown as follows.



The operation of ladder diagram is to scan from left upper corner to right lower corner. The output handling, including the operation frame of coil and application command, at the most right side in ladder diagram.

Take the following diagram for example; we analyze the process step by step. The number at the right corner is the explanation order.

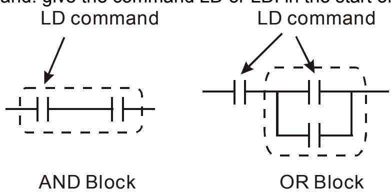


The explanation of command order:

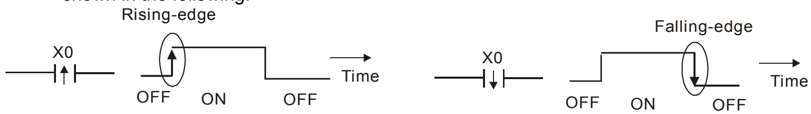
1	LD	X0
2	OR	M0
3	AND	X1
4	LD	X3
	AND	M1
	ORB	
5	LD	Y1
	AND	X4
6	LD	T0
	AND	M3
	ORB	
7	ANB	
8	OUT	Y1
	TMR	T0 K10

The detail explanation of basic structure of ladder diagram

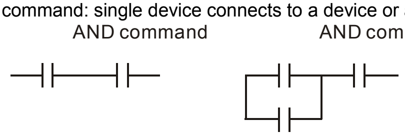
1. LD (LDI) command: give the command LD or LDI in the start of a block.



The structures of command LDP and LDF are similar to the command LD. The difference is that command LDP and LDF will act in the rising-edge or falling-edge when contact is ON as shown in the following.

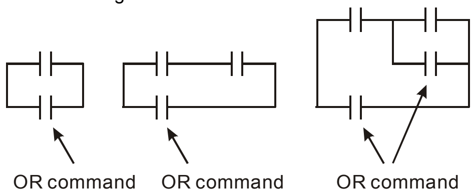


2. AND (ANI) command: single device connects to a device or a block in series.



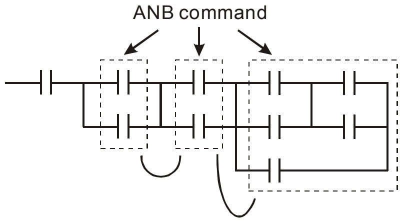
The structures of ANDP and ANDF are the same but the action is in rising-edge or falling-edge.

3. OR (ORI) command: single device connects to a device or a block.

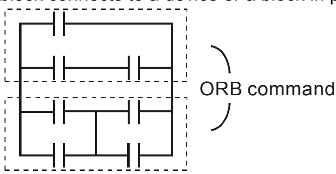


The structures of ORP and ORF are the same but the action is in rising-edge or falling-edge.

4. ANB command: a block connects to a device or a block in series.



5. ORB command: a block connects to a device or a block in parallel.



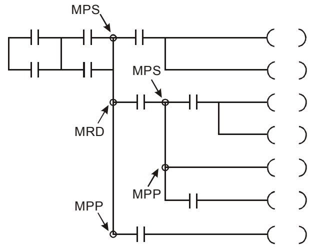
If there are several blocks when operate ANB or ORB, they should be combined to blocks or network from up to down or from left to right.

6. MPS, MRD, MPP commands: Divergent memory of multi-output. It can produce many various outputs.
7. The command MPS is the start of divergent point. The divergent point means the connection place between horizontal line and vertical line. We should determine to have contact memory command or not according to the contacts status in the same vertical line. Basically, each contact could have memory command but in some places of ladder diagram conversion will be omitted due to the PLC operation convenience and capacity limit. MPS command can be used for 8 continuous times and you can recognize this command by the symbol "┬".
8. MRD command is used to read memory of divergent point. Because the logical status is the same in the same horizontal line, it needs to read the status of original contact to keep

on analyzing other ladder diagram. You can recognize the command MRD by the symbol "├".

9. MPP command is used to read the start status of the top level and pop it out from stack. Because it is the last item of the horizontal line, it means the status of this horizontal line is ending.

You can recognize this command by the symbol "└". Basically, that is all right to use the above method to analyze but sometimes compiler will omit the same outputs as shown at the right.



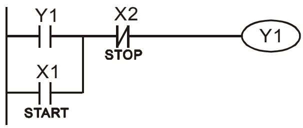
D.3.4 The Example for Designing Basic Program

- Start, Stop and Latching

In the same occasions, it needs transient close button and transient open button to be start and stop switch. Therefore, if you want to keep the action, you should design latching circuit. There are several latching circuits in the following:

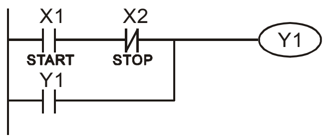
Example 1: the latching circuit for priority of stop

When start normally open contact X1=On, stop normally contact X2＝Off, and Y1=On are set at the same time, if X2=On, the coil Y1 will stop acting. Therefore, it calls priority of stop.



Example 2: the latching circuit for priority of start

When start normally open contact X1=On, stop normally contact X2＝Off and Y1=On (coil Y1 will be active and latching) are valid at the same time, if X2=On, coil Y1 will be active due to latched contact. Therefore, it calls priority of start.



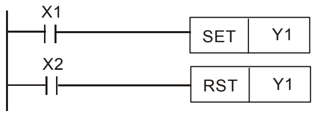
Example 3: the latching circuit of SET and RST commands

The figure at the right side is latching circuit that made up of RST and SET command.

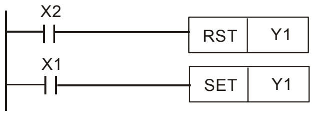
It is top priority of stop when RST command is set behind SET command. When executing PLC from up to down, The coil Y1 is ON and coil Y1 will be OFF when X1 and X2 act at the same time, therefore it calls priority of stop.

It is top priority of start when SET command is set after RST command. When X1 and X2 act at the same time, Y1 is ON so it calls top priority of start.

Top priority of stop

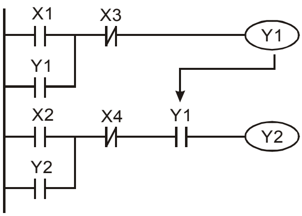


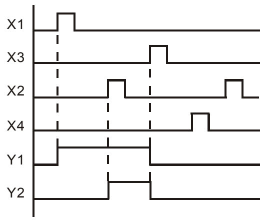
Top priority of start



- The common control circuit

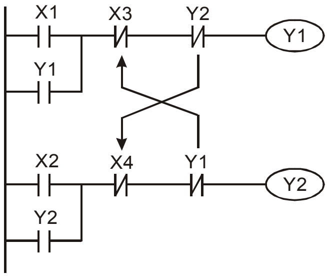
Example 4: condition control

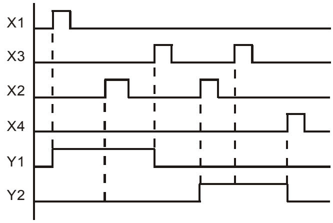




X1 and X3 can start/stop Y1 separately, X2 and X4 can start/stop Y2 separately and they are all self latched circuit. Y1 is an element for Y2 to do AND function due to the normally open contact connects to Y2 in series. Therefore, Y1 is the input of Y2 and Y2 is also the input of Y1.

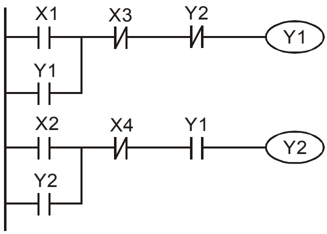
Example 5: Interlock control





The figure above is the circuit of interlock control. Y1 and Y2 will act according to the start contact X1 and X2. Y1 and Y2 will act not at the same time, once one of them acts and the other won't act. (This is called interlock.) Even if X1 and X2 are valid at the same time, Y1 and Y2 won't act at the same time due to up-to-down scan of ladder diagram. For this ladder diagram, Y1 has higher priority than Y2.

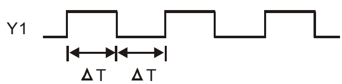
Example 6: Sequential Control



If add normally close contact Y2 into Y1 circuit to be an input for Y1 to do AND function. (as shown in the left side) Y1 is an input of Y2 and Y2 can stop Y1 after acting. In this way, Y1 and Y2 can execute in sequential.

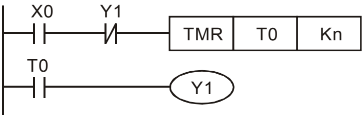
Example 7: Oscillating Circuit

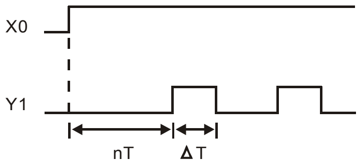
The period of oscillating circuit is $\Delta T + \Delta T$



The figure above is a very simple ladder step diagram. When starting to scan Y1 normally close contact, Y1 normally close contact is close due to the coil Y1 is OFF. Then it will scan Y1 and the coil Y1 will be ON and output 1. In the next scan period to scan normally close contact Y1, Y1 normally close contact will be open due to Y1 is ON. Finally, coil Y1 will be OFF. The result of repeated scan, coil Y will output the vibrating pulse with cycle time ΔT(On)+ΔT(Off).

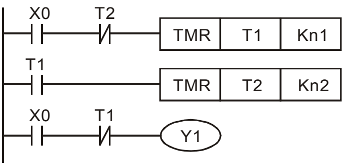
The vibrating circuitry of cycle time $\Delta T(On)+\Delta T(Off)$:

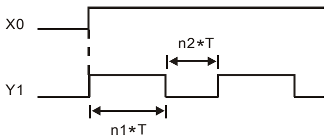




The figure above uses timer T0 to control coil Y1 to be ON. After Y1 is ON, timer T0 will be closed at the next scan period and output Y1. The oscillating circuit will be shown as above. (n is the setting of timer and it is decimal number. T is the base of timer. (clock period))

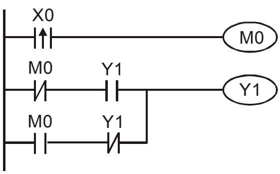
Example 8: Blinking Circuit

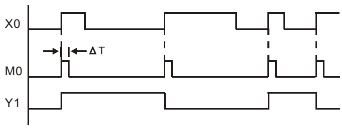




The figure above is common used oscillating circuit for indication light blinks or buzzer alarms. It uses two timers to control On/OFF time of Y1 coil. If figure, n1 and n2 are timer setting of T1 and T2. T is the base of timer (clock period)

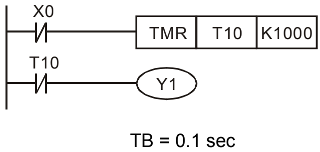
Example 9: Triggered Circuit

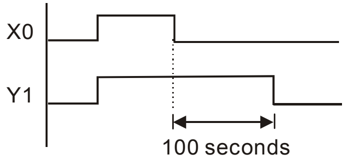




In figure above, the rising-edge differential command of X0 will make coil M0 to have a single pulse of ΔT (a scan time). Y1 will be ON during this scan time. In the next scan time, coil M0 will be OFF, normally close M0 and normally close Y1 are all closed. However, coil Y1 will keep on being ON and it will make coil Y1 to be OFF once a rising-edge comes after input X0 and coil M0 is ON for a scan time. The timing chart is as shown above. This circuit usually executes alternate two actions with an input. From above timing: when input X0 is a square wave of a period T, output coil Y1 is square wave of a period 2T.

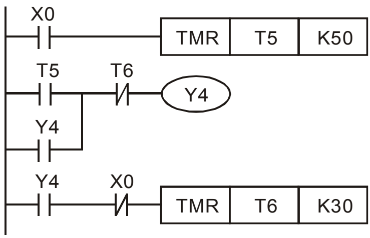
Example 10: Delay Circuit

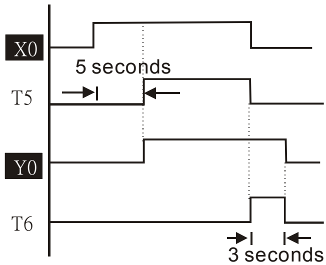




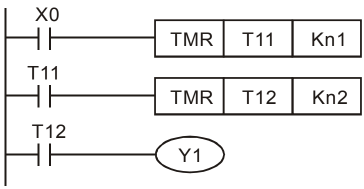
When input X0 is ON, output coil Y1 will be ON at the same time due to the corresponding normally close contact OFF makes timer T10 to be OFF. Output coil Y1 will be OFF after delaying 100 seconds (K1000*0.1 seconds =100 seconds) once input X0 is OFF and T10 is ON. Please refer to timing chart above.

Example 11: Output delay circuit, in the following example, the circuit is made up of two timers. No matter input X0 is ON or OFF, output Y4 will be delay.

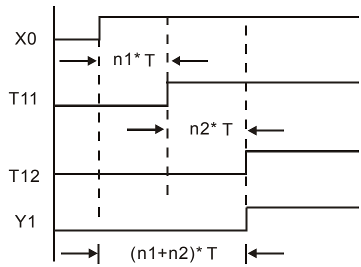




Example12: Extend Timer Circuit



In this circuit, the total delay time from input X0 is close and output Y1 is ON= (n1+n2)* T. where T is clock period.



D.4 PLC Devices

D.4.1 Summary of DVP-PLC Device Number

<table>
<tr><th colspan="5">Items</th><th colspan="2">Specifications</th><th>Remarks</th></tr>
<tr><td colspan="5">Control Method</td><td colspan="2">Stored program, cyclic scan system</td><td></td></tr>
<tr><td colspan="5">I/O Processing Method</td><td colspan="2">Batch processing (when END instruction is executed)</td><td>I/O refresh instruction is available</td></tr>
<tr><td colspan="5">Execution Speed</td><td colspan="2">Basic commands (minimum 0.24 us)</td><td>Application commands (10 ~ hundreds us)</td></tr>
<tr><td colspan="5">Program Language</td><td colspan="2">Instruction, Ladder Logic, SFC</td><td>Including the Step commands</td></tr>
<tr><td colspan="5">Program Capacity</td><td colspan="2">500 STEPS</td><td>SRAM + Battery</td></tr>
<tr><td colspan="5">Commands</td><td colspan="2">45 commands</td><td>28 basic commands
17 application commands</td></tr>
<tr><td colspan="5">Input/Output Contact</td><td colspan="2">Input (X): 6, output (Y): 2</td><td></td></tr>
<tr><td rowspan="9">Relay bit mode</td><td>X</td><td colspan="3">External Input Relay</td><td>X0~X17, 16 points, octal number system</td><td rowspan="2">Total is 32 points</td><td>Correspond to external input point</td></tr>
<tr><td>Y</td><td colspan="3">External Output Relay</td><td>Y0~Y17, 16 points, octal number system</td><td>Correspond to external output point</td></tr>
<tr><td rowspan="2">M</td><td rowspan="2">Auxiliary</td><td colspan="2">For general</td><td>M0~M159, 160 points</td><td rowspan="2">Total is 192 points</td><td rowspan="2">Contacts can switch to On/Off in program</td></tr>
<tr><td colspan="2">For special</td><td>M1000~M1031, 32 points</td></tr>
<tr><td>T</td><td>Timer</td><td colspan="2">100ms timer</td><td>T0~T15, 16 points</td><td>Total is 16 points</td><td>When the timer indicated by TMR command attains the setting, the T contact with the same number will be On.</td></tr>
<tr><td rowspan="4">C</td><td rowspan="4">Counter</td><td colspan="2">16-bit count up for general</td><td>C0~C7, 8 points</td><td>Total is 8 points</td><td rowspan="4">When the counter indicated by CNT command attains the setting, the C contact with the same number will be On.</td></tr>
<tr><td rowspan="3">32-bit count up/down high-speed counter</td><td>1-phase input</td><td rowspan="3">C235, 1 point (need to use with PG card)</td><td rowspan="3">Total is 1 point</td></tr>
<tr><td>1-phase 2 inputs</td></tr>
<tr><td>2-phase 2 inputs</td></tr>
</table>

<table>
<tr><th colspan="4">Items</th><th colspan="2">Specifications</th><th>Remarks</th></tr>
<tr><td rowspan="5">Register WORD data</td><td>T</td><td colspan="2">Present value of timer</td><td colspan="2">T0~T15, 16 points</td><td>When timer attains, the contact of timer will be On.</td></tr>
<tr><td>C</td><td colspan="2">Present value of counter</td><td colspan="2">C0~C7, 8-bit counter, 8 points</td><td>When timer attains, the contact of timer will be On.</td></tr>
<tr><td rowspan="3">D</td><td rowspan="3">Data register</td><td>For latched</td><td>D0~D9, 10 points</td><td rowspan="3">Total is 75 points</td><td rowspan="3">It can be memory area for storing data.</td></tr>
<tr><td>For general</td><td>D10~D29, 20 points</td></tr>
<tr><td>For special</td><td>D1000~D1044, 45 points</td></tr>
<tr><td rowspan="2">Constant</td><td>K</td><td colspan="2">Decimal</td><td colspan="3">K-32,768 ~ K32,767 (16-bit operation)</td></tr>
<tr><td>H</td><td colspan="2">Hexadecimal</td><td colspan="3">H0000 ~ HFFFF (16-bit operation)</td></tr>
<tr><td colspan="4">Communication port (for read/write program)</td><td colspan="3">RS485 (slave)</td></tr>
<tr><td colspan="4">Analog input/output</td><td colspan="3">Built-in 2 analog inputs and 1 analog output</td></tr>
<tr><td colspan="4">Function extension module (optional)</td><td colspan="3">Digital input/output card (A/D, D/A card)</td></tr>
</table>

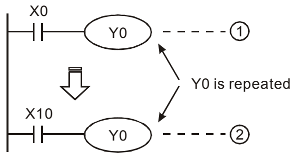
D.4.2 Devices Functions

- The Function of Input/output Contacts

The function of input contact X: input contact X reads input signal and enter PLC by connecting with input equipment. It is unlimited usage times for A contact or B contact of each input contact X in program. The On/Off of input contact X can be changed with the On/Off of input equipment but can’t be changed by using peripheral equipment (WPLSoft).

- The Function of Output Contact Y

The mission of output contact Y is to drive the load that connects to output contact Y by sending On/Off signal. There are two kinds of output contact: one is relay and the other is transistor. It is unlimited usage times for A or B contact of each output contact Y in program. But there is number for output coil Y and it is recommended to use one time in program. Otherwise, the output result will be decided by the circuit of last output Y with PLC program scan method.



The output of Y0 will be decided by circuit ②, i.e. decided by On/Off of X10.

D.4.3 Value, Constant [K] / [H]

Constant	K	Decimal	K-32,768 ~ K32,767 (16-bit operation)
	H	Hexadecimal	H0000 ~ HFFFF (16-bit operation)

There are five value types for DVP-PLC to use by the different control destination. The following is the explanation of value types.

1. Binary Number (BIN)

It uses binary system for the PLC internal operation or storage. The relative information of binary system is in the following.

Bit : Bit is the basic unit of binary system, the status are 1 or 0.

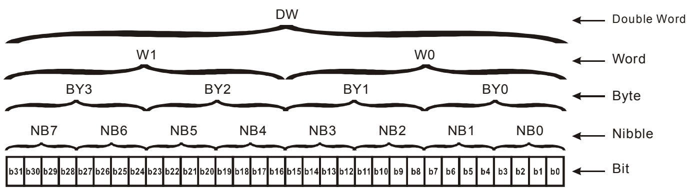
Nibble : It is made up of continuous 4 bits, such as b3~b0. It can be used to represent number 0~9 of decimal or 0~F of hexadecimal.

Byte : It is made up of continuous 2 nibbles, i.e. 8 bits, b7~b0. It can used to represent 00~FF of hexadecimal system.

Word : It is made up of continuous 2 bytes, i.e. 16 bits, b15~b0. It can used to represent 0000~FFFF of hexadecimal system.

Double Word : It is made up of continuous 2 words, i.e. 32 bits, b31~b0. It can used to represent 00000000~FFFFFFFF of hexadecimal system.

The relations among bit, nibble, byte, word, and double word of binary number are shown as follows.



2. Octal Number (OCT)

The numbers of external input and output terminal of DVP-PLC use octal number.

Example:

External input: X0~X7, X10~X17…(device number)

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External output: Y0~Y7, Y10~Y17…(device number)

3. Decimal Number (DEC)

The suitable time for decimal number to use in DVP-PLC system.

- To be the setting value of timer T or counter C, such as TMR C0 K50. (K constant)
- To be the device number of M, T, C and D. For example: M10, T30. (device number)
- To be operand in application command, such as MOV K123 D0. (K constant)

4. BCD (Binary Code Decimal, BCD)

It shows a decimal number by a unit number or four bits so continuous 16 bits can use to represent the four numbers of decimal number. BCD code is usually used to read the input value of DIP switch or output value to 7-segment display to be display.

5. Hexadecimal Number (HEX)

The suitable time for hexadecimal number to use in DVP-PLC system.

- To be operand in application command. For example: MOV H1A2B D0. (constant H)

Constant K:

In PLC, it is usually have K before constant to mean decimal number. For example, K100 means 100 in decimal number.

Exception:

The value that is made up of K and bit equipment X, Y, M, S will be bit, byte, word or double word. For example, K2Y10, K4M100. K1 means a 4-bit data and K2~K4 can be 8, 12 and 16-bit data separately.

Constant H:

In PLC, it is usually have H before constant to mean hexadecimal number. For example, H100 means 100 in hexadecimal number.

D.4.4 The Function of Auxiliary Relay

There are output coil and A, B contacts in auxiliary relay M and output relay Y. It is unlimited usage times in program. User can control loop by using auxiliary relay, but can't drive external load directly. There are two types divided by its characteristics.

1. Auxiliary relay for general : It will reset to Off when power loss during running. Its state will be Off when power on after power loss.
2. Auxiliary relay for special : Each special auxiliary relay has its special function. Please don't use undefined auxiliary relay.

D.4.5 The Function of Timer

The unit of timer is 1ms, 10ms and 100ms. The count method is count up. The output coil will be On when the present value of timer equals to the settings. The setting is K in decimal number. Data register D can be also used as settings.

The real setting time of timer = unit of timer * settings

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D.4.6 The Features and Functions of Counter

Features:

Item	16 bits counters	32 bits counters	
Type	General	General	High speed
Count direction	Count up	Count up/down	
Settings	0~32,767	-2,147,483,648~+2,147,483,647	
Designate for constant	Constant K or data register D	Constant K or data register D (2 for designated)	
Present value change	Counter will stop when attaining settings	Counter will keep on counting when attaining settings	
Output contact	When count attains settings, contact will be On and latched.	When count up attains settings, contact will be On and latched. When count down attains settings, contact will reset to Off.	
Reset action	The present value will reset to 0 when RST command is executed and contact will reset to Off.		
Present register	16 bits	32 bits	
Contact action	After scanning, act together.	After scanning, act together.	Act immediately when count attains. It has no relation with scan period.

Functions:

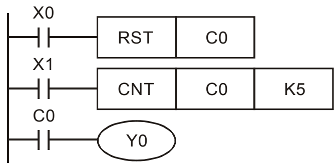
When pulse input signal of counter is from Off to On, the present value of counter equals to settings and output coil is On. Settings are decimal system and data register D can also be used as settings.

16-bit counters C0~C7:

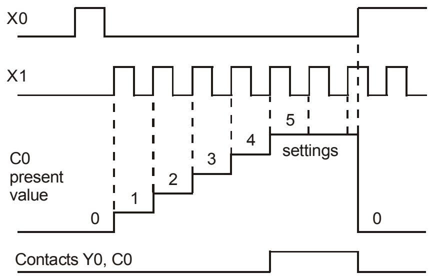
1. Setting range of 16-bit counter is K0~K32,767. (K0 is the same as K1. output contact will be On immediately at the first count.
2. General counter will be clear when PLC is power loss. If counter is latched, it will remember the value before power loss and keep on counting when power on after power loss.
3. If using MOV command, WPLSoft to send a value, which is large than setting to C0, register, at the next time that X1 is from Off to On, C0 counter contact will be On and present value will be set to the same as settings.
4. The setting of counter can use constant K or register D (not includes special data register D1000~D1044) to be indirect setting.
5. If using constant K to be setting, it can only be positive number but if setting is data register D, it can be positive/negative number. The next number that counter counts up from 32,767 is -32,768.

Example:

```
LD    X0
RST   C0
LD    X1
CNT   C0  K5
LD    C0
OUT   Y0
```



1. When X0=On, RST command is executed, C0 reset to 0 and output contact reset to Off.
2. When X1 is from Off to On, counter will count up (add 1).
3. When counter C0 attains settings K5, C0 contact is On and C0 = setting =K5. C0 won't accept X1 trigger signal and C0 remains K5.



32-bit high-speed addition/subtraction counter C235:

1. Setting range of 32-bit high-speed addition/subtraction counter is : K-2,147,483,648~K2,147,483,647.
2. The settings can be positive / negative numbers by using constant K or data register D (special data register D1000~D1044 is not included). If using data register D, the setting will occupy two continuous data register.

The total band width of high-speed counter that VFD-E supports is up to 30kHz and 500kHz for pulse input.

D.4.7 Register Types

There are two types of register which sorts by characters in the following:

1. General register : The data in register will be cleared to 0 when PLC switches from RUN to STOP or power is off.
2. Special register : Each special register has the special definition and purpose. It is used to save system status, error messages, monitor state.

D.4.8 Special Auxiliary Relays

Special M	Function	Read(R)/ Write(W)
M1000	Normally open contact (a contact). This contact is On when running and it is On when the status is set to RUN.	R
M1001	Normally closed contact (b contact). This contact is Off in running and it is Off when the status is set to RUN.	R
M1002	On only for 1 scan after RUN. Initial pulse is contact a. It will get positive pulse in the RUN moment. Pulse width=scan period.	R
M1003	Off only for 1 scan after RUN. Initial pulse is contact a. It will get negative pulse in the RUN moment. Pulse width=scan period.	R
M1004	Reserved	--
M1005	Fault indication of the AC motor drives	R
M1006	Output frequency is 0	R
M1007	The operation direction of AC motor drives (FWD: 0, REV: 1)	R
M1008	Reserved	--
M1009	Reserved	--
M1010	Reserved	--
M1011	10ms clock pulse, 5ms On/5ms Off	R
M1012	100ms clock pulse, 50ms On / 50ms Off	R
M1013	1s clock pulse, 0.5s On / 0.5s Off	R
M1014	1min clock pulse, 30s On / 30s Off	R
M1015	Frequency attained	R
M1016	Parameter read/write error	R
M1017	Succeed to write parameter	R
M1018	Enable high-speed counter function (When M1028=On)	R
M1019	Reserved	R
M1020	Zero flag	R
M1021	Borrow flag	R
M1022	Carry flag	R
M1023	Divisor is 0	R
M1024	Reserved	--
M1025	RUN(ON) / STOP(OFF) the AC motor drive	R/W

Special M	Function	Read(R)/ Write(W)
M1026	The operation direction of the AC motor drive (FWD: OFF, REV: ON)	R/W
M1027	Reserved	--
M1028	Enable(ON)/disable(OFF) high-speed counter function	R/W
M1029	Clear the value of high-speed counter	R/W
M1030	Decide to count up(OFF)/count down(ON)	R/W
M1031	Reserved	--

D.4.9 Special Registers

Special D	Function	Read(R)/ Write(W)
D1000	Reserved	--
D1001	PLC firmware version	R
D1002	Program capacity	R
D1003	Checksum	R
D1004-D1009	Reserved	--
D1010	Present scan time (Unit: 0.1ms)	R
D1011	Minimum scan time (Unit: 0.1ms)	R
D1012	Maximum scan time (Unit: 0.1ms)	R
D1013-D1019	Reserved	--
D1020	Output frequency	R
D1021	Output current	R
D1022	The ID of the extension card: 02 USB Card 03 12-Bit A/D (2CH) 12-Bit D/A (2CH) 04 Relay Card-2C 05 Relay Card-3A 06 3IN/3OUT Card 07 PG Card	R
D1023-D1024	Reserved	--

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Special D	Function	Read(R)/ Write(W)
D1025	The present value of the high-speed counter C235 (low byte)	R
D1026	The present value of the high-speed counter C235 (high byte)	R
D1027	Frequency command of the PID control	R
D1028	The value of AVI (analog voltage input) 0-10V corresponds to 0-1023	R
D1029	The value of ACI (analog current input) 4-20mA corresponds to 0-1023 or the value of AVI2 (analog voltage input) 0-10V corresponds to 0-1023	R
D1030	The value of V.R digital keypad 0-10V corresponds to 0-1023	R
D1031-D1035	Reserved	--
D1036	PLC error code	R
D1037-D1039	Reserved	--
D1040	Analog output value	R/W
D1041-D1042	Reserved	--
D1043	User defined (when Pr.00.04 is set to 2, the register data will be displayed as C xxx)	R/W
D1044	High-speed counter mode	R/W

D.4.10 Communication Addresses for Devices (only for PLC2 mode)

Device	Range	Type	Address (Hex)
X	00–17 (octal)	Bit	0400-040F
Y	00–17 (octal)	Bit	0500-050F
T	00-15	Bit/word	0600-060F
M	000-159	Bit	0800-089F
M	1000-1031	Bit	0BE8-0C07
C	0-7	Bit/word	0E00-0E07
D	00-63	Word	1000-101D
D	1000-1044	Word	13E8-1414

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NOTE: when it is in PLC1 mode, the communication address will correspond to the parameter NOT the device. For example, address 0400H will correspond to Pr.04.00 NOT X0.

D.4.11 Function Code (only for PLC2 mode)

Function Code	Description	Supported Devices
01	Read coil status	Y, M, T, C
02	Read input status	X, Y, M, T, C
03	Read one data	T, C, D
05	Force changing one coil status	Y, M, T, C
06	Write in one data	T, C, D
0F	Force changing multiple coil status	Y, M, T, C
10	Write in multiple data	T, C, D

D.5 Commands

D.5.1 Basic Commands

Commands	Function	Operands
LD	Load contact A	X, Y, M, T, C
LDI	Load contact B	X, Y, M, T, C
AND	Series connection with A contact	X, Y, M, T, C
ANI	Series connection with B contact	X, Y, M, T, C
OR	Parallel connection with A contact	X, Y, M, T, C
ORI	Parallel connection with B contact	X, Y, M, T, C
ANB	Series connects the circuit block	--
ORB	Parallel connects the circuit block	--
MPS	Save the operation result	--
MRD	Read the operation result (the pointer not moving)	--
MPP	Read the result	--
INV	Inverter the result	--

D.5.2 Output Commands

Commands	Function	Operands
OUT	Drive coil	Y, M
SET	Action latched (ON)	Y, M
RST	Clear the contacts or the registers	Y, M, T, C, D

D.5.3 Timer and Counters

Commands	Function	Operands
TMR	16-bit timer	T-K or T-D
CNT	16-bit counter	C-K or C-D

D.5.4 Main Control Commands

Commands	Function	Operands
MC	Connect the common series connection contacts	N0~N7
MCR	Disconnect the common series connection contacts	N0~N7

D.5.5 Rising-edge/falling-edge Detection Commands of Contact

Commands	Function	Operands
LDP	Rising-edge detection operation starts	X, Y, M, T, C
LDF	Falling-edge detection operation starts	X, Y, M, T, C
ANDP	Rising-edge detection series connection	X, Y, M, T, C
ANDF	Falling-edge detection series connection	X, Y, M, T, C
ORP	Rising-edge detection parallel connection	X, Y, M, T, C
ORF	Falling-edge detection parallel connection	X, Y, M, T, C

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D.5.6 Rising-edge/falling-edge Output Commands

Commands	Function	Operands
PLS	Rising-edge output	Y, M
PLF	Falling-edge output	Y, M

D.5.7 End Command

Command	Function	Operands
END	Program end	none

D.5.8 Explanation for the Commands

Mnemonic	**Function**					
LD	Load A contact					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

The LD command is used on the A contact that has its start from the left BUS or the A contact that is the start of a contact circuit. Function of the command is to save present contents, and at the same time, save the acquired contact status into the accumulative register.

Program Example:

Ladder diagram	Command code		Operation
	**LD**	**X0**	Load contact A of X0
	AND	X1	Connect to contact A of X1 in series
	OUT	Y1	Drive Y1 coil

Mnemonic	**Function**					
LDI	Load B contact					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

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Explanations:

The LDI command is used on the B contact that has its start from the left BUS or the B contact that is the start of a contact circuit. Function of the command is to save present contents, and at the same time, save the acquired contact status into the accumulative register.

Program Example:

Ladder diagram:

Command code:		Operation:
LDI	**X0**	Load contact B of X0
AND	X1	Connect to contact A of X1 in series
OUT	Y1	Drive Y1 coil

Mnemonic	Function					
AND	Series connection- A contact					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

The AND command is used in the series connection of A contact. The function of the command is to readout the status of present specific series connection contacts first, and then to perform the “AND” calculation with the logic calculation result before the contacts, thereafter, saving the result into the accumulative register.

Program Example:

Ladder diagram:

Command code:		Operation:
LDI	X1	Load contact B of X1
AND	**X0**	Connect to contact A of X0 in series
OUT	Y1	Drive Y1 coil

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Mnemonic	Function					
ANI	Series connection- B contact					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

The ANI command is used in the series connection of B contact. The function of the command is to readout the status of present specific series connection contacts first, and then to perform the "AND" calculation with the logic calculation result before the contacts, thereafter, saving the result into the accumulative register.

Program Example:

Ladder diagram:

Command code:		Operation:
LD	X1	Load contact A of X1
ANI	**X0**	Connect to contact B of X0 in series
OUT	Y1	Drive Y1 coil

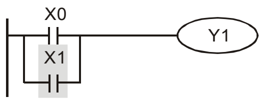
Mnemonic	Function					
OR	Parallel connection- A contact					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

The OR command is used in the parallel connection of A contact. The function of the command is to readout the status of present specific series connection contacts, and then to perform the "OR" calculation with the logic calculation result before the contacts, thereafter, saving the result into the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
OR	**X1**	Connect to contact A of X1 in parallel
OUT	Y1	Drive Y1 coil

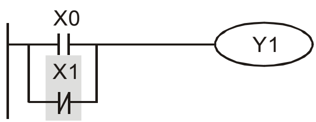
Mnemonic	Function					
ORI	Parallel connection- B contact					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

The ORI command is used in the parallel connection of B contact. The function of the command is to readout the status of present specific series connection contacts, and then to perform the "OR" calculation with the logic calculation result before the contacts, thereafter, saving the result into the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X1	Load contact A of X0
ORI	**X1**	Connect to contact B of X1 in parallel
OUT	Y1	Drive Y1 coil

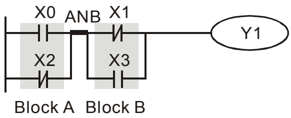
Mnemonic	Function
ANB	Series connection (Multiple Circuits)
Operand	None

Explanations:

To perform the "ANB" calculation between the previous reserved logic results and contents of the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
ORI	X2	Connect to contact B of X2 in parallel
LDI	X1	Load contact B of X1
OR	X3	Connect to contact A of X3 in parallel
ANB		Connect circuit block in series
OUT	Y1	Drive Y1 coil

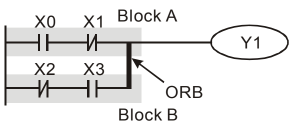
Mnemonic	**Function**
ORB	Parallel connection (Multiple circuits)
Operand	None

Explanations:

To perform the "OR" calculation between the previous reserved logic results and contents of the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
ANI	X1	Connect to contact B of X1 in series
LDI	X2	Load contact B of X2
AND	X3	Connect to contact A of X3 in series
ORB		Connect circuit block in parallel
OUT	Y1	Drive Y1 coil

Mnemonic	**Function**
MPS	Store the current result of the internal PLC operations
Operand	None

Explanations:

To save contents of the accumulative register into the operation result. (the result operation pointer pluses 1)

Mnemonic	**Function**
MRD	Reads the current result of the internal PLC operations
Operand	None

Explanations:

Reading content of the operation result to the accumulative register. (the pointer of operation result doesn't move)

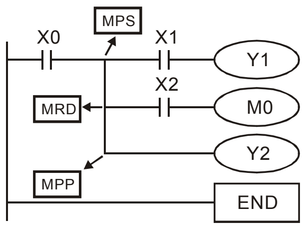
Mnemonic	**Function**
MPP	Reads the current result of the internal PLC operations
Operand	None

Explanations:

Reading content of the operation result to the accumulative register. (the stack pointer will decrease 1)

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
MPS		Save in stack
AND	X1	Connect to contact A of X1 in series
OUT	Y1	Drive Y1 coil
MRD		Read from the stack (without moving pointer)
AND	X2	Connect to contact A of X2 in series
OUT	M0	Drive M0 coil
MPP		Read from the stack
OUT	Y2	Drive Y2 coil
END		End program

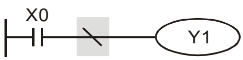
Mnemonic	**Function**
INV	Inverting Operation
Operand	None

Explanations:

Inverting the operation result and use the new data as an operation result.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load A contact of X0
INV		Inverting the operation result
OUT	Y1	Drive Y1 coil

Mnemonic	**Function**					
OUT	Output coil					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	--	✓	✓	--	--	--

Explanations:

Output the logic calculation result before the OUT command to specific device.

Motion of coil contact

Operation result	**OUT command**		
	Coil	**Contact**	
		A contact (normally open)	**B contact (normally closed)**
FALSE	OFF	Non-continuity	Continuity
TRUE	ON	Continuity	Non-continuity

Program Example:

Ladder diagram:

Command code:		Operation:
LDI	X0	Load contact B of X0
AND	X1	Connect to contact A of X1 in series
OUT	**Y1**	Drive Y1 coil

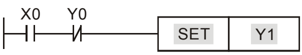
Mnemonic	Function					
SET	Latch (ON)					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	--	✓	✓	--	--	--

Explanations:

When the SET command is driven, its specific device is set to be “ON,” which will keep “ON” whether the SET command is still driven. You can use the RST command to set the device to “OFF”.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
ANI	Y0	Connect to contact B of Y0 in series
SET	**Y1**	Y1 latch (ON)

Mnemonic	Function					
RST	Clear the contacts or the registers					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	--	✓	✓	✓	✓	--

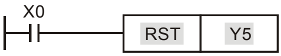
Explanations:

When the RST command is driven, motion of its specific device is as follows:

Device	Status
Y, M	Coil and contact will be set to “OFF”.
T, C	Present values of the timer or counter will be set to 0, and the coil and contact will be set to “OFF.”
D	The content value will be set to 0.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0
RST	**Y5**	Clear contact Y5

Mnemonic	Function	
TMR	16-bit timer	
Operand	T-K	T0~T15, K0~K32,767
	T-D	T0~T15, D0~D29

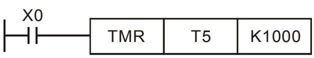
Explanations:

When TMR command is executed, the specific coil of timer is ON and timer will start to count. When the setting value of timer is attained (counting value >= setting value), the contact will be as following:

NO(Normally Open) contact	Open collector
NC(Normally Closed) contact	Close collector

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0 T5 timer
TMR	**T5 K1000**	Setting is K1000

Mnemonic	Function	
CNT	16-bit counter	
Operand	C-K	C0~C7, K0~K32,767
	C-D	C0~C7, D0~D29

Explanations:

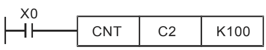
1. When the CNT command is executed from OFF→ON, which means that the counter coil is driven, and 1 should thus be added to the counter's value; when the counter achieved specific set value (value of counter = the setting value), motion of the contact is as follows:

NO(Normally Open) contact	Continuity
NC(Normally Closed) contact	Non-continuity

2. If there is counting pulse input after counting is attained, the contacts and the counting values will be unchanged. To re-count or to conduct the CLEAR motion, please use the RST command.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	X0	Load contact A of X0 C2 counter
CNT	**C2 K100**	Setting is K100

Mnemonic	Function
MC / MCR	Master control Start/Reset
Operand	N0~N7

Explanations:

1. MC is the main-control start command. When the MC command is executed, the execution of commands between MC and MCR will not be interrupted. When MC command is OFF, the motion of the commands that between MC and MCR is described as follows:

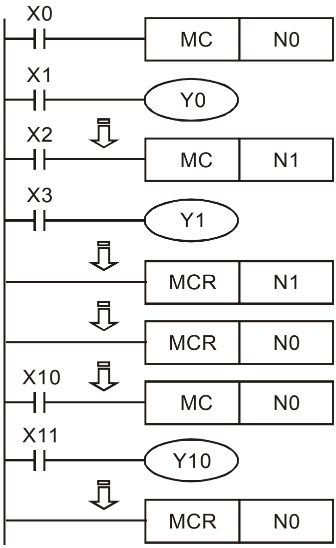
Timer	The counting value is set back to zero, the coil and the contact are both turned OFF
Accumulative timer	The coil is OFF, and the timer value and the contact stay at their present condition
Subroutine timer	The counting value is back to zero. Both coil and contact are turned OFF.

Counter	The coil is OFF, and the counting value and the contact stay at their present condition
Coils driven up by the OUT command	All turned OFF
Devices driven up by the SET and RST commands	Stay at present condition
Application commands	All of them are not acted , but the nest loop FOR-NEXT command will still be executed for times defined by users even though the MC-MCR commands is OFF.

2. MCR is the main-control ending command that is placed at the end of the main-control program and there should not be any contact commands prior to the MCR command.
3. Commands of the MC-MCR main-control program supports the nest program structure, with 8 layers as its greatest. Please use the commands in order from N0~ N7, and refer to the following:

Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
MC	**N0**	Enable N0 common series connection contact
LD	X1	Load A contact of X1
OUT	Y0	Drive Y0 coil
:		
LD	X2	Load A contact of X2
MC	**N1**	Enable N1 common series connection contact
LD	X3	Load A contact of X3
OUT	Y1	Drive Y1 coil
:		
MCR	**N1**	Disable N1 common series connection contact
:		
MCR	**N0**	Disable N0 common series connection contact
:		
LD	X10	Load A contact of X10
MC	**N0**	Enable N0 common series connection contact

LD	X11	Load A contact of X11
OUT	Y10	Drive Y10 coil
:		
MCR	**N0**	Disable N0 common series connection contact

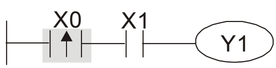
Mnemonic	Function					
LDP	Rising-edge detection operation					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

Usage of the LDP command is the same as the LD command, but the motion is different. It is used to reserve present contents and at the same time, saving the detection status of the acquired contact rising-edge into the accumulative register.

Program Example:

Ladder diagram:



Command code:		Operation:
LDP	**X0**	Start X0 rising-edge detection
AND	X1	Series connection A contact of X1
OUT	Y1	Drive Y1 coil

Mnemonic	Function					
LDF	Falling-edge detection operation					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

Usage of the LDF command is the same as the LD command, but the motion is different. It is used to reserve present contents and at the same time, saving the detection status of the acquired contact falling-edge into the accumulative register.

Program Example:

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Ladder diagram:

Command code:		Operation:
LDF	**X0**	Start X0 falling-edge detection
AND	X1	Series connection A contact of X1
OUT	Y1	Drive Y1 coil

Mnemonic	Function					
ANDP	Rising-edge series connection					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

ANDP command is used in the series connection of the contacts' rising-edge detection.

Program Example:

Ladder diagram:

Command code:		Operation:
LD	**X0**	Load A contact of X0
ANDP	**X1**	X1 rising-edge detection in series connection
OUT	Y1	Drive Y1 coil

Mnemonic	Function					
ANDF	Falling-edge series connection					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

ANDF command is used in the series connection of the contacts' falling-edge detection.

Program Example:

Ladder diagram:

Command code:		Operation:
LD	**X0**	Load A contact of X0
ANDF	**X1**	X1 falling-edge detection in series connection
OUT	Y1	Drive Y1 coil

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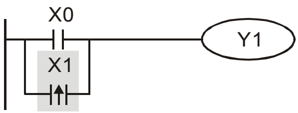
Mnemonic	Function					
ORP	Rising-edge parallel connection					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

The ORP commands are used in the parallel connection of the contact's rising-edge detection.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
ORP	**X1**	X1 rising-edge detection in parallel connection
OUT	Y1	Drive Y1 coil

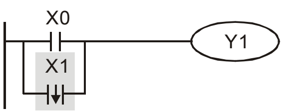
Mnemonic	Function					
ORF	Falling-edge parallel connection					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	✓	✓	✓	✓	✓	--

Explanations:

The ORP commands are used in the parallel connection of the contact's falling-edge detection.

Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
ORF	**X1**	X1 falling-edge detection in parallel connection
OUT	Y1	Drive Y1 coil

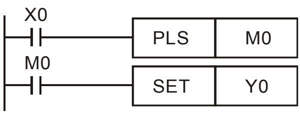
Mnemonic	**Function**					
PLS	Rising-edge output					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	--	✓	✓	--	--	--

Explanations:

When X0=OFF→ON (rising-edge trigger), PLS command will be executed and M0 will send the pulse of one time which the length is a scan time.

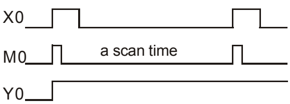
Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
PLS	**M0**	M0 rising-edge output
LD	M0	Load the contact A of M0
SET	Y0	Y0 latched (ON)

Timing Diagram:



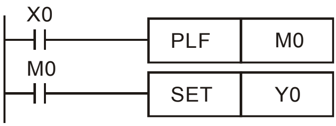
Mnemonic	**Function**					
PLF	Falling-edge output					
Operand	X0~X17	Y0~Y17	M0~M159	T0~15	C0~C7	D0~D29
	--	✓	✓	--	--	--

Explanations:

When X0= ON→OFF (falling-edge trigger), PLF command will be executed and M0 will send the pulse of one time which the length is the time for scan one time.

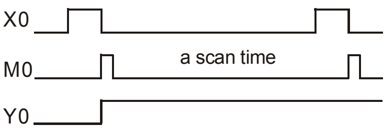
Program Example:

Ladder diagram:



Command code:		Operation:
LD	**X0**	Load A contact of X0
PLF	**M0**	M0 falling-edge output
LD	M0	Load the contact A of M0
SET	Y0	Y0 latched (ON)

Timing Diagram:



Mnemonic	**Function**
END	Program End
Operand	None

Explanations:

It needs to add the END command at the end of ladder diagram program or command program. PLC will scan from address o to END command, after executing it will return to address 0 to scan again.

D.5.9 Description of the Application Commands

	API	Mnemonic Codes		P Command	Function	Steps	
		16 bits	32 bits			16-bit	32-bit
Transmission Comparison	10	CMP	--	✓	Compare	7	--
	11	ZCP	--	✓	Zone compare	9	--
	12	MOV	--	✓	Data Move	5	--
	15	BMOV	--	✓	Block move	7	--
Four Fundamental Operations of Arithmetic	20	ADD	--	✓	Perform the addition of BIN data	7	--
	21	SUB	--	✓	Perform the subtraction of BIN data	7	--

	API	Mnemonic Codes		P Command	Function	Steps	
		16 bits	32 bits			16-bit	32-bit
	22	MUL	--	✓	Perform the multiplication of BIN data	7	--
	23	DIV	--	✓	Perform the division of BIN data	7	--
	24	INC	--	✓	Perform the addition of 1	3	--
	25	DEC	--	✓	Perform the subtraction of 1	3	--
Rotation and Displacement	30	ROR	--	✓	Rotate to the right	5	--
	31	ROL	--	✓	Rotate to the left	5	--
Special command for AC motor drive	53	--	DHSCS	X	High speed counter enable	--	13
	139	FPID	--	✓	Control PID parameters of inverter	5	--
	140	FREQ	--	✓	Control frequency of inverter	5	--
	141	RPR	--	✓	Read the parameter	9	--
	142	WPR	--	✓	Write the parameter	7	--

D.5.10 Explanation for the Application Commands

API	Mnemonic			Operands	Function
10		CMP	P	S_1, S_2, D	Compare

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	CMP, CMPP: 7 steps
S_1				*	*	*	*	*	*	*	*	
S_2				*	*	*	*	*	*	*	*	
D		*	*									

Operands:

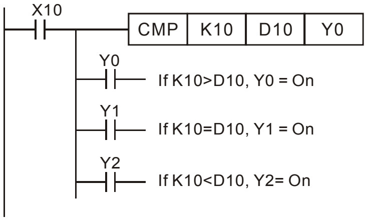
S1: Comparison Value 1 S2: Comparison Value 2 D: Comparison result

Explanations:

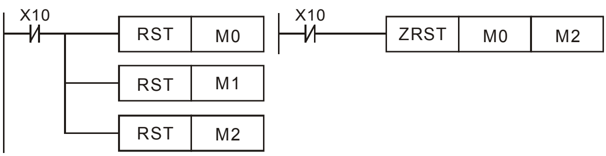
1. Operand D occupies 3 consecutive devices.
2. See the specifications of each model for their range of use.
3. The contents in S1 and S2 are compared and the result will be stored in D.
4. The two comparison values are compared algebraically and the two values are signed binary values. When b15 = 1 in 16-bit instruction, the comparison will regard the value as negative binary values.

Program Example:

1. Designate device Y0, and operand D automatically occupies Y0, Y1, and Y2.
2. When X10 = On, CMP instruction will be executed and one of Y0, Y1, and Y2 will be On. When X10 = Off, CMP instruction will not be executed and Y0, Y1, and Y2 remain their status before X10 = Off.
3. If the user need to obtain a comparison result with ≥ ≤, and ≠, make a series parallel connection between Y0 ~ Y2.



4. To clear the comparison result, use RST or ZRST instruction.



API	Mnemonic		Operands	Function
11	ZCP	P	S_1, S_2, S, D	Zone Compare

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	ZCP, ZCPP: 9 steps
S_1				*	*	*	*	*	*	*	*	
S_2				*	*	*	*	*	*	*	*	
S				*	*	*	*	*	*	*	*	
D		*	*									

Operands:

S1: Lower bound of zone comparison S2: Upper bound of zone comparison S: Comparison value D: Comparison result

Explanations:

1. The content in S1 should be smaller than the content in S2.
2. Operand D occupies 3 consecutive devices.
3. See the specifications of each model for their range of use.
4. S is compared with its S1 S2 and the result is stored in D.
5. When S1 > S2, the instruction performs comparison by using S1 as the lower/upper bound.
6. The two comparison values are compared algebraically and the two values are signed binary values. When b15 = 1 in 16-bit instruction or b31 = 1 in 32-bit instruction, the comparison will regard the value as negative binary values.

Program Example:

1. Designate device M0, and operand D automatically occupies M0, M1 and M2.
2. When X0 = On, ZCP instruction will be executed and one of M0, M1, and M2 will be On. When X10 = Off, ZCP instruction will not be executed and M0, M1, and M2 remain their status before X0 = Off.

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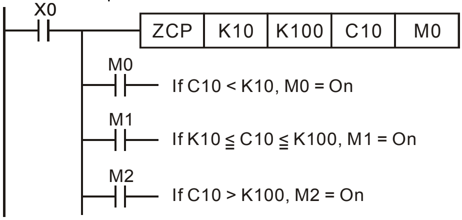
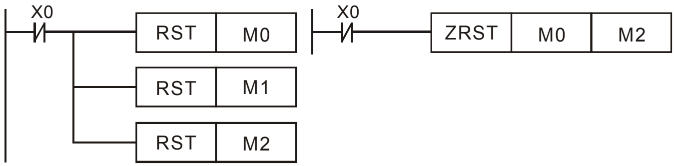


3. To clear the comparison result, use RST or ZRST instruction.



API	Mnemonic			Operands	Function
12		MOV	P	S, D	Move

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	MOV, MOVP: 5 steps
S				*	*	*	*	*	*	*	*	
D							*	*	*	*	*	

Operands:

S: Source of data D: Destination of data

Explanations:

1. See the specifications of each model for their range of use.
2. When this instruction is executed, the content of S will be moved directly to D. When this instruction is not executed, the content of D remains unchanged.

Program Example:

MOV instruction has to be adopted in the moving of 16-bit data.

1. When X0 = Off, the content in D10 will remain unchanged. If X0 = On, the value K10 will be moved to D10 data register.
2. When X1 = Off, the content in D10 will remain unchanged. If X1 = On, the present value T0 will be moved to D10 data register.

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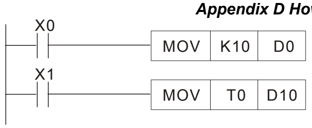


API	Mnemonic			Operands	Function
15		BMOV	P	S, D, n	Block Move

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	BMOV, BMOVP: 7 steps
S						*	*	*	*	*	*	
D							*	*	*	*	*	
n				*	*				*	*	*	

Operands:

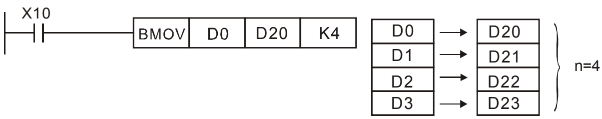
S: Start of source devices D: Start of destination devices n: Number of data to be moved

Explanations:

1. Range of **n**: 1 ~ 512
2. See the specifications of each model for their range of use.
3. The contents in n registers starting from the device designated by S will be moved to n registers starting from the device designated by D. If n exceeds the actual number of available source devices, only the devices that fall within the valid range will be used.

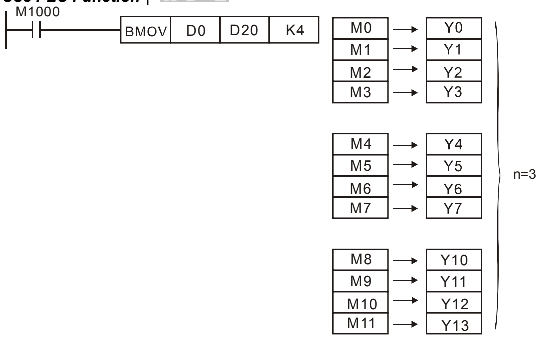
Program Example 1:

When X10 = On, the contents in registers D0 ~ D3 will be moved to the 4 registers D20 ~ D23.



Program Example 2:

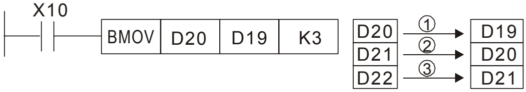
Assume the bit devices KnX, KnY, KnM and KnS are designated for moving, the number of digits of S and D has to be the same, i.e. their n has to be the same.



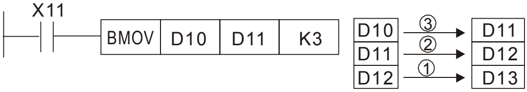
Program Example 3:

To avoid coincidence of the device numbers to be moved designated by the two operands and cause confusion, please be aware of the arrangement on the designated device numbers.

When S > D, the BMOV command is processed in the order as ①→②→③



When S < D, the BMOV command is processed in the order as ③→②→①



API	Mnemonic			Operands	Function
20		ADD	**P**	S_1, S_2, D	Addition

Type / OP	Bit Devices			Word devices									Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D		ADD, ADDP: 7 steps
S_1				*	*	*	*	*	*	*	*		
S_2				*	*	*	*	*	*	*	*		
D							*	*	*	*	*		

Operands:

S1: Summand S2: Addend D: Sum

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Explanations:

1. See the specifications of each model for their range of use.
2. This instruction adds S1 and S2 in BIN format and store the result in D.
3. The highest bit is symbolic bit 0 (+) and 1 (-), which is suitable for algebraic addition, e.g. 3 + (-9) = -6.
4. Flag changes in binary addition

   16-bit command:

   A. If the operation result = 0, zero flag M1020 = On.

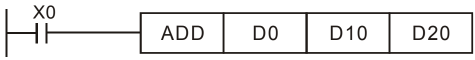
   B. If the operation result < -32,768, borrow flag M1021 = On.

   C. If the operation result > 32,767, carry flag M1022 = On.

Program Example 1:

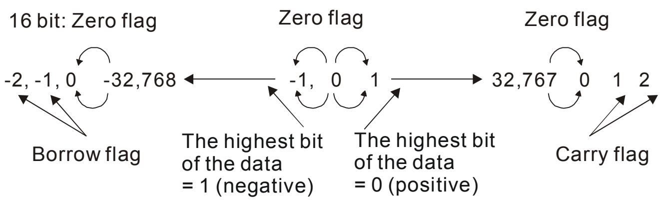
16-bit command:

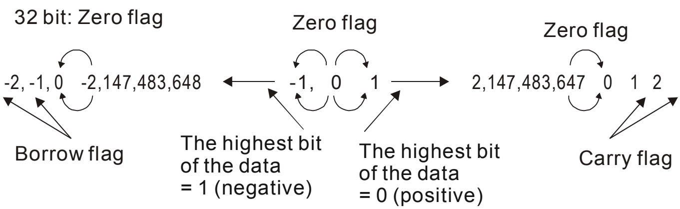
When X0 = On, the content in D0 will plus the content in D10 and the sum will be stored in D20.



Remarks:

Flags and the positive/negative sign of the values:





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API	Mnemonic			Operands	Function
21		SUB	P	S_1, S_2, D	Subtraction

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	SUB, SUBP: 7 steps DSUB, DSUBP: 13 steps
S_1				*	*	*	*	*	*	*	*	
S_2				*	*	*	*	*	*	*	*	
D							*	*	*	*	*	

Operands:

S1: Minuend S2: Subtrahend D: Remainder

Explanations:

1. This instruction subtracts S1 and S2 in BIN format and stores the result in D.
2. The highest bit is symbolic bit 0 (+) and 1 (-), which is suitable for algebraic subtraction.
3. Flag changes in binary subtraction

   In 16-bit instruction:

   A. If the operation result ＝ 0, zero flag M1020 = On.

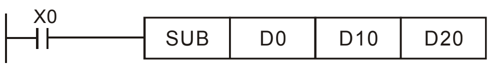
   B. If the operation result ＜ -32,768, borrow flag M1021 = On.

   C. If the operation result ＞ 32,767, carry flag M1022 = On.

Program Example:

In 16-bit BIN subtraction:

When X0 = On, the content in D0 will minus the content in D10 and the remainder will be stored in D20.



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API	Mnemonic		Operands	Function
22	MUL	P	S_1, S_2, D	Multiplication

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	MUL, DMULP: 7 steps
S_1				*	*	*	*	*	*	*	*	
S_2				*	*	*	*	*	*	*	*	
D							*	*	*	*	*	

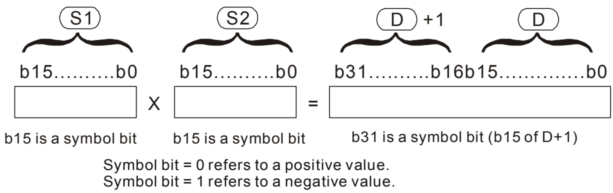
Operands:

S1: Multiplicand   S2: Multiplicator   D: Product

Explanations:

1. In 16-bit instruction, D occupies 2 consecutive devices.
2. This instruction multiplies S1 by S2 in BIN format and stores the result in D. Be careful with the positive/negative signs of S1, S2 and D when doing 16-bit and 32-bit operations.

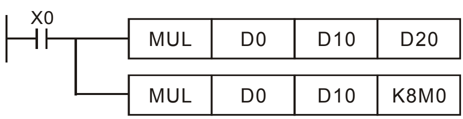
   16-bit command:



When D serves as a bit device, it can designate K1 ~ K4 and construct a 16-bit result, occupying consecutive 2 groups of 16-bit data.

Program Example:

The 16-bit D0 is multiplied by the 16-bit D10 and brings forth a 32-bit product. The higher 16 bits are stored in D21 and the lower 16-bit are stored in D20. On/Off of the most left bit indicates the positive/negative status of the result value.



API		Mnemonic		Operands	Function
23		DIV	P	S_1, S_2, D	Division

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	DIV, DIVP: 7 steps
S_1				*	*	*	*	*	*	*	*	
S_2				*	*	*	*	*	*	*	*	
D							*	*	*	*	*	

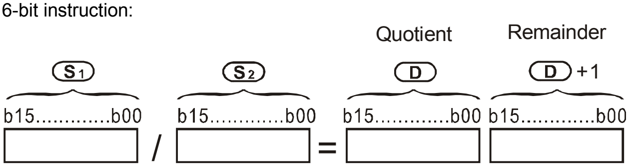
Operands:

S_1: Dividend S_2: Divisor D: Quotient and remainder

Explanations:

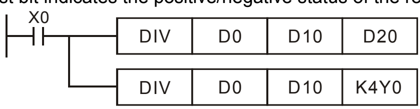
1. In 16-bit instruction, **D** occupies 2 consecutive devices.
2. This instruction divides $\mathbf{S_1}$ and $\mathbf{S_2}$ in BIN format and stores the result in **D**. Be careful with the positive/negative signs of $\mathbf{S_1}$, $\mathbf{S_2}$ and **D** when doing 16-bit and 32-bit operations.

   16-bit instruction:



Program Example:

When X0 = On, D0 will be divided by D10 and the quotient will be stored in D20 and remainder in D21. On/Off of the highest bit indicates the positive/negative status of the result value.



API		Mnemonic		Operands	Function
24		INC	P	D	Increment

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	INC, INCP: 3 steps
D							*	*	*	*	*	

Operands:

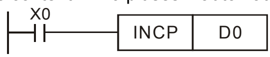
D: Destination device

Explanations:

1. If the instruction is not a pulse execution one, the content in the designated device D will plus “1” in every scan period whenever the instruction is executed.
2. This instruction adopts pulse execution instructions (INCP).
3. In 16-bit operation, 32,767 pluses 1 and obtains -32,768. In 32-bit operation, 2,147,483,647 pluses 1 and obtains -2,147,483,648.

Program Example:

When X0 goes from Off to On, the content in D0 pluses 1 automatically.



API	Mnemonic			Operands	Function
25		DEC	P	D	Decrement

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	DEC, DECP: 3 steps
D							*	*	*	*	*	

Operands:

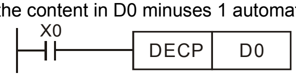
D: Destination

Explanations:

1. If the instruction is not a pulse execution one, the content in the designated device D will minus “1” in every scan period whenever the instruction is executed.
2. This instruction adopts pulse execution instructions (DECP).
3. In 16-bit operation, -32,768 minuses 1 and obtains 32,767. In 32-bit operation, -2,147,483,648 minuses 1 and obtains 2,147,483,647.

Program Example:

When X0 goes from Off to On, the content in D0 minuses 1 automatically.



API	Mnemonic			Operands	Function
30		ROR	P	D, n	Rotate to the Right

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	ROR, RORP: 5 steps
D							*	*	*	*	*	
n				*	*							

Operands:

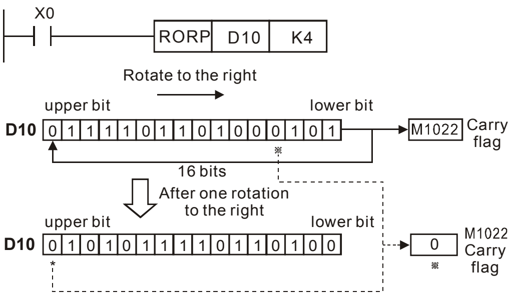
D: Device to be rotated n: Number of bits to be rotated in 1 rotation

Explanations:

1. This instruction rotates the device content designated by **D** to the right for **n** bits.
2. This instruction adopts pulse execution instructions (RORP).

Program Example:

When X0 goes from Off to On, the 16 bits (4 bits as a group) in D10 will rotate to the right, as shown in the figure below. The bit marked with ※ will be sent to carry flag M1022.



API	Mnemonic			Operands	Function
31		ROL	P	D, n	Rotate to the Left

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	ROL, ROLP: 5 steps
D							*	*	*	*	*	
n				*	*							

Operands:

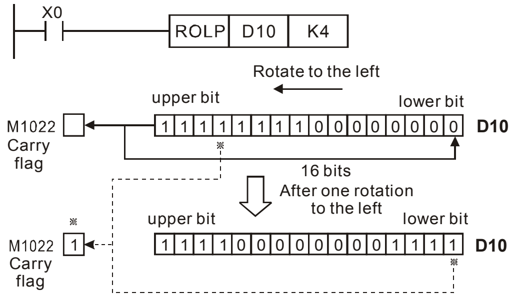
D: Device to be rotated n: Number of bits to be rotated in 1 rotation

Explanations:

1. This instruction rotates the device content designated by **D** to the left for **n** bits.
2. This instruction adopts pulse execution instructions (ROLP).

Program Example:

When X0 goes from Off to On, the 16 bits (4 bits as a group) in D10 will rotate to the left, as shown in the figure below. The bit marked with ※ will be sent to carry flag M1022.



D.5.11 Special Application Commands for the AC Motor Drive

API	Mnemonic	Operands	Function
53	DHSCS	S1, S2, D	Compare (for high-speed counter)

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	DHSCS: 13 steps
S1				*	*						*	
S2										*		
D		*	*						*	*	*	

Operands:

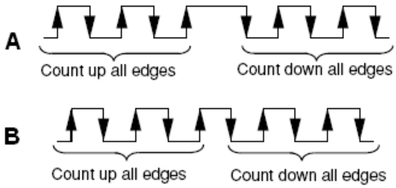
S1: Comparison Value S2: High-speed counter C235 D: Comparison result

Explanations:

1. It needs optional PG card to receive external input pulse.
2. To count automatically, please set the target value by using DHSCS command and set M1028=On. The counter C235 will be ON when the count number = target value. If you want to clear C235, please set M1029=ON.

3. Please use rising-edge/falling-edge command, such as LDP/LDF, for the contact condition. Please notice that error may occur when using contact A/B for the contact condition.
4. There are three input modes for high-speed counter in the following can be set by D1044.

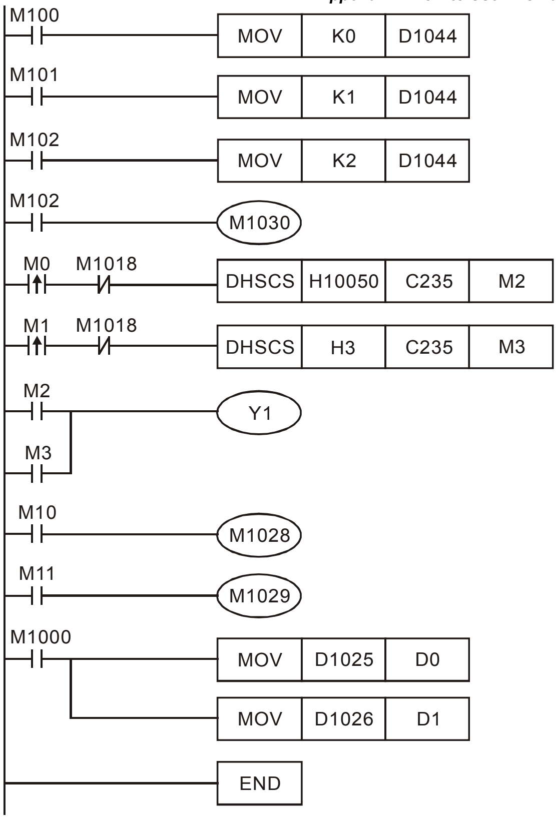
- A-B phase mode(4 times frequency)(D1044=0): user can input the A and B pulse for counting. Make sure that $\overline{A}$, $\overline{B}$ and GND are grounding.



- Pulse + signal mode(D1044=1): user can count by pulse input or signal. A is for pulse and B is for signal. Make sure that $\overline{A}$, $\overline{B}$ and GND are grounding.
- Pulse + flag mode(D1044=2): user can count by M1030. Only A is needed for this mode and make sure that $\overline{A}$, and GND are grounding.

Program Example:

1. Assume that when M100=ON, it is set to A-B phase mode. When M101=ON, it is set to pulse+signal mode. When M102=ON, it is set to pulse+flag mode.
2. M1030 is used to set to count up (OFF) and count down (ON).
3. If M0 goes from OFF to ON, DHSCS command starts to execute the comparison of high-speed counter. When C235 goes from H'2 to H'3 or from H'4 to H'3, M3 will be always be ON.
4. If M1 goes from OFF to ON, DHSCS command starts to execute the comparison of high-speed counter. When C235 goes from H'1004F to H'10050 or from H'10051 to H'10050, M2 will be always be ON.
5. M1028: it is used to enable(ON)/disable(OFF) the high-speed counter function. M1029: it is used to clear the high-speed counter. M1018: it is used to start high-speed counter function. (when M1028 is ON).
6. D1025: the low word of high-speed counter C235. D1026: the high word of high-speed counter C235.



API	Mnemonic		Operands	Function
139	RPR	P	S1, S2	Read the AC motor drive's parameters

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	RPR, RPRP: 5 steps
S1				*	*						*	
S2											*	

Operands:

S1: Data address for reading S2: Register that saves the read data

API	Mnemonic			Operands	Function
140		WPR	P	S1, S2	Write the AC motor drive's parameters

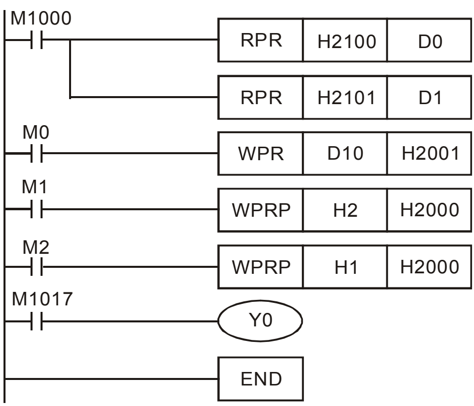
Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	WPR, WPRP: 5 steps
S1				*	*						*	
S2				*	*						*	

Operands:

S1: Data address for writing S2: Register that saves the written data

Program Example:

1. Assume that it will write the data in address H2100 of the VFD-E into D0 and H2101 into D1.
2. When M0=ON, it will write the data in D10 to the address H2001 of the VFD-E.
3. When M1=ON, it will write the data in H2 to the address H2000 of the VFD-E, i.e. start the AC motor drive.
4. When M2=ON, it will write the data in H1 to the address H2000 of the VFD-E, i.e. stop the AC motor drive.
5. When data is written successfully, M1017 will be ON.



API		Mnemonic		Operands	Function
141		FPID	P	S1, S2, S3, S4	PID control for the AC motor drive

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	FPID, FPIDP: 9 steps
S1				*	*						*	
S2				*	*						*	
S3				*	*						*	
S4				*	*						*	

Operands:

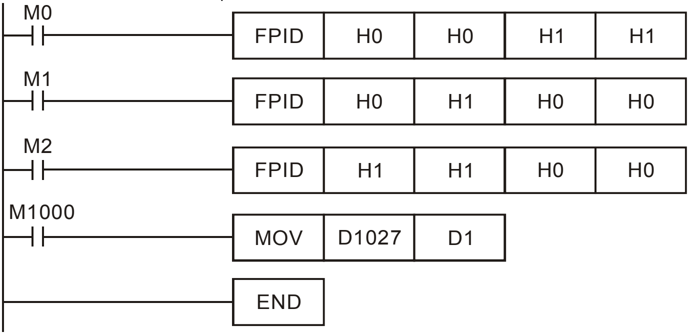
S1: PID Set Point Selection(0-4), S2: Proportional gain P (0-100), S3: Integral Time I (0-10000), S4: Derivative control D (0-100)

Explanation:

1. This command FPID can control the PID parameters of the AC motor drive directly, including Pr.10.00 PID set point selection, Pr.10.02 Proportional gain (P), Pr.10.03 Integral time (I) and Pr.10.04 Derivative control (D)

Program Example:

1. Assume that when M0=ON, S1 is set to 0 (PID function is disabled), S2=0, S3=1 (unit: 0.01 seconds) and S4=1 (unit: 0.01 seconds).
2. Assume that when M1=ON, S1 is set to 0 (PID function is disabled), S2=1 (unit: 0.01), S3=0 and S4=0.
3. Assume that when M2=ON, S1 is set to 1(frequency is inputted by digital keypad), S2=1 (unit: 0.01), S3=0 and S4=0.
4. D1027: frequency command controlled by PID.



API		Mnemonic		Operands	Function
142		FREQ	P	S1, S2, S3	Operation control of the AC motor drive

Type / OP	Bit Devices			Word devices								Program Steps
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	FREQ, FREQP: 7 steps
S1				*	*						*	
S2				*	*						*	
S3				*	*						*	

Operands:

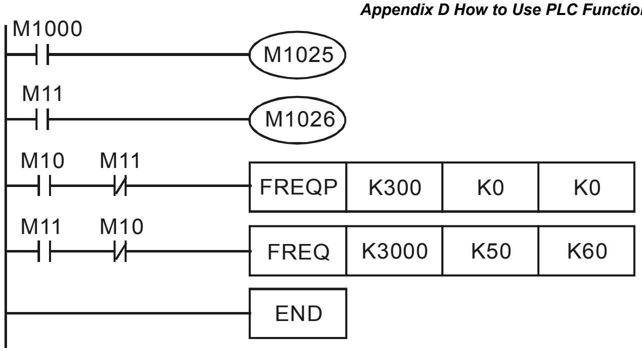
S1: frequency command, S2: acceleration time, S3: deceleration time

Explanation:

1. This command can control frequency command, acceleration time and deceleration time of the AC motor drive. Please use M1025 to RUN(ON)/STOP(OFF) the AC motor drive and use M1025 to control the operation direction: FWD(ON)/REV(OFF).

Program Example:

1. M1025: RUN(ON)/STOP(Off) the AC motor drive. M1026: operation direction of the AC motor drive – FWD(OFF)/REV(ON). M1015: frequency is reached.
2. When M10=ON, setting frequency command of the AC motor drive to K300(3.00Hz) and acceleration/deceleration time is 0.
3. When M11=ON, setting frequency command of the AC motor drive to K3000(30.00Hz), acceleration time is 50 and deceleration time is 60.


M1000
M1025
M11
M1026
M10
M11
FREQP
K300
K0
K0
M11
M10
FREQ
K3000
K50
K60
END

D.6 Error Code

Code	ID	Description	Corrective Actions
PLod	20	Data write error	Check if the program is error and download the program again
PLSv	21	Data write error when executing	Power on again and download the program again
PLdA	22	Program upload error	1. Please upload again. 2. Return to the factory if it occurs continuously
PLFn	23	Command error when download program	Check if the program is error and download program again
PLor	30	Program capacity exceeds memory capacity	Power on again and download program again
PLFF	31	Command error when executing	
PLSn	32	Check sum error	
PLEd	33	There is no "END" command in the program	
PLCr	34	The command MC is continuous used more than nine times	

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Appendix E CANopen Function

The built-in CANopen function is a kind of remote control. Master can control the AC motor drive by using CANopen protocol. CANopen is a CAN-based higher layer protocol. It provides standardized communication objects, including real-time data (Process Data Objects, PDO), configuration data (Service Data Objects, SDO), and special functions (Time Stamp, Sync message, and Emergency message). And it also has network management data, including Boot-up message, NMT message, and Error Control message. Refer to CiA website http://www.can-cia.org/ for details. The content of this instruction sheet may be revised without prior notice. Please consult our distributors or download the most updated version at http://www.delta.com.tw/industrialautomation

Delta CANopen supports functions:

- Support CAN2.0A Protocol;
- Support CANopen DS301 V4.02;
- Support DSP-402 V2.0.
-

Delta CANopen supports services:

- PDO (Process Data Objects): PDO1~ PDO2
- SDO (Service Data Object):
  Initiate SDO Download;
  Initiate SDO Upload;
  Abort SDO;
  SDO message can be used to configure the slave node and access the Object Dictionary in every node.
- SOP (Special Object Protocol):
  Support default COB-ID in Predefined Master/Slave Connection Set in DS301 V4.02;
  Support SYNC service;
  Support Emergency service.
- NMT (Network Management):
  Support NMT module control;
  Support NMT Error control;
  Support Boot-up.

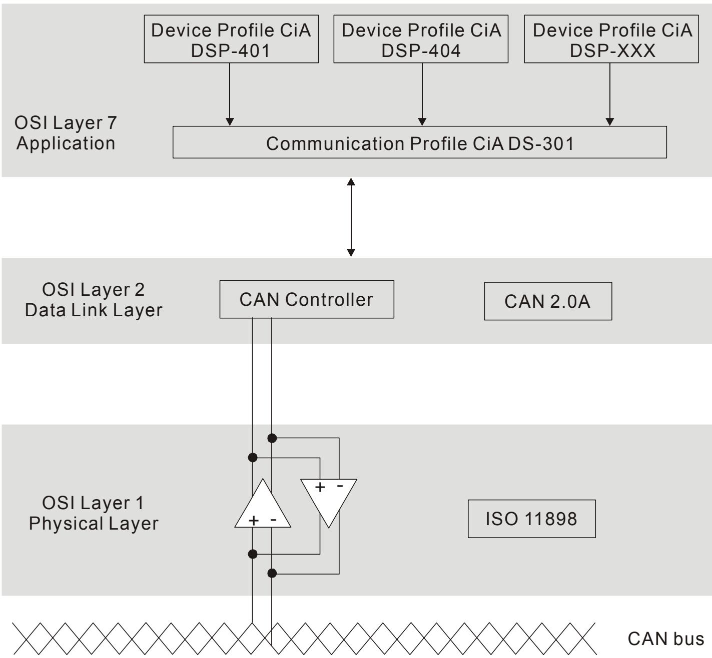
Delta CANopen doesn't support service:

- Time Stamp service

E.1 Overview

E.1.1 CANopen Protocol

CANopen is a CAN-based higher layer protocol, and was designed for motion-oriented machine control networks, such as handling systems. Version 4 of CANopen (CiA DS301) is standardized as EN50325-4. The CANopen specifications cover application layer and communication profile (CiA DS301), as well as a framework for programmable devices (CiA 302), recommendations for cables and connectors (CiA 303-1) and SI units and prefix representations (CiA 303-2).



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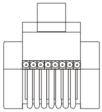
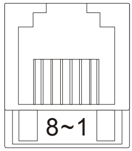
E.1.2 RJ-45 Pin Definition





PIN	Signal	Description
1	CAN_H	CAN_H bus line (dominant high)
2	CAN_L	CAN_L bus line (dominant low)
3	CAN_GND	Ground / 0V /V-
4	SG+	485 communication
5	SG-	485 communication
7	CAN_GND	Ground / 0V /V-

E.1.3 Pre-Defined Connection Set

To reduce configuration effort for simple networks, CANopen define a mandatory default identifier allocation scheme. The 11-bit identifier structure in predefined connection is set as follows:

COB Identifier (CAN Identifier)										
10	9	8	7	6	5	4	3	2	1	0
Function Code				Node Number						

Object	Function Code	Node Number	COB-ID	Object Dictionary Index
Broadcast messages				
NMT	0000	-	0	-
SYNC	0001	-	0x80	0x1005, 0x1006, 0x1007
TIME STAMP	0010	-	0x100	0x1012, 0x1013
Point-to-point messages				
Emergency	0001	1-127	0x81-0xFF	0x1014, 0x1015

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Object	Function Code	Node Number	COB-ID	Object Dictionary Index
TPDO1	0011	1-127	0x181-0x1FF	0x1800
RPDO1	0100	1-127	0x201-0x27F	0x1400
TPDO2	0101	1-127	0x281-0x2FF	0x1801
RPDO2	0110	1-127	0x301-0x37F	0x1401
TPDO3	0111	1-127	0x381-0x3FF	0x1802
RPDO3	1000	1-127	0x401-0x47F	0x1402
TPDO4	1001	1-127	0x481-0x4FF	0x1803
RPDO4	1010	1-127	0x501-0x57F	0x1403
Default SDO (tx)	1011	1-127	0x581-0x5FF	0x1200
Default SDO (rx)	1100	1-127	0x601-0x67F	0x1200
NMT Error Control	1110	1-127	0x701-0x77F	0x1016, 0x1017

E.1.4 CANopen Communication Protocol

It has services as follows:

- NMT (Network Management Object)
- SDO (Service Data Object)
- PDO (Process Data Object)
- EMCY (Emergency Object)

E.1.4.1 NMT (Network Management Object)

The Network Management (NMT) follows a Master/Slave structure for executing NMT service. Only one NMT master is in a network, and other nodes are regarded as slaves. All CANopen nodes have a present NMT state, and NMT master can control the state of the slave nodes. The state diagram of a node are shown as follows:

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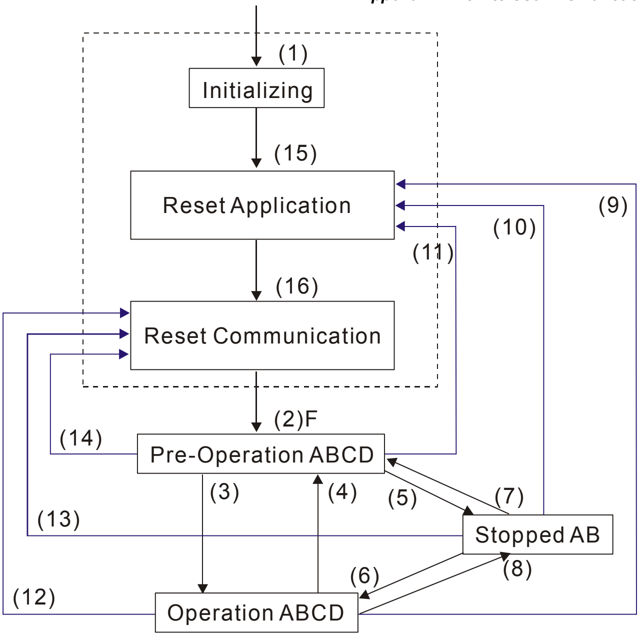

(1) After power is applied, it is auto in initialization state	A: NMT
(2) Enter pre-operational state automatically	B: Node Guard
(3) (6) Start remote node	C: SDO
(4) (7) Enter pre-operational state	D: Emergency
(5) (8) Stop remote node	E: PDO
(9) (10) (11) Reset node	F: Boot-up
(12) (13) (14) Reset communication	
(15) Enter reset application state automatically	
(16) Enter reset communication state automatically	

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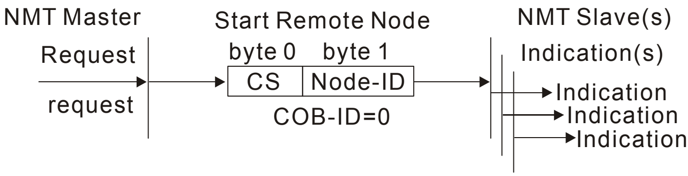
	Initializing	Pre-Operational	Operational	Stopped
PDO			○	
SDO		○	○	
SYNC		○	○	
Time Stamp		○	○	
EMERG		○	○	
Boot-up	○			
NMT		○	○	○

NMT Protocol is shown as follows:



Cs

Value	Definition
1	Start
2	Stop
128	Enter Pre-Operational
129	Reset Node
130	Reset Communication

E.1.4.2 SDO (Service Data Object)

SDO is used to access the Object Dictionary in every CANopen node by Client/Server model. One SDO has two COB-ID (request SDO and response SDO) to upload or download data between two nodes. No data limit for SDOs to transfer data. But it needs to transfer by segment when data exceeds 4 bytes with an end signal in the last segment.

The Object Dictionary (OD) is a group of objects in CANopen node. Every node has an OD in the system, and OD contains all parameters describing the device and its network behavior. The access path of OD is the index and sub-index, each object has a unique index in OD, and has sub-index if necessary.

The request and response frame structure of SDO communication is shown as follows:

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Type		Data 0								Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7
		7	6	5	4	3	2	1	0	Index	Index	Index	Data	Data	Data	Data
		command								L	H	Sub	LL	LH	HL	HH
Initiate Domain Download	Client	0	0	1	-	N		E	S							
	Server	0	1	1	-	-	-	-	-							
Initiate Domain Upload	Client	0	1	0	-	-	-	-	-							
	Server	0	1	0	-	N		E	S							
Abort Domain Transfer	Client	1	0	0	-	-	-	-	-							
	Server	1	0	0	-	-	-	-	-							

N: Bytes not use
E: normal(0)/expedited(1)
S: size indicated

E.1.4.3 PDO (Process Data Object)

PDO communication can be described by the producer/consumer model. Each node of the network will listen to the messages of the transmission node and distinguish if the message has to be processed or not after receiving the message. PDO can be transmitted from one device to one another device or to many other devices.

Every PDO has two PDO services: a TxPDO and a RxPDO. PDOs are transmitted in a non-confirmed mode.

PDO Transmission type is defined in the PDO communication parameter index (1400h for the 1st RxPDO or 1800h for the 1st TxPDO), and all transmission types are listed in the following table:

Type Number	PDO				
	Cyclic	Acyclic	Synchronous	Asynchronous	RTR only
0		○	○		
1-240	○		○		
241-251	Reserved				
252			○		○
253				○	○
254				○	
255				○	

Type number 1-240 indicates the number of SYNC message between two PDO transmissions.

Type number 252 indicates the data is updated (but not sent) immediately after receiving SYNC.

Type number 253 indicates the data is updated immediately after receiving RTR.

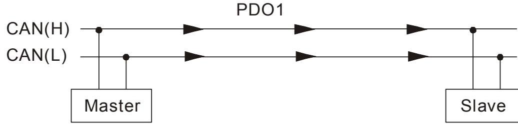
Type number 254: Delta CANopen doesn’t support this transmission format.

Type number 255 indicates the data is asynchronous transmission.

All PDO transmission data must be mapped to index via Object Dictionary.

Example:

Master transmits PDO data to Slave



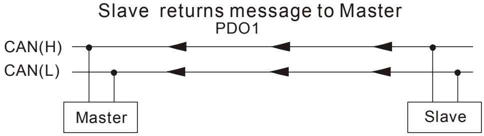
PDO1 data value Data 0, Data 1, Data 2, Data 3, Data 4, Data 5, Data 6, Data 7,
0x11, 0x22, 0x33, 0x44, 0x55, 0x66, 0x77, 0x88,

PDO1 Map

Index	Sub	Definition	Value	R/W	Size
0x1600	0	0. Number	1	R/W	U8
0x1600	1	1. Mapped Object	0x60400010	R/W	U32
0x1600	2	2. Mapped Object	0	R/W	U32
0x1600	3	3. Mapped Object	0	R/W	U32
0x1600	4	4. Mapped Object	0	R/W	U32
0x6040	0	0. Control word	0x2211	R/W	U16 (2 Bytes)

0x60400010

Slave returns message to Master



PDO1 data value Data 0, Data 1, Data 2, Data 3, Data 4, Data 5, Data 6, Data 7,
0xF3, 0x00,

PDO1 Map

Index	Sub	Definition	Value	R/W	Size
0x1A00	0	0. Number	1	R/W	U8
0x1A00	1	1. Mapped Object	0x60410010	R/W	U32
0x1A00	2	2. Mapped Object	0	R/W	U32
0x1A00	3	3. Mapped Object	0	R/W	U32
0x1A00	4	4. Mapped Object	0	R/W	U32
0x6041	0	Status Word	0xF3	R/W	U16

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E.1.4.4 EMCY (Emergency Object)

Emergency objects are triggered when hardware failure occurs for a warning interrupt. The data format of a emergency object is a 8 bytes data as shown in the following:

Byte	0	1	2	3	4	5	6	7
Content	Emergency Error Code		Error register (Object 1001H)	Manufacturer specific Error Field				

Definition of Emergency Object

Display	Controller Error Code	Description	CANopen Error Code	CANopen Error Register (bit 0~7)
oc	0001H	Over current	7400H	1
ou	0002H	Over voltage	7400H	2
oH1	0003H	Overheating	4310H	3
oL	0005H	Overload	2310H	1
oL1	0006H	Overload 1	7120H	1
oL2	0007H	Overload 2	2310H	1
EF	0008H	External Fault	9000H	7
ocA	0009H	Over-current during acceleration	2310H	1
ocd	000AH	Over-current during deceleration	2310H	1
ocn	000BH	Over-current during constant speed operation	2310H	1
GFF	000CH	Ground fault	2240H	1
Lv	000DH	Lower than standard voltage	3220h	2
PHL	000EH	Phase Loss	3130h	7
bb	000FH	External Base Block	9000h	7
codE	0011H	Software protection failure	6320h	7
cF1.0	0013H	Internal EEPROM can not be programmed	5530h	7
cF2.0	0014H	Internal EEPROM can not be read	5530h	7
HPF1	0015H	CC (current clamp)	5000h	7
HPF2	0016H	OV hardware error	5000h	2
HPF3	0017H	GFF hardware error	5000h	2
HPF4	0018H	OC hardware error	5000h	1
cF3.0	0019H	U-phase error	2300h	1
cF3.1	001AH	V-phase error	2300h	1
cF3.2	001BH	W-phase error	2300h	1
cF3.3	001CH	OV or LV	3210h	2
cF3.4	001DH	Temperature sensor error	4310h	3
cF1.1	001FH	Internal EEPROM can not be programmed	5530h	7

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Display	Controller Error Code	Description	CANopen Error Code	CANopen Error Register (bit 0~7)
cF21	0020H	Internal EEPROM can not be read	5530h	7
AErr	0021H	Analog signal error	FF00h	7
PtC1	0023H	Motor overheat protection	7120h	3
PGEr	0024H	PG signal error	7300h	7
cP10	0029H	Communication time-out error on the control board or power board	7500h	4

Definition of Index

Index	Sub	Definition	Factory Setting	R/W	Size	Unit	NOTE
0x1000	0	Abort connection option code	0x00010192	RO	U32		
0x1001	0	Error register	0	RO	U8		
0x1005	0	COB-ID SYNC message	0x80	RW	U32		
0x1006	0	Communication cycle period	0	RW	U32	us	500us~15000us
0x1008	0	Manufacturer device name	0	RO	U32		
0x1009	0	Manufacturer hardware version	0	RO	U32		
0x100A	0	Manufacturer software version	0	RO	U32		
0x100C	0	Guarding time	0	RW	U16	ms	0x80 + node 1
0x100D	0	Guarding factor	0	RW	U8		
0x1014	0	COB-ID emergency	0x0000080 +Node-ID	RO	U32		
0x1015	0	Inhibit time EMCY	0	RW	U16	100us	It is set to be multiple of 10.
0x1016	0	Number	0x1	RO	U8		
	1	Consumer heartbeat time	0x0	RW	U32	1ms	Heartbeat time can be used when Guarding time is invalid.
0x1017	0	Producer heartbeat time	0x0	RW	U16	1ms	Heartbeat time can be used when Guarding time is invalid.
0x1018	0	Number	0x3	RO	U8		
	1	Vender ID	0x000001DD	RO	U32		
	2	Product code	0x00002600 +model	RO	U32		
	3	Revision	0x00010000	RO	U32		
0x1200	0	Server SDO Parameter	2	RO	U8		
	1	COB-ID Client -> Server	0x0000600+ Node-ID	RO	U32		

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Index	Sub	Definition	Factory Setting	R/W	Size	Unit	NOTE
	2	COB-ID Client <- Server	0x0000580+ Node-ID	RO	U32		
0x1400	0	Number	2	RO	U8		
	1	COB-ID used by PDO	0x00000200 +Node-ID	RW	U32		
	2	Transmission Type	5	RW	U8		00:Acyclic & Synchronous 01~240:Cyclic & Synchronous 255: Asynchronous
0x1401	0	Number	2	RO	U8		
	1	COB-ID used by PDO	0x80000300 +Node-ID	RW	U32		
	2	Transmission Type	5	RW	U8		00:Acyclic & Synchronous 01~240:Cyclic & Synchronous 255: Asynchronous
0x1600	0	Number	2	RW	U8		
	1	1.Mapped Object	0x60400010	RW	U32		
	2	2.Mapped Object	0x60420020	RW	U32		
	3	3.Mapped Object	0	RW	U32		
	4	4.Mapped Object	0	RW	U32		
0x1601	0	Number	0	RW	U8		
	1	1.Mapped Object	0	RW	U32		
	2	2.Mapped Object	0	RW	U32		
	3	3.Mapped Object	0	RW	U32		
	4	4.Mapped Object	0	RW	U32		
0x1800	0	Number	5	RO	U8		
	1	COB-ID used by PDO	0x00000180 +Node-ID	RW	U32		
	2	Transmission Type	5	RW	U8		00:Acyclic & Synchrouous 01~240:Cyclic & Synchrouous 253: Remote function 255: Asynchronous
	3	Inhibit time	0	RW	U16	100us	It is set to be multiple of 10.
	4	Reserved	3	RW	U8		Reserved
	5	Event timer	0	RW	U16	1ms	
0x1801	0	Number	5	RO	U8		
	1	COB-ID used by PDO	0x80000280 +Node-ID	RW	U32		
	2	Transmission Type	5	RW	U8		00:Acyclic & Synchrouous 01~240:Cyclic & Synchrouous 253: Remote function 255: Asynchronous

Index	Sub	Definition	Factory Setting	R/W	Size	Unit	NOTE
	3	Inhibit time	0	RW	U16	100us	It is set to be multiple of 10.
	4	Reserved	3	RW	U8		
	5	Event timer	0	RW	U16	1ms	
0x1A00	0	Number	2	RW	U8		
	1	1.Mapped Object	0x60410010	RW	U32		
	2	2.Mapped Object	0x60430010	RW	U32		
	3	3.Mapped Object	0	RW	U32		
	4	4.Mapped Object	0	RW	U32		
0x1A01	0	Number	0	RW	U8		
	1	1.Mapped Object	0	RW	U32		
	2	2.Mapped Object	0	RW	U32		
	3	3.Mapped Object	0	RW	U32		
	4	4.Mapped Object	0	RW	U32		

Index	Sub	Definition	Factory Setting	RW	Size	Unit	Map	NOTE
0x6007	0	Abort connection option code	2	RW	S16		Yes	0: No action 2: Disable Voltage 3: Quick stop
0x603F	0	Error code	0	RO	U16		Yes	
0x6040	0	Control word	0	RW	U16		Yes	bit 0 ~ 3: switch status bit 4: rfg enable bit 5: rfg unlock bit 6: rfg use ref bit 7: Fault reset
0x6041	0	Status word	0	RO	U16		Yes	Bit0 Ready to switch on Bit1 Switched on Bit2 Operation enabled Bit3 Fault Bit4 Voltage enabled Bit5 Quick stop Bit6 Switch on disabled Bit7 Warning Bit8 Bit9 Remote Bit10 Target reached Bit11 Internal limit active Bit12 - 13 Bit14 - 15
0x6042	0	vl target velocity	0	RW	S16	rpm	Yes	
0x6043	0	vl velocity demand	0	RO	S16	rpm	Yes	
0x604F	0	vl ramp function time	10000	RW	U32	1ms	Yes	If Pr.01.19 is set to 0.1, the unit must be 100ms and can't be set to 0.
0x6050	0	vl slow down time	10000	RW	U32	1ms	Yes	If Pr.01.19 is set to 0.1, the unit must be 100ms and can't be set to 0.
0x6051	0	vl quick stop time	1000	RW	U32	1ms	Yes	If Pr.01.19 is set to 0.1, the unit must be 100ms and can't be set to 0.

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Index	Sub	Definition	Factory Setting	RW	Size	Unit	Map	NOTE
0x605A	0	Quick stop option code	2	RW	S16	1ms	Yes	0 : disable drive function 1 :slow down on slow down ramp 2: slow down on quick stop ramp (2th decel. time) 5 slow down on slow down ramp and stay in QUICK STOP 6 slow down on quick stop ramp and stay in QUICK STOP
0x6060	0	Mode of operation	2	RO	U8		Yes	Speed mode
0x6061	0	Mode of operation display	2	RO	U8		Yes	

E.2 How to Control by CANopen

To control the AC motor drive by CANopen, please set parameters by the following steps:

Step 1. Operation source setting: set Pr.02.01 to 5 (CANopen communication. Keypad STOP/RESET disabled.)

Step 2. Frequency source setting: set Pr.02.00 to 5 (CANopen communication)

Step 3. CANopen station setting: set Pr.09.13 (CANopen Communication Address 1-127)

Step 4. CANopen baud rate setting: set Pr.09.14 (CANBUS Baud Rate)

Step 5. Set multiple input function to quick stop when necessary: Set Pr.04.05 to 04.08 or Pr.11.06 to 11.11 to 23.

According to DSP-402 motion control rule, CANopen provides speed control mode. There are many status can be switched during Start to Quick Stop. To get current status, please read “Status Word”. Status is switched by the PDO index control word via external terminals.

Control word is a 16-byte in index 0x6040 and each bit has specific definition. The status bits are bit 4 to bit 6 as shown in the following:

Bit 4: ramp function enabled

Bit 5: ramp function disabled

Bit 6: rfg use reference

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Following is the flow chart for status switch: