INOVANCE

User Guide

MD38CAN2 (CANopen) Card

Optional Part for the MD Series Modular Vector AC Drive

User Guide

A01
Data code 19010927

Contents

1 Overview

Thank you for purchasing Inovance's MD38CAN2 (CANopen) card, the field bus adapter for the MD series AC drives.

The MD38CAN2 (CANopen) card is a communication extension card specialized for CAN communication of the MD series AC drives. It enables the AC drive to access the high-speed CAN communication network and implements control of the field bus.

CANopen is a universal field bus standard and devices that support this protocol can access the CANopen network.

Before using the product, read this user guide thoroughly.

2 Installation and Setting

2.1 Installation of MD380CAN2

The MD38CAN2 card is installed inside Inovance's AC drive. Before the installation, power off the AC drive, wait about 10 minutes until the charging indicator on the AC drive becomes OFF, and insert the card in the position shown in the following figure.

Then, fix the card with screws.

Note that the MD38CAN2 card cannot be inserted at power-on.

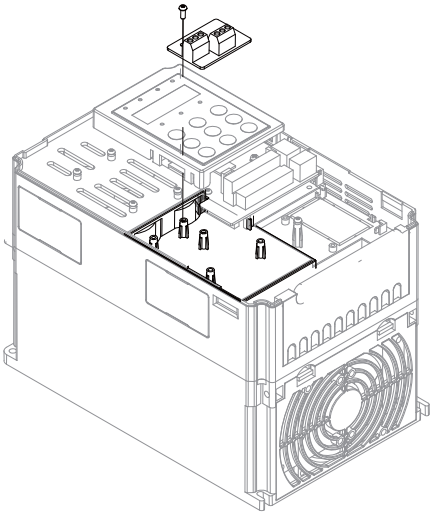

Figure 2-1 Installation of the MD38CAN2

2.2 Hardware Layout

The following figure shows the hardware layout of the MD380CAN2. CN1 is the CAN bus communication interface; DIP switch S1 is used to configure the CAN bus termination resistor; DIP switches S2 and S3 are used to set the baud rate and address for CAN communication; the three LED indicators indicate the running state; SW1 is the factory test interface, and do not connect it.

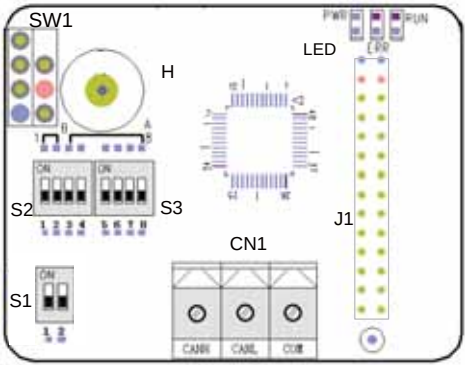

Figure 2-2 Hardware layout of the MD38CAN2

Mark	Hardware Name	Function Description
SW1	SW1 pin header	It is used for the factory test. Do not connect it.
S2/S3	DIP switch	It is used to set the baud rate and address for CAN communication.
S1	Termination resistor setting	It is used to set the termination resistor.
J1	Interface for connecting AC drive	It is used to connect the card to the AC drive.
H	Screw fixing hole	It is used to fix the card with the M3*8 self-taping screw.
CN1	Wiring terminal	It is the CANopen bus wiring terminal.
LED	State indicator	The three indicators are used to indicate the running state.

2.3 Interface Description

1) Communication interface

Terminal CN1 is used to connect the CAN bus. It includes three interfaces, as described in Table 2.1.

Table 2-1 Interface description of CN1

No.	Mark	Description
1	CANH	Connect positive of the CAN bus.
2	CANL	Connect negative of the CAN bus.
3	CGND	Connect the shield of the CAN bus.

2) CAN bus connection

The following figure shows the CAN bus connection. The shielded twisted pairs are recommended for CAN bus connection. The two sides of the bus are respectively connected with two 120-Ω terminal matching resistors to prevent signal reflection. Single-point grounding is generally used for the shield.

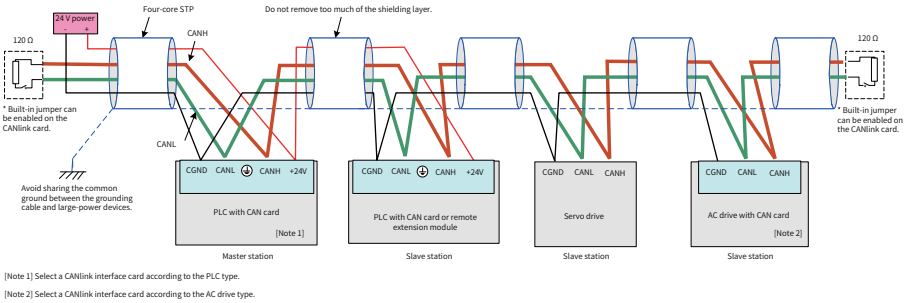

Figure 2-3 CAN bus connection

NOTE

◆ Inovance's PLC and MDCAN2 are equipped with built-in resistors, which can be enabled by the DIP switch.

3) CAN bus transmission distance

The CANopen bus transmission distance is directly related to the baud rate and communication cable. The following table describes the relationship between the maximum bus length and the baud rate.

Table 2-2 Relationship between the bus length and the baud rate

Baud Rate (bps)	1 M	500 K	250 K	125 K
Bus Length (m)	30	80	150	150

4) DIP switch

DIP switch S1 of MD38CAN2 composes a 2-digit DIP switch for setting the CAN bus termination resistor. It is recommended that the termination resistor be used at two sides of the network topology structure. The switch on the ON position indicates 1, and indicates 0 otherwise.

Table 2-3 Setting the termination resistor for MD38CAN2

DIP Switch No.		Termination Resistor
1	2	
0	0	Disconnected
1	1	Connected

The DIP switches S2 and S3 compose an 8-digit DIP switch for setting the baud rate and device address for CAN bus communication. The following figure shows the numbering of DIP switches. Switches 1 and 2 are used to set the baud rate, and switches 3 to 8 are used to set the CANopen device addresses. The switch on the ON position indicates 1, and indicates 0 otherwise.

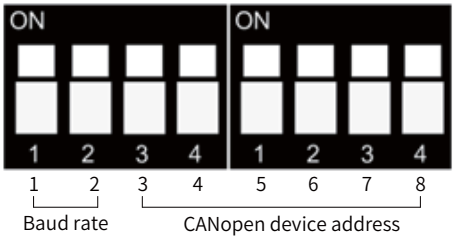

Figure 2-4 Numbering of MD38CAN2 DIP switches

■ Baud rate

The following table describes the relationship between the DIP switch states and the baud rates.

Table 2-4 Setting the baud rate for MD38CAN2

DIP Switch No.		Baud Rate
1	2	
0	0	125 Kbps
0	1	250 Kbps
1	0	500 Kbps
1	1	1 Mbps

■ CANopen device address

MD38CAN2 provides six switches for setting the CANopen device addresses. Switch 3 is the highest bit, and switch 8 is the lowest bit. Switches 3 to 8 correspond to b5 to b0 of a 16-bit binary integer. The address range to be set is 1–63, as listed in the following table. Address 0 is reserved and cannot be used. If you set address 0, MD38CAN2 will not work.

Table 2-5 Addresses set by the DIP switches of the MD38CAN2

DIP Switch No.						Address
3	4	5	6	7	8	
0	0	0	0	0	0	Reserved
0	0	0	0	0	1	1
0	0	0	0	1	0	2
0	0	0	0	1	1	3
.....						...
1	1	1	1	1	1	63

5) State indicators

Table 2-6 Description of MD38CAN2 state indicators

Indicator	State	Description
PWR (red)	ON	Power-on normal
	OFF	Power-on abnormal (check whether the installation is correct)
ERR (red)	ON	Internal AC drive communication timeout
	Blinking quickly	CANopen address setting incorrect
	Blinking twice	CANopen emergency message indicating AC drive fault
RUN (green)	ON	CANopen "Operational"
	Blinking	CANopen "Pre-Operational"
	OFF	CANopen "Stopped"

3 Protocol Description of the MD38CAN2

3.1 Software Feature

MD38CAN2 supports five protocols, described as follows:

- NodeGuarding: The master can query the device state with this function.
- Heartbeat: The slave reports its current state periodically to the master.
- Service data object (SDO): Only expedited transfer is supported. Two bytes of a parameter is transferred each time.
- Three transmit process data objects (TPDOs) and three receive process data objects (RPDOs)
- Emergency (EMCY) objects

3.2 COB-ID

CANopen provides many types of communication objects (COBs), each having different features (for details, see the description of the CANopen standard protocol). Different communication objects are used based on the actual application scenarios. MD38CAN2 adopts the pre-defined communication object identifiers (COB-IDs), as follows:

1) Network management (NMT) object: 0x000
2) Synchronization (SYNC) object: 0x080
3) SDO:

- Transmit SDO: 0x600+Node-Id
- Receive SDO: 0x580+Node-Id

4) PDO:

- RPDO1: 0x200+Node-Id
- RPDO2: 0x300+Node-Id
- RPDO3: 0x400+Node-Id
- TPDO1: 0x180+Node-Id
- TPDO2: 0x280+Node-Id
- TPDO3: 0x380+Node-Id

5) EMCY object: 0x80+Node-Id

- Node-Id: Indicates the device ID (node address), and it is set by the DIP switch.
- COB-ID is fixedly allocated and cannot be changed.

3.3 Parameter Operation of AC Drive

1) AC drive parameter mapping

■ AC drive parameter address

The AC drive parameter addresses are classified into parameter addresses and non-parameter addresses. For details, see the related description in the section of the Modbus communication protocol in the MD380 Series High-Performance AC Drive User Manual.

■ Mapping description

The AC drive parameter addresses map to the range of 0x2000 to 0x20FF. The object dictionary subindex can be obtained by adding one to the parameter number. For example, if the AC drive parameter is F0-03, the object dictionary index is 0x20F0, and the subindex is 0x04.

■ Mapping description of AC drive parameters

The MD380 parameters are divided into three large groups, groups F0 to FF, groups A0 to AF, and groups U0 to UF.

The following table lists the mapping addresses at the read parameter operation.

Parameter Group	CANopen Address Index
F0 to FF	0x20F0 to 0x20FF
A0 to AF	0x20A0 to 0x20AF
U0 to UF	0x2070 to 0x207F

The following table lists the mapping addresses at the read EEPROM operation.

Parameter Group	CANopen Address Index
F0 to FF	0x20F0 to 0x20FF
A0 to AF	0x20A0 to 0x20AF

The following table lists the mapping addresses at the read RAM operation.

Parameter Group	CANopen Address Index
F0 to FF	0x2000 to 0x200F
A0 to AF	0x2040 to 0x204F

You can obtain the CANopen subindex by adding one to the parameter index.

Parameter Group Index	CANopen Subindex
0x0 to 0xFE	0x1 to 0xFF

Take the parameter F0-17 (Acceleration time 1) as an example.

- When the operation is F0-17 reading, the object dictionary index is 0x20F0, and the subindex is 0x12.
- When the operation is F0-17 reading and writing to EEPROM, the object dictionary index is 0x20F0, and the subindex is 0x12.
- When the operation is F0-17 reading and writing only to RAM, the object dictionary index is 0x2000, and the subindex is 0x12.


NOTE

- Motor auto-tuning cannot be implemented by changing the parameter values by means of communication.
- The AC drive parameters are stored in the EEPROM. They can be read repeatedly but cannot be rewritten many times. Pay attention to the parameter rewrite command. The PLC programs cannot be driven unconditionally to prevent cyclic communication write operation which may damage the storage of the AC drive.
- If parameters need to be rewritten repeatedly, the mapping addresses of the parameters at the read RAM operation can be used. For example, repeated rewriting of the RAM mapping address 0x2002 for F0-02 is allowed. However, the EEPROM mapping address 0x20F2 cannot be rewritten repeatedly.

2) AC Drive Operation Example (SDO)

Set the CANopen address of the AC drive to 0x06.

- Read the AC drive command source.

To read the parameter F0-02 of the AC drive, the master sends a CANopen message, as described in the following table.

Table 3-1 Master sending a message to read F0-02

Message Identifier (Hex)	RTR	Data (Hex)
0x606	0	40 F0 20 03 00 00 00 00

The AC drive returns a CANopen response message, as described in the following table. The value of F0-02 is 0x0002, indicating that the current command source is communication control.

Table 3-2 AC drive's response to F0-02 reading

Message Identifier (Hex)	RTR	Data (Hex)
0x586	0	4B F0 20 03 02 00 00 00

- Set the command source to operating panel control.

To set the command source to operating panel control, the AC drive parameter F0-02 must be written to 0. The master sends a CANopen message, as described in the following table.

Table 3-3 Master sending a message to write F0-02

Message Identifier (Hex)	RTR	Data (Hex)
0x606	0	2B F0 20 03 00 00 00 00

The AC drive returns a CANopen response message, as described in the following table. The value of F0-02 is written to 0, and the current command source is changed to operation panel control.

Table 3-4 AC drive's response to F0-02 writing

Message Identifier (Hex)	RTR	Data (Hex)
0x586	0	60 F0 20 03 00 00 00 00

3.4 SDO Read-Write Operations

1) SDO Read AC Drive Operation

The CANopen SDO is used to perform the read operation on the AC drive. The data format of the SDO sent by the server is described in the following table.

CAN	CANopen Data	Description
11-bit ID	0x600+Node-ID	Node-ID (device address) set by the DIP switch
RTR	0	Remote frame flag "0"
DATA0	Command code (0x40)	0x40 read command
DATA1	Low byte of index	Parameter group (F0 "0xF0")
DATA2	High byte of index	Mapping address (see the description in section 4.3.1)
DATA3	Subindex	Parameter number + 1 ("0x03")
DATA4	Data 1	Reserved "0"
DATA5	Data 2	Reserved "0"
DATA6	Data 3	Reserved "0"
DATA7	Data 4	Reserved "0"

The data format of the SDO returned by the client is described in the following table.

If the operation is successful, the return value for the command code is 0x4B, with the index unchanged; the return value of data 4 and 5 is the read data, and that of data 6 and 7 is 0.

If the operation fails, the return value for the command code is 0x80, with the index unchanged; the return value of data 4 to 7 is the SDO failure error code (for details about the error code, see the description of the CANopen protocol).

Table 3-5 SDO returned for reading operation

CAN	CANopen Data	Description
11-bit ID	0x580+Node-ID	Node-ID (device address) set by the DIP switch
DATA0	Return of the command code	Success: 0x4B, error: 0x80
DATA1	Low byte of index	Parameter group (F0 "0xF0")
DATA2	High byte of index	Mapping address (see the description in section 4.3.1)
DATA3	Subindex	Parameter number +1 ("0x03")
DATA4	Data 1	Low byte of data
DATA5	Data 2	High byte of data
DATA6	Data 3	Success: 0 Error: SDO failure error code (refer to the CANopen protocol)
DATA7	Data 4	

2) SDO Write AC Drive Operation

The CANopen SDO is used to perform the write operation on the AC drive. The data format of the SDO sent by the server is described in the following table.

Table 3-6 SDO sending for write operation

CAN	CANopen Data	Description
11-bit ID	0x600+Node-ID	Node-ID (device address) set by the DIP switch
RTR	0	Remote frame flag "0"
DATA0	Command code	0x2B
DATA1	Low byte of index	Parameter group (F0 "0xF0")
DATA2	High byte of index	Mapping address (see the description in section 4.3.1)
DATA3	Subindex	Parameter number + 1 ("0x03")
DATA4	Data 1	Low byte of data
DATA5	Data 2	High byte of data
DATA6	Data 3	Reserved "0"
DATA7	Data 4	Reserved "0"

The data format of the SDO returned by the client is described in the following table.

If the operation is successful, the return value for the command code is 0x60, with the index unchanged; the return data of data 4 to 7 is 0.

If the operation fails, the return value for the command code is 0x80, with the index unchanged; the return data of data 4 to 7 is the SDO failure error code (for details about the error code, see the description of the CANopen protocol).

Table 3-7 Table 3-8 SDO returned for write operation

CAN	CANopen Data	Description
11-bit ID	0x580+Node-ID	Node-ID (device address) set by the DIP switch
RTR	0	Remote frame flag "0"
DATA0	Return of the command code	Success: 0x60, error: 0x80
DATA1	Low byte of index	Parameter group (F0 "0xF0")
DATA2	High byte of index	Mapping address (see the description in section 4.3.1)
DATA3	Subindex	Parameter number + 1 ("0x03")
DATA4	Data 1	Success: 0 Error: SDO failure error code (refer to the CANopen protocol)
DATA5	Data 2	
DATA6	Data 3	
DATA7	Data 4	

3) SDO failure error code

Error Code	Description	Error Code	Description
0x05040000	SDO access timeout	0x06070010	Data type not matched, service parameter length not matched
0x06010000	Object access not supported	0x06090011	Subindex not exist
0x06010001	Reading write-only object	0x06090030	Parameter range exceeded for the write operation
0x06010002	Writing read-only object	0x08000022 [1]	Data failed to be transferred or stored to the application due to current device status
0x06020000	Object dictionary not exist	0x08000000	General error

[1] This error code is returned when the AC drive is operated to map the object dictionary parameter, parameters and parameter addresses cannot be changed during AC drive running, and read-only parameters are written.

3.5 PDO AC Drive Operation

1) RPDO AC Drive Operation

Three RPDOs are supported, namely, RPDO1, RPDO2, and RPDO3. The following table describes the PDO mapping. For more details, see the MD380CANopen.eds file.

Table 3-8 RPDO mapping

RPDO	Name	Description
RPDO1	FE-00	AC drive control command
	FE-01	AC drive set frequency
	FE-02	
	FE-03	
RPDO2	FE-04	
	FE-05	
	FE-06	
	FE-07	
RPDO3	FE-08	
	FE-09	
	FE-10	
	FE-11	

Drivecom: AC drive control command (The command source is communication control, that is, F0-02 is set to 2.)

0001: Forward RUN

0002: Reverse RUN

0003: Forward jog

0004: Reverse jog

0005: Coast to stop

0006: Decelerate to stop

0007: Fault reset

Frequency: AC drive set frequency (The frequency source is communication setting, that is, F0-03 is set to 9. The frequency unit is 0.01 Hz.)

2) TPDO AC Drive Operation

Three TPDOs are supported, namely, TPDO1, TPDO2, and TPDO3. The following table describes the PDO mapping. For more details, see the MD380CANopen.eds file.

Table 3-9 RPDO mapping

TPDO	Name	Description
TPDO1	FE-20	AC drive running state (fixed mapping)
	FE-21	AC drive running frequency
	FE-22	
	FE-23	
TPDO2	FE-24	
	FE-25	
	FE-26	
	FE-27	
TPDO3	FE-28	
	FE-29	
	FE-30	
	FE-31	

Drive Status: AC drive running state

Bit0: 0 indicating stop, and 1 indicating running

Bit1: 0 indicating forward RUN, and 1 indicating reverse RUN

Bit2: 0 indicating no fault, and 1 indicating AC drive fault

Bit3: 0 indicating not reached, and 1 indicating set frequency reached

Bit4 to bit7: Reserved

Bit8 to Bit15: AC drive error code

Frequency: AC drive running frequency (The frequency unit is 0.01 Hz.)

Note: PDO mapping must contain the command word and status word.

4 Parameters Related to CANopen Communication

4.1 CANopen Card Enabling

To enable the CANopen card, set the parameters as described in the following table.

Table 4-1 Related parameters for CANopen card enabling

Parameter	Parameter Name	Setting Range
F0-28	Communication extension card type	0: 485 communication card 1: Communication extension card (CANopen or DP)
F0-02	Command source selection	0: Operation panel control 1: Terminal control 2: Communication control
F0-03	Main frequency source X selection	9: Communication setting
F0-04	Auxiliary frequency source Y selection	Same as F0-03 (Main frequency source X selection)

4.2 Parameters Related to Communication Control

The following table lists the major parameters related to communication control. The main index address is 0x2073. For details on other parameters, see the MD380 Series High-Performance AC Drive User Manual.

Table 4-2 Major parameters related to communication control

Parameter	Parameter Name	CANopen Subindex	Setting Range
U3-16	Frequency setting	0x11	-Maximum frequency to +Maximum frequency 0.01 Hz

Parameter	Parameter Name	CANopen Subindex	Setting Range
U3-17	Control command	0x12	0001: Forward RUN 0002: Reverse RUN 0003: Forward jog 0004: Reverse jog 0005: Coast to stop 0006: Decelerate to stop 0007: Fault reset
U3-18	DO control	0x13	Bit0: DO1 output control Bit1: DO2 output control Bit2: Relay1 output control Bit3: Relay2 output control Bit4: FMR output control Bit5: VDO1 Bit6: VDO2 Bit7: VDO3 Bit8: VDO4 Bit9: VDO5
U3-19	AO1 control	0x14	0 to 7FFF indicates 0% to 100%.
U320	AO2 control	0x15	0 to 7FFF indicates 0% to 100%.
U3-21	FMP control	0x166	0 to 7FFF indicates 0% to 100%.
U3-22	Reserved	Reserved	Users cannot write this parameter.
U3-23	Rotation speed control	0x18	Signed value. 1 rpm

4.3 Parameters Related to Communication Monitoring

The following table lists the major parameters related to communication monitoring. For details on other parameters, see the MD380 Series High-Performance AC Drive User Manual.

Table 4-3 Major parameters related to communication monitoring

Parameter	Parameter Name	CANopen Subindex	Unit
U0-00	Running frequency (Hz)	0x01	0.01 Hz
U0-01	Set frequency (Hz)	0x02	0.01 Hz
U0-02	Bus voltage (V)	0x03	0.1 V
U0-03	Output voltage (V)	0x04	1 V
U0-04	Output current (A)	0x05	0.01 A

Parameter	Parameter Name	CANopen Subindex	Unit
U0-05	Output power (kW)	0x06	0.1 kW
U0-06	Output torque (%)	0x07	0.1%
U0-07	DI state	0x08	1
U0-08	DO state	0x09	1
U0-09	AI1 voltage (V)	0x0A	0.01 V
U0-10	AI2 voltage (V)	0x0B	0.01 V
U0-11	AI3 voltage (V)	0x0C	0.01 V
U0-12	Count value	0x0D	1
U0-13	Length value	0x0E	1
U0-14	Load speed display	0x0F	1
U0-15	PID setting	0x10	1
U0-16	PID feedback	0x11	1
U0-17	PLC stage	0x12	1
U0-18	Pulse input frequency (Hz)	0x13	0.01 kHz
U0-19	Feedback speed (Hz)	0x14	0.01 Hz
U0-20	Remaining running time	0x15	0.1 min
U0-21	AI1 voltage before correction	0x16	0.001 V
U0-22	AI2 voltage before correction	0x17	0.001 V
U0-23	AI3 voltage before correction	0x18	0.001 V
U0-24	Linear speed	0x19	1 m/min
U0-25	Current power-on time	0x1A	1 min
U0-26	Current running time	0x1B	0.1 min
U0-27	Pulse input frequency	0x1C	1 Hz
U0-28	Communication setting value	0x1D	0.01%
U0-29	Encoder feedback speed	0x1E	0.01 Hz
U0-30	Main frequency X display	0x1F	0.01 Hz
U0-31	Auxiliary frequency Y display	0x20	0.01 Hz
U0-32	Viewing any memory address value	0x21	1
U0-33	Synchronous motor rotor position	0x22	0.1°
U0-34	Motor temperature	0x23	1°C
U0-35	Target torque (%)	0x24	0.1%
U0-36	Resolver position	0x25	1
U0-37	Power factor angle	0x26	0.1°
U0-38	ABZ position	0x27	1

Parameter	Parameter Name	CANopen Subindex	Unit
U0-39	Target voltage upon V/F separation	0x28	1 V
U0-40	Output voltage upon V/F separation	0x29	1 V
U0-41	DI state display	0x2A	1
U0-42	DO state display	0x2B	1
U0-43	DI function state visual display 1 (1–40)	0x2C	1
U0-44	DI function state visual display 2 (41–80)	0x2D	1
U0-45	Fault information	0x2E	1
U0-58	Z signal counting	0x3B	1
U0-59	Set frequency (%)	0x3C	0.01%
U0-60	Running frequency (%)	0x3D	0.01%
U0-61	AC drive state	0x3E	1
U0-62	Current fault code	0x3F	1
U0-63	Master-sent data of point-to-point communication	0x40	0.01%
U0-64	Slave-received data of point-to-point communication	0x41	0.01%
U0-65	Torque upper limit	0x42	0.1%
U0-66	Extension card model	0x43	100: CANopen 200: PROFIBUS-DP
U0-67	Extension card version No.	0x44	Two decimal places
U0-68	AC drive state	0x45	
U0-69	Running frequency	0x46	
U0-70	Motor speed	0x47	1 rmp
U0-71	Output current	0x48	0.1 A
U0-72	Bus state		CAN bus disconnection times

4.4 Emergency Message and AC Drive Fault Description

1) Emergency message data

The following table describes the 7-byte emergency message data.

Table 4-4 Emergency message data

Emergency Error Code	Error Register	Manufacturer-specified Error Code
0 to 1	2	3 to 7

- Emergency error code: For details, see the DS301 file. 0x8100 indicates communication error, and 0xFF00 indicates the error specified by the manufacturer.
- Error register: For details, see the data value of 1001H in the object dictionary described in the DS301 file. Bit0 indicates the error generating flag, Bit4 indicates the communication error flag, and Bit7 indicates the error specified by the manufacturer.
- Manufacturer-specified error code: Corresponds to the AC drive fault code.

2) Fault code

The following table lists the standard fault codes of the MD380 AC drive. For more details on other fault codes, see the MD380 user guide.

Table 4-5 Fault codes

AC Drive Fault Code
0000: No fault
0001: Reserved
0002: Overcurrent during acceleration
0003: Overcurrent during deceleration
0004: Overcurrent at constant speed
0005: Overvoltage during acceleration
0006: Overvoltage during deceleration
0007: Overvoltage at constant speed
0008: Pre-charge resistor overload
0009: Undervoltage
000A: AC drive overload
000B: Motor overload
000C: Input phase loss
000D: Output phase loss
000E: IGBT overheat
000F: External fault
0010: Communication abnormal
0011: Contactor abnormal
0012: Current detection fault
0013: Motor auto-tuning fault
0014: Encoder/PG card fault
0015: Parameter read-write abnormal
0016: AC drive hardware fault
0017: Motor short-circuited to ground
0018: Reserved
0019: Reserved
001A: Running time reached
001B: User-defined fault 1
001C: User-defined fault 2
001D: Power-on time reached
001E: Load loss
001F: PID feedback loss during running
0028: Fast current limit timeout
0029: Motor switchover fault during running
002A: Large speed error
002B: Motor overspeed
002D: Motor overtemperature
005A: Incorrect setting of PPR of the encoder
005B: Encoder disconnected
005C: Incorrect initial position
005E: Speed feedback error

5 Simple Diagnosis

5.1 Brief Introduction

The AC drive's parameter U0-72 allows you to perform simple diagnosis. It displays the total times of CAN bus disconnection caused by strong inference since the AC drive is powered on.

5.2 Diagnosis

If the value of U0-72 is greater than 0 and does not increase, long-time strong inference occurred before. If the value of U0-72 is greater than 0 and increases within 5 minutes, the network is suffering from strong inference or the configuration is incorrect. In this case, perform troubleshooting accordingly.

5.3 Troubleshooting

Check all nodes to see whether the baud rate and address configuration are consistent, the DIP switch setting is correct, and the baud rate and address configuration of the master controller is correct.

Check whether the termination resistor is only connected to the two ends of the bus. Power off all devices and use a multimeter to check the resistance between CANH and CANL. The normal resistance range is 50 to 60 Ω.

Check whether CANH and CANL are connected reversely and the bus terminal CGND is connected. (Generally, you only need to connect CGND of all devices without grounding CGND.)

6 Overview of the CANopen Protocol

6.1 Brief Introduction

CANopen is an application layer protocol of the network transmission system based on CAN bus. It complies with the ISO/OSI standard model, and defines the data link layer and certain physical layer in the OSI model. It supports the multi-master mode, in which any node in the network can send a message to other nodes. Network nodes are classified with different priorities based on the system real-time requirements, reducing the bus arbitration time in case of a transmission collision. The CAN network uses the data block coding rather than the traditional address coding. With data block coding, the number of nodes in the network is not limited theoretically, and different nodes can receive the same data. This coding mode also features short transmission byte, fast speed, good fault tolerance, and reliable data transmission, making it suitable for industrial control and distributed real-time control. The following figure shows the CANopen device model.

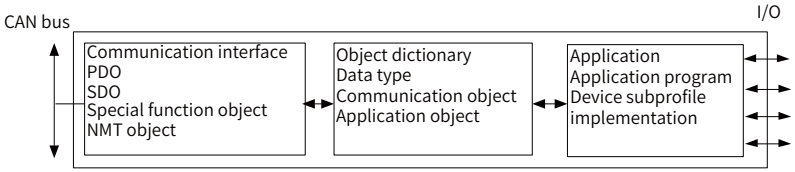

Figure 6-1 CANopen device model

6.2 Object Dictionary

The object dictionary is essentially a grouping of objects accessible using the network in an ordered predefined fashion.

Each object within the object dictionary is addressed using a 16-bit index and an 8-bit sub-index. A master node or configuration tool can access all values in the object dictionary of a slave node. The following figure shows the structure of the object dictionary.

Index	Object
000	Not used
0001-001F	Static data types (standard data types, such as Boolean, Integer16)
0020-003F	Complex data types (structure composed of simple types, such as PDOCommPar, SDOParmeter)
0040-005F	Manufacturer-specific complex data types
0060-007F	Device profile specific data types
0080-009F	Device profile specific complex data types
00A0-0FFF	Reserved
1000-1FFF	Communication profile area (such as device type, error register, supported number of PDOs)
2000-5FFF	Manufacturer-specific profile area
6000-9FFF	Standardized profile area (such as "DSP-401 I/O module device subprofile: Read State 8 Input Lines)
A000-FFFF	Reserved

Figure 6-2 Structure of the object dictionary

6.3 Common Communication Objects

1) Network Management (NMT) Object

The NMT objects include the Boot-up message, heartbeat protocol, and NMT message. Based on the master/slave communication mode, NMT is used to manage and monitor all nodes in the network, implementing node state control, error control, and node startup.

2) Service Data Object (SDO)

With SDOs, the object dictionary entries can be accessed based on the index and subindex.

The SDO is implemented using the CAN-based message specification (CMS) object of multi-domain in the CAN application layer (CAL) and can transmit data of any length (segmented into several messages when the data length exceeds four bytes).

The SDO protocol produces a response for every request. The SDO request and response always contain eight bytes.

3) Process Data Object (PDO)

PDO is used to transmit real-time data from one node to one or multiple nodes. The data length is restricted to one to eight bytes.

Each CANopen device includes eight default PDO channels, that is, four TPDOs and four RPDOs.

PDO supports synchronous transmission and asynchronous transmission, determined by the PDO communication parameters.

7 Format Description of CANopen Message

7.1 NMT Module Control Message

Only the NMT master can send the NMT Module ControlNMT message. Table 7-1 shows the message format. COB-ID is fixed to 0x000, and Data0 is the command word and occupies one byte, as shown in Table 7-2. Data1 is the CANopen network device address, and occupies one byte; when Data1 is 0, this message is broadcast to all slaves in the network.

For example, to set the device with the address "6" to the operational state, the command "0x000 0x01 0x06" is sent.

Table 7-1 NMT module ControlNMT message format

COB-ID	RTR	Data0	Data1
0x000	0	Command word	Node ID

Table 7-2 Command word of NMT Module ControlNMT message

Command Word	Description
0x01	Start Remote Node
0x02	Stop Remote Node
0x80	Enter Pre-operational State
0x81	Reset Node
0x82	Reset Communication

7.2 NodeGuarding Message

With the NodeGuarding service, the NMT master can check the current state of all nodes. This service can be used to detect whether data transmission of the nodes is available.

The standard protocol objects 0x100C and 0x100D respectively set the guard time and the guard time multiplicative factor, which together determine the node guarding time period.

Table 7-3 is the remote frame sent by the NMT master.

Table 7-3 Frame sent by the NMT master

COB-ID	RTR
0x700+Node-ID	1

Table 7-4 is the response message returned by the NMT slave. Table 7-5 shows the status word one-byte format.

Table 7-4 Response message returned by the NMT slave

COB-ID	RTR	Data0
0x700+Node-ID	0	Status word

Table 7-5 Status word in the response message

Data Bit	Description
bit7	0 or 1 alternative
bit6 to bit0	State: 4: Stopped 5: Operational 127: Pre-operational

7.3 Heartbeat Message

A node can be configured to produce periodic messages, called heartbeat message, as described in Table 7-6, in which bit7 is 0, and bit6 to bit0 are the same as those of the NodeGuarding message in Table 7-5.

The heartbeat time is defined by the standard protocol object 0x1017. A node cannot support both the NodeGuarding and Heartbeat protocols.

Table 7-6 Heartbeat message

COB-ID	RTR	Data0
0x700+Node-ID	0	Status word

Revision History

Date	Version	Description
December 2018	A00	First issue.
November 2020	A01	Made minor corrections.

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   c. Hardware damage caused by dropping or transportation after procurement
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