BALDOR
MOTION PRODUCTS

CAN Option
for FlexDrive^{II} , Flex+Drive^{II}
and MintDrive^{II}

Reference Manual

10/02 **MN1909**

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Limited Warranty
For a period of two (2) years from the date of original purchase, Baldor will repair or replace without charge controls and accessories that our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. This warranty is in lieu of any other warranty or guarantee expressed or implied. Baldor shall not be held responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person or property caused by items of our manufacture or sale. (Some countries and U.S. states do not allow exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply.) In any event, Baldor's total liability, under all circumstances, shall not exceed the full purchase price of the control. Claims for purchase price refunds, repairs, or replacements must be referred to Baldor with all pertinent data as to the defect, the date purchased, the task performed by the control, and the problem encountered. No liability is assumed for expendable items such as fuses. Goods may be returned only with written notification including a Baldor Return Authorization Number and any return shipments must be prepaid.

Product notice

Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment. This equipment may be connected to other machines that have rotating parts or parts that are controlled by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to start-up, program or troubleshoot this equipment.

Safety Notice

Intended use: Drives incorporating the CAN option are intended for use in stationary ground based applications in industrial power installations according to the standards EN60204 and VDE0160. They are designed for machine applications that require variable speed controlled three-phase brushless AC motors. These drives are not intended for use in applications such as:

- Home appliances
- Medical instrumentation
- Mobile vehicles
- Ships
- Airplanes.

Unless otherwise specified, this drive is intended for installation in a suitable enclosure. The enclosure must protect the drive from exposure to excessive or corrosive moisture, dust and dirt or abnormal ambient temperatures. The exact operating specifications are found in the main installation manual supplied with the drive. The installation, connection and control of drives is a skilled operation, disassembly or repair must not be attempted. In the event that a drive fails to operate correctly, contact the place of purchase for return instructions.

Precautions

WARNING: Do not touch any circuit board, power device or electrical connection before you first ensure that no high voltage is present at this equipment or other equipment to which it is connected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt to start-up, program or troubleshoot this equipment.

WARNING: Be sure that you are completely familiar with the safe operation and programming of this equipment. This equipment may be connected to other machines that have rotating parts or parts that are controlled by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to program, start-up or troubleshoot this equipment.

WARNING: Be sure the system is properly earthed/grounded before applying power. Do not apply AC power before you ensure that earths/grounds are connected. Electrical shock can cause serious or fatal injury.

WARNING: Improper operation or programming of the drive may cause violent motion of the motor and driven equipment. Be certain that unexpected motor movement will not cause injury to personnel or damage to equipment. Peak torque of several times the rated motor torque can occur during control failure.

WARNING: The motor circuit might have high voltages present whenever AC power is applied, even when the motor is not moving. Electrical shock can cause serious or fatal injury.

CAUTION: To prevent equipment damage, be certain that input and output signals are powered and referenced correctly.

CAUTION: To ensure reliable performance of this equipment be certain that all signals are shielded correctly.

2.1 CAN option

The CAN option is available as a factory-fitted option in the FlexDrive^{II}, Flex+Drive^{II} and MintDrive^{II}. The option adds a CANopen interface to the drive.

The MintDrive^{II} has the ability to act as the network manager node or as a slave.
The FlexDrive^{II} and Flex+Drive^{II} may only act as slave devices.

The presence of the CAN option can be easily identified by the extra connectors on the front panel of the drive:

- Connectors X10 and X11, two eight-pin RJ45 sockets providing access to the CAN interface
- LED for monitoring CAN activity
- DIP switches SW2 for connecting an internal termination resistor to the CAN network.

The CAN option is also indicated in the drive's catalog number, which will have the letter C in the last four characters, for example MDH1A05TB-R**C**23, or FPH1A02TB-E**C**23.

The catalog number is marked on the front of the unit, just below the Baldor logo.

2.2 Units and abbreviations

The following units and abbreviations are used in this manual:

CAL . . . . . CAN Application Layer
CAN . . . . . Controller Area Network
CiA . . . . . CAN in Automation group
ISO . . . . . International Organization for Standards
LED . . . . . Light Emitting Diode
MintMT . . . . . The control language used by Baldor drives
WorkBench v5 . . The Windows application software used to setup and program Baldor drives

3.1 Introduction

Connections to the CAN bus are made using connectors X10 and X11. Additional LEDs are also present on the front panel, labeled CAN. Only the left LED is used. This LED shows various status conditions of the CAN1 (CANopen) bus - see section 3.3.4.

3.2 Connector, LED and switch locations

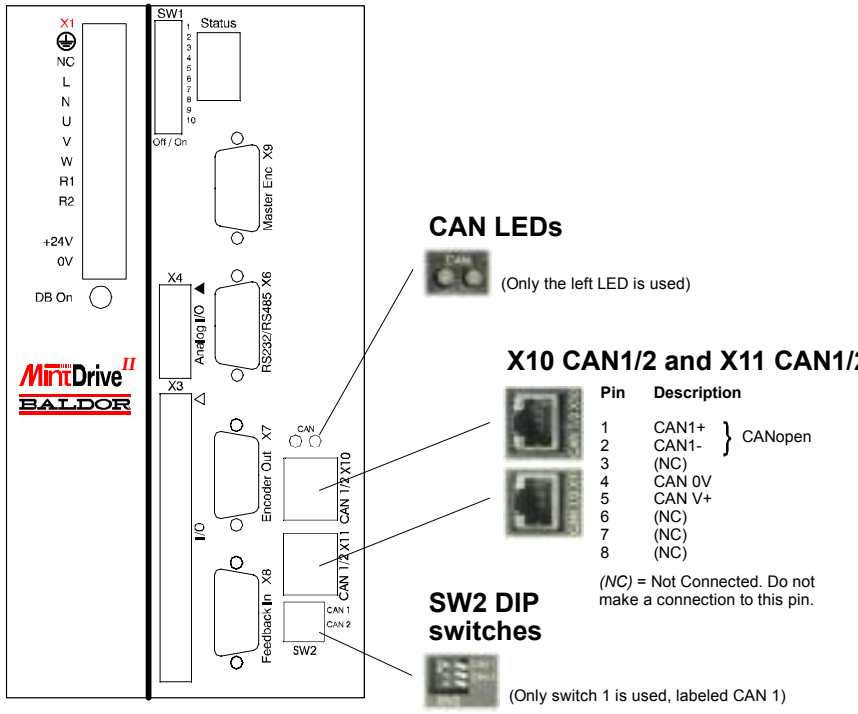

Figure 1 - CAN, LED and switch locations

3.3 CAN

The CAN option provides one CANopen channel. CANopen offers very reliable serial communications over a two wire twisted pair cable. In an industrial environment, the probability of an undetected error is 4.7×10^{-11}. CANopen also offers high speed data transfer (up to 1Mbit/s, dependent on bus length) and low cost multiplex wiring schemes. CAN is optimized for the transmission of small data packets and therefore offers fast update of I/O devices (peripherals) connected to the bus. The CANopen network allows 127 CANopen peripheral devices to be attached to the same controller.

The CAN option provides access to the CANopen (CAN1) bus on identical connectors X10 and X11. Two connectors are provided to simplify “daisy-chaining” of peripherals.

3.3.1 CAN connectors - X10 and X11

Location	Connectors X10 / X11	
Pin	**Name**	**Description**
1	CAN1+	CANopen
2	CAN1-	CANopen
3	-	*(NC)*
4	CAN 0V	Ground/earth reference for CAN signals
5	CAN V+	CAN remote node power V+ (12-24V)
6	-	*(NC)*
7	-	*(NC)*
8	-	*(NC)*
Description	CANopen interface using a RJ45 connectors.	

Correct operation of CANopen can only be achieved with screened/shielded twisted-pair cabling. The CAN1+ and CAN1- must form a twisted pair with the shield connected to the connector backshell, as shown in Figure 2. A range of suitable CAN cables are available from Baldor, with catalog numbers beginning CBL004-5...

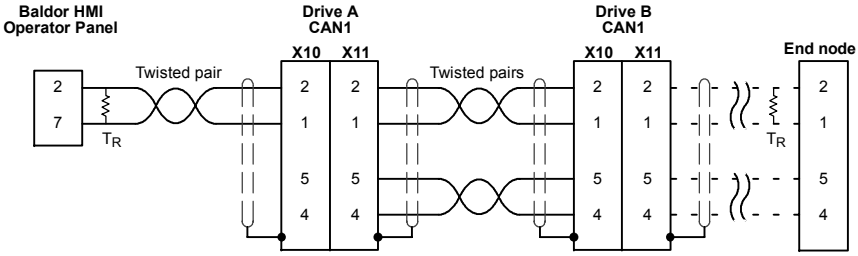

Figure 2 - Typical CAN network connections

3.3.2 CANopen

CANopen is a networking system based on the serial bus CAN. It uses the international CAN standard ISO 11898 as the basis for communication. The Mint firmware implements a CANopen protocol on CAN bus 1, based on the 'Communication Profile' CiA DS-301, which supports both direct access to device parameters and time-critical process data communication. This provides support for a range of Baldor and third-party devices.

The CANopen channel is opto-isolated and available on connectors X10 and X11. Voltages of 12-24V may be applied to pin 5 of X10 and X11. An internal voltage regulator provides the 5V required for the isolated CAN circuit.

Practical operation of this CANopen channel is limited to 500Kbit/s owing to the propagation delay of the opto-isolators.

CAN1 must be terminated by a 120Ω resistor connected between CAN1+ and CAN1- at both ends of the network and nowhere else. If the drive is at the end of the network then ensure that the SW2 CAN1 DIP switch (located on the front panel) is in the On position, which will connect an internal terminating resistor.

The MintDrive^{II} has the ability to act as the network manager node or as a slave on the CANopen network. The FlexDrive^{II} and Flex+Drive^{II} may only act as slave devices.

3.3.3 SW2 DIP switches

On ⟷ Off

The CAN 1 DIP switch can be used to connect an internal termination resistor to the CAN network.

When a switch is in the On position, the internal termination resistor is connected to the CANopen bus.

Switches 2 and 3 have no purpose.

3.3.4 CAN LEDs

The left LED shows activity on the CAN1 (CANopen) bus.
The right LED has no purpose.

The LED is a bi-color device (can appear green or red), and can have the following states:

Color	Meaning
Green	The bus is operational. This indicates that the CAN controller has not detected a number of errors greater than the 'Passive' threshold (127 errors).
Red (flashing)	The bus is passive. This indicates that the CAN controller is experiencing a number of Tx or Rx errors, greater than the 'Passive' threshold (127 errors). See Appendix A.
Red	The bus is OFF. This indicates that the CAN controller has experienced a fatal number of errors (255 errors) and has switched itself into a state whereby it cannot influence the bus. See Appendix A.
Off	No primary power to the option.

A.1 Specifications

A.1.1 CAN Bus interfaces (X10 & X11)

Item	Unit	Value
Signal	-	2-wire, isolated
Channels	-	1
Protocol	-	CANopen
Bit rates	**Kbit/s**	10, 20, 50, 100, 125, 250, 500

A.1.2 CAN wiring

A very low error rate over CANopen can only be achieved with a suitable wiring scheme, so the following points should be observed:

- CANopen devices must be connected via twisted pair cabling to reduce RF emissions and provide immunity to conducted interference. The connection arrangement is normally a simple multi-point drop. The CAN cables should have a characteristic impedance of 120Ω and a delay of 5ns/m. Other characteristics depend upon the length of the cabling:

Cable length	Maximum bit rate	Resistance	Conductor area
0m - 40m (0ft - 131ft)	1000Kbit/s*	<70mΩ/m	0.25 - 0.34mm^2
40m - 300m (131ft - 984ft)	500Kbit/s	<60mΩ/m	0.34 - 0.60mm^2
300m - 600m (984ft - 1968ft)	100Kbit/s	<40mΩ/m	0.50 - 0.60mm^2
600m - 1000m (1968ft - 3280ft)	50Kbit/s	<26mΩ/m	0.75 - 0.80mm^2

- Terminators must only be fitted at each end of the network, not at intermediate nodes.
- The 0V rails of all of the nodes on the network must be tied together through the CAN cabling. This ensures that the CAN signal levels transmitted by the drive or CANopen peripheral devices are within the common mode range of the receiver circuitry of other nodes on the network.

***Note:** 1000Kbit/s is the maximum theoretical bit rate. Practical operation of the CANopen option is limited to 500Kbit/s owing to the propagation delay of the opto-isolators.

B.1 Operation

The MintDrive^{II} has the ability to act as the network manager node or as a slave on a CAN network. The FlexDrive^{II} and Flex+Drive^{II} may only act as slave devices.

The drives have a data array that is accessible by external devices over CANopen. This array, known as the COMMS array, has 155 read-only elements which contain data such as position and I/O states. The Flex+Drive^{II} and MintDrive^{II} also have 99 user elements, which can be used for data exchange.

B.1.1 Making a connection

When a MintDrive^{II} is acting as a network manager node (node 1), it scans the CANopen network for other nodes. If it detects another Baldor device, for example a Flex+Drive^{II}, it will automatically make a connection. The device now becomes an operational slave on the network, and the master may read and write data to its COMMS array (except FlexDrive^{II}).

The MintMT keyword `CONNECT` is normally used to make connections. Therefore, when the master *automatically* connects to a slave device, it uses a command equivalent to:

```
CONNECT.1.5 = 1
```

where the initial `1` is the master's node number and `5` is the node number of the detected slave (for example). The final `1` indicates that the connection is to be made; zero is used to break a connection. For full details of `CONNECT` and other related keywords, see the MintMT help file.

B.1.2 Peer-to-peer connections

If a peer-to-peer connection is required, where the slave device (except FlexDrive^{II}) is allowed to read and write data to the master's COMMS array, a manual connection must be made. The command required to make this connection can only be issued from the master, which retains overall control of the network. Continuing the example in B.1.1, the command:

```
CONNECT.5.1 = 1
```

could be issued from the master to enable the slave to access the master's COMMS array.

B.1.3 COMMS and BUS Events

A drive's MintMT program can use *Events* to detect changes to any of the first five COMMS elements (1-5). An Event must be defined for each location to be monitored. For example, to detect changes to comms location 3, Event COMMS3 must be defined:

```
Event COMMS3
  ...'statements
End Event
```

Similarly, an Event called BUS1 can be used to detect events occurring on the CANopen bus. For example:

```
Event BUS1
  ... 'statements
End Event
```

The BUS Event can be used to capture many events such as nodes becoming live or dead, or a bus becoming operational.

Events are monitored continuously and have a high priority, allowing a MintMT program to react quickly to changes in a drive's COMMS locations or events occurring on the CAN bus. For full details and examples of Events, see the MintMT help file.

B.2 Troubleshooting CANopen

Use this section to troubleshoot problems involving CAN. For more information about CAN networks, MintMT keywords and error messages, see the WorkBench v5 help file.

Problem	Check
The CAN1 LED is illuminated red	The CAN1 bus is off. This means that the CAN controller has experienced a fatal number of errors (255 errors) and has switched itself into a state whereby it cannot influence the bus. 1) Check the CAN cable is not broken or disconnected. 2) Check that all nodes are running at the same baud rate. 3) Try using the `BUSRESET.1` command to reset the bus.
The CAN1 LED is flashing red	The CAN1 bus is passive. This means that the CAN controller is experiencing a number of Tx or Rx errors, greater than the 'Passive' threshold (127 errors). 1) Check the CAN cable is not broken or disconnected. 2) Check that all nodes are running at the same baud rate. 3) Check that each node has been assigned a unique NodeID. The master must be assigned NodeID #1. 4) Check that the network has been terminated at each end. If the drive is at the end of the network, check that the CAN1 switch on the front panel is in the ON position. 5) Try using the `BUSRESET.1` command to reset the bus.
The CAN1 LED is green but communication with a node is not possible.	When the drive scans the CANopen network and detects another Baldor device, it will automatically make a connection. However, if the device is not a Baldor product it will be necessary to make the connection manually. Assuming WorkBench v5 is connected to the drive, use the command: `CONNECT.1.`*`n`*` = 1` where the initial `1` is the drive's node number (the master) and *n* is the node number of the peripheral device. This should put the device into its operational state, allowing communication.

Problem	Check
The master device reports that a node has died	The master sends periodic node guarding messages to check that each node on a CAN network is operating correctly ('live'). The slave must respond to the message within a specified period. Sometimes a node may unexpectedly be reported as 'dead': 1) Confirm that the CAN bus is not being overloaded. This can sometimes happen on large networks with multiple nodes. Excessive network 'traffic' can prevent the master from receiving the slave's response within the specified period. A CAN analysis tool may be required to determine this problem. 2) If a slave is operating in a peer-to-peer configuration with another slave (communicating directly, independently of the master) check that their communications do not prevent them responding to the master's node guarding messages.

C.1 Description

The following table lists the objects supported on the CANopen bus. These conform to the DS-301 specification, unless otherwise indicated. The columns have the following meanings:

Index The address of the named item, expressed as a hexadecimal value.

Name The name of the item.

Code The format of the data, where:
VAR = single data field of a pre-defined variable type.
ARRAY = multiple data field where each field is of the same variable type.
RECORD = multiple data field where each field can be of any variable type.

Type Specifies the type of the Object Dictionary item, for example BOOLEAN, FLOAT or UNSIGNED.

Attribute Defines the access rights for the Object Dictionary item:
RW = Read and Write access.
RO = Read Only access.
Const = Read Only access and value is constant.

Index (hex)	Name	Code	Type	Attribute
1000	Device type	VAR.	UNSIGNED 32	RO
1001	Error register	VAR.	UNSIGNED 8	RO
1002	Manufacturer status register	VAR.	UNSIGNED 32	RO
1003	Pre-defined error field	ARRAY	UNSIGNED 32	RO
1005	COB-ID SYNC	VAR.	UNSIGNED 32	RW
1006	Communication cycle period	VAR.	UNSIGNED 32	RW
1007	Synchronous window length	VAR.	UNSIGNED 32	RW
100C	Guard time	VAR.	UNSIGNED 16	RW
100D	Lifetime factor	VAR.	UNSIGNED 8	RW
1014	COB-ID emergency	VAR.	UNSIGNED 32	RW
Server SDO Parameters				
1200	1st Server SDO parameter	RECORD	SDO Parameter (22h)	RO
≀				
127F	128th Server SDO parameter	RECORD	SDO Parameter (22h)	RW

Index (hex)	Name	Code	Type	Attribute
Client SDO Parameters				
1280	1st Client SDO parameter	RECORD	SDO Parameter (22h)	RW
		≀		
12FF	128th Client SDO parameter	RECORD	SDO Parameter (22h)	RW
Receive PDO Communication Parameters				
1400	1st Receive PDO parameter	RECORD	PDO CommPar (20h)	RW
		≀		
14FF	255th Receive PDO parameter	RECORD	PDO CommPar (20h)	RW
Group Receive PDO Communication Parameters				
1500	1st Group Receive PDO parameter	RECORD	PDO CommPar (20h)	RW
		≀		
1509	10th Group Receive PDO parameter	RECORD	PDO CommPar (20h)	RW
Transmit PDO Communication Parameters				
1800	1st Transmit PDO parameter	RECORD	PDO CommPar (20h)	RW
		≀		
18FF	255th Transmit PDO parameter	RECORD	PDO CommPar (20h)	RW
Group Transmit PDO Communication Parameters				
1900	1st Group Transmit PDO parameter	RECORD	PDO CommPar (20h)	RW
		≀		
1909	10th Group Transmit PDO parameter	RECORD	PDO CommPar (20h)	RW
Program Download				
1F50	Download Program Data	ARRAY	Domain	RW
1F51	Program Control	VAR.	UNSIGNED 8	RW

Index (hex)	Name	Code	Type	Attribute
Manufacturer Specific				
2000	Comms array	ARRAY	UNSIGNED 32	RW
2100	Remote node type	ARRAY	UNSIGNED 8	RW
2101	Remote node TX1 PDO	ARRAY	UNSIGNED 8	RW
2102	Remote node RX1 PDO	ARRAY	UNSIGNED 8	RW
2103	Remote node TX2 PDO	ARRAY	UNSIGNED 8	RW
2104	Remote node RX2 PDO	ARRAY	UNSIGNED 8	RW
2105	Remote node server SDO	ARRAY	UNSIGNED 8	RW
2106	Remote node client SDO	ARRAY	UNSIGNED 8	RW
2107	Remote node digital output bytes	ARRAY	UNSIGNED 8	RW
2108	Remote node digital input bytes	ARRAY	UNSIGNED 8	RW
Digital Input Module (DS-401)				
6000	Read state 8 input lines	ARRAY	UNSIGNED 8	RO
Digital Output Module (DS-401)				
6200	Write state 8 output lines	ARRAY	UNSIGNED 8	RW
Analog Input Module (DS-401)				
6423	Analog input global interrupt enable	VAR.	BOOLEAN	RW
6426	Analog input interrupt delta	ARRAY	UNSIGNED 32	RO
Baldor HMI Module (DS-403)				
6700	Read input variable unsigned32	RECORD	UNSIGNED 32	RO
7100	Read input variable float	RECORD	FLOAT	RO
8100	Write output variable unsigned32	RECORD	UNSIGNED 32	RW
8500	Write output variable float	RECORD	FLOAT	RW

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