BALDOR
MOTION PRODUCTS

MOTION CONTROL

NextMove ES
Motion Controller

Installation Manual

2/03 MN1920

Contents

Appendices

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 which 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.

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Safety Notice

Only qualified personnel should attempt to start-up, program 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.

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.

⚠ **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.

⚠ **WARNING**: The stop input to this equipment should not be used as the single means of achieving a safety critical stop. Drive disable, motor disconnect, motor brake and other means should be used as appropriate.

⚠ **WARNING**: Improper operation or programming may cause violent motion of the motor shaft and driven equipment. Be certain that unexpected motor shaft 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.

⚠ **CAUTION**: The safe integration of this equipment into a machine system is the responsibility of the machine designer. Be sure to comply with the local safety requirements at the place where the machine is to be used. In Europe these are the Machinery Directive, the ElectroMagnetic Compatibility Directive and the Low Voltage Directive. In the United States this is the National Electrical code and local codes.

⚠ **CAUTION**: Electrical components can be damaged by static electricity. Use ESD (electrostatic discharge) procedures when handling this drive.

2.1 NextMove ES features

NextMove ES is a high speed multi-axis intelligent controller for servo and stepper motors.

NextMove ES features the MintMT motion control language. MintMT is a structured form of Basic, custom designed for stepper or servo motion control applications. It allows you to get started very quickly with simple motion control programs. In addition, MintMT includes a wide range of powerful commands for complex applications.

Standard features include:

- Control of 4 stepper and 2 servo axes.
- Point to point moves, software cams and gearing.
- 20 general purpose digital inputs, software configurable as level or edge triggered.
- 12 general purpose digital outputs and 1 error output.
- 2 differential analog inputs with 12-bit resolution.
- 2 single-ended analog outputs with 12-bit resolution.
- CANopen or proprietary Baldor CAN protocol for communication with MintMT controllers and other third party devices.
- Programmable in MintMT.

Included with NextMove ES is the Baldor Motion Toolkit CD. This contains a number of utilities and useful resources to get the most from you MintMT controller. These include:

- Mint WorkBench v5
  This is the user interface for communicating with the NextMove ES. Installing Mint WorkBench will also install firmware for NextMove ES.
- PC Developer Libraries
  Installing Mint WorkBench will install ActiveX interfaces that allow PC applications to be written that communicate with the NextMove ES.
- Embedded Developer Libraries
  Allows embedded C33 applications to be developed using the Texas Instruments TMS320C3x v5.11 compiler.

This manual is intended to guide you through the installation of NextMove ES.

The chapters should be read in sequence.

The *Basic Installation* section describes the mechanical installation of the NextMove ES. The following sections require knowledge of the low level input/output requirements of the installation and an understanding of computer software installation. If you are not qualified in these areas you should seek assistance before proceeding.

Note: You can check that you have the latest firmware and WorkBench v5 releases by visiting the website *www.supportme.net*.

2.2 Receiving and inspection

When you receive your NextMove ES, there are several things you should do immediately:

1. Check the condition of the packaging and report any damage immediately to the carrier that delivered your NextMove ES.
2. Remove the NextMove ES from the shipping container but do not remove it from its anti-static bag until you are ready to install it. The packing materials may be retained for future shipment.
3. Verify that the catalog number of the NextMove ES you received is the same as the catalog number listed on your purchase order. The catalog/part number is described in the next section.
4. Inspect the NextMove ES for external damage during shipment and report any damage to the carrier that delivered it.
5. If the NextMove ES is to be stored for several weeks before use, be sure that it is stored in a location that conforms to the storage humidity and temperature specifications shown in section 3.1.1.

2.2.1 Identifying the catalog number

NextMove ES cards are available with a number of optional backplane connector cards. As a reminder of which products have been installed, it is a good idea to write the catalog numbers in the space provided below.

NextMove ES catalog number: **NES001-501**

Backplane catalog number: **BPL010-50**________

Installed in: ________________________________ **Date:** __________

A description of the catalog numbers are shown in the following table:

Catalog number	Description
NES001-501	NextMove ES controller card
BPL010-501	Backplane card: Non-isolated
BPL010-502	Backplane card: Opto-isolated with ‘PNP’ (current sourcing) outputs and ‘active high’ inputs.
BPL010-503	Backplane card: Opto-isolated with ‘NPN’ (current sinking) outputs and ‘active low’ inputs.

2.3 Units and abbreviations

The following units and abbreviations may appear in this manual:

V . . . . Volt (also VAC and VDC)
W . . . . Watt
A . . . . Ampere
Ω . . . . Ohm
μF . . . . microfarad
pF . . . . picofarad
mH . . . . millihenry

Φ . . . . phase
ms . . . . millisecond
μs . . . . microsecond
ns . . . . nanosecond

Kbaud . . . . kilobaud (the same as Kbit/s in most applications)
MB . . . . megabytes
CDROM . . . . Compact Disc Read Only Memory
CTRL+E . . . . on the PC keyboard, press **Ctrl** then **E** at the same time.

mm . . . . millimeter
m . . . . meter
in . . . . inch
ft . . . . feet
lb-in . . . . pound-inch (torque)
Nm . . . . Newton-meter (torque)

DAC . . . . Digital to Analog Converter
ADC . . . . Analog to Digital Converter
AWG . . . . American Wire Gauge
(NC) . . . . Not Connected

3.1 Introduction

You should read all the sections in *Basic Installation*.
It is important that the correct steps are followed when installing the NextMove ES.
This section describes the mechanical installation of the NextMove ES.

3.1.1 Location requirements

You must read and understand this section before beginning the installation.

⚠ **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 to/from the NextMove ES are shielded correctly.

⚠ **CAUTION**: Avoid locating the NextMove ES immediately above or beside heat generating equipment, or directly below water steam pipes.

⚠ **CAUTION**: Avoid locating the NextMove ES in the vicinity of corrosive substances or vapors, metal particles and dust.

The safe operation of this equipment depends upon its use in the appropriate environment. The following points must be considered:

- The NextMove ES is designed to be mounted in a IEC297 / DIN41494 rack with card frames and guides to support the card.
- The NextMove ES must be installed in an ambient temperature of 0°C to 40°C (32°F to 104°F).
- The NextMove ES must be installed in relative humidity levels of less than 80% for temperatures up to 31°C (87°F) decreasing linearly to 50% relative humidity at 40°C (104°F), non-condensing.
- The NextMove ES must be installed where the pollution degree according to IEC664 shall not exceed 2.
- There shall not be abnormal levels of nuclear radiation or X-rays.

3.1.2 Installing the NextMove ES card

⚠ **CAUTION**: Before touching the card, be sure to discharge static electricity from your body and clothing by touching a grounded metal surface. Alternatively, wear an earth strap while handling the card.

The NextMove ES is designed to be mounted in a IEC297 / DIN41494 rack with card frames and guides to support the card. An additional backplane card is recommended (see section 5).

1. Mount the backplane connector card (optional) at the rear of the rack system.
2. Slide the NextMove ES card into the guide rails, ensuring that it plugs securely into the backplane connector.
3. Confirm that any neighboring cards or equipment are not touching the NextMove ES card.

3.1.3 Other requirements for installation

- The NextMove ES requires +5V and ±12V power supplies. The total power requirement (excluding any option cards) is +5V at 1A, +12V at 50mA and -12V at 50mA. If digital outputs are to be used, a supply will be required to drive them - see section 4.4.2.
- A PC that fulfills the following specification:

	Minimum specification	Recommended specification
Processor	Intel Pentium 133MHz	Intel Pentium 200MHz or faster
RAM	32MB	64MB
Hard disk space	40MB	60MB
CD-ROM	A CD-ROM drive	
Serial port	One free RS232 serial (COM) port	
Screen	800 x 600, 256 colors	1024 x 768, 256 colors
Mouse	A mouse or similar pointing device	
Operating system	Windows 95, Windows 98, Windows ME, Windows NT, Windows 2000 or Windows XP	

Software installation will be described later, in section 6.

- An RS232 cable, connected as shown in section 4.5.3.
- Your PC operating system user manual might be useful if you are not familiar with Windows.

4.1 Introduction

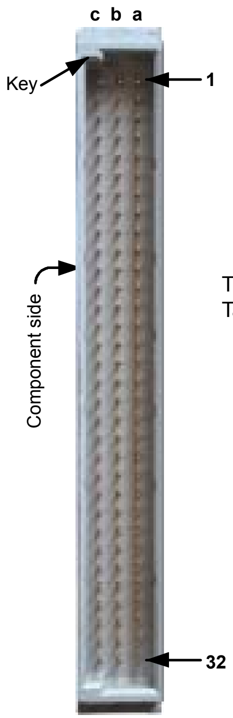
This section describes the input and output capabilities of the NextMove ES.

The following conventions will be used to refer to the inputs and outputs:

I/O . . . . Input / Output
DIN . . . . Digital Input
DOUT . . . . Digital Output
AIN . . . . Analog Input
AOUT . . . . Analog Output

Most external connections to the NextMove ES card are made using an optional backplane card, described in section 5.

4.2 96-pin edge connector



The pin assignment for the 96-pin DIN41612 connector is shown in Table 1.

4.2.1 96-pin connector pin assignment

Pin	Row		
	c	**b**	**a**
1	+5VDC	+5VDC	+5VDC
2	+5VDC	+5VDC	+5VDC
3	DGND	DGND	DGND
4	DOUT6	DOUT7	OUT COM
5	DOUT3	DOUT4	DOUT5
6	DOUT0	DOUT1	DOUT2
7	Encoder 0 CHB+	Encoder 0 CHA+	Encoder 0 CHB+
8	Encoder 1 CHZ+	Encoder 0 CHZ+	Encoder 1 CHA+
9	Encoder 1 CHA-	Encoder 0 CHZ-	Encoder 1 CHZ-
10	Encoder 0 CHB-	Encoder 0 CHA-	Encoder 1 CHB-
11	DIN16	Error Out	DGND
12	!RST IN	DGND	DGND
13	DGND	DOUT9	DOUT8
14	STEP2	STEP1	STEP0
15	DIR2	DIR1	DIR0
16	DOUT10	DGND	*(NC)*
17	DGND	AOUT2	*(NC)*
18	DIN4	DIN15	DIN2
19	DIN3	DIN5	DIN7
20	DIN6	DIN1	RXD
21	DIN0	RTS	TXD
22	DOUT11	AOUT3	CTS
23	DIN14	STEP3	DIR3
24	DIN17	DIN13	DIN10
25	DIN18	DIN9	DIN11
26	DIN12	DIN19	DIN8
27	Demand0 (AOUT0)	Demand1 (AOUT1)	AIN1-
28	AIN1+	AIN0+	AIN0-
29	+12VDC	+12VDC	+12VDC
30	AGND	AGND	AGND
31	-12VDC	-12VDC	-12VDC
32	Shield	Shield	Shield

Table 1 - 96-pin connector pin assignment

4.3 Analog I/O

The NextMove ES provides:

- Two 12-bit resolution analog inputs.
- Four 12-bit resolution analog outputs.

4.3.1 Analog inputs

The analog inputs are available on pins a28 & b28 (AIN0) and a27 & c28 (AIN1).

- Differential inputs.
- Voltage range: ±10V.
- Resolution: 12-bit with sign (accuracy ±4.9mV @ ±10V input).
- Input impedance: 120kΩ.
- Sampling frequency: 4kHz maximum, 2kHz if both inputs are enabled.

The analog inputs pass through a differential buffer and second order low-pass filter with a cut-off frequency of approximately 1kHz.

Both inputs are normally sampled at 2kHz. However, an input can be disabled by setting `ADCMODE` to 4 (`_acOFF`). With one input disabled, the remaining input will be sampled at 4kHz. In MintMT, analog inputs can be read using the `ADC` keyword. See the MintMT help file for full details of `ADC` and `ADCMODE`.

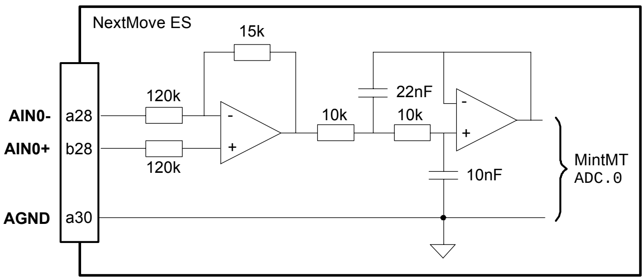


Figure 1 - Analog input, AIN0 shown

For differential inputs connect input lines to AIN+ and AIN-. Leave AGND unconnected.

4.3.2 Analog outputs

The four analog outputs are available on a range of pins, as shown in section 4.2.1.

- Four independent analog outputs.
- Output range: ±10VDC (±0.1%).
- Resolution: 12-bit (accuracy ±4.9mV).
- Output current: 10mA maximum.
- Update frequency: 10kHz maximum (factory default 1kHz).

MintMT and the Mint Motion Library use analog outputs Demand0 and Demand1 to control servo drives. Demand outputs 0 and 1 correspond to servo axes 4 and 5 respectively. The Demand2 and Demand3 outputs may be used as general purpose analog outputs. See the `DAC` keyword in the MintMT help file.

The analog outputs may be used to drive loads of 1kΩ or greater. Shielded twisted pair cable should be used. The shield connection should be made at one end only.

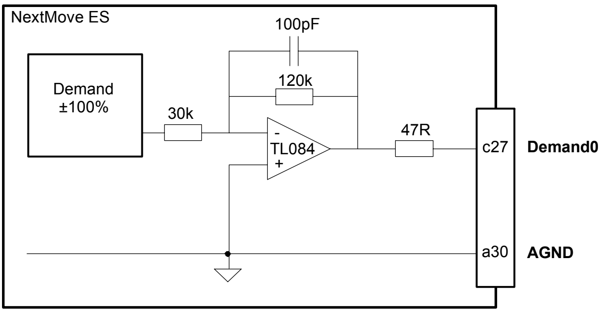


Figure 2 - Analog output - Demand0 shown

4.4 Digital I/O

The NextMove ES provides:

- 20 general purpose digital inputs.
- 12 general purpose digital outputs.

4.4.1 Digital inputs

The digital inputs are available across a range of pins, as shown in section 4.2.1. All digital inputs have a common specification:

- 5V digital inputs with internal pull-up resistors. Can also be assigned to special purpose functions such as Home, Limit, Stop and Error inputs.
- Sampling frequency: 1kHz.

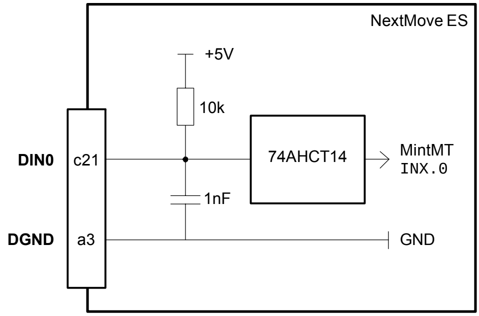


Figure 3 - General purpose digital input - DIN0 shown

CAUTION: Do not connect 24V signals to the digital inputs.

These unprotected inputs are connected directly to TTL compatible 74AHCT14 devices. If an input is configured as edge triggered, the triggering pulse must have a duration of at least 1ms (one software scan) to guarantee acceptance by MintMT. The use of shielded cable for inputs is recommended.

4.4.1.1 General purpose inputs

The general purpose digital inputs DIN0 - DIN19 can be shared between axes, and are programmable in Mint (using a range of keywords beginning with the letters `INPUT...`) to determine their active level and if they should be edge triggered. The state of individual inputs can be read directly using the `INX` keyword. See the MintMT help file.

A general purpose digital input can be assigned to a special purpose function such as a home, limit, stop or error input. See the keywords `HOMEINPUT`, `LIMITFORWARDINPUT`, `LIMITREVERSEINPUT`, `STOPINPUT`, and `ERRORINPUT` in the MintMT help file.

4.4.1.2 Reset input - !RSTIN

When grounded, the reset input will cause a hardware reset of the NextMove ES. This is equivalent to power-cycling the NextMove ES. Due to the internal pull-up resistor, the reset input may be left floating.

4.4.2 Digital outputs

The digital outputs are available across a range of pins, as shown in section 4.2.1.

- 12 general purpose digital outputs.
- One error output, configurable as a general purpose digital output.
- Update frequency: Immediate.

There are 12 general purpose digital outputs. An output can be configured in MintMT as a general purpose output, a drive enable output or a global error output. Outputs can be shared between axes and can be configured using WorkBench v5 (or the `OUTPUTACTIVELEVEL` keyword) to determine their active level.

4.4.2.1 DOUT0 - DOUT7

Outputs DOUT0 - DOUT7 are driven by a ULN2803 device. The outputs are designed to sink current from an external supply (typically 24VDC), but have no overcurrent or short circuit protection. When an output is activated, it is grounded through the ULN2803.

The ULN2803 has a maximum power dissipation of 2W at 25°C. The total output requirements of DOUT0 - DOUT7 must not exceed this limit. The maximum current limit for an individual output is 500mA if only one output is in use, reducing to 150mA if all outputs are in use. These limits are for a 100% duty cycle.

If the outputs are driving inductive loads such as relays, connect the OUT COM connection to the output's power supply, as shown in Figure 4. This will connect internal clamp diodes on all outputs.

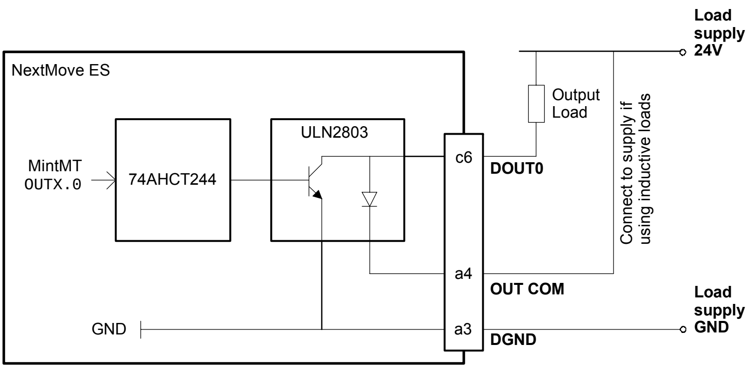


Figure 4 - Digital outputs (DOUT0-7) - DOUT0 shown

4.4.2.2 DOUT8 - DOUT11

Outputs DOUT8 - DOUT11 are driven by a ULN2003 device. The outputs are designed to sink current from an external supply (typically 24VDC), but have no overcurrent or short circuit protection. When an output is activated, it is grounded through the ULN2003.

The ULN2003 has a maximum power dissipation of 900mW at 25°C. The total output requirements of DOUT8 - DOUT11 must not exceed this limit. The maximum current limit for an individual output is 400mA if only one output is in use, reducing to 50mA if all outputs are in use. These limits are for a 100% duty cycle.

DOUT8 - DOUT11 are sourced from the same ULN2003 device as the DIR2 and STEP2 outputs (see section 4.5.2), so the current demands of these signals must also be considered.

If an output is driving an inductive load such as a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity. This is to protect the output from the back-EMF generated by the relay coil when it is de-energized.

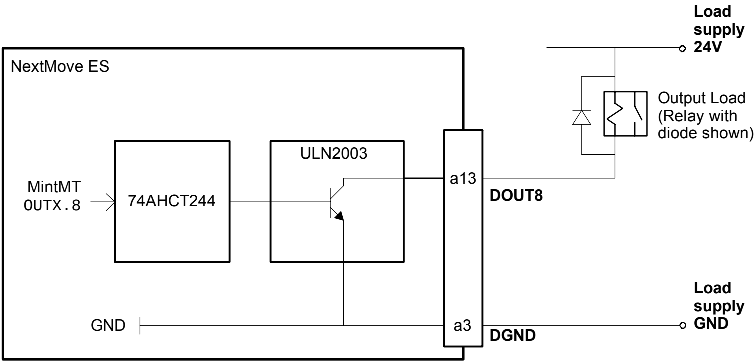
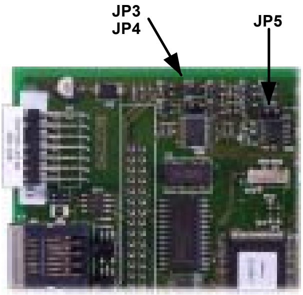


Figure 5 - Digital outputs (DOUT8-11) - DOUT8 shown

4.4.3 Error output - Error Out

The error output is available on pin b11. This 5V 100mA output can be used to stop external equipment in the event of an error. The output level can be controlled using jumpers JP3, JP4 and JP5 as shown in Table 2. The jumpers are situated at the top edge of the card.



Jumpers			Inactive state (no error)	Active state (error)
JP3	JP4	JP5		
▬	□ □	□ □	Floating	5V
□ □	▬	□ □	0V	Floating
▬	▬	□ □	0V	5V
▬	□ □	▬	5V	Floating
□ □	▬	▬	Floating	0V
▬	▬	▬	5V	0V

Table 2 - Error Out level configuration

There are a number of methods for controlling the error output.

4.4.3.1 RELAY keyword

If the NextMove ES is connected to an opto-isolated backplane (optional) the output directly controls the relay (see section 5.3.1.1). For this reason, the error output can be controlled by the `RELAY` keyword. The command `RELAY=1` will enable the error output; the command `RELAY=0` will disable it. This is true regardless of whether an opto-isolating backplane is connected.

4.4.3.2 DRIVEENABLEOUTPUT keyword

The `DRIVEENABLEOUTPUT` keyword can be used to configure the error output as the drive enable output. For example, the command `DRIVEENABLEOUTPUT.1=_RELAY0` will mean that the error output will be the drive enable output for axis 1. When axis 1 is enabled, the error output will be activated and the axis enabled. If multiple axes are configured to use the error output as their drive enable output, enabling one axis will enable all of them. Similarly, if one axis is disabled, all will be disabled.

The `RELAY` keyword cannot control the error output if is configured as a drive enable output.

4.4.3.3 GLOBALERROROUTPUT keyword

By default, the error output is used as the global error output. In the event of an error on any axis, the global error output will be deactivated. This action overrides the state of the error output defined by other methods, such as the drive enable status or `RELAY` keyword. Alternatively, the `GLOBALERROROUTPUT` keyword can be used to configure a general purpose digital output to be the global error output.

See the MintMT help file for details of each keyword.

4.5 Other I/O

4.5.1 Encoder inputs

The encoder inputs are available on pins a7-a10, b7-b10 and c7-c10. See section 4.2.1.

Two incremental encoders may be connected to NextMove ES, each with complementary A, B and Z channel inputs. Each input channel uses a MAX3095 differential line receiver with pull up resistors and terminators. Encoders must provide RS422 differential signals. The use of individually shielded twisted pair cable is recommended. See section 8.1.10 for details of the encoder power supply.

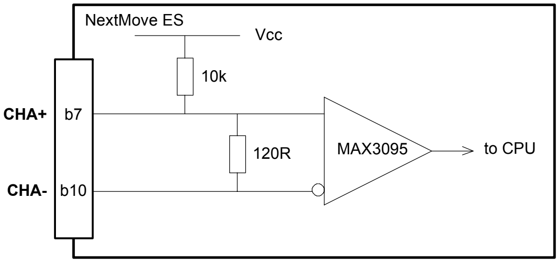


Figure 6 - Encoder channel input - Encoder 0, Channel A shown

4.5.1.1 Encoder input frequency

The maximum encoder input frequency is affected by the length of the encoder cables. The theoretical maximum frequency is 20 million quadrature counts per second. This is equivalent to a maximum frequency for the A and B signals of 5MHz. However, the effect of cable length is shown in Table 3:

Frequency	Maximum cable length	
	meters	feet
1.3MHz	2	6.56
500kHz	10	32.8
250kHz	20	65.6
100kHz	50	164.0
50kHz	100	328.1
20kHz	300	984.2
10kHz	700	2296.6
7kHz	1000	3280.8

Table 3 - Effect of cable length on maximum encoder frequency

The maximum recommended cable length is 30.5m (100ft).

4.5.2 Stepper control outputs

The stepper control outputs are available across a range of pins, as shown in section 4.2.1.

There are four sets of stepper motor control outputs, operating in the range 10Hz to 1MHz. Each of the step (pulse) and direction signals from the NextMove ES is driven by a ULN2003 open collector Darlington output device.

The ULN2003 has a maximum power dissipation of 900mW at 25°C. The total combined output requirements of DIR0 - DIR2 and STEP0 - STEP2 must not exceed this limit. The maximum current limit for an individual output is 400mA if only one output is in use, reducing to 50mA if all outputs are in use. These limits are for a 100% duty cycle.

DIR3 and STEP3 are sourced from the same ULN2003 device as the DOUT8 - DOUT11 outputs (see section 4.4.2.2), so the current demands of these signals must also be considered.

It is recommended to use separate shielded cables for the step outputs. The shield should be connected at one end only.

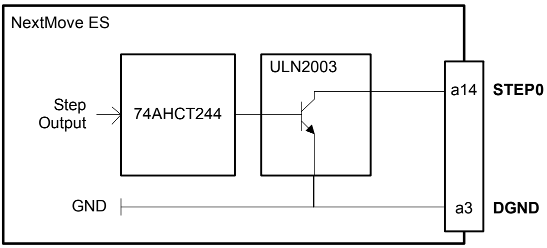
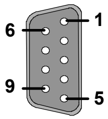


Figure 7 - Stepper output - STEP0 output shown

4.5.3 RS232 serial connection



Location	Serial Mating connector: 9-pin female D-type		
Pin	**Name**	**Description**	**96-pin connector**
1	Shield	Shield connection	a32
2	RXD	Receive Data	a20
3	TXD	Transmitted Data	a21
4	*(NC)*	*(Not connected)*	a16*
5	DGND	Digital ground	a3
6	*(NC)*	*(Not connected)*	a17*
7	RTS	Request To Send	b21
8	CTS	Clear To Send	a22
9	DGND	Digital ground	a3

* Pins a16 and a17 are linked on the NextMove ES.

The serial connector duplicates the signals present on the 96-pin connector. It is used to connect the NextMove ES to the PC running WorkBench v5, or other controller. If an optional Baldor backplane is being used, its serial connector (section 5.2.13 or 5.3.13) will carry the same signals. Do not attempt to use more than one set of serial connections at the same time. The port provides a full-duplex RS232 serial port with the following preset configuration:

- 57,600 baud
- 1 start bit
- 8 data bits
- 1 stop bit
- No parity
- Hardware handshaking lines (RS232) RTS and CTS must be connected.

The configuration can be changed using the `SERIALBAUD` keyword. It is stored in EEPROM and restored at power up. The port is capable of operation at up to 115,200 baud.

The port is configured as a DCE (Data Communications Equipment) unit so it is possible to operate the controller with any DCE or DTE (Data Terminal Equipment). Full duplex transmission with hardware handshaking is supported.

Only the TXD, RXD and 0V GND connections are required for communication. Pins 4 and 6 are linked on the NextMove ES.

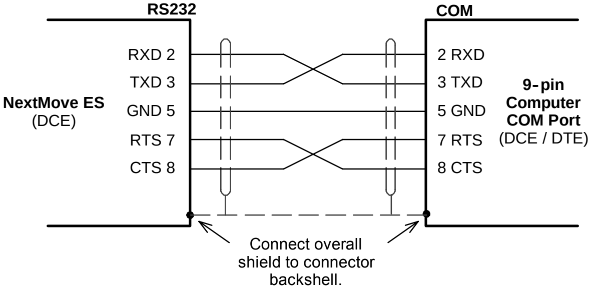
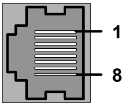


Figure 8 - RS232 serial port connections

The maximum recommended cable length is 3m (10ft) at 57.6Kbaud. When using lower baud rates, longer cable lengths may be used up to maximum of 15m (49ft) at 9600 baud. A suitable cable is available from Baldor, catalog number CBL001-501.

4.5.4 CAN connection

The CAN connection is made using the RJ45 connector on the NextMove ES card.



Location	NextMove ES card	
Pin	**Name**	**Description**
1	CAN+	CAN channel positive
2	CAN-	CAN channel negative
3	-	*(NC)*
4	CAN 0V	Ground/earth reference for CAN signals
5	CAN V+	CAN power V+ (12-24V)
6	-	*(NC)*
7	-	*(NC)*
8	-	*(NC)*
Description Opto-isolated CAN interface using a RJ45 connector.		

CAN offers serial communications over a two wire twisted pair cable up to maximum length of 500m (1640ft). It offers very high communication reliability in an industrial environment; the probability of an undetected error is 4.7×10^{-11}. CAN is optimized for the transmission of small data packets and therefore offers fast update of I/O devices (peripheral devices) connected to the bus. The maximum (default) transmission rate on NextMove ES is 500Kbit/s.

Correct operation of CAN can only be achieved with screened/shielded twisted-pair cabling. For improved noise immunity, CAN+ and CAN- must form a twisted pair with the shield connected to the connector backshell, as shown in Figure 9. A range of suitable CAN cables are available from Baldor, with catalog numbers beginning CBL004-5...

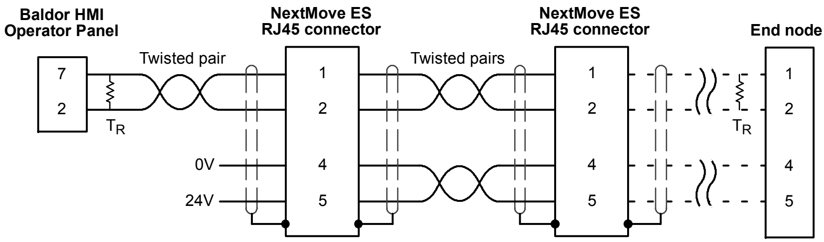
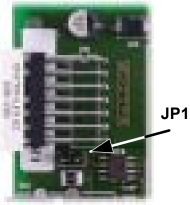


Figure 9 - Typical CAN network connections

The CAN channel is opto-isolated. A voltage in the range 12-24V must be applied to pin 5 of the CAN connector. An internal voltage regulator provides the 5V required for the isolated CAN circuit. Practical operation of the CAN channel is limited to 500Kbit/s owing to the propagation delay of the opto-isolators.



The CAN channel must be terminated by a 120Ω resistor connected between CAN+ and CAN- at both ends of the network and nowhere else. If the NextMove ES is at the end of the network then ensure that jumper JP1, located just below the status display, is in position. This will connect an internal terminating resistor.

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

- The connection arrangement is normally a 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 theoretical bit rate	Resistance	Conductor area
0m ~ 300m (0ft ~ 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

- The 0V connection 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 NextMove ES or CAN peripheral devices are within the common mode range of the receiver circuitry of other nodes on the network.

4.5.4.1 CANopen and Baldor CAN

The NextMove ES can communicate with other MintMT controllers over a CANopen network. Baldor CAN is a proprietary CAN protocol, allowing the NextMove ES to communicate with a range of Baldor ioNode CAN peripherals.

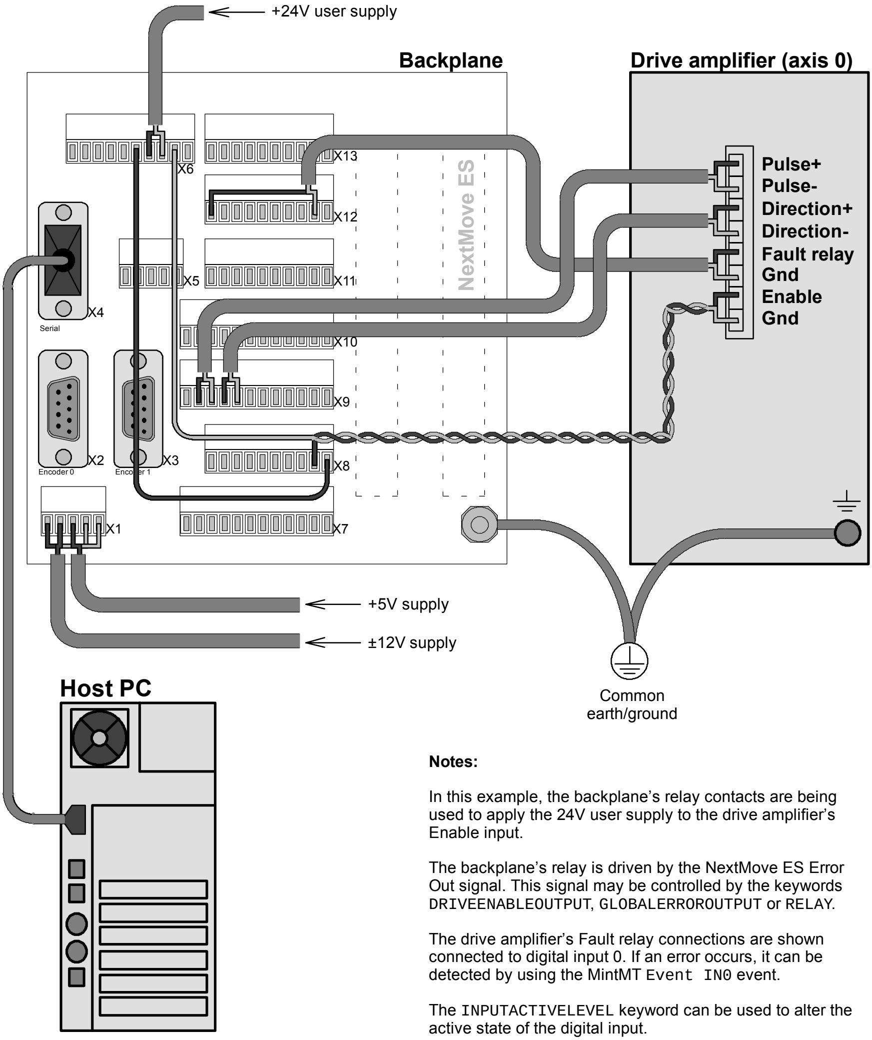
CANopen is a networking system based on the serial bus CAN. It uses the international CAN standard ISO 11898 as the basis for communication. The Mint firmware implements a CANopen protocol, based on the 'Communication Profile' CiA DS-301, which supports both direct access to device parameters and time-critical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

Baldor CAN is also a networking system based on the serial bus CAN. It uses the international CAN standard ISO 11898 as the basis for communication. Optional MintMT firmware can be downloaded to implement a proprietary Baldor protocol on CAN bus 2, based on CAL (the CAN Application Layer). This supports both direct access to device parameters and time-critical process data communication. Baldor CAN provides support for the full range of Baldor ioNode CAN peripherals.

The baud rate and node number of the NextMove ES can be set using the `BUSBAUD` and `NODE` keywords.

4.6 Connection summary - minimum system wiring

As a guide, Figure 10 shows an example of the typical minimum wiring required to allow the NextMove ES and a single axis stepper amplifier to work together. The optional opto-isolating backplane card BPL010-502 is shown. Details of the connector pins are shown in Table 4.



Notes:

In this example, the backplane's relay contacts are being used to apply the 24V user supply to the drive amplifier's Enable input.

The backplane's relay is driven by the NextMove ES Error Out signal. This signal may be controlled by the keywords `DRIVEENABLEOUTPUT`, `GLOBALERROROUTPUT` or `RELAY`.

The drive amplifier's Fault relay connections are shown connected to digital input 0. If an error occurs, it can be detected by using the MintMT `Event IN0` event.

The `INPUTACTIVELEVEL` keyword can be used to alter the active state of the digital input.

Figure 10 - Example minimum system wiring

Backplane card connector	Pin	Name of signal	Function	Connection on drive (Note: drive may be labelled differently)
X6	9	USR GND	User power supply GND	Enable signal ground
X8	9	REL NO	Switched relay contact	Enable signal input
	10	REL COM	Common relay connection (linked to USR V+)	
X9	2	STEP0-	Step signal for axis 0	Step (pulse) input
	3	STEP0+		
	4	DIR0-	Direction signal for axis 0	Direction input
	5	DIR0+		
X12	1	DIN0	Digital input 0	Fault relay output
	11	USR GND	User power supply GND	Fault relay GND

Table 4 - Connector details for minimum system wiring shown in Figure 10

5.1 Introduction

This section describes the optional backplane cards available for use with the NextMove ES. These cards all provide standard wiring connections to the NextMove ES, but there are a number of variants available:

- Baldor part number BPL010-501: Non-isolated backplane.
- Baldor part number BPL010-502: Isolated PNP backplane.
- Baldor part number BPL010-503: Isolated NPN backplane.

It is recommended to use one of these dedicated backplanes with your NextMove ES.

Each table shows the required mating connector and the associated pin on the NextMove ES 96-pin connector. Where multiple pins exist with the same function, for example AGND, one example pin number is shown, but any identically named pin represents the same electrical connection.

See section 4.2 for details of the 96-pin connector.

5.2 BPL010-501 non-isolated backplane

This backplane provides direct connection to the NextMove ES signals without isolation. The electrical specifications of all signals are therefore the same as described in section 4.

In the following sections, the signals AGND, DGND and Shield are listed with nominal corresponding pins on the 96-pin connector, although they are all electrically connected on the backplane. The OUT COM pin on connector X11 is not connected to ground.

Some signals are duplicated on multiple identically named pins on the 96-pin connector.
In these cases, only the lowest numbered pin is listed.

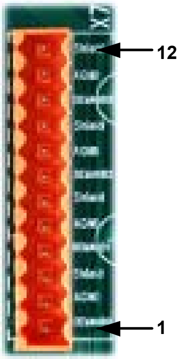
⚠ **CAUTION**: Some components are static sensitive devices. Take appropriate ESD precautions when handling the backplane.

5.2.1 Analog inputs

Location	X8 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**96-pin connector**
10	Shield	Shield connection	a32
9	DGND	Digital ground	a3
8	!RSTIN	Reset input	c12
7	ERROR	Error output	b11
6	AGND	Analog ground	a30
5	AIN1-	Analog input AIN1-	a27
4	AIN1+	Analog input AIN1+	c28
3	AGND	Analog ground	a30
2	AIN0-	Analog input AIN0-	a28
1	AIN0+	Analog input AIN0+	b28

See section 4.3.1 for electrical specifications of the analog inputs.

5.2.2 Analog outputs (demands)



Location	X7 Mating connector: Weidmüller Omnimate BL 3.5/12		
Pin	**Name**	**Description**	**96-pin connector**
12	Shield	Shield connection	a32
11	AGND	Analog ground	a30
10	DEMAND3	Analog output AOUT3	b22
9	Shield	Shield connection	a32
8	AGND	Analog ground	a30
7	DEMAND2	Analog output AOUT2	b17
6	Shield	Shield connection	a32
5	AGND	Analog ground	a30
4	DEMAND1	Demand 1 output (AOUT1)	b27
3	Shield	Shield connection	a32
2	AGND	Analog ground	a30
1	DEMAND0	Demand 0 output (AOUT0)	c27

See section 4.3.2 for electrical specifications of the analog outputs.

5.2.3 Digital inputs 0-7

Location	X12 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**96-pin connector**
10	Shield	Shield connection	a32
9	DGND	Digital ground	a3
8	DIN7	Digital input DIN7	a19
7	DIN6	Digital input DIN6	c20
6	DIN5	Digital input DIN5	b19
5	DIN4	Digital input DIN4	c18
4	DIN3	Digital input DIN3	c19
3	DIN2	Digital input DIN2	a18
2	DIN1	Digital input DIN1	b20
1	DIN0	Digital input DIN0	c21

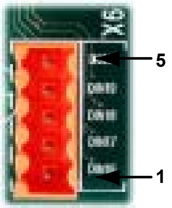
See section 4.4.1 for electrical specifications of the digital inputs.

5.2.4 Digital inputs 8-15

Location	X13 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**96-pin connector**
10	Shield	Shield connection	a32
9	DGND	Digital ground	a3
8	DIN15	Digital input DIN15	b18
7	DIN14	Digital input DIN14	c23
6	DIN13	Digital input DIN13	b24
5	DIN12	Digital input DIN12	c26
4	DIN11	Digital input DIN11	a25
3	DIN10	Digital input DIN10	a24
2	DIN9	Digital input DIN9	b25
1	DIN8	Digital input DIN8	a26

See section 4.4.1 for electrical specifications of the digital inputs.

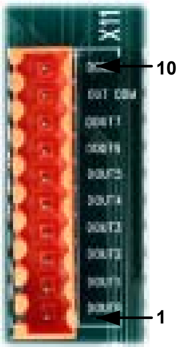
5.2.5 Digital inputs 16-19



Location	X6 Mating connector: Weidmüller Omnimate BL 3.5/5		
Pin	**Name**	**Description**	**96-pin connector**
5	DGND	Digital ground	a3
4	DIN19	Digital input DIN19	b26
3	DIN18	Digital input DIN18	c25
2	DIN17	Digital input DIN17	c24
1	DIN16	Digital input DIN16	c11

See section 4.4.1 for electrical specifications of the digital inputs.

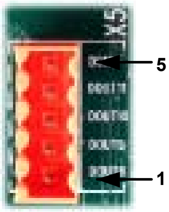
5.2.6 Digital outputs 0-7



Location	X11 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**96-pin connector**
10	DGND	Digital ground	a3
9	OUT COM	Common	a4
8	DOUT7	Digital output DOUT7	b4
7	DOUT6	Digital output DOUT6	c4
6	DOUT5	Digital output DOUT5	a5
5	DOUT4	Digital output DOUT4	b5
4	DOUT3	Digital output DOUT3	c5
3	DOUT2	Digital output DOUT2	a6
2	DOUT1	Digital output DOUT1	b6
1	DOUT0	Digital output DOUT0	c6

See section 4.4.2 for electrical specifications of the digital outputs.

5.2.7 Digital outputs 8-11



Location	X5 Mating connector: Weidmüller Omnimate BL 3.5/5		
Pin	**Name**	**Description**	**96-pin connector**
5	DGND	Digital ground	a3
4	DOUT11	Digital output DOUT11	c22
3	DOUT10	Digital output DOUT10	c16
2	DOUT9	Digital output DOUT9	b13
1	DOUT8	Digital output DOUT8	a13

See section 4.4.2 for electrical specifications of the digital outputs.

5.2.8 Stepper axes outputs 0-1

Location	X9 Mating connector: Weidmüller Omnimate BL 3.5/12		
Pin	**Name**	**Description**	**96-pin connector**
12	Shield	Shield connection	a32
11	DIR1+	Direction output 1+	b15
10	DIR1-	Direction output 1-	
9	STEP1+	Step (pulse) output 1+	b14
8	STEP1-	Step (pulse) output 1-	
7	DGND	Digital ground	a3
6	Shield	Shield connection	a32
5	DIR0+	Direction output 0+	a15
4	DIR0-	Direction output 0-	
3	STEP0+	Step (pulse) output 0+	a14
2	STEP0-	Step (pulse) output 0-	
1	DGND	Digital ground	a3

The stepper outputs on the backplane are driven by DS26LS31 line drivers, providing RS422 differential outputs.

CAUTION: The DS26LS31 drivers are static sensitive devices. Take appropriate ESD precautions when handling the backplane.

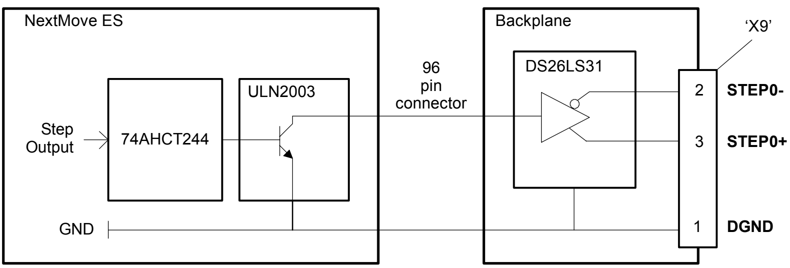


Figure 11 - Stepper output - STEP0 output shown

5.2.9 Stepper axes outputs 2-3

Location	X10 Mating connector: Weidmüller Omnimate BL 3.5/12		
Pin	**Name**	**Description**	**96-pin connector**
12	Shield	Shield connection	a32
11	DIR3+	Direction output 3+	a23
10	DIR3-	Direction output 3-	
9	STEP3+	Step (pulse) output 3+	b23
8	STEP3-	Step (pulse) output 3-	
7	DGND	Digital ground	a3
6	Shield	Shield connection	a32
5	DIR2+	Direction output 2+	c15
4	DIR2-	Direction output 2-	
3	STEP2+	Step (pulse) output 2+	c14
2	STEP2-	Step (pulse) output 2-	
1	DGND	Digital ground	a3

The stepper outputs on the backplane are driven by DS26LS31 line drivers, providing RS422 differential outputs.

CAUTION: The DS26LS31 drivers are static sensitive devices. Take appropriate ESD precautions when handling the backplane.

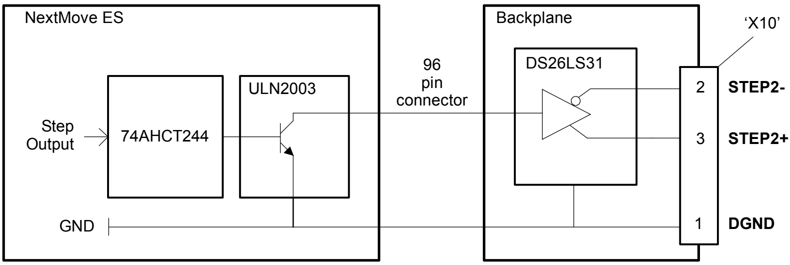
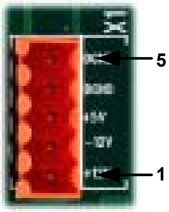


Figure 12 - Stepper output - STEP2 output shown

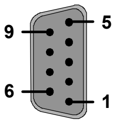
5.2.10 Power inputs



Location	X1 Mating connector: Weidmüller Omnimate BL 3.5/5		
Pin	**Name**	**Description**	**96-pin connector**
5	DGND	Digital ground	a3
4	DGND	Digital ground	a3
3	+5	+5V input	a1
2	-12	-12V input	a31
1	+12	+12V input	a29

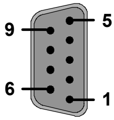
See section 3.1.3 for power requirements.

5.2.11 Encoder input 0



Location	X3 Encoder0 Mating connector: 9-pin male D-type		
Pin	**Name**	**Description**	**96-pin connector**
1	CHA+	Channel A signal	b7
2	CHB+	Channel B signal	a7
3	CHZ+	Index channel signal	b8
4	Shield	Shield connection	a32
5	DGND	Digital ground	a3
6	CHA-	Channel A signal complement	b10
7	CHB-	Channel B signal complement	c10
8	CHZ-	Index channel signal complement	b9
9	+5V out	Power supply to encoder	a1

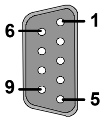
5.2.12 Encoder input 1



Location	X2 Encoder1 Mating connector: 9-pin male D-type		
Pin	**Name**	**Description**	**96-pin connector**
1	CHA+	Channel A signal	a8
2	CHB+	Channel B signal	c7
3	CHZ+	Index channel signal	c8
4	Shield	Shield connection	a32
5	DGND	Digital ground	a1
6	CHA-	Channel A signal complement	c9
7	CHB-	Channel B signal complement	a10
8	CHZ-	Index channel signal complement	a9
9	+5V out	Power supply to encoder	a1

See section 4.5.1 for specifications of the encoder inputs.

5.2.13 RS232 serial communication



Location	X4 Serial Mating connector: 9-pin female D-type		
Pin	**Name**	**Description**	**96-pin connector**
1	Shield	Shield connection	a32
2	RXD	Receive Data	a20
3	TXD	Transmitted Data	a21
4	*(NC)*	*(Not connected)*	a16*
5	DGND	Digital ground	a3
6	*(NC)*	*(Not connected)*	a17*
7	RTS	Request To Send	b21
8	CTS	Clear To Send	a22
9	DGND	Digital ground	a3

This serial connector carries the same signals as the serial connector on the NextMove ES control card. Do not use both serial connectors at the same time.

* Pins 4 and 6 are linked on the NextMove ES.

5.3 BPL010-502/503 backplane with opto-isolator card

These backplanes are provided with an additional plug in card which provides opto-isolation for many of the NextMove ES signals.

On BPL010-502, the general purpose digital outputs are PNP (current sourcing) outputs. The general purpose digital inputs are activated when a positive voltage is applied.

On BPL010-503, the general purpose digital outputs are NPN (current sinking) outputs. The general purpose digital inputs are activated when grounded.

There are two 96-pin connectors present on the opto-isolating backplane. The male connector accepts the opto-isolator card. The female 96-pin connector nearest the edge of the backplane accepts the NextMove ES card. The backplane will not operate without the opto-isolating card.

In the following sections, the signals AGND, DGND and Shield are listed with nominal corresponding pins on the 96-pin connector, although they are all electrically connected on the backplane. The OUT COM pin on connector X11 is not connected to ground.

All terminals labeled USR GND are electrically connected on the backplane, but are not connected to the AGND, DGND or Shield terminals. USR GND forms an independent common connection for the 0V side of the external power supply used for the digital inputs and outputs. It will be necessary to link the OUT COM or USR COM terminal to USR GND to allow the digital outputs to operate. However, the OUT COM and USR COM connectors have different purposes depending on model - see sections 5.3.6.1 and 5.3.6.2.

Some signals are duplicated on multiple identically named pins on the 96-pin connector. In these cases, only the lowest numbered pin is listed.

CAUTION: Some components are static sensitive devices. Take appropriate ESD precautions when handling the backplane.

5.3.1 Analog inputs

Location	X8 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
10	REL COM	Common relay contact	
9	REL NO	Normally open relay contact	
8	REL NC	Normally closed relay contact	
7	REL COM	Common relay contact	
6	Shield	Shield connection	a32
5	AIN1-	Analog input AIN1-	a27
4	AIN1+	Analog input AIN1+	c28
3	AGND	Analog ground	a30
2	AIN0-	Analog input AIN0-	a28
1	AIN0+	Analog input AIN0+	b28

The analog inputs on the backplane are connected directly to the NextMove ES and do not pass through any circuitry on the opto-isolator card. See section 4.3.1 for electrical specifications of the analog inputs.

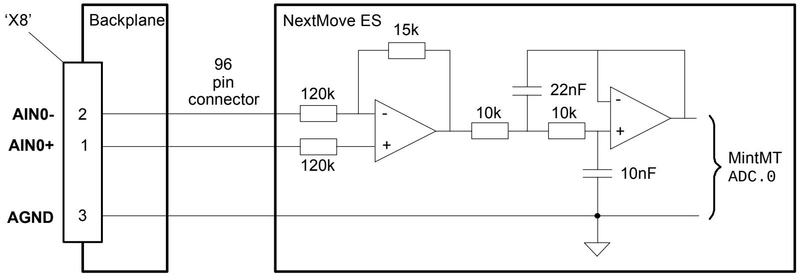


Figure 13 - Analog input, AIN0 shown

5.3.1.1 Error relay connections

The double-pole relay on the opto-isolator card is controlled directly by the Error Out signal (section 4.4.3), as shown in Figure 14.

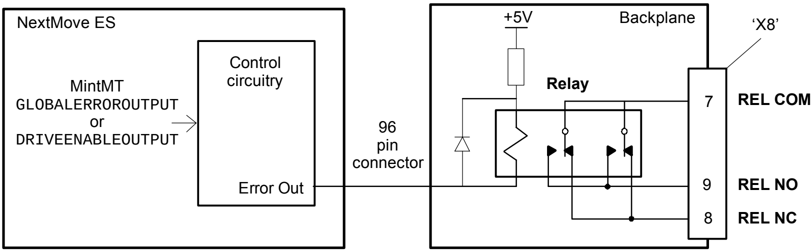


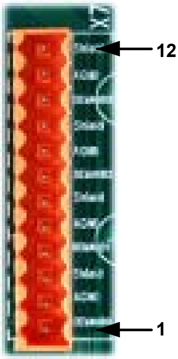
Figure 14 - Relay connections

The error output can be controlled by the `RELAY` keyword, and can be configured as the global error output by setting `GLOBALERROROUTPUT` to 1000 (`_RELAY0`). See the Mint MT help file.

While there is no error, the relay is energized, and REL COM is connected to REL NO. When an error occurs, the relay is de-energized, and REL COM is connected to REL NC.

CAUTION: It is important that the NextMove ES jumper settings are correct to allow it to control the backplane relay. JP4 must be fitted. Jumpers JP3 and JP5 must be removed. See section 4.4.3 for jumper locations.

5.3.2 Analog outputs (demands)



Location	X7 Mating connector: Weidmüller Omnimate BL 3.5/12		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
12	Shield	Shield connection	a32
11	AGND	Analog ground	a30
10	DEMAND3	Analog output AOUT3	b22
9	Shield	Shield connection	a32
8	AGND	Analog ground	a30
7	DEMAND2	Analog output AOUT2	b17
6	Shield	Shield connection	a32
5	AGND	Analog ground	a30
4	DEMAND1	Demand 1 output (AOUT1)	b27
3	Shield	Shield connection	a32
2	AGND	Analog ground	a30
1	DEMAND0	Demand 0 output (AOUT0)	c27

The outputs on the backplane are connected directly to the NextMove ES and do not pass through any circuitry on the opto-isolator card. See section 4.3.2 for electrical specifications of the analog outputs.

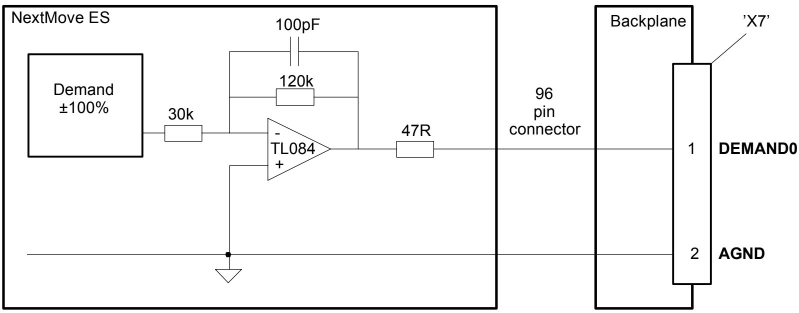
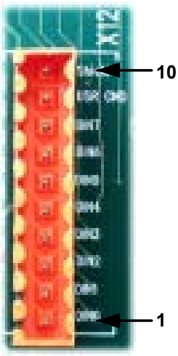


Figure 15 - Analog output, DEMAND0 shown

5.3.3 Digital inputs 0-7



Location	X12 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
10	Shield	Shield connection	a32
9	USR GND	Customer power supply ground	
8	DIN7	Digital input DIN7	a19
7	DIN6	Digital input DIN6	c20
6	DIN5	Digital input DIN5	b19
5	DIN4	Digital input DIN4	c18
4	DIN3	Digital input DIN3	c19
3	DIN2	Digital input DIN2	a18
2	DIN1	Digital input DIN1	b20
1	DIN0	Digital input DIN0	c21

The BPL010-502 and BPL010-503 opto-isolating cards use different input configurations. Sections 5.3.5.1 and 5.3.5.2 describe the two input types.

5.3.4 Digital inputs 8-15

Location	X13 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
10	Shield	Shield connection	a32
9	USR GND	Customer power supply ground	
8	DIN15	Digital input DIN15	b18
7	DIN14	Digital input DIN14	c23
6	DIN13	Digital input DIN13	b24
5	DIN12	Digital input DIN12	c26
4	DIN11	Digital input DIN11	a25
3	DIN10	Digital input DIN10	a24
2	DIN9	Digital input DIN9	b25
1	DIN8	Digital input DIN8	a26

The BPL010-502 and BPL010-503 opto-isolating cards use different input configurations. Sections 5.3.5.1 and 5.3.5.2 describe the two input types.

5.3.5 Digital inputs 16-19

Location	X6 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
10	Shield	Shield connection	a32
9	USR GND	Customer power supply ground	
8	USR GND	Customer power supply ground	
7	USR V+	Customer power supply	
6	USR V+	Customer power supply	
5	!RST IN	Reset input	c12
4	DIN19	Digital input DIN19	b26
3	DIN18	Digital input DIN18	c25
2	DIN17	Digital input DIN17	c24
1	DIN16	Digital input DIN16	c11

The BPL010-502 and BPL010-503 opto-isolating cards use different input configurations. Sections 5.3.5.1 and 5.3.5.2 describe the two input types.

5.3.5.1 BPL010-502 - Active high inputs

The user power supply connection USR GND is common to all inputs. To activate an input, a voltage must be applied that is sufficient to cause at least 5mA in the input circuit. To ensure that an input becomes inactive, the current must be less than 1mA.

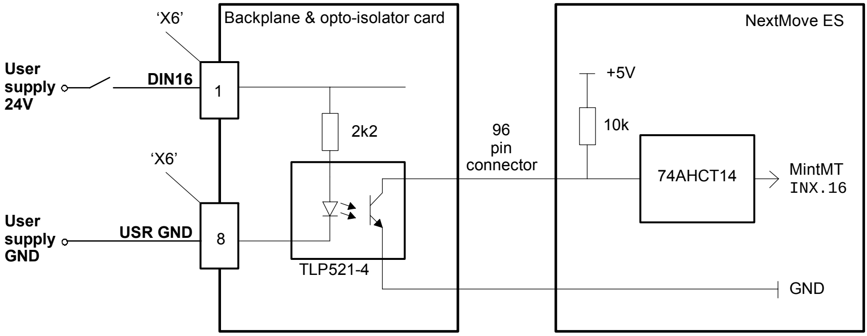


Figure 16 - Digital input circuit (DIN16) with 'active high' inputs

5.3.5.2 BPL010-503 - Active low inputs

The user power supply connection USR V+ is common to all inputs. To activate an input it must be grounded to the 0V side of the user power supply (USR GND). The internal pull-up resistor on the NextMove ES allows the input to be left floating when inactive or not being used.

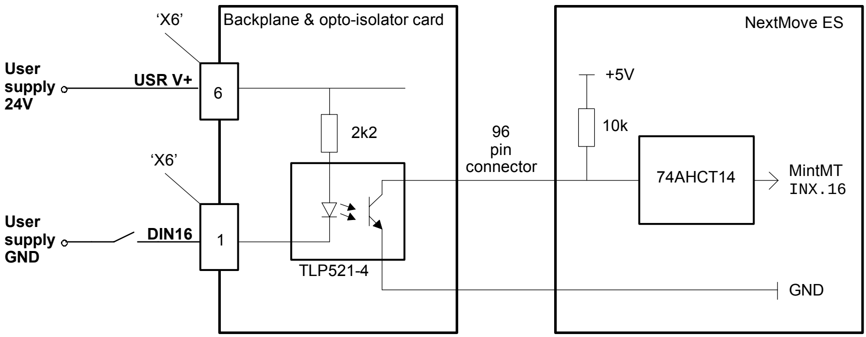


Figure 17 - Digital input circuit (DIN16) with 'active low' inputs

5.3.6 Digital outputs 0-7

Location	X11 Mating connector: Weidmüller Omnimate BL 3.5/10		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
10	USR COM	Common supply connection*	a3
9	OUT COM	Common*	a4
8	DOUT7	Digital output DOUT7	b4
7	DOUT6	Digital output DOUT6	c4
6	DOUT5	Digital output DOUT5	a5
5	DOUT4	Digital output DOUT4	b5
4	DOUT3	Digital output DOUT3	c5
3	DOUT2	Digital output DOUT2	a6
2	DOUT1	Digital output DOUT1	b6
1	DOUT0	Digital output DOUT0	c6

The digital outputs DOUT0 - DOUT7 are buffered by the opto-isolator card.

* The BPL010-502 and BPL010-503 opto-isolating cards use different output driver ICs, as shown in Figures 18 and 19. Due to the pin configuration of these ICs, the functions of the X11 connector's USR COM and OUT COM pins are different on the PNP and NPN cards.

Sections 5.3.6.1 and 5.3.6.2 describe the two output types.

CAUTION: Digital outputs DOUT8 - DOUT11 on connector X5 are *not* buffered by the opto-isolator card - see section 5.3.7.

5.3.6.1 BPL010-502 - PNP outputs

An external supply (typically 24VDC) is used to power the UDN2982 output devices, as shown in Figure 18. When an output is activated, current is sourced from the user supply through the UDN2982, which can source up to 75mA per output (all outputs on, 100% duty cycle). Connect OUT COM to the user supply GND. This will connect internal transient suppression diodes on all outputs. If an output is used to drive a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity (see Figure 20). The use of shielded cable is recommended.

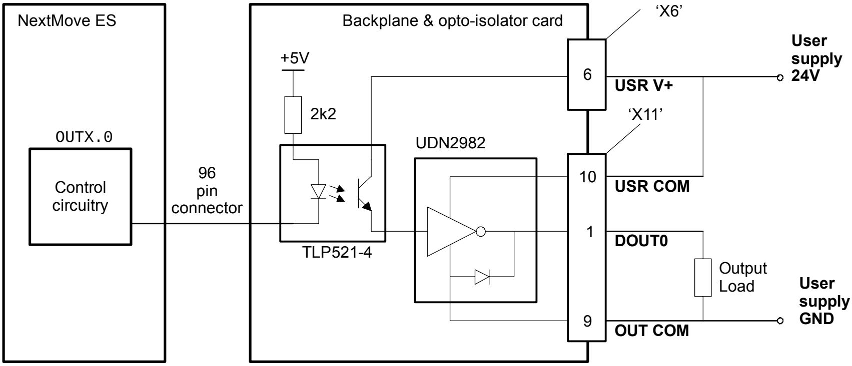


Figure 18 - Digital output circuit (DOUT0-7) with 'PNP' current sourcing module - DOUT0 shown

5.3.6.2 BPL010-503 - NPN outputs

An external supply (typically 24VDC) is used to power the UDN2803 output devices and drive the load, as shown in Figure 19. When an output is activated it is connected to USR COM through the ULN2803, which can sink up to 150mA per output (all outputs on, 100% duty cycle). Connect OUT COM to the user supply 24V. This will connect internal transient suppression diodes on all outputs. If an output is used to drive a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity (see Figure 20). The use of shielded cable is recommended.

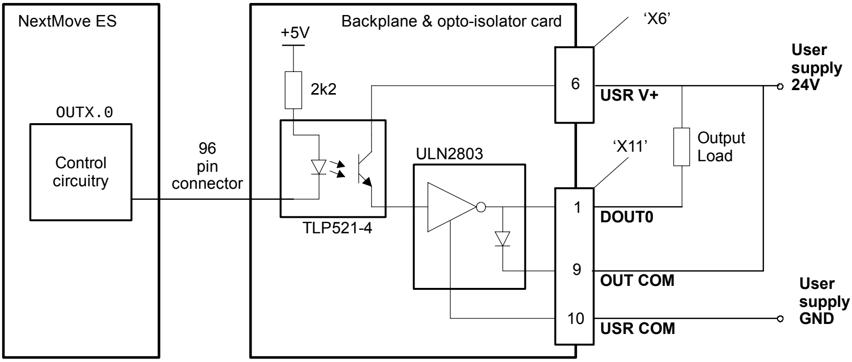
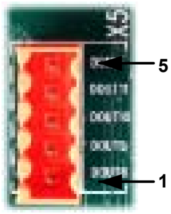


Figure 19 - Digital output circuit (DOUT0-7) with 'NPN' current sinking module - DOUT0 shown

5.3.7 Digital outputs 8-11



Location	X5 Mating connector: Weidmüller Omnimate BL 3.5/5		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
5	DGND	Digital ground	a3
4	DOUT11	Digital output DOUT11	c22
3	DOUT10	Digital output DOUT10	c16
2	DOUT9	Digital output DOUT9	b13
1	DOUT8	Digital output DOUT8	a13

CAUTION: Digital outputs DOUT8 - DOUT11 on the backplane are *not* buffered by the opto-isolator card; they are connected directly to the NextMove ES outputs.

When an output is activated, it is grounded through the ULN2003, which can sink up to 50mA per output (all outputs on, 100% duty cycle). If an output is used to drive a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity. This is to protect the output from the back-EMF generated by the relay coil when it is de-energized.

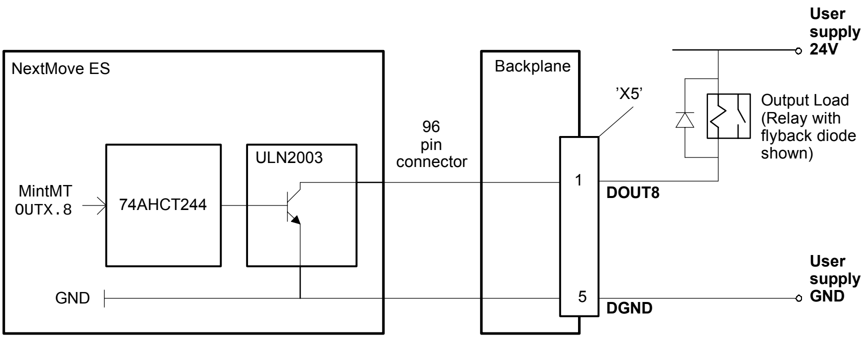
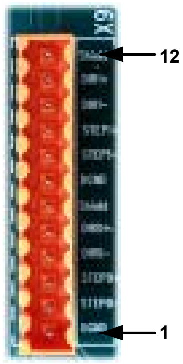


Figure 20 - Digital output circuit (DOUT8-11) - DOUT8 shown

5.3.8 Stepper axes outputs 0-1



Location	X9 Mating connector: Weidmüller Omnimate BL 3.5/12		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
12	Shield	Shield connection	a32
11	DIR1+	Direction output 1+	b15
10	DIR1-	Direction output 1-	
9	STEP1+	Step (pulse) output 1+	b14
8	STEP1-	Step (pulse) output 1-	
7	DGND	Digital ground	a3
6	Shield	Shield connection	a32
5	DIR0+	Direction output 0+	a15
4	DIR0-	Direction output 0-	
3	STEP0+	Step (pulse) output 0+	a14
2	STEP0-	Step (pulse) output 0-	
1	DGND	Digital ground	a3

The stepper outputs on the backplane are driven by DS26LS31 line drivers, providing RS422 differential outputs.

CAUTION: The DS26LS31 drivers are static sensitive devices. Take appropriate ESD precautions when handling the backplane.

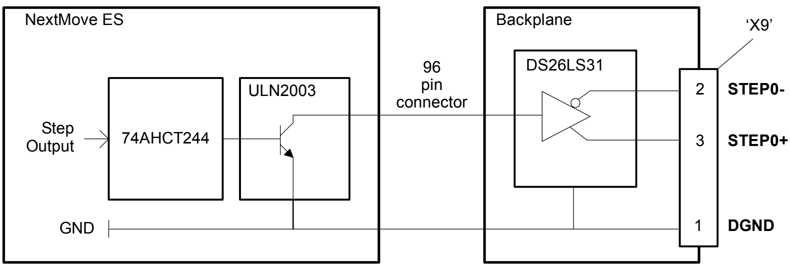
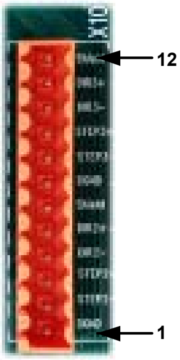


Figure 21 - Stepper output - STEP0 output shown

5.3.9 Stepper axes outputs 2-3



Location	X10 Mating connector: Weidmüller Omnimate BL 3.5/12		
Pin	**Name**	**Description**	**96-pin connector**
12	Shield	Shield connection	a32
11	DIR3+	Direction output 3+	a23
10	DIR3-	Direction output 3-	
9	STEP3+	Step (pulse) output 3+	b23
8	STEP3-	Step (pulse) output 3-	
7	DGND	Digital ground	a3
6	Shield	Shield connection	a32
5	DIR2+	Direction output 2+	c15
4	DIR2-	Direction output 2-	
3	STEP2+	Step (pulse) output 2+	c14
2	STEP2-	Step (pulse) output 2-	
1	DGND	Digital ground	a3

The stepper outputs on the backplane are driven by DS26LS31 line drivers, providing RS422 differential outputs.

CAUTION: The DS26LS31 drivers are static sensitive devices. Take appropriate ESD precautions when handling the backplane.

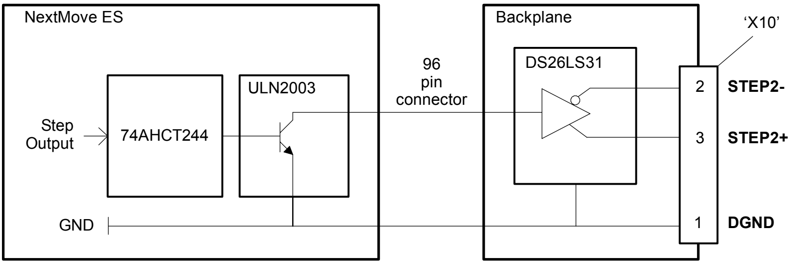
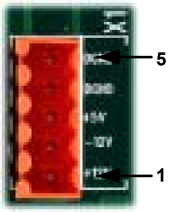


Figure 22 - Stepper output - STEP2 output shown

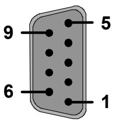
5.3.10 Power inputs



Location	X1 Mating connector: Weidmüller Omnimate BL 3.5/5		
Pin	**Name**	**Description**	**NextMove ES 96-pin connector**
5	DGND	Digital ground	a3
4	DGND	Digital ground	a3
3	+5	+5V input	a1
2	-12	-12V input	a31
1	+12	+12V input	a29

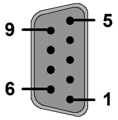
See section 3.1.3 for power requirements.

5.3.11 Encoder input 0



Location	X3 Encoder0 Mating connector: 9-pin male D-type		
Pin	**Name**	**Description**	**96-pin connector**
1	CHA+	Channel A signal	b7
2	CHB+	Channel B signal	a7
3	CHZ+	Index channel signal	b8
4	Shield	Shield connection	a32
5	GND	Digital ground	a3
6	CHA-	Channel A signal complement	b10
7	CHB-	Channel B signal complement	c10
8	CHZ-	Index channel signal complement	b9
9	+5V out	Power supply to encoder	a1

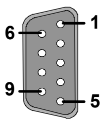
5.3.12 Encoder input 1



Location	X2 Encoder1 Mating connector: 9-pin male D-type		
Pin	**Name**	**Description**	**96-pin connector**
1	CHA+	Channel A signal	a8
2	CHB+	Channel B signal	c7
3	CHZ+	Index channel signal	c8
4	Shield	Shield connection	a32
5	GND	Digital ground	a1
6	CHA-	Channel A signal complement	c9
7	CHB-	Channel B signal complement	a10
8	CHZ-	Index channel signal complement	a9
9	+5V out	Power supply to encoder	a1

See section 4.5.1 for specifications of the encoder inputs.

5.3.13 RS232 serial communication



Location	X4 Serial Mating connector: 9-pin female D-type		
Pin	**Name**	**Description**	**96-pin connector**
1	Shield	Shield connection	a32
2	RXD	Receive Data	a20
3	TXD	Transmitted Data	a21
4	*(NC)*	*(Not connected)*	a16*
5	DGND	Digital ground	a3
6	*(NC)*	*(Not connected)*	a17*
7	RTS	Request To Send	b21
8	CTS	Clear To Send	a22
9	DGND	Digital ground	a3

This serial connector carries the same signals as the serial connector on the NextMove ES control card. Do not use both serial connectors at the same time.

* Pins 4 and 6 are linked on the NextMove ES.

6.1 Introduction

The software provided includes a number of applications and utilities to allow you to configure, tune and program the NextMove ES. The Baldor Motion Toolkit CD containing the software can be found separately within the packaging.

6.1.1 Connecting the NextMove ES to the PC

Connect the serial cable between a PC serial port (often labeled as “COM”) to the NextMove ES RS232 connector. WorkBench v5 can scan all the COM ports, so you can use any port. If you are not using the Baldor serial cable CBL001-501, your cable must be wired in accordance with Figure 8 in section 4.5.3.

6.1.2 Installing WorkBench v5

You will need to install WorkBench v5 to configure and tune the NextMove ES.

1. Insert the CD into the drive.
2. After a few seconds the setup wizard should start automatically. If the setup wizard does not appear, select Run... from the Windows Start menu and type

   d:\start

   where **d** represents the drive letter of the CD device.

   Follow the on-screen instructions to install WorkBench v5. The setup Wizard will copy the files to appropriate folders on the hard drive. The preset folder is C:\Program Files\Baldor\MintMT, although this can be changed during setup.

6.1.3 Starting the NextMove ES

If you have followed the instructions in the previous sections, you should have now connected power sources, your choice of inputs and outputs and the serial cable linking the PC with the NextMove ES.

6.1.4 Preliminary checks

Before you apply power for the first time, it is very important to verify the following:

- Disconnect the load from the motor until instructed to apply a load.
- Inspect all power connections for accuracy, workmanship and tightness.
- Verify that all wiring conforms to applicable codes.
- Verify that the NextMove ES is properly earthed/grounded.
- Check all signal wiring for accuracy.

6.1.5 Power on checks

If at any time the status display shows a digit and a flashing decimal point, this indicates that the NextMove ES has detected a fault - see section 7.

1. Turn on the 5V and ±12V supplies.
2. After a brief test sequence (8 followed by -.), the Status display should show the node number, for example 2 , the factory default. If the display is not lit then re-check the power supply connections. A green surface mount LED (D16) near the center of the NextMove ES should also be flashing once every two seconds. The NextMove ES is now ready to be configured using WorkBench v5.

Note: If the red LED (D4) near the center of the NextMove ES remains illuminated, then the supply voltage is too low. See section 7.2.2 for LED locations.

6.2 WorkBench v5

WorkBench v5 is a fully featured application for programming and controlling the NextMove ES. The main WorkBench window contains a menu system, the Toolbox and other toolbars. Many functions can be accessed from the menu or by clicking a button - use whichever you prefer. Most buttons include a 'tool-tip'; hold the mouse pointer over the button (don't click) and its description will appear.

6.2.1 Help file

WorkBench v5 includes a comprehensive help file that contains information about every MintMT keyword, how to use WorkBench and background information on motion control topics. The help file can be displayed at any time by pressing F1. On the left of the help window, the Contents tab shows the tree structure of the help file; each book contains a number of topics . The Index tab provides an alphabetic list of all topics in the file, and allows you to search for them by name. The Search tab allows you to search for words or phrases appearing anywhere in the help file. Many words and phrases are underlined and highlighted with a color (normally blue) to show that they are links. Just click on the link to go to an associated keyword. Most keyword topics begin with a list of relevant *See Also* links.

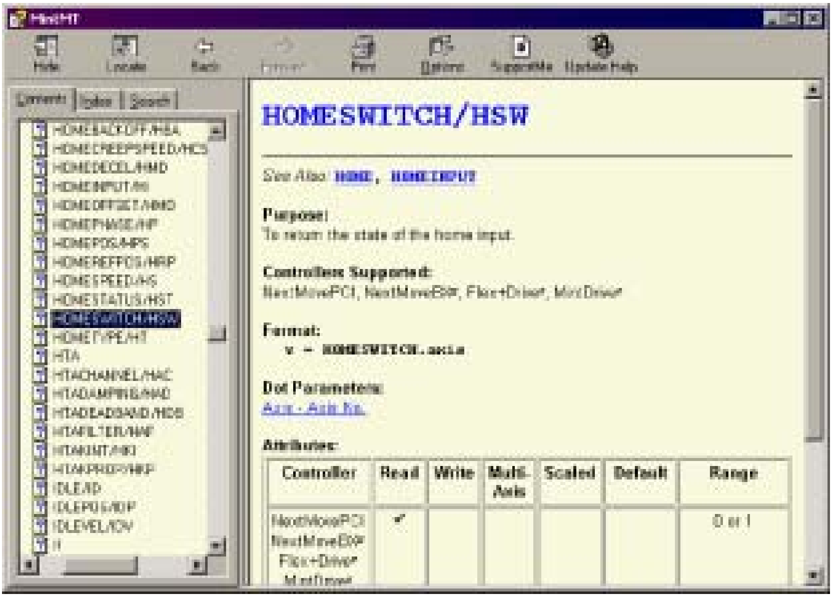


Figure 23 - The WorkBench help file

For help on using WorkBench v5, click the **Contents** tab, then click the small plus sign beside the **WorkBench v5** book icon. Double click a topic name to display it.

6.2.2 Starting WorkBench v5

1. On the Windows **Start** menu, select Programs, WorkBench v5, WorkBench v5.

   WorkBench v5 will start, and the Tip of the Day dialog will be displayed.

   You can prevent the Tip of the Day dialog appearing next time by removing the check mark next to Show tips at startup.

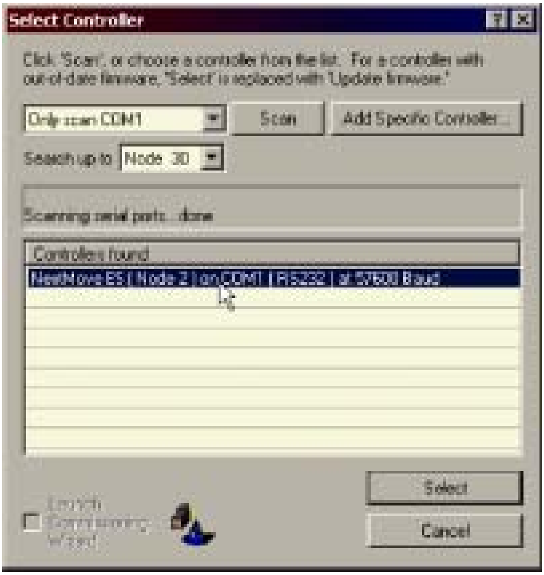
   Click **Close** to continue.

2. In the opening dialog box, click **Start New Project...**

3. In the Select Controller dialog, go to the drop down box near the top and select the PC serial port to which the NextMove ES is connected. If you are unsure which PC serial port is connected to the drive, select **Scan all serial ports**.

   Click **Scan** to search for the NextMove ES.

   When the search is complete, click ‘NextMove ES’ in the list to select it, and then click **Select**.



Note: If the NextMove ES is not listed, check the serial lead between the NextMove ES and the PC. Check that the NextMove ES is powered correctly. Click **Scan** to re-scan the ports.

4. A dialog box may be displayed to tell you that WorkBench v5 has detected new firmware. Click **OK** to continue. WorkBench v5 reads back data from the NextMove ES. When this is complete, Fine-tuning mode is displayed. This completes the software installation.

6.3 Configuring an axis

The NextMove ES is capable of controlling 4 stepper and 2 servo axes. This section describes the basic setup for both types of axis. Commands typed in the Command window have immediate effect - they do not need to be separately downloaded to the NextMove ES.

6.3.1 Selecting a scale

MintMT defines all positional and speed related motion keywords in terms of encoder quadrature counts (for servo motors) or steps for stepper motors. The number of quadrature counts (or steps) is divided by the `SCALE` factor allowing you to use units more suitable for your application. The unit defined by setting a value for scale is called the *user unit* (uu).

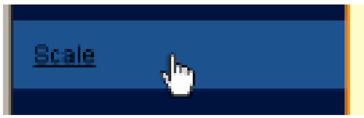
Consider a servo motor with a 1000 line encoder. This provides 4000 quadrature counts for each revolution. If `SCALE` is not set, a MintMT command that involves distance, speed, or acceleration may need to use a large number to specify a significant move. For example `MOVER=16000` (Move Relative) would rotate the motor by 16000 quadrature counts - only four revolutions. By setting a `SCALE` factor of 4000, the user unit becomes revolutions. The more understandable command `MOVER=4` could now be used to move the motor four revolutions.

The same concept applies to stepper motors, where the scale can be set according to the number of steps per revolution. Typically, this would be 200 for a motor with a 1.8° step angle, or 400 if driven in half step mode. By setting a `SCALE` factor of 200 (or 400 if driven in half step mode), the user unit becomes revolutions.

In applications involving linear motion a suitable value for `SCALE` would allow commands to express values in linear distance, for example inches, feet or millimetres.

1. In the Toolbox, click **Setup**, then click the Parameters icon.

2. Click the Scale tab.



3. Click in the Axis drop down box to select the axis. Each axis can have a different scale if required.

4. Click in the Scale box and type a value.

5. Click **Apply**.

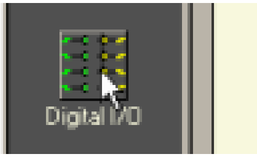
This immediately sets the scaling factor for the selected axis, which will remain in the NextMove ES until another scale is defined or power is removed from the NextMove ES.

6.3.2 Setting the drive enable output

A drive enable output allows NextMove ES to disable the external drive amplifier in the event of an error. Each axis can be configured with its own drive enable output, or can share an output with other axes. If an output is shared, an error on any of the axes sharing the output will cause all of them to be disabled.

The drive enable output can either be a digital output or the error output (see section 4.4.3). If the NextMove ES is connected to a Baldor backplane with opto-isolating card, the error output controls the relay.

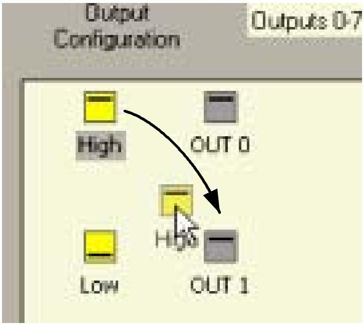
1. In the Toolbox, click the Digital I/O icon.



2. At the bottom of the Digital I/O screen, click the **Digital Outputs** tab.

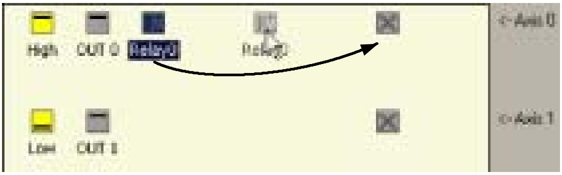
The left of the screen shows yellow High and Low icons. These describe how the output should behave when activated (to enable the axis).

3. If you are going to use the error output, ignore this step and go straight to step 4.



If you are going to use a digital output, drag the appropriate yellow icon to the grey OUT icon that will be used as the drive enable output. In this example, OUT1 is being used. The icon's color will change to bright blue.

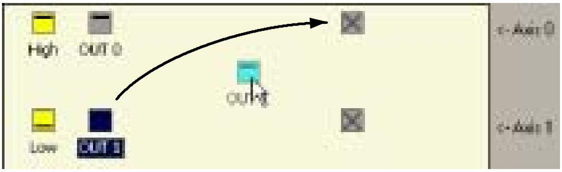
4. If you are going to use the error output, drag the Relay0 icon to the grey Drive Enable OP icon on the right of the screen.



Note: The error output is represented by the Relay0 icon. This is because the error output always controls a relay when the NextMove ES is used in conjunction with an opto-isolating backplane. When the NextMove ES is not used with an opto-isolating backplane, the Relay0 icon still represents the error output.

To configure multiple axes to use the error output, repeat this step for the other axes.

If you are using a digital output, drag the bright blue OUT icon to the grey Drv Enable OP axis icon on the right of the screen.



To configure multiple axes with the same drive enable output, repeat this step for the other axes.

5. Click **Apply** at the bottom of the screen. This sends the output configuration to the NextMove ES.

6.3.3 Testing the drive enable output

1. On the main WorkBench v5 toolbar, click the Axis 0 button. In the Select Default Axes dialog, select the axes to be controlled. Click **OK** to close the dialog.

2. On the main WorkBench v5 toolbar, click the Drive enable button. Click the button again. Each time you click the button, the drive enable outputs for the selected axes are toggled.

   When the button is in the pressed (down) position the drive amplifier should be enabled. When the button is in the raised (up) position the drive amplifier should be disabled.

   If this is not working, or the action of the button is reversed, check the electrical connections between the backplane and drive amplifier. If you are using the relay, check that you are using the correct normally open (REL NO) or normally closed (REL NC) connections.

   If you are using a digital output, check that it is using the correct high or low triggering method expected by the drive amplifier.

6.4 Stepper axis - testing

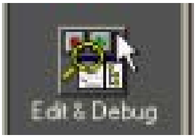
This section describes the method for testing a stepper axis. The stepper control is an open loop system so no tuning is necessary.

6.4.1 Testing the output

This section tests the operation and direction of the output. It is recommended that the system is initially tested with the motor shaft disconnected from other machinery.

1. Check that the Drive enable button is pressed (down).

2. In the Toolbox, click the Edit & Debug icon.



3. Click in the Command window.

4. Type:
   `JOG.0=2`

   where 0 is the axis (stepper output) to be tested and 2 is the speed.

   The `JOG` command specifies the speed in user units per second, so the speed is affected by `SCALE` (section 6.3.1). If you have not selected a scale, the command `JOG.0=2` will cause rotation at only 2 half steps per second, so it may be necessary to increase this figure significantly, to 200 for example. If you have selected a scale that provides user units of revolutions (as described in section 6.3.1) `JOG.0=2` will cause rotation at 2 revolutions per second. If there appears to be no step or direction output, check the electrical connections on the backplane.

5. To repeat the tests for reverse moves, type:
   `JOG.0 = -2`

6. To remove the demand and stop the test, type:
   `STOP.0`

6.5 Servo axis - testing and tuning

This section describes the method for testing and tuning a servo axis.

6.5.1 Testing the demand output

This section tests the operation and direction of the demand output for axis 4. By default, axis 4 is a servo axis (although it can be reconfigured as a stepper - see section A.1). It is recommended that the motor is disconnected for this test.

1. Check that the Drive enable button is pressed (down).

2. In the Toolbox, click **Application** then click the Edit & Debug icon.

3. Click in the Command window.

4. Type:
   `TORQUE.4=5`

   where 4 is the axis to be tested. In this example, this should cause a demand of +5% of maximum output (0.5V) to be produced at the DEMAND0 output (backplane connector X7, pin 1). In WorkBench v5, look at the Spy window located on the right of the screen. In the Axis selection box at the top, select Axis 4.

   The virtual LED Command display in the Spy window should show 5 percent (approximately). If there seems to be no command output, check the electrical connections on the backplane.

   The virtual LED Velocity display should show a positive value. If the value is negative check that the DEMAND0 output, and the Encoder0 A and B channels, have been wired correctly. If necessary, the `ENCODERMODE` keyword can be used to swap the encoder A and B channels - see the MintMT help file.

   By default, axis 4 uses demand output 0 and encoder 0, and axis 5 uses demand output 1 and encoder 1. See section 4.3.2 for details of the demand outputs.

5. To repeat the tests for negative (reverse) demands, type:
   `TORQUE.4=-5`

   This should cause a demand of -5% of maximum output (-0.5V) to be produced at the DEMAND0 output. Correspondingly, the virtual LED Velocity display should show a negative value.

6. To remove the demand and stop the test, type:
   `STOP.4`

   This should cause the demand produced at the DEMAND0 output to become 0V.

6.5.2 An introduction to closed loop control

This section describes the basic principles of closed loop control. If you are familiar with closed loop control go straight to section 6.6.1.

When there is a requirement to move an axis, the NextMove ES control software translates this into a demand output voltage. This is used to control the drive (servo amplifier) which powers the motor. An encoder or resolver on the motor is used to measure the motor's position. Every 1ms* (adjustable using the `LOOPTIME` keyword) the NextMove ES compares the demanded and measured positions. It then calculates the demand needed to minimize the difference between them, known as the **following error**.

This system of constant measurement and correction is known as closed loop control.
[*For the analogy, imagine you are in your car waiting at an intersection. You are going to go straight on when the lights change, just like the car standing next to you which is called* Demand*. You're not going to race* Demand *though - your job as the controller (NextMove ES) is to stay exactly level with* Demand, *looking out of the window to measure your position*].

The main term that the NextMove ES uses to correct the error is called **Proportional gain** (**KPROP**). A very simple proportional controller would simply multiply the amount of error by the Proportional gain and apply the result to the motor [*the further* Demand *gets ahead or behind you, the more you press or release the gas pedal*].

If the Proportional gain is set too high overshoot will occur, resulting in the motor vibrating back and forth around the desired position before it settles [*you press the gas pedal so hard you go right past* Demand. *To try and stay level you ease off the gas, but end up falling behind a little. You keep repeating this and after a few tries you end up level with* Demand, *travelling at a steady speed. This is what you wanted to do but it has taken you a long time*].
If the Proportional gain is increased still further, the system becomes unstable [*you keep pressing and then letting off the gas pedal so hard you never travel at a steady speed*].

To reduce the onset of instability, a term called **Velocity Feedback gain** (**KVEL**) is used. This resists rapid movement of the motor and allows the Proportional gain to be set higher before vibration starts. Another term called **Derivative gain** (**KDERIV**) can also be used to give a similar effect.

With Proportional gain and Velocity Feedback gain (or Derivative gain) it is possible for a motor to come to a stop with a small following error [Demand *stopped so you stopped too, but not quite level*]. The NextMove ES tries to correct the error, but because the error is so small the amount of torque demanded might not be enough to overcome friction.

This problem is overcome by using a term called **Integral gain** (**KINT**). This sums the error over time, so that the motor torque is gradually increased until the positional error is reduced to zero [*like a person gradually pushing harder and harder on your car until they've pushed it level with* Demand].

However, if there is large load on the motor (it is supporting a heavy suspended weight for example), it is possible for the output to increase to 100% demand. This effect can be limited using the `KINTLIMIT` keyword which limits the effect of KINT to a given percentage of the demand output. Another keyword called `KINTMODE` can even turn off integral action when it's not needed.

***** The 1ms sampling interval can be changed using the `LOOPTIME` keyword to either 500μs, 200μs or 100μs.

The remaining gain terms are **Velocity Feed forward** (**KVELFF**) and **Acceleration Feed forward** (**KACCEL**) described below.

In summary, the following rules can be used as a guide:

- KPROP: Increasing KPROP will speed up the response and reduce the effect of disturbances and load variations. The side effect of increasing KPROP is that it also increases the overshoot, and if set too high it will cause the system to become unstable. The aim is to set the Proportional gain as high as possible without getting overshoot, instability or hunting on an encoder edge when stationary (the motor will buzz).
- KVEL: This gain has a damping effect, and can be increased to reduce any overshoot. If KVEL becomes too large it will amplify any noise on the velocity measurement and introduce oscillations.
- KINT: This gain has a de-stabilizing effect, but a small amount can be used to reduce any steady state errors. By default, KINTMODE is set so that the KINT term is either ignored, or is only applied during periods of constant velocity.
- KINTLIMIT: The integration limit determines the maximum value of the effect of integral action. This is specified as a percentage of the full scale demand.
- KDERIV: This gain has a damping effect. The Derivative action has the same effect as the velocity feedback if the velocity feedback and feedforward terms are equal.
- KVELFF: This is a feed forward term and as such has a different effect on the servo system than the previous gains. KVELFF is outside the closed loop and therefore does not have an effect on system stability. This gain allows a faster response to demand speed changes with lower following errors, for example you would increase KVELFF to reduce the following error during the slew section of a trapezoidal move. The trapezoidal test move can be used to fine-tune this gain. This term is especially useful with velocity controlled servos
- KACCEL: This term is designed to reduce velocity overshoots on high acceleration moves.

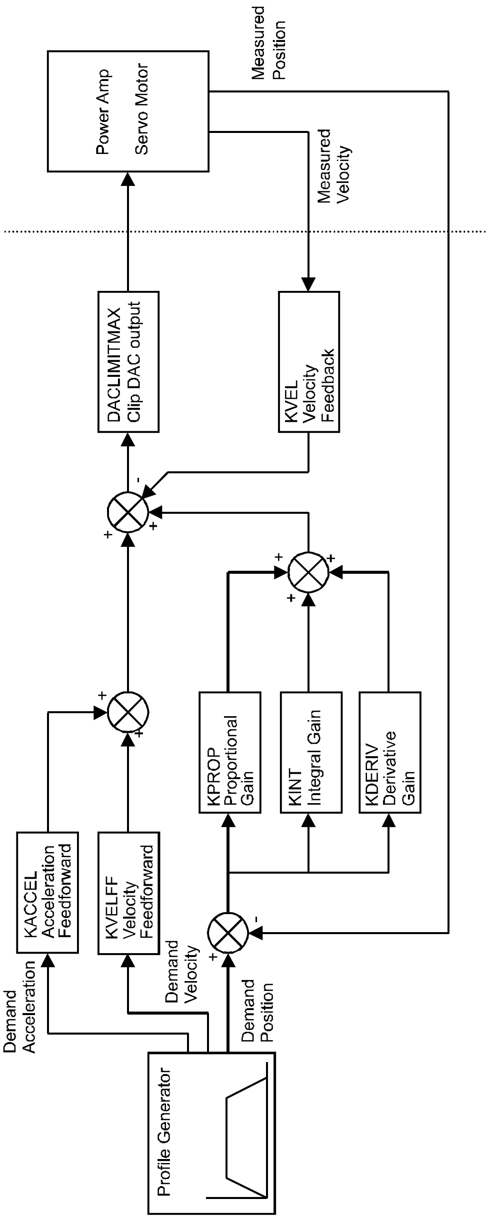


Figure 24 - The NextMove ES servo loop

6.6 Servo axis - tuning for current control

6.6.1 Selecting servo loop gains

All servo loop parameters default to zero, meaning that the demand output will be zero at power up. Most servo amplifiers can be set to current (torque) control mode or velocity control mode; check that the servo amplifier will operate in the correct mode. The procedure for setting system gains differs slightly for each. To tune an axis for velocity control, go straight to section 6.8. It is recommended that the system is initially tested and tuned with the motor shaft disconnected from other machinery. Confirm that the encoder feedback signals from the motor or servo amplifier have been connected.

Note: The method explained in this section should allow you to gain good control of the motor, but will not necessarily provide the optimum response without further fine-tuning. Unavoidably, this requires a good understanding of the effect of the gain terms.

1. In the Toolbox, click the Fine-tuning icon.

   The Fine-tuning window is displayed at the right of the screen. The main area of the WorkBench v5 window displays the Capture window. When tuning tests are performed, this will display a graph representing the response.

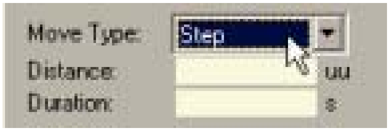
2. In the Fine-tuning window, click in the Axis selection box at the top and select Axis 4. By default, axis 4 is a servo axis (although it can be reconfigured as a stepper - see section A.1).

   Click in the KDERIV box and enter a starting value of 1.

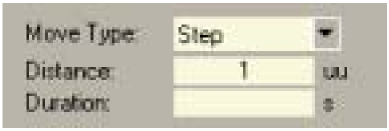
   Click **Apply** and then turn the motor shaft by hand. Repeat this process, slowly increasing the value of KDERIV until you begin to feel some resistance in the motor shaft. The exact value of KDERIV is not critical at this stage.

3. Click in the KPROP box and enter a value that is approximately one quarter of the value of KDERIV. If the motor begins to vibrate, decrease the value of KPROP or increase the value of KDERIV until the vibration stops. Small changes may be all that is necessary.

4. In the Move Type drop down box, check that the move type is set to Step.

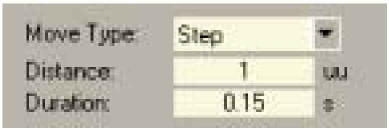


5. Click in the Distance box and enter a distance for the step move. It is recommended to set a value that will cause the motor to turn a short distance, for example one revolution.



Note: The distance depends on the scale set in section 6.3.1.
If you set a scale so that units could be expressed in revolutions (or other unit of your choice), then those are the units that will be used here. If you did not set a scale, the amount you enter will be in encoder counts.

6. Click in the Duration box and enter a duration for the move, in seconds. This should be a short duration, for example 0.15 seconds.



7. Click **Go**.

The NextMove ES will perform the move and the motor will turn. As the soon as the move is completed, WorkBench v5 will download captured data from the NextMove ES. The data will then be displayed in the Capture window as a graph.

Note: The graphs that you see will not look exactly the same as the graphs shown here! Remember that each motor has a slightly different response.

8. Using the check boxes below the graph, select the traces you require, for example Demand position and Measured position.

6.6.2 Underdamped response

If the graph shows that the response is underdamped (it overshoots the demand, as shown in Figure 25) then the value for KDERIV should be increased to add extra damping to the move. If the overshoot is excessive or oscillation has occurred, it may be necessary to reduce the value of KPROP.

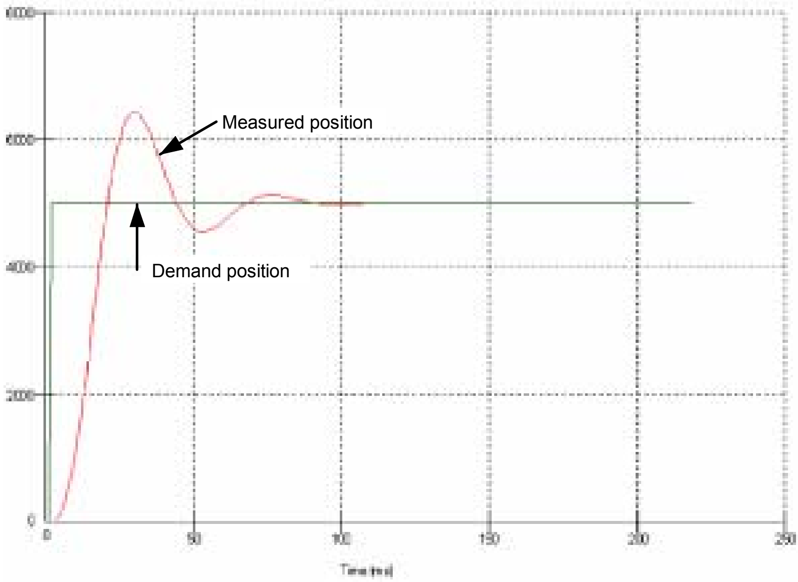


Figure 25 - Underdamped response

9. Click in the KDERIV and/or KPROP boxes and make the required changes. The ideal response is shown in section 6.6.4.

6.6.3 Overdamped response

If the graph shows that the response is overdamped (it reaches the demand too slowly, as shown in Figure 26) then the value for KDERIV should be decreased to reduce the damping of the move. If the overdamping is excessive, it may be necessary to increase the value of KPROP.

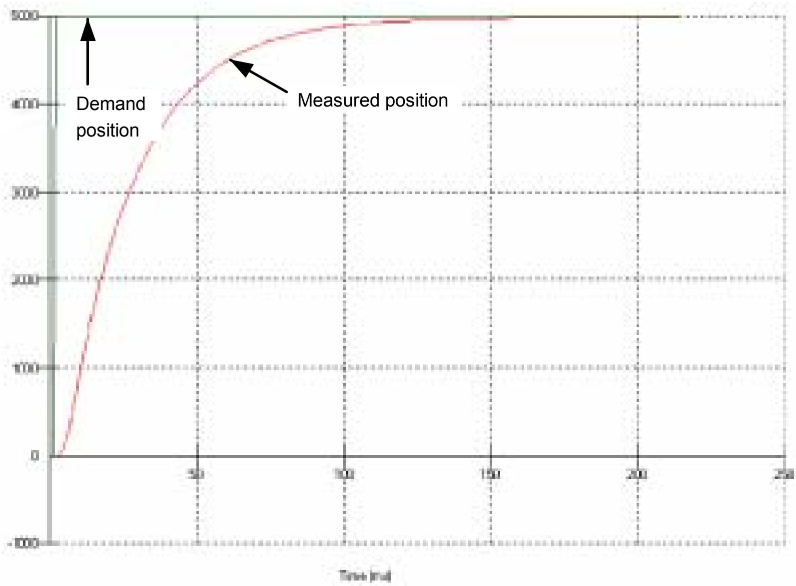


Figure 26 - Overdamped response

10. Click in the KDERIV and/or KPROP boxes and make the required changes. The ideal response is shown in section 6.6.4.

6.6.4 Critically damped response

If the graph shows that the response reaches the demand quickly and only overshoots the demand by a small amount, this can be considered an ideal response for most systems. See Figure 27.

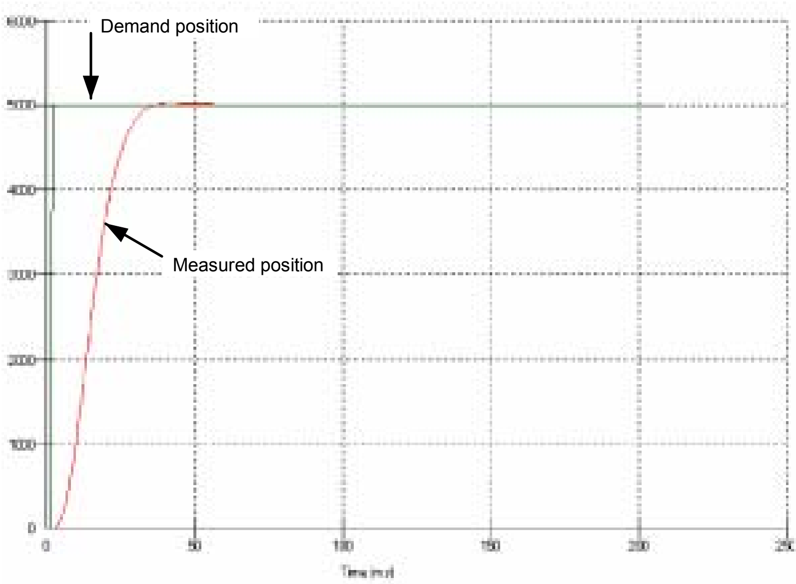


Figure 27 - Critically damped (ideal) response

6.7 Servo axis - eliminating steady-state errors

In systems where precise positioning accuracy is required, it is often necessary to position within one encoder count. Proportional gain, KPROP, is not normally able to achieve this because a very small following error will only produce a small demand for the drive which may not be enough to overcome mechanical friction (this is particularly true in current controlled systems). This error can be overcome by applying integral gain. The integral gain, KINT, works by accumulating following error over time to produce a demand sufficient to move the motor into the required position with zero following error.
KINT can therefore overcome errors caused by gravitational effects such as vertically moving linear tables. With current controlled drives a non-zero demand output is required to hold the load in the correct position, to achieve zero following error.

Care is required when setting KINT since a high value will cause instability during moves.
A typical value for KINT would be 0.1. The effect of KINT should also be limited by setting the integration limit, KINTLIMIT, to the smallest possible value that is sufficient to overcome friction or static loads, for example 5. This will limit the contribution of the integral term to 5% of the full demand output range.

1. Click in the KINT box and enter a small starting value, for example 0.1.

2. Click in the KINTLIMIT box and enter a value of 5.

With NextMove ES, the action of KINT and KINTLIMIT can be set to operate in various modes:

- Never - the KINT term is never applied
- Always - the KINT term is always applied
- Smart - the KINT term is only applied when the demand is zero or constant.

This function can be selected using the KINTMODE drop down box.

6.8 Servo axis - tuning for velocity control

Drives designed for velocity control incorporate their own velocity feedback term to provide system damping. For this reason, KDERIV (and KVEL) can be set to zero.

Correct setting of the velocity feed forward gain KVELFF is important to get the optimum response from the system. The velocity feed forward term takes the instantaneous velocity demand from the profile generator and adds this to the output block (see Figure 24). KVELFF is outside the closed loop and therefore does not have an effect on system stability. This means that the term can be increased to maximum without causing the motor to oscillate, provided that other terms are setup correctly.

When setup correctly, KVELFF will cause the motor to move at the speed demanded by the profile generator. This is true without the other terms in the closed loop doing anything except compensating for small errors in the position of the motor. This gives faster response to changes in demand speed, with reduced following error.

Before proceeding, confirm that the encoder feedback signals from the motor or servo amplifier have been connected.

6.8.1 Calculating KVELFF

To calculate the correct value for KVELFF, you will need to know:

- The speed, in revolutions per minute, produced by the motor when a maximum demand (+10V) is applied to the drive.
- The setting for `LOOPTIME`. The factory preset setting is 1ms.
- The number of encoder lines for the attached motor. Baldor BSM motors typically use either 1000 or 2500 line encoders.

The servo loop formula uses speed values expressed in *quadrature counts per servo loop*. To calculate this figure:

1. First, divide the speed of the motor, in revolutions per minute, by 60 to give the number of revolutions per second. For example, if the motor speed is 3000rpm when a maximum demand (+10V) is applied to the drive:

   Revolutions per second = 3000 / 60
   = <u>50</u>

2. Next, calculate how many revolutions will occur during one servo loop. The factory preset servo loop time is 1ms (0.001 seconds), so:

   Revolutions per servo loop = 50 x 0.001 seconds
   = <u>0.05</u>

3. Now calculate how many quadrature encoder counts there are per revolution. The NextMove ES counts both edges of both pulse trains (CHA and CHB) coming from the encoder, so for every encoder line there are 4 ‘quadrature counts’. With a 1000 line encoder:

   Quadrature counts per revolution = 1000 x 4
   = <u>4000</u>

4. Finally, calculate how many quadrature counts there are per servo loop:

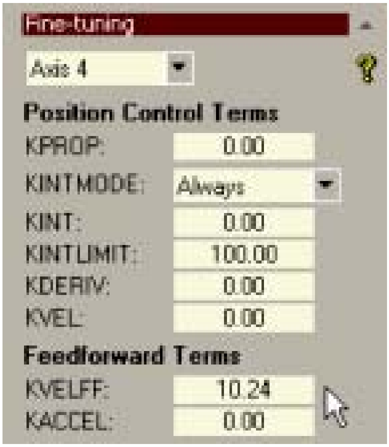
   Quadrature counts per servo loop = 4000 x 0.05
   = <u>200</u>

The analog demand output is controlled by a 12-bit DAC, which can create output voltages in the range -10V to +10V. This means a maximum output of +10V corresponds to a DAC value of 2048. The value of KVELFF is calculated by dividing 2048 by the number of quadrature counts per servo loop, so:

KVELFF	=	2048 / 200
	=	**<u>10.24</u>**

5. Click in the KVELFF box and enter the value.

   The calculated value should give zero following error at constant velocity. Using values greater than the calculated value will cause the controller to have a following error ahead of the desired position. Using values less than the calculated value will cause the controller to have following error behind the desired position.



6. In the Move Type drop down box, check that the move type is set to Trapezoid.

7. Click in the Distance box and enter a distance for the step move. It is recommended to set a value that will cause the motor to make a few revolutions, for example 10.

   Note: The distance depends on the scale set in section 6.3.1. If you set a scale so that units could be expressed in revolutions (or other unit of your choice), then those are the units that will be used here. If you did not set a scale, the amount you enter will be in encoder counts.

8. Click **Go**.

   The NextMove ES will perform the move and the motor will turn. As the soon as the move is completed, WorkBench v5 will download captured data from the NextMove ES. The data will then be displayed in the Capture window as a graph.

   Note: The graph that you see will not look exactly the same as the graph shown here! Remember that each motor has a slightly different response.

9. Using the check boxes below the graph, select the Measured velocity and Demand velocity traces.

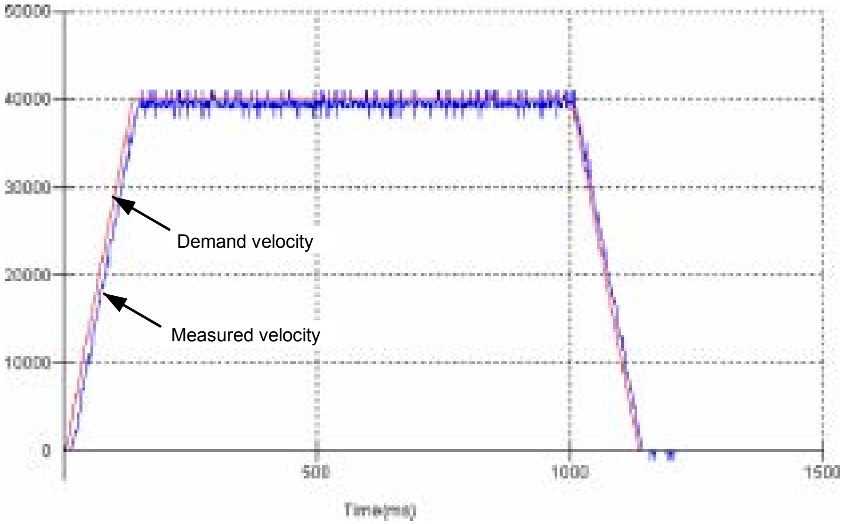


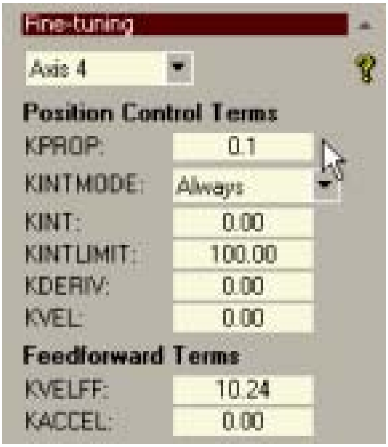
Figure 28 - Correct value of KVELFF

It may be necessary to make changes to the calculated value of KVELFF. If the trace for Measured velocity appears above the trace for Demand velocity, reduce the value of KVELFF. If the trace for Measured velocity appears below the trace for Demand velocity, increase the value of KVELFF. Repeat the test after each change. When the two traces appear on top of each other (approximately), the correct value for KVELFF has been found as shown in Figure 28.

6.8.2 Adjusting KPROP

The KPROP term can be used to reduce following error. Its value will usually be much smaller than the value used for an equivalent current controlled system. A fractional value, for example 0.1, will probably be a good starting figure which can then be increased slowly.

1. Click in the KPROP box and enter a starting value of 0.1.

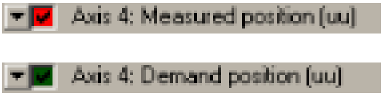


2. Click **Go**.

The NextMove ES will perform the move and the motor will turn. As the soon as the move is completed, WorkBench v5 will download captured data from the NextMove ES. The data will then be displayed in the Capture window as a graph.

Note: The graph that you see will not look exactly the same as the graph shown here! Remember that each motor has a slightly different response.

3. Using the check boxes below the graph, select the Measured position and Demand position traces.



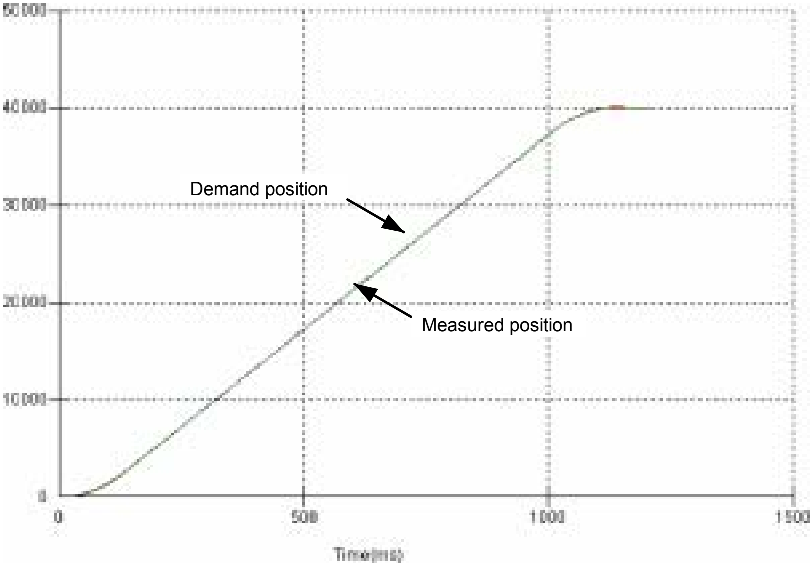


Figure 29 - Correct value of KPROP

The two traces will probably appear with a small offset from each other, which represents the following error. Adjust KPROP by small amounts until the two traces appear on top of each other (approximately), as shown in Figure 29.

Note: It may be useful to use the zoom function to magnify the end point of the move. In the graph area, click and drag a rectangle around the end point of the traces. To zoom out, right-click in the graph area and choose Undo Zoom.

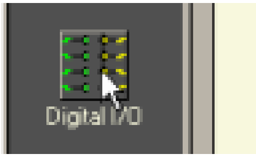
6.9 Digital input/output configuration

The Digital I/O window can be used to setup other digital inputs and outputs.

6.9.1 Digital input configuration

The Digital Inputs tab allows you to define how each digital input will be triggered, and if it should be assigned to a special purpose function such as a Home or Limit input. In the following example, digital input 1 will be set to trigger on a falling edge, and allocated to the forward limit input of axis 0:

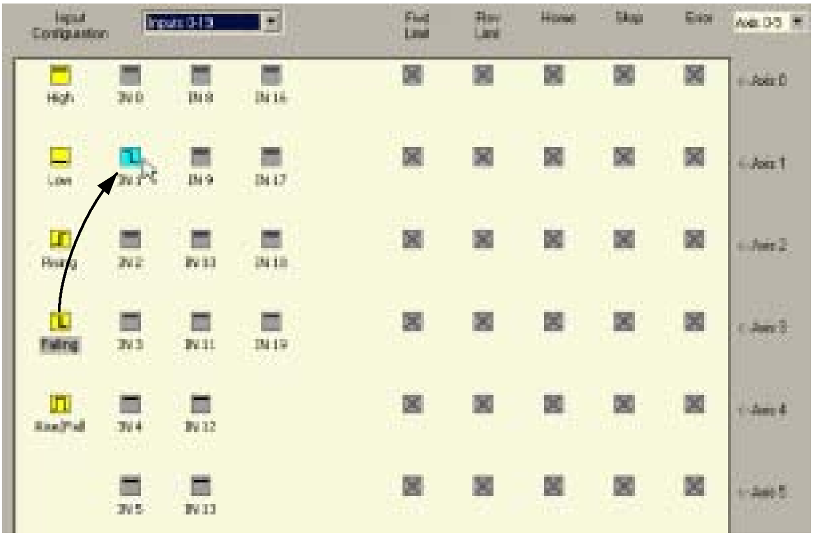
1. In the Toolbox, click the Digital I/O icon.



2. At the bottom of the Digital I/O screen, click the **Digital Inputs** tab.

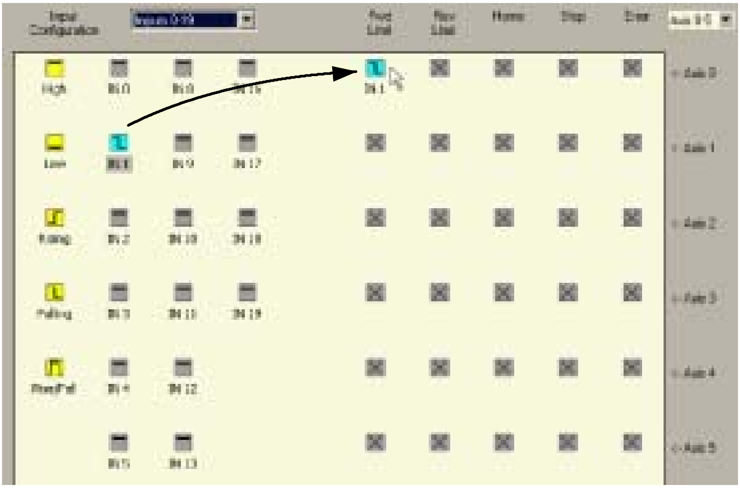
   The left of the screen shows a column of yellow icons - High, Low, Rising, Falling and Rise/Fall. These describe how the input will be triggered.

3. Drag the **Falling** icon  onto the **IN1** icon . This will setup IN1 to respond to a falling edge.



4. Now drag the **IN1** icon  onto the **Fwd Limit** icon .

This will setup IN1 as the Forward Limit input of axis 0.



5. Click **Apply** to send the changes to the NextMove ES.

Note: If required, multiple inputs can be configured before clicking **Apply**.

6.9.2 Digital output configuration

The Digital Outputs tab allows you to define how each digital output will operate and if it is to be configured as a drive enable output (see section 6.3.2). Remember to click **Apply** to send the changes to the NextMove ES.

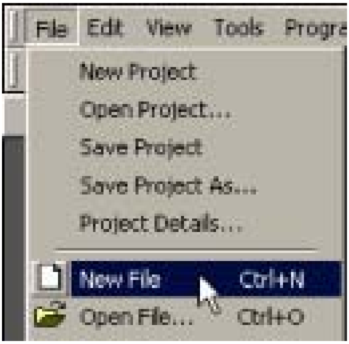
6.10 Saving setup information

When power is removed from the NextMove ES all data, including configuration and tuning parameters, is lost. You should therefore save this information in a file, which can be loaded when the card is next used. Alternatively, the information can be included in program files as part of the Startup block.

1. In the Toolbox, click the Edit & Debug icon.

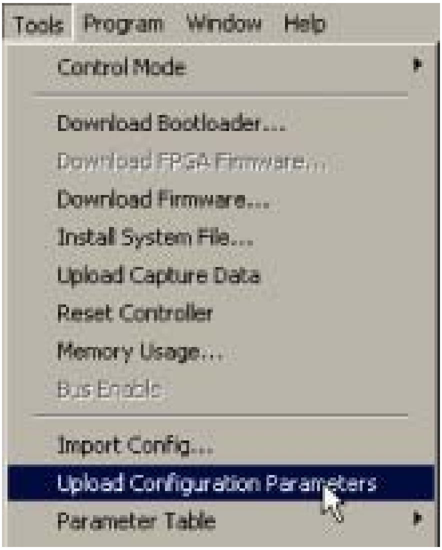
2. On the main menu, choose **File**, **New File**.

   A new program editing window will appear.



3. On the main menu, choose **Tools**, **Upload Configuration Parameters**.

   WorkBench v5 will read all the configuration information from the NextMove ES and place it in a Startup block. For details of the Startup block, see the MintMT help file.



4. On the main menu, choose **File**, **Save File**. Locate a folder, enter a filename and click **Save**.

6.10.1 Loading saved information

1. In the Toolbox, click the Edit & Debug icon.

2. On the main menu, choose **File**, **Open File...**
   Locate the file and click **Open**.

A Startup block should be included in every Mint program, so that whenever a program is loaded and run the NextMove ES will be correctly configured. Remember that every drive/motor combination has a slightly different response. If the same program is used on a different NextMove ES installation, the Startup block will need to be changed.

7.1 Introduction

This section explains common problems and their solutions.
If you want to know the meaning of the LED indicators, see section 7.2.

7.1.1 Problem diagnosis

If you have followed all the instructions in this manual in sequence, you should have few problems installing the NextMove ES. If you do have a problem, read this section first.
In WorkBench v5, use the Error Log tool to view recent errors and then check the help file.
If you cannot solve the problem or the problem persists, the SupportMe feature can be used.

7.1.2 SupportMe feature

The SupportMe feature is available from the Help menu, or by clicking the button on the motion toolbar. SupportMe can be used to gather information which can then be e-mailed, saved as a text file, or copied to another application. The PC must have e-mail facilities to use the e-mail feature. If you prefer to contact Baldor technical support by telephone or fax, contact details are provided at the front of this manual. Please have the following information ready:

- The serial number of your NextMove ES (if known).
- Use the Help, SupportMe menu item in WorkBench v5 to view details about your system.
- The type of servo amplifier and motor that you are using.
- A clear description of what you are trying to do, for example performing fine-tuning.
- A clear description of the symptoms that you can observe, for example error messages displayed in WorkBench v5, or the current value of any of the Mint error keywords `AXISERROR`, `AXISSTATUS`, `INITERROR`, and `MISCERROR`.
- The type of motion generated in the motor shaft.
- Give a list of any parameters that you have setup, for example the gain settings you have entered.

7.2 NextMove ES indicators

7.2.1 Status display

The Status LED normally displays the unit's node number. To display information about a specific axis, use the `LED` keyword (see the MintMT help file). When a specific axis is selected, the following symbols may be displayed by the Status LED. Some characters will flash to indicate an error.

2	Spline. A spline move is being performed. See the `SPLINE` keyword and related commands.
8	Axis enabled.
q	Torque mode. The NextMove ES is in Torque mode. See the `TORQUE` keyword and related commands.
A	Hold to Analog. The axis is in Hold To Analog mode. See the `HTA` keyword and related commands.
a	Follow and offset. When an axis is following a demand signal it may be necessary to advance or retard the slave in relation to the master. To do this an offset move is performed in parallel with the follow. See the `FOLLOW` and `OFFSET` keywords.
C	Circle. A circle move is being performed. See the `CIRCLEA` or `CIRCLER` keywords.
c	Cam. A Cam profile is being profiled. See the `CAM` keyword.
E.	General error. See the `AXISERROR` keyword. The motion toolbar displays the status of `AXISERROR`, which is a bit pattern of all latched errors. See also the *Error Log* topics in the help file.
e.	Error input. The `ERRORINPUT` has been activated and generated an error.
F	Flying shear. A flying shear is being profiled. See the `FLY` keyword.
F.	Position following error. A following error has occurred. See the `AXISERROR` keyword and associated keywords. Following errors could be caused by a badly tuned drive/motor. At higher acceleration and deceleration rates, the following error will typically be greater. Ensure that the drive/motor is adequately tuned to cope with these acceleration rates. The following error limit can be adjusted to suit your application (see the `FOLERRORFATAL` and `VELFATAL` keywords). Following error could also be the cause of encoder/resolver loss (see also the `FEEDBACKFAULTENABLE` keyword).
ɟ	Follow mode. The axis is in Follow mode. See the `FOLLOW` keyword.
h	Homing. The axis is currently homing. See the `HOME` keyword.
I	Incremental move. An incremental move is being profiled. See the `INCA` and `INCR` keywords.
J	Jog. The axis is jogging. In the Mint help file, see the topics `JOG`, `JOGCOMMAND` and *Jog mode*.

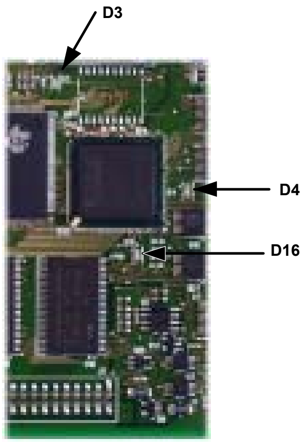
o	Offset move. The axis is performing an offset move.
P	Positional Move. The axis is performing a linear move. See the `MOVEA` and `MOVER` keywords.
S	Stop. A `STOP` command has been issued or the stop input is active.
-	Axis disabled. The axis/drive must be enabled before operation can continue. See section 6.3.3. Click the **Drive enable** button in WorkBench v5.
=	Suspend. The `SUSPEND` command has been issued and is active. Motion will be ramped to zero demand whilst active.
r.	Reverse software or hardware limit. A reverse software limit has been activated. See `AXISERROR` and/or `AXISSTATUS` to determine which applies.
-|.	Forward software or hardware limit. A forward software limit has been activated. See `AXISERROR` and/or `AXISSTATUS` to determine which applies.
≡	Firmware being updated (horizontal bars appear sequentially). New firmware is being downloaded to the NextMove ES.
i.	Initialization error. An initialization error has occurred at power on. See the *Error Log* or `INITERROR` topics in the help file. Initialization errors should not normally occur.

When a node number between 1 and 15 is displayed, it is shown in hexadecimal format (1 - F). For node numbers greater than 15, three horizontal bars are displayed. User defined symbols can be made to appear using the keywords `LED` and `LEDDISPLAY`.

See the MintMT help file for details of each keyword.

7.2.2 Surface mount LEDs D3, D4 and D16

The NextMove ES card contains a number of surface mount LEDs that indicate hardware status:



D3 (yellow):
Indicates that the FPGA is being initialized at startup.

D4 (red):
Indicates that the card is in a hardware reset. If this LED remains illuminated after power up, the supply voltage to the card is too low. Check power supply connections.

D16 (flashing green):
Flashes at 0.5Hz to indicate normal operation.

7.2.3 Communication

If the problem is not listed below please contact Baldor Technical Support.

Symptom	Check
Cannot detect NextMove ES	Check that the NextMove ES is powered. Check that the serial lead is wired correctly and properly connected. Check that no other application on the PC is attempting to use the same serial port.
Cannot communicate with the controller.	Verify that WorkBench v5 is loaded and that NextMove ES is the currently selected controller. Check that the NextMove ES card is correctly connected to the backplane.

7.2.4 Motor control

Symptom	Check
Controller appears to be working but will not cause motor to turn.	Check that the connections between motor and drive are correct. Use WorkBench v5 to perform the basic system tests (see section 6.5 or 6.4). Ensure that while the NextMove ES is not in error the drive is enabled and working. When the NextMove ES is first powered up the drive should be disabled if there is no program running (there is often an LED on the front of the drive to indicate status). *(Servo outputs only)* Check that the servo loop gains are setup correctly - check the Fine-tuning window. See sections 6.5.2 to 6.7.
Motor runs uncontrollably when controller is switched on.	Verify that the backplane (if used) and drive are correctly grounded to a common earth point. *(Servo outputs only)* Check that the correct encoder feedback signal is connected to the encoder input, the encoder has power (if required, see section 5.2.11) and is functioning correctly. Check that the drive is connected correctly to the NextMove ES and that with zero demand there is 0V at the drive's demand input. See section 6.5.1.

Symptom	Check
Motor runs uncontrollably when controller is switched on and servo loop gains are applied or when a move is set in progress. Motor then stops after a short time.	*(Servo outputs only)* Check that the encoder feedback signal(s) are connected to the correct encoder input(s). Check the demand to the drive is connected with the correct polarity. Check that for a positive demand signal, a positive increase in axis position is seen. The `ENCODERMODE` keyword can be used to change encoder input direction. The `DACMODE` keyword can be used to reverse DAC output polarity. Check that the maximum following error is set to a reasonable value. For setting up purposes, following error detection may be disabled by setting `FOLERRORMODE = 0`.
Motor is under control, but vibrates or overshoots during a move.	*(Servo outputs only)* Servo loop gains may be set incorrectly. See sections 6.5.2 to 6.7.
Motor is under control, but when moved to a position and then back to the start it does not return to the same position.	Verify that the backplane and drive are correctly grounded to a common earth point. *(Servo outputs only)* Using an oscilloscope at the backplane connectors, check: ■ all encoder channels are free from electrical noise; ■ they are correctly wired to the controller; ■ when the motor turns, the two square wave signals are 90 degrees out of phase. Also check the complement signals. Ensure that the encoder lead uses shielded twisted pair cable and that the shield is connected only at the backplane end. *(Stepper outputs only)* The motor is not maintaining synchronization with the NextMove ES drive output signals due to excessive acceleration, speed or load demands on the motor. Check that the acceleration, speed and load are within the capabilities of the motor.

8.1 Introduction

This section provides technical specifications of the NextMove ES card. Separate specifications for the optional opto-isolating backplanes are shown where necessary.

8.1.1 Input power

Description	**Value**
Input power	+5V, 1A +12V, 50mA -12V, 50mA

8.1.2 Analog inputs

Description	**Unit**	**Value**
Type		Differential
Common mode voltage range	**VDC**	±10
Input impedance	**kΩ**	120
Input ADC resolution	**bits**	12 (includes sign bit)
Equivalent resolution (±10V input)	**mV**	±4.9
Sampling interval	**μs**	500 (both inputs enabled) 250 (one input disabled)

8.1.3 Analog outputs

Description	**Unit**	**Value**
Type		Bipolar
Output voltage range	**VDC**	±10
Output current (maximum)	**mA**	10
Output DAC resolution	**bits**	12
Equivalent resolution	**mV**	±4.9
Update interval	**ms**	1

8.1.4 Digital inputs (non-isolated)

This specification is for the NextMove ES card when used separately or in conjunction with the optional non-isolating backplane BPL010-501:

Description	**Unit**	**Value**
Type		+5V inputs, non-isolated
Input voltage Maximum Minimum High Low	**VDC**	 5.5 0 >3.5V <1.5V
Input current (approximate, per input)	**mA**	0.5
Sampling interval	**ms**	1

8.1.5 Digital inputs (opto-isolated)

This specification is for the optional opto-isolating backplanes BPL010-502 or BPL010-503, when used in conjunction with the NextMove ES card.

Description	**Unit**	**Value**
Type		Opto-isolated
USR V+ supply voltage Maximum Minimum	**VDC**	 30 12
Input voltage BPL010-502 ‘active high’ inputs BPL010-503 ‘active low’ inputs	**VDC**	 Active: >12V Inactive: <2V Active: 0V Inactive: Unconnected
Input current (maximum per input, USR V+ = 24V)	**mA**	10

8.1.6 Digital outputs - general purpose (non-isolated)

This specification is for the NextMove ES card when used separately or in conjunction with the optional non-isolating backplane BPL010-501:

Description	**Unit**	**Value**
Load supply voltage (maximum)	**V**	50
Output current Max. sink per output, one output on Max. sink per output, all outputs on	**mA**	DOUT0-7 DOUT8-11 500 400 150 50
Update interval		Immediate

8.1.7 Digital outputs - general purpose (opto-isolated)

This specification is for the optional opto-isolating backplanes BPL010-502 or BPL010-503, when used in conjunction with the NextMove ES card.

Description	**Unit**	**Value**
USR V+ supply voltage Maximum Minimum	**VDC**	 30V 12V
Output current (BPL010-502) Max. source per output, one output on Max. source per output, all outputs on	**mA**	DOUT0-7 DOUT8-11 350 400 75 50
Output current (BPL010-503) Max. sink per output, one output on Max. sink per output, all outputs on	**mA**	DOUT0-7 DOUT8-11 500 400 150 50
Update interval		Immediate

8.1.8 Digital output - error output (non-isolated)

This specification is for the NextMove ES card when used separately or in conjunction with the optional non-isolating backplane BPL010-501:

Description	**Unit**	**Value**
Output voltage	**V**	5
Output current (maximum)	**mA**	100
Update interval		Immediate

8.1.9 Error relay (opto-isolated backplanes)

This specification is for the optional opto-isolating backplanes BPL010-502 or BPL010-503, when used in conjunction with the NextMove ES card. See sections 4.4.3 and 5.3.1.1.

All models	Unit	All models
Contact rating (resistive)		2A @ 28VDC or 0.5A @ 125VAC
Operating time (max)	**ms**	6

8.1.10 Encoder inputs

Description	Unit	Value
Encoder input		RS422 A/B Differential, Z index
Maximum input frequency (quadrature)	**MHz**	20
Output power supply to encoders		5V, 500mA max.
Maximum recommended cable length		30.5m (100ft)

8.1.11 Stepper control outputs

Description	Unit	Value
Output type		RS422 step (pulse) and direction
Maximum output frequency	**MHz**	3
Output current (maximum sink, per output)	**mA**	100

8.1.12 CAN interface

Description	Unit	Value
Signal		2-wire, isolated
Channels		2
Protocols		CANopen Baldor CAN (with optional firmware)
Bit rates	**Kbit/s**	10, 20, 50, 100, 125, 250, 500

8.1.13 Environmental

Description	**Unit**		
Operating temperature range		**Min**	**Max**
	°C	0	+40
	°F	+32	+104
Maximum humidity	**%**	80% for temperatures up to 31°C (87°F) decreasingly linearly to 50% relative humidity at 40°C (104°F), non-condensing (according to DIN40 040 / IEC144)	
Maximum installation altitude (above m.s.l.)	**m**	2000	
	ft	6560	

See also section 3.1.1.

8.1.14 Weights and dimensions

Description	**Value**
Weight	Approximately 140g (0.3lb)
Nominal overall dimensions	160mm x 100mm (6.3in x 3.937in)

A.1 Axis renumbering

The factory preset axis numbering assigns axes 0 - 3 as stepper axes and axes 4 and 5 as servo axes. However, it is possible to alter the axis numbering scheme. For example, you might wish axes 0 and 1 to refer to the servo axes, and axes 2 to 5 to refer to the stepper axes. There are certain hardware limitations that must be considered when altering the axis numbering scheme:

- A maximum of two servo axes and 4 stepper axes may be assigned.
- Axes 0 and 4 share an internal hardware channel. This means they cannot both be servo or stepper axes. If one is servo, the other must be stepper. The servo demand output for axis 0 or 4 is always the DEMAND0 output, with Encoder0 as the feedback channel. The stepper output is always STEP0.
- Axes 1 and 5 share an internal hardware channel. This means they cannot both be servo or stepper axes. If one is servo, the other must be stepper. The servo demand output for axis 1 or 5 is always the DEMAND1 output, with Encoder1 as the feedback channel. The stepper output is always STEP1.
- Axes 2 and 3 are always stepper axes; they cannot be reassigned as servo axes. Their outputs are STEP2 and STEP3 respectively.

Before axes can be reassigned, they must be turned off. This removes their existing servo / stepper assignments and inhibits their electrical outputs. In the following example, axis 4 will be reassigned as a stepper axis, and axis 0 as a servo axis:

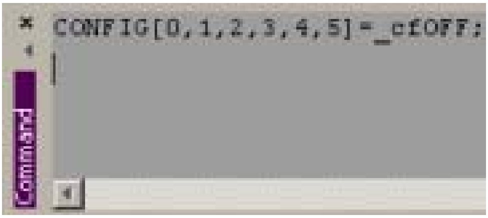
1. In the Toolbox, click **Application**, then click the Edit & Debug icon.

2. Click in the Command window.

3. Type the command:

   CONFIG[0,1,2,3,4,5]=_cfOFF;

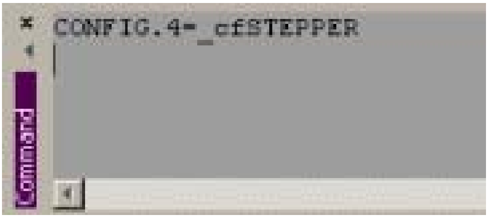
   This will turn off all axes. There will now be no electrical output for any of the axes.



4. Now type:

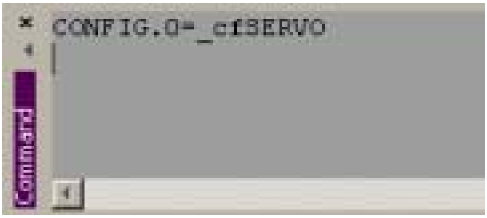
   CONFIG.4=_cfSTEPPER

   where 4 is the axis to be configured. Press Enter to enter the value. This immediately configures axis 4 to be a stepper axis.



5. To configure axis 0 as a servo axis, type:

   CONFIG.0=_cfSERVO



Other axes can be assigned as required, subject to the limitations described above. It is recommended that unused axes are always turned off. This provides more processing time for the axes that are in use. Attempting to assign an axis when there is not an appropriate hardware channel available, or the axis is already in use, will result in a “Hardware channel required is in use” or “Hardware not available” error message. See the MintMT help file for details of the CONFIG and AXISCHANNEL keywords.

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If you have any suggestions for improvements to this manual, please let us know. Write your comments in the space provided below, remove this page from the manual and mail it to:

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Thank you for taking the time to help us.

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