NextMove BX

Installation Manual for Mint v4

Issue 4.0

MN1258V4 08/2000

Mint
THE MOTION LANGUAGE

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Safety Notice: **Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.**

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

Precautions:

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

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

⚠ **WARNING: Be sure that you are completely familiar with the safe 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 programming of this equipment can cause serious or fatal injury. Only qualified personnel should attempt to program, start-up or troubleshoot this equipment.**

⚠ **WARNING: Be sure all wiring complies with the National Electrical Code and all regional and local codes. Improper wiring may result in unsafe conditions.**

⚠ **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. Only qualified personnel should attempt to program, start-up or troubleshoot this equipment.**

⚠ **WARNING:** **Improper operation or programming of the control 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.**

⚠ **WARNING:** **The motor shaft will rotate during the homing procedure. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment.**

⚠ **CAUTION:** **To prevent equipment damage, be certain that the input power has correctly sized protective devices installed.**

⚠ **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 controller are shielded correctly.**

⚠ **CAUTION:** **Avoid locating this equipment above or beside heat generating equipment or below water steam pipes.**

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

Manual Revision History

Issue	Date	BOCL Reference	Comments
1.0	May 1998	MN00278-000	First release of Installation Manual comprising: • NextMove BX Overview • Getting Started Guide • *cTERM* for Windows User Guide • NextMove BX Hardware Guide
1.01	Sept 1998	MN00278-001	KeypadNode 4 information included.
1.02	Nov 1998	UM00507-000	New revision raised. Format improvements made.
4.0	August 2000	UM00580-000	New version of manual to support Mint v4 on NextMove BX. New BOCL reference UM00580. Modified MN reference MN1258V4.

Read Me First

1

This chapter provides an overview of the manual and symbols used throughout this document.

This manual is intended for use with NextMove BX running Mint v4. If Mint v3 is being used, then the NextMove BX installation manual MN1258 should be used in preference. The hardware details are common between these manuals but the software references are different.

1.1 Key to Symbols Used in this Manual

Throughout this section various icons and conventions are used to indicate specific functions:

- 🪛 The screwdriver icon indicates that it is necessary to make a physical connection to NextMove BX by way of the screw terminations on the front panel of the controller.
- 💾 The disk icon together with filename is used to indicate that a MINT program (the motion control language used to program NextMove BX) should be downloaded to the controller. The filename indicates the name of the buffer.
- > The prompt icon indicates that the following commands should be typed in directly to the terminal at the MINT P> or C> prompt.
- **`[Ctrl]+[E]`** Type **`Ctrl`** and **`E`** at the same time.

Product Overview

2

A brief overview of NextMove BX and the software tools available on the Baldor Motion Toolkit.

NextMove BX is an intelligent servo motion controller which supports up to four servo axes. It is supplied in an metal enclosure for the convenience of those customers who do not wish to install a rack system for a single card. For other situations the board is available in a 6U rack mounting format (NextMove RK).

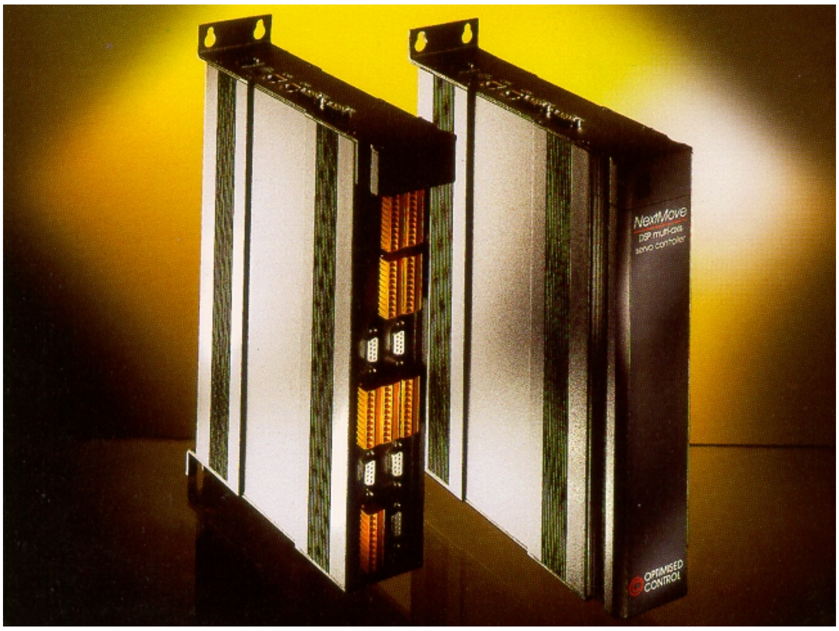


Figure 2-1: NextMove BX Controller

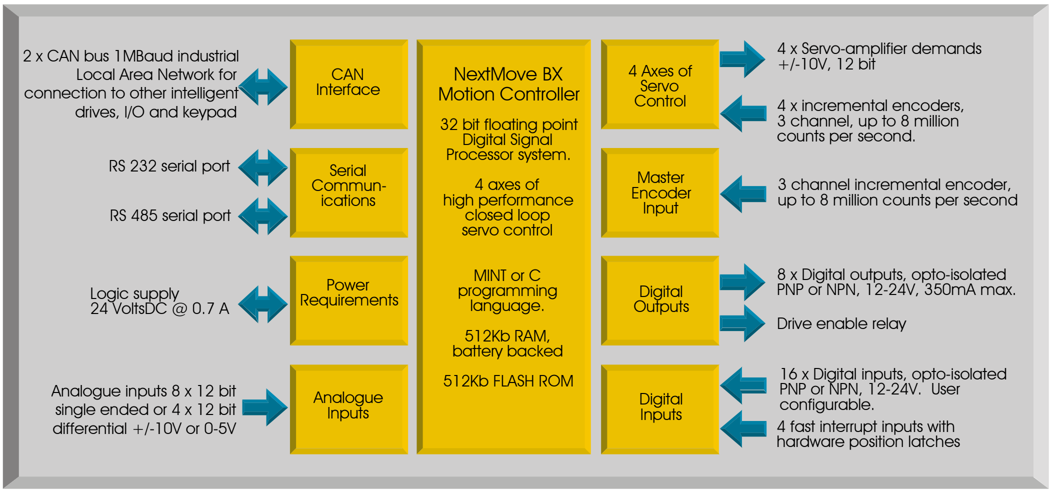

2 x CAN bus 1MBaud industrial Local Area Network for connection to other intelligent drives, I/O and keypad
RS 232 serial port
RS 485 serial port
Logic supply 24 VoltsDC @ 0.7 A
Analogue inputs 8 x 12 bit single ended or 4 x 12 bit differential +/-10V or 0-5V
CAN Interface
Serial Commun-ications
Power Requirements
Analogue Inputs
NextMove BX Motion Controller
32 bit floating point Digital Signal Processor system.
4 axes of high performance closed loop servo control
MINT or C programming language.
512Kb RAM, battery backed
512Kb FLASH ROM
4 Axes of Servo Control
Master Encoder Input
Digital Outputs
Digital Inputs
4 x Servo-amplifier demands +/-10V, 12 bit
4 x incremental encoders, 3 channel, up to 8 million counts per second.
3 channel incremental encoder, up to 8 million counts per second
8 x Digital outputs, opto-isolated PNP or NPN, 12-24V, 350mA max.
Drive enable relay
16 x Digital inputs, opto-isolated PNP or NPN, 12-24V. User configurable.
4 fast interrupt inputs with hardware position latches

Figure 2-2: Technical Overview

NextMove BX features the Mint^{TM} v4 motion control language. Mint is a structured form of Basic, custom designed for motion control applications, either stepper or servo. It allows users to quickly get up and running with simple motion control programs. In addition, Mint includes a wide range of powerful commands for complex applications.

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

Mint Configuration Tool is a rapid getting started and configuration utility designed for use with a number of Mint v4 controllers. See the 'Mint Configuration Tool Users Guide' for details.

Mint WorkBench is the IDE and user interface for communicating with a Mint controller. See the 'Mint WorkBench Users Guide' for details.

PC Developer Libraries allow PC applications to be written that communicate with Mint controllers. This includes C++ source and ActiveX interface. See the 'Mint v4 PC Programming Guide' for details.

Embedded Developer Libraries allow embedded C31 applications to be developed using the Texas Instruments TMS320C3x compiler. See the 'Mint v4 Embedded Programming Guide' for details.

Mint Code Analyzer Tool is a utility designed to help in the process of upgrading to Mint v4. The utility will scan existing Mint and C application files and highlight the keywords and functions that have been changed from older firmware versions. See the 'Mint v4 Code Analyzer Tool' manual for details.

Hardware Guide

3

This chapter describes in detail the hardware interface to the NextMove BX controller.

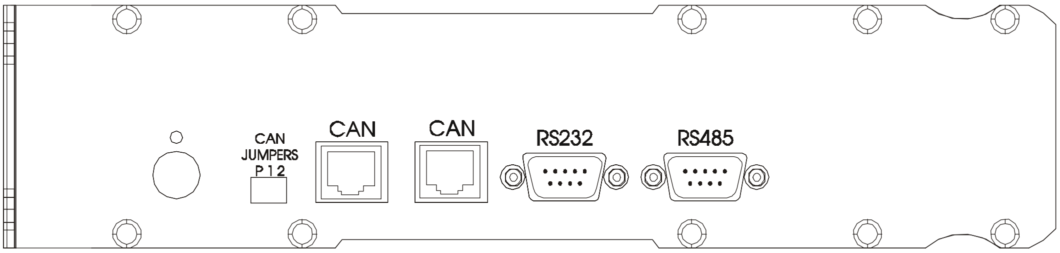
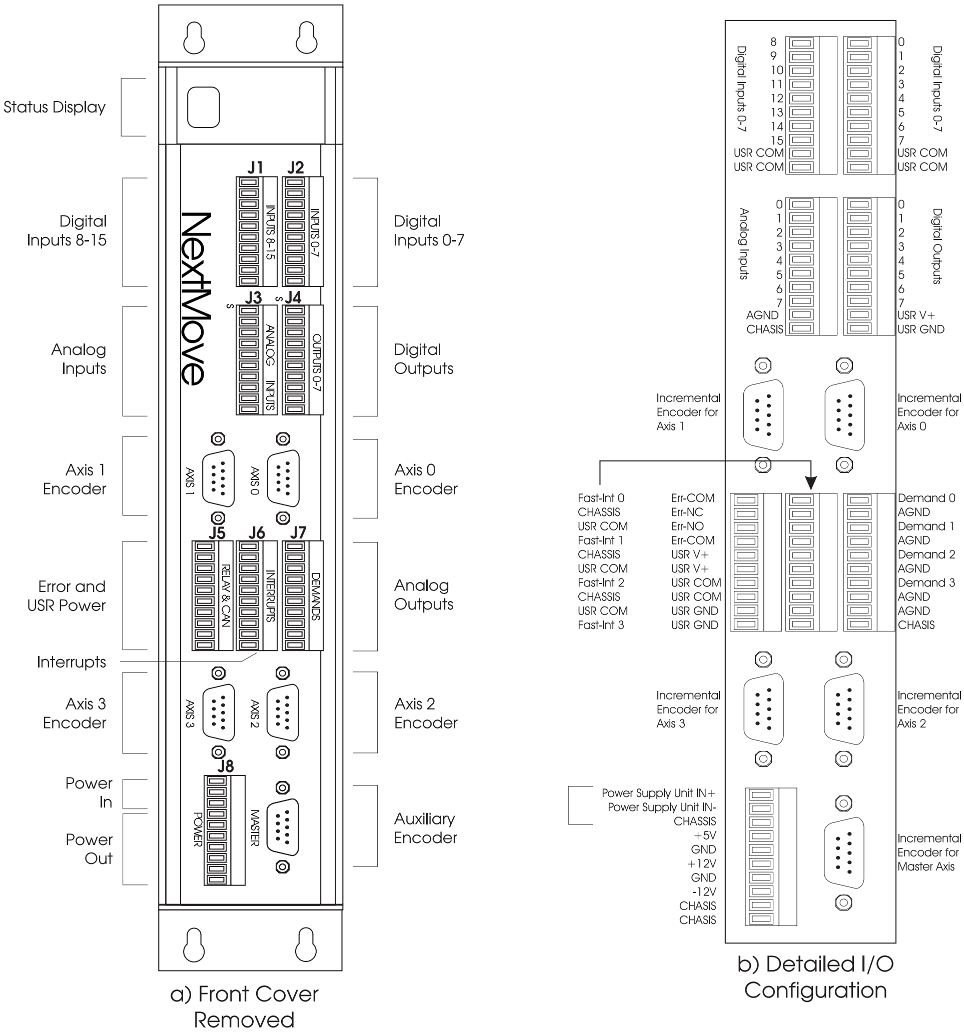


Figure 3-1: NextMove BX Top Panel



a) Front Cover Removed

b) Detailed I/O Configuration

Figure 3-2: NextMove BX Hardware

3.1 Operating Environment

The safe operation of this equipment depends upon its use in the appropriate environment:

- At an altitude of ≤ 2000m (6560ft) above sea level
- In an ambient temperature of 0°C to 40°C (32°F to 104°F)
- In relative humidity levels of 80% for temperatures up to 31°C (87°F) decreasingly linearly to 50% relative humidity at 40°C (104°F), non-condensing
- The pollution degree according to IEC664 shall not exceed 2
- The 24V dc supplied to the unit to power the control circuit shall be isolated from the mains using double or reinforced insulation so as to constitute a safety extra low voltage supply. The inputs and outputs of control circuit shall also be confined to SELV circuits
- The atmosphere shall not contain flammable gases or vapors
- There shall not be abnormal levels of nuclear radiation or X-rays
- The product shall be secured by the slots in the flange, the protective earth/ground stud shall be bonded to a safety earth/ground by a 25A conductor.

3.2 NextMove BX PCB Settings

Anti-static pre-cautions must be taken before handling the printed circuit board (PCB).

Access to jumpers, EEPROM and other components can be achieved via a slide-down cover on the right hand side of the box. The cover is held in place by a set screw which should first be removed. A screwdriver may then be required to ease the cover free.

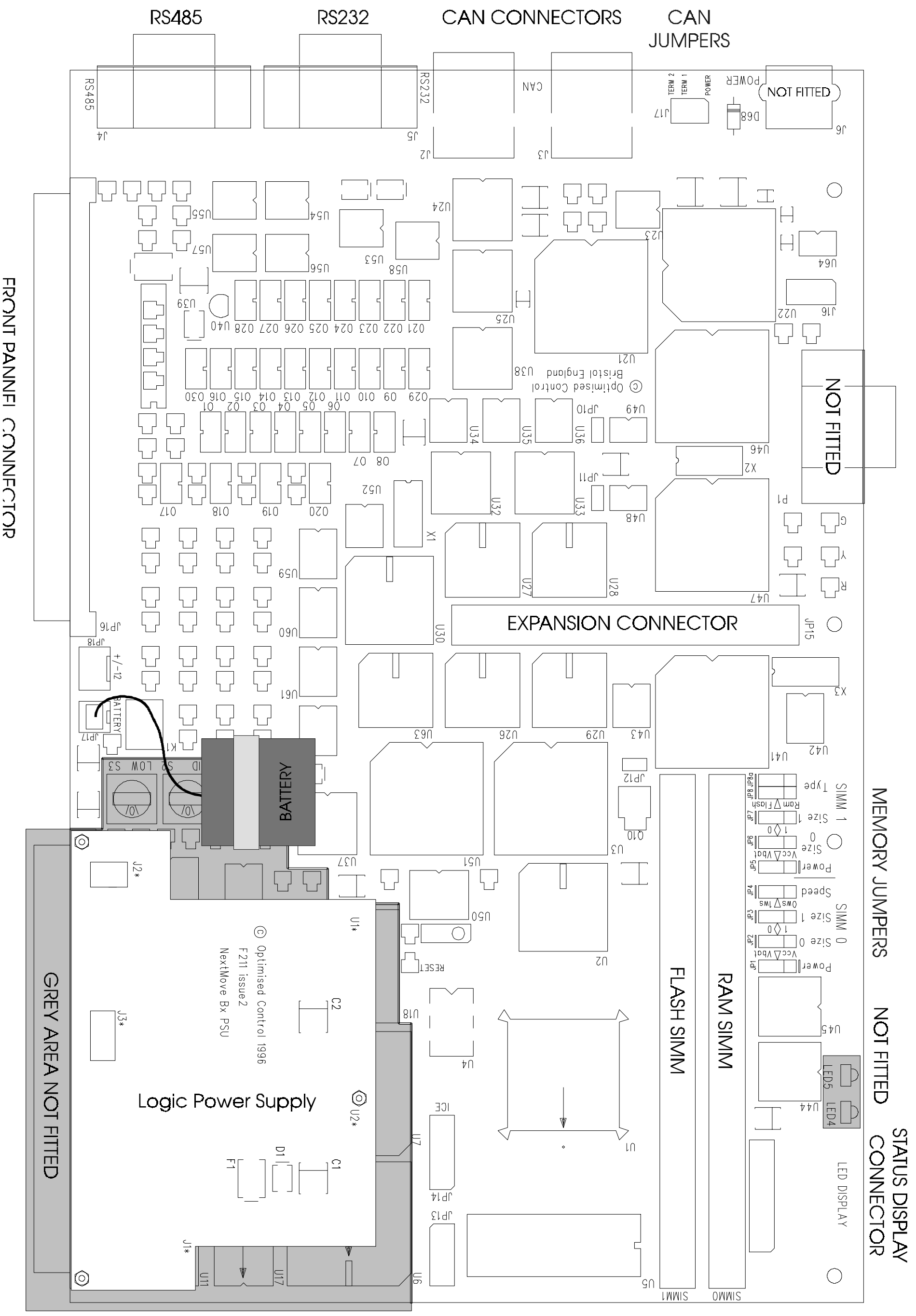


Figure 3-3: Board Settings

3.3 Power Connection

The unit requires 24V dc ±20% at approximately 700mA (max.) for the logic power supply unit. The unit also takes 12-24V dc ±20% at approximately 400mA (max.) for the isolated outputs and 12V to 24V dc or -12V to -24V dc ±20% at approximately 200mA for the isolated digital inputs and fast interrupts.

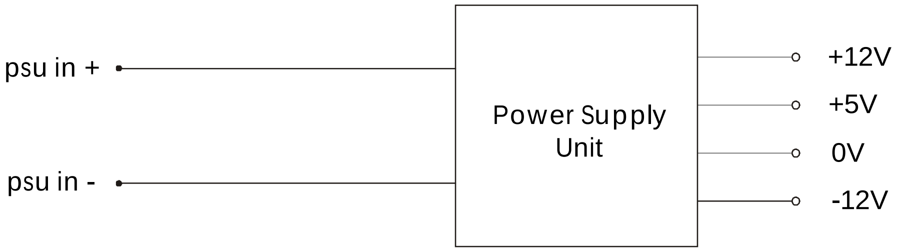


Figure 3-4: NextMove BX Power Supply Unit

The unit has an on board power supply to provide the following:

- 5V regulated output for incremental encoders.
- +/-12V output, 5V output for general use. Note that these must not be used for machine I/O. Do not attempt to draw more than 200mA from the 12V rails and no more than 650mA from the 5V (including the encoders).

If the encoders require more than 650mA total, some of them (or all) must be powered from an external 5V supply. This additional supply must NOT be connected to the NextMove BX 5V supply.

3.3.1 Front Panel Power Connection: J8

Pin No	Signal	Function
1	**psu in +**	Power Input 24V dc (18-30V)
2	**psu in -**	Power Input 0V
3	**chassis**	Chassis ground for cable screen
4	**+5V**	Voltage output for analog circuitry @ 100mA
5	**gnd**	Ground
6	**+12V**	Voltage output for analog circuitry @ 50mA
7	**gnd**	Ground
8	**-12V**	Voltage output for analog circuitry @ 50mA
9	**chassis**	Chassis ground for cable screen
10	**chassis**	Chassis ground for cable screen

Two dc-dc converters are used to generate the internal logic voltages from a dc input of 24V ±20%. The logic power rails are brought out on the front panel for analog sensors and associated circuitry. These rails should not be used for machine I/O, **usr-V+** and **usr-gnd** should be used instead.

The controller has opto-isolation between the microprocessor controller and the inputs and outputs to provide noise immunity required for industrial environments. The power supply unit inputs (24V dc) include isolated grounds.

Using a power supply of 24V dc at 2A is sufficient to drive all the outputs at 50mA and with all the inputs on.

- WARNING -

Applying mains voltages to NextMove BX (110V/220V) will damage the unit. Ensure that the power input voltages comply.

3.4 Digital I/O

There are a total of 16 general purpose digital inputs and 8 general purpose digital outputs. The digital inputs are software configurable for any one of the following functions:

- Forward **limit** (end of travel) input on axis of the axes.
- Reverse **limit** input on any of the axes.
- **home** input on any of the axes.
- **drive error** input on any of the axes.
- **stop** input (controlled) on any of the axes.

The inputs can be programmed such that any of the axes can share the same input if necessary.

The inputs are also programmable in software for being edge triggered (positive and negative) or level triggered (active high or low).

The digital outputs can be programmed as a **drive enable** output for any axis or **general error output**. Again, axes can share the same output. The active level of the output is also software programmable.

As well as the general purpose I/O, NextMove BX also supports four fast position latch inputs (described in section 3.4.2).

3.4.1 Digital Inputs: J1 and J2

Connector J2:

Pin No	Signal	Function
1	**din 0**	Digital input bit 0
2	**din 1**	Digital input bit 1
3	**din 2**	Digital input bit 2
4	**din 3**	Digital input bit 3
5	**din 4**	Digital input bit 4
6	**din 5**	Digital input bit 5
7	**din 6**	Digital input bit 6
8	**din 7**	Digital input bit 7
9	**usr-com**	Common reference for Inputs
10	**usr-com**	Common reference for Inputs

Connector J1:

Pin No	Signal	Function
1	**din 8**	Digital input bit 8
2	**din 9**	Digital input bit 9
3	**din 10**	Digital input bit 10
4	**din 11**	Digital input bit 11
5	**din 12**	Digital input bit 12
6	**din 13**	Digital input bit 13
7	**din 14**	Digital input bit 14
8	**din 15**	Digital input bit 15
9	**usr-com**	Common reference for Inputs
10	**usr-com**	Common reference for Inputs

Inputs may be 12 to 24V positive or negative with respect to **usr-com**. **usr-com** is shared with the interrupt inputs.

The sixteen digital inputs are optically isolated using ac input isolators. One input pin of each device is connected to the common reference. This common rail may be connected to a positive voltage, e.g. **usr-V+,** for use with NPN drive transistors or low-side switches. Alternatively the common rail may be connected to a negative voltage, e.g. **usr-gnd**, for use with PNP drive transistors or high-side switches.

In either case the user provides an external supply which drives the inputs with a voltage in the range 12V to 24V ±20%.

The voltage applied to the inputs should be in the range 12 to 24V ±20% (9.6 to 28.8V) above or below the **usr-com** rail to activate the inputs. If the voltage exceeds the maximum stated, the input circuit may overheat and be damaged The voltage applied should be less than 3V above or below the **usr-com** rail to deactivate the inputs.

The inputs have low pass filters and Schmitt trigger buffers An input pulse must have a duration of at least 2ms (one software scan) to guarantee acceptance by the application program. Pulses below 2ms are not guaranteed to be ignored.

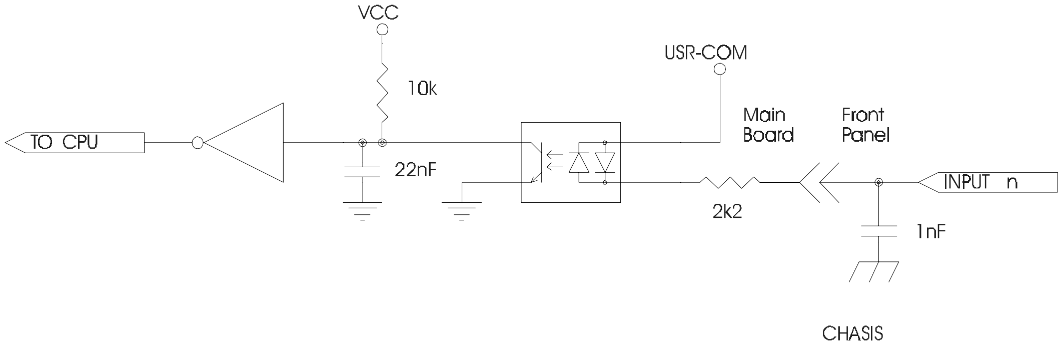


Figure 3-5: Digital Input Circuit

Associated MINT keywords are:

#INx, INPUTACTIVELEVEL, IN, INx, INPUTMODE, INPUTNEGTRIGGER, INPUTPOSTRIGGER, INSTATE

3.4.2 Fast Interrupts: J6

Pin No	Signal	Function
1	**fast-int 0**	Fast interrupt 0
2	**chassis**	Chassis ground for cable screen
3	**usr-com**	Common reference
4	**fast-int 1**	Fast interrupt 1
5	**chassis**	Chassis ground for cable screen
6	**usr-com**	Common reference
7	**fast-int 2**	Fast interrupt 2
8	**chassis**	Chassis ground for cable screen
9	**usr-com**	Common reference
10	**fast-int 3**	Fast interrupt 3

Interrupt inputs may be 12 to 24V positive or negative with respect to **usr-com**. **usr-com** is shared with the digital inputs.

There is a facility for 4 high speed external interrupts on NextMove BX. These are isolated using high speed opto-isolators and full bridge rectification. They are driven in the same way as the digital inputs, see the digital input section for details on the voltage levels. The interrupt inputs can cause an interrupt on both activating and deactivating edges of the signal. Fast interrupt 0 has a maximum latency of 30µs. Fast interrupts 1 to 3 have a maximum latency of 1ms.

Because of the fast response time of the input circuitry (approx. 200ns)these inputs are more susceptible to high frequency noise. Care must be taken with shielding/screening and routing of these signals, i.e. do not route high speed interrupt cabling near motor drive cabling.

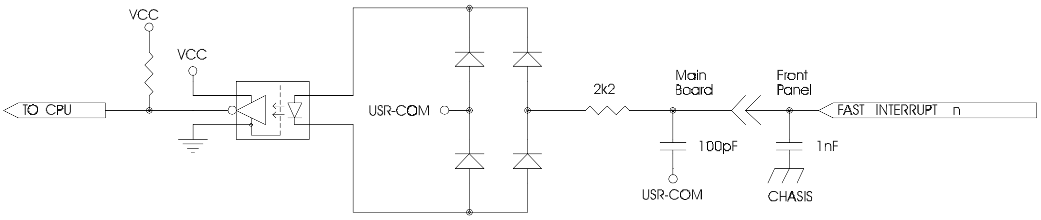


Figure 3-6: Fast Interrupt Input Circuit

See section ‘Fast Position Latch’ in the ‘Mint v4 Programming Guide’ for more details.

3.4.3 Digital Outputs: J4

Pin No	Signal	Function
1	**out 0**	Digital output bit 0
2	**out 1**	Digital output bit 1
3	**out 2**	Digital output bit 2
4	**out 3**	Digital output bit 3
5	**out 4**	Digital output bit 4
6	**out 5**	Digital output bit 5
7	**out 6**	Digital output bit 6
8	**out 7**	Digital output bit 7
9	**usr-V+**	Power for output driver
10	**usr-gnd**	0v reference for outputs

usr-V+ can be 12-24V +/20% relative to **usr-gnd**. Damage to the unit may occur if the voltage exceeds 30V and the operation will be unpredictable below 8V

The eight digital outputs are opto-isolated. They are driven by a PNP open collector Darlington type UDN2987A with internal over-current and over temperature protection. The over-current circuit shuts down the faulty output and indicates the error to the processor and thus to the application which, after corrective action, can reset the device. Note that there is a single **error** output and so the program is unable to determine which output is at fault. Also there is a single **reset** input which resets all of the outputs. Any outputs which are ON when the device is reset will go OFF during the reset. This lasts approximately 10ms.

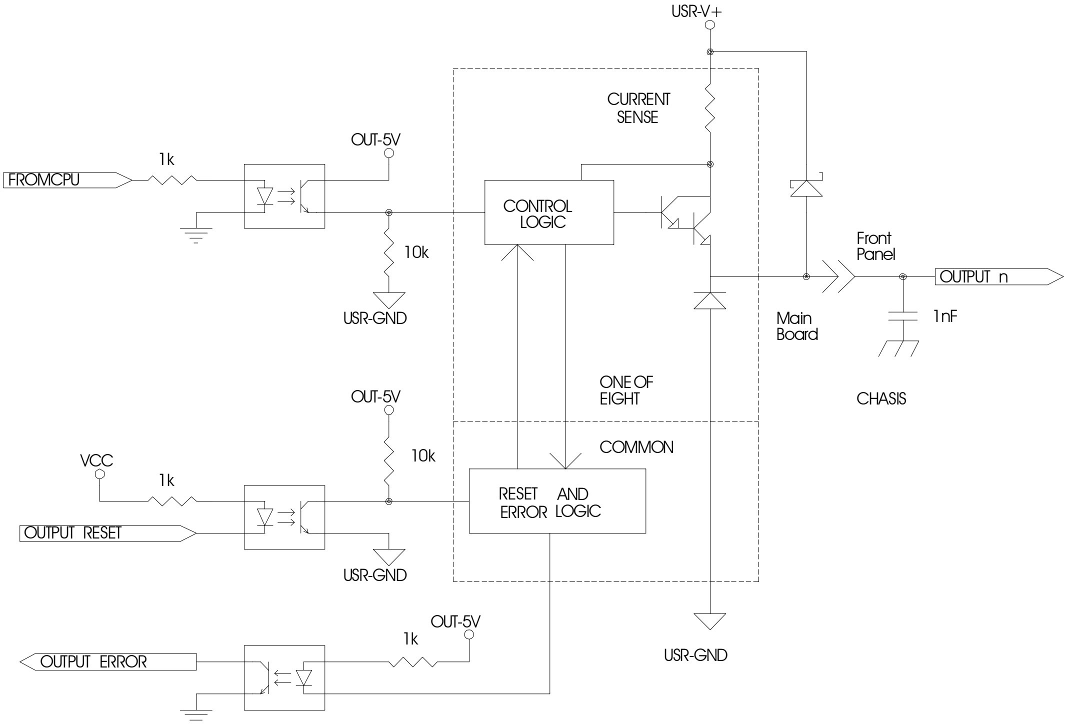


Figure 3-7: Digital Output Circuit

If the device is reset too often during a short circuit condition (greater than twice per second) the device will eventually overheat and will be damaged. Damage will also occur if the output is taken above **usr-V+**, however transient excursions above **usr-V+** are clamped and therefore tolerated.

Each output has a freewheeling diode in parallel with the load. This allows inductive loads (such as relays) to be used without damaging the output Darlington devices. The outputs can all switch 50mA continuously through a voltage of 12 to 24V. More current can be supplied, subject to a power dissipation limit (shown on the graph in Figure 3-8). Further information is given in the Allegro Semiconductors UDN2987 data sheet.

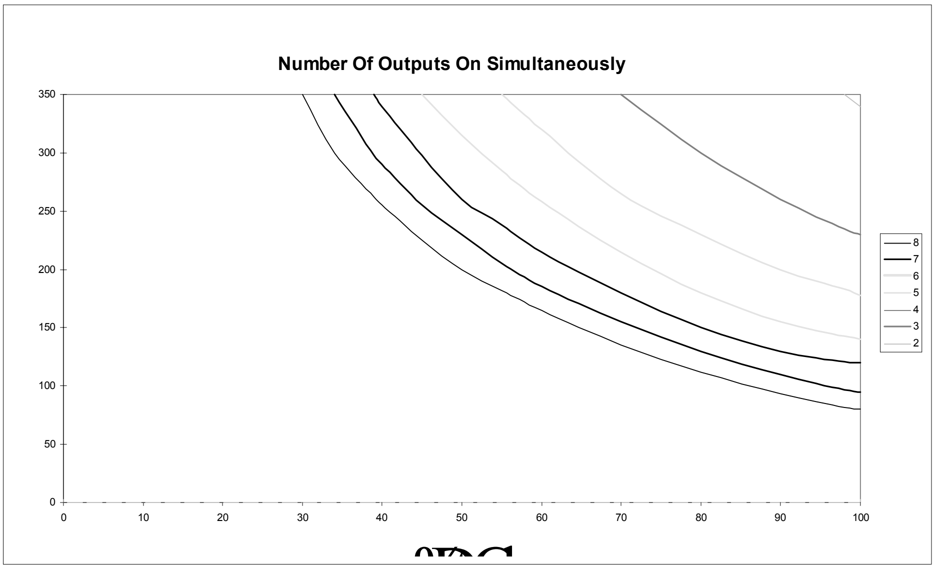


Figure 3-8: Output Current

Power to the output circuit is protected with a 750mA PTC style self re-setting fuse and a 30V transient suppressor. A 5V supply (**out-5V**) is generated from the user voltage to power the isolation stage, allowing any user voltage to function with the same characteristics.

The digital outputs are inactive following system reset.

The digital inputs and outputs can share the same 24V power supply or machine power rail.

Opto-isolation is provided on these outputs to offer the user some flexibility in the earthing/grounding scheme, but not to provide level translation. usr-gnd must be connected to system ground - typically at a star point

Associated Mint keywords are:

OUTPUTACTIVELEVEL, OUT, OUTx

3.5 Analog I/O

3.5.1 Analog Inputs: J3

Pin No	Signal	Function
1	**ain 0**	Analog Input 0 (differential input 0-)
2	**ain 1**	Analog Input 1 (differential input 0+)
3	**ain 2**	Analog Input 2 (differential input 1-)
4	**ain 3**	Analog Input 3 (differential input 1+)
5	**ain 4**	Analog Input 4 (differential input 2-)
6	**ain 5**	Analog Input 5 (differential input 2+)
7	**ain 6**	Analog Input 6 (differential input 3-)
8	**ain 7**	Analog Input 7 (differential input 3+)
9	**agnd**	0v reference for analog circuit
10	**chassis**	Chassis ground for cable screen

Analog ground (**agnd**) is at the same potential as digital ground (**gnd**). They are connected at the DAC chip.

The analog inputs are led to a MAX180. This is an eight channel, 12 bit, multiplexed analog-to-digital converter. The input circuit for each pair of inputs is as follows:-

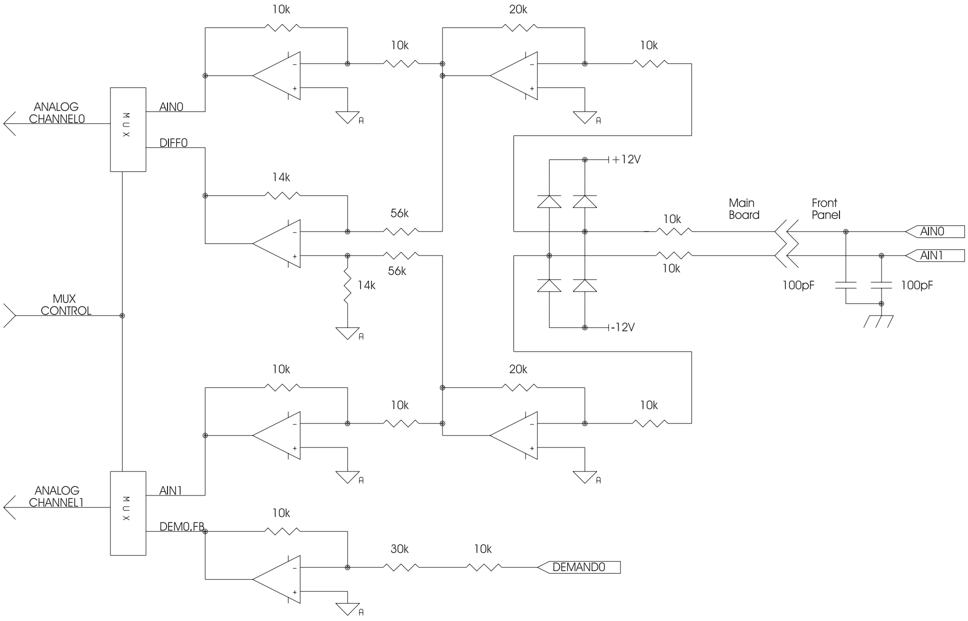


Figure 3-9: Analog input circuit (1 pair)

NextMove BX uses a Data Acquisition Chip (Maxim MAX180). This device has:

- 12 bit resolution with ½ LSB linearity
- Built in track and hold
- A 2us sample window.

The chip can operate with either bipolar or unipolar input voltages, the selection of which is made under software control.

Input buffers with an impedance of 20k and clamping diodes protect the device from voltage extremes, and analog switches allow true differential measurement. The voltage range of the inputs when used in single-ended mode is ±2.5V (bipolar) or 0-5V (unipolar), and when used in differential mode is ±10V (bipolar only).

The input buffers do not have any filtering. Therefore any noise on the inputs will be reflected in the value read.

When analog channel 0 (2, 4, 6) is switched to differential mode, channel 1(3, 5, 7) is switched to feed back of analog output 0 (1, 2, 3).

Associated MINT keywords are:

ADCMODE, ADC

3.5.2 Analog Outputs (Drive Command: J7)

The controller provides up to four ±10V (±0.1%) analog outputs for motor **command** – one for each servo axis. A 14 bit DAC is used which gives a resolution of 1.2mV/bit. The optimum cabling arrangement is to use a separate shielded twisted pair cable, twist **command+** with **command-** and connect the screen/shield to screen/shield at the controller end only.

Pin No	Signal	Function
1	**demand 0**	Demand/Command output for axis 0
2	**agnd**	Analog ground
3	**demand 1**	Demand/Command output for axis 1
4	**agnd**	Analog ground
5	**demand 2**	Demand/Command output for axis 2
6	**agnd**	Analog ground
7	**demand 3**	Demand/Command output for axis 3
8	**agnd**	Analog ground
9	**agnd**	Analog ground
10	**chassis**	Chassis ground for cable screen

Analog ground (**agnd**) is at the same potential as digital ground (**gnd**). They are connected at the DAC chip.

There are four 14 bit resolution analog outputs implemented in an MP7611. The outputs have a range of ± 10V, and revert to 0V during system reset. The outputs are referred to the system ground (not opto-isolated) via a separate but connected analog ground plane.

The outputs are buffered by op-amps suitable for driving a load resistance of ≥10kΩ, and are brought out on the front panel. When connecting to a drive it is recommended that screened/shielded twisted pair cable is used, with the demand signal twisted with **agnd**. This in turn should be connected to the demand 'minus' input of the drive. The screen/shield should be connected to chassis earth/ground at one end only.

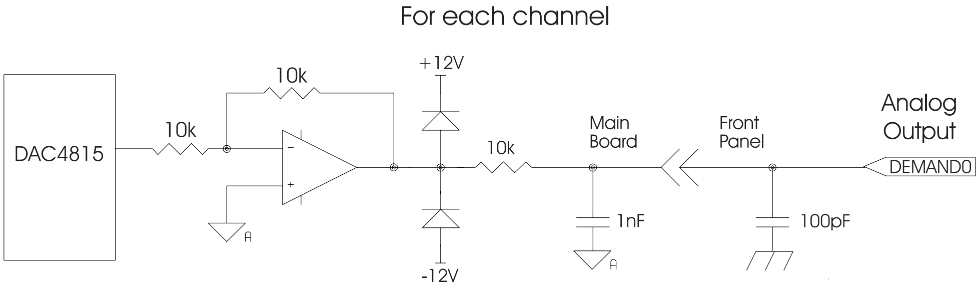


Figure 3-10: Analogue Output Buffer

Associated MINT keywords are:

DACLIMITMAX, DAC, DACMODE, DACOFFSET

3.6 Encoder Interface

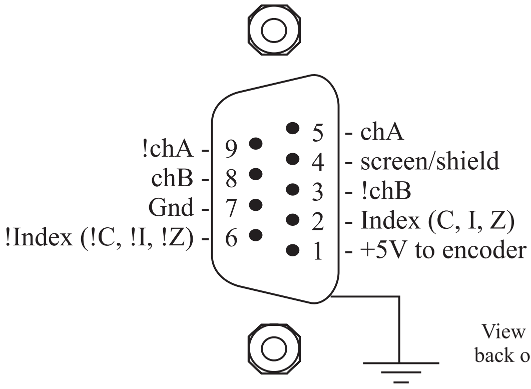
Up to five incremental encoders may be connected to the controller (four axis encoders and a master encoder). These encoders must provide complementary signals. The input circuit is a differential line receiver with open circuit protection and 120Ω termination. Each encoder channel has **chA**, **chB** and **index** plus their complements. The encoders should be powered from **+5V**, and are referred to the controller GND.

If the encoders require more than 650mA total, some of them (or all) must be powered from an external 5V supply. This additional supply must NOT be connected to the NextMove BX 5V supply.

The encoders are the position sensors used by the controller to measure axis position and consist of two pulse trains, 90 degrees out of phase. The controller uses the phase difference to determine direction of motion and counts the encoder edges to determine position. The frequency of these counted edges reflects the motor velocity.

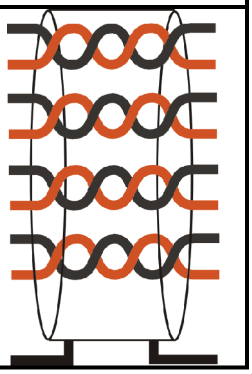
The four axis encoders are labeled *AXIS 0* to *AXIS 3* and the master speed/position encoder is labeled *AUXILIARY*.

The encoder must be wired to a 9 pin 'D' male plug, using good quality multi-core/conductor screened/shielded cable, according to the diagram shown in **Error! Reference source not found.**. Although there is a Screen/Shield pin, the cable screen/shield should be connected to the connector shell. The pin is for use with not metallic connector shells (not recommended). If the encoder does not have an index (Z) output, leave the **index** and **!index** unconnected.



View taken from the back of the connector.

Figure 3-11: Encoder Connector

Pin	Signal	Function	Cabling
1	**Encoder V+**	Power to the encoder	
7	**gnd**	Power and signal ground	
5	**chA**	Channel A true signal	
9	**!chA**	Channel A complement signal	
8	**chB**	Channel B true signal	
3	**!chB**	Channel B complement signal	
2	**index**	Index true signal (channel I or Z or C)	
6	**!index**	Index complement signal (channel I or Z or C)	
4	**chassis**	Chassis connection	
Shell	**chassis**	Screen	

The maximum input frequency the encoders can normally accept is 8 million quadrature counts per second. This equates to a maximum frequency for the **chA** and **chB** signals of 2MHz. However this maximum is limited to short cables, the following table shows recommended length vs. frequency for differential signals.

Frequency	Max. Length
1.3MHz	2m (6½ ft approx.)
500kHz	10m (33ft approx.)
250kHz	20m (65½ ft approx.)
100kHz	50m (164ft approx.)
50kHz	100m (328ft approx.)
20kHz	300m (984ft approx.)
10kHz	700m (2296ft approx.)
7kHz	1000m (3280ft approx.)

The input receiver circuit allows encoders with either single ended or differential line drivers to be used. However, single-ended encoders provide inferior noise immunity and should only be used on the shortest of cable runs (< 3m or approx. 9½ ft) away from sources of interference. The input receiver circuit includes diode protection on the inputs to guard against noise spikes. The diodes prevent any input from exceeding 5.6V or below -0.6V. The circuit is shown in Figure 3-12.

The encoder inputs are brought out to 9 pin 'D' type female sockets. The encoder should be wired to a 9 pin 'D' male plug. Low profile hoods are available from ITT Canon (part no. DE-12107354).

Associated MINT keywords are:

ENCODER, ENCODERSCALE, ENCODERVEL, ENCODERWRAP, POS, SCALE, VEL

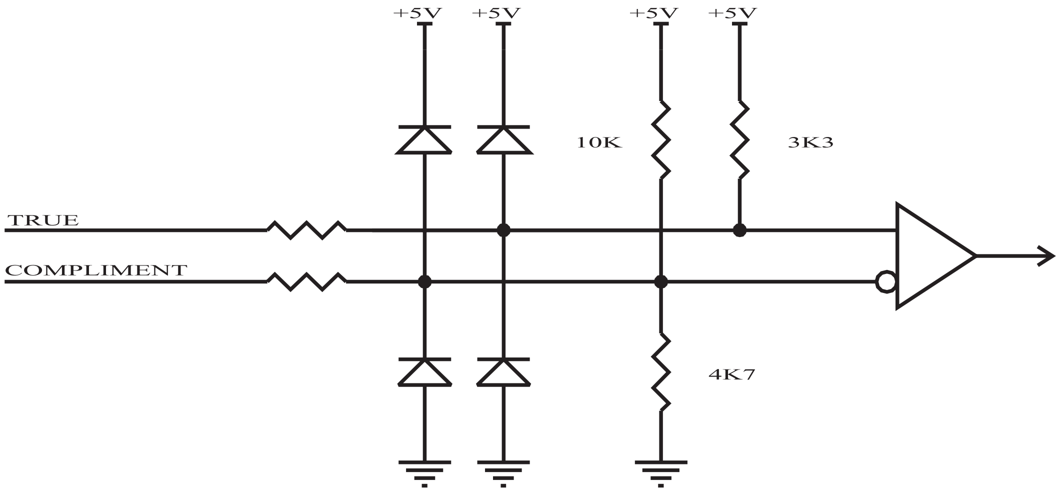


Figure 3-12: Encoder line receiver circuit

3.7 Relay: J5

The relay connections on the connector are shown as the shaded boxes.

Pin No	Signal	Function
1	**err-com**	Relay common contact
2	**err-nc**	Relay normally closed contact
3	**err-no**	Relay normally open contact
4	**err-com**	Relay common contact
5	**usr-V+**	Power rail for digital output driver
6	**usr-V+**	Power rail for digital output driver
7	**usr-com**	Common reference for digital inputs
8	**usr-com**	Common reference for digital inputs
9	**usr-com**	0v reference for digital output driver
10	**usr-com**	0v reference for digital output driver

A single pole, change-over relay is included on the card to provide a volt-free contact for the enabling of other parts of the system, such as drives. The relay is controlled by a latch which is cleared during reset of the unit. Reset occurs on power up or power down, watchdog error and 5V under-voltage. The relay is energized only by software control. The relay is the default global error output channel.

Because of the track rating on the PCB, the relay is limited to a rating of 500mA at 24V dc. For this reason, the relay should be used for voltage free signal switching and should not be used for power.

Associated MINT keywords are:

RELAY, DRIVEENABLEOUTPUT, GLOBALERROROUTPUT

3.8 Serial Ports

The unit is fitted with a DUART providing one RS232 port and one RS485 port. The serial ports are set up for the following configuration by default:

- 9600 Baud
- 1 start bit
- 8 data bits
- 1 stop bit
- No parity
- RTS/CTS Hardware handshaking disabled (RS232 port only)

The baud rate of both ports is user-configurable with the RS232 capable of 19,200 and the RS485 up to 9,600. Hardware handshaking (RTS / CTS) is permanently enabled. Both serial ports are brought out on the top of the unit on 9 pin 'D'-type connectors.

3.8.1 RS232

The RS232 connections are brought out onto a male 9 pin D-type connector on the top panel of the controller. The RS232 cable should be screened/shielded with the screen/shield connected to the body of the connector at both ends to give overall protection. Twisted pair cable is **not** recommended since the signals do not have compliments. The cable should not exceed 20m (65ft) at 19,200 baud and 30m (98ft) at 9,600 baud.

The minimum requirement is for three wires **txd**, **rxd** and **gnd**. This will only function without hardware handshaking.

The RS232 port is configured as a DTE (Data Terminal Equipment) unit so it is possible to operate the controller with any DCE (Data Communications Equipment) or DTE equipment. Full Duplex transmission with CTS/RTS handshaking is supported. Both the output and input circuitry are single ended and operate between ±12V.

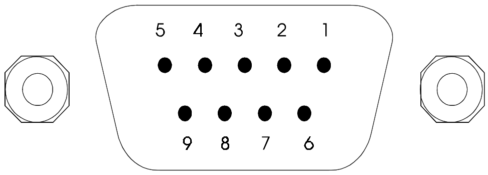


Figure 3-13: RS232 D-Type connector pin-out

Pin No.	Signal Name	Function	Type
1	**scrn**	Cable screen/shield	Input
2	**rxd**	Receive Data	Input
3	**txd**	Transmit Data	Output
4	**dtr**	Data Terminal Ready (Internal connection to pin 6)	Output
5	**gnd**	Signal Ground	
6	**dsr**	Data Set Ready (Internal Connection to pin 4)	Input
7	**rts**	Request to Send	Output
8	**cts**	Clear to Send	Input
9	**gnd**	Signal Ground	

The following table shows the wiring required for a standard PC 25 pin or 9 pin connector:

Controller Pin No.	Signal Name	Function	Wire to: 25 Pin	Wire to: 9 Pin
1	**scrn**	Cable screen/shield	-	-
2	**rxd**	Receive Data	2	3
3	**txd**	Transmit Data	3	2
4	**dtr**	Data Terminal Ready (Internal connection to pin 6)	6	6
5	**gnd**	Signal Ground	7	5
6	**dsr**	Data Set Ready (Internal Connection to pin 4)	20	4
7	**rts**	Request to Send	5	8
8	**cts**	Clear to Send	4	7
9	**gnd**	Signal Ground	7	9

Associated MINT keywords are:

SERIALBAUD

3.8.2 RS485

The RS485 connections are brought out onto a male 9-way D-type connector on the top of the unit. These signals are not isolated. The RS485 cable should be a screened/shielded twisted pair with at least two pairs and ground. The screen should be connected to the body of the connector at both ends to give overall protection. The maximum cable length is 1000m (3280ft) at 9,600 baud un-terminated or 1200m (3937ft) with terminators.

The RS485 supports a full multi-drop protocol. Both the output and input signals are differential and operate between 0 and 5V.

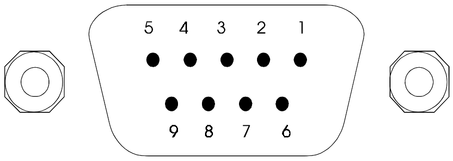


Figure 3-14: 9 Pin Connector

Pin No.	Signal	Function	Type
1	**scrn**	Cable screen/shield	Input
2	**rxd**	Receive Data	Input
3	**txd**	Transmit Data	Output
4	Not connected		
5	**gnd**	Signal Ground	
6	Not connected		
7	**!txd**	Transmit Data Complement	Output
8	**!rxd**	Receive Data Complement	Input
9	**gnd**	Signal Ground	

See section 4 in the Mint v4 Programmers Manual for details on default software configuration.

3.8.3 RS485 Multi-Drop

NextMove BX supports up to 15 cards using a four wire RS485 serial connection. This configuration has a *transmit* wire pair carrying data from the host to all controllers and a *receive* wire pair carrying data from all controllers to the host. Each card is distinguished by a unique address which is set by software. This address value is stored in EEPROM within the NextMove BX and is restored at power up. Software details on RS485 multi-drop can be found in the Mint v4 Programmers Manual. A multi-drop layout is shown in Figure 3-15.

Note that the **rxd** and **txd** pairs can be terminated with 120Ω resistors. This allows longer cable lengths for the same data rate as mentioned above. Cable spurs to each controller should be as short as possible.

The resisters R1 can be fitted as shown to prevent the receive lines picking up noise or cross-talk from the transmit lines when all controllers have there transmitters disabled.

The RS485 port can also be used in two wire configuration when using one of the data packet protocols by connecting the pairs (**txd** to **rxd** and **!txd** to **!rxd**). This is possible because the data packet protocols are half duplex, and only one controller will respond to any packet. In normal terminal mode the communication is full duplex and two wire connection schemes will not work.

Hardware disable of the transmitter after the last byte is sent allows high speed half duplex transmission.

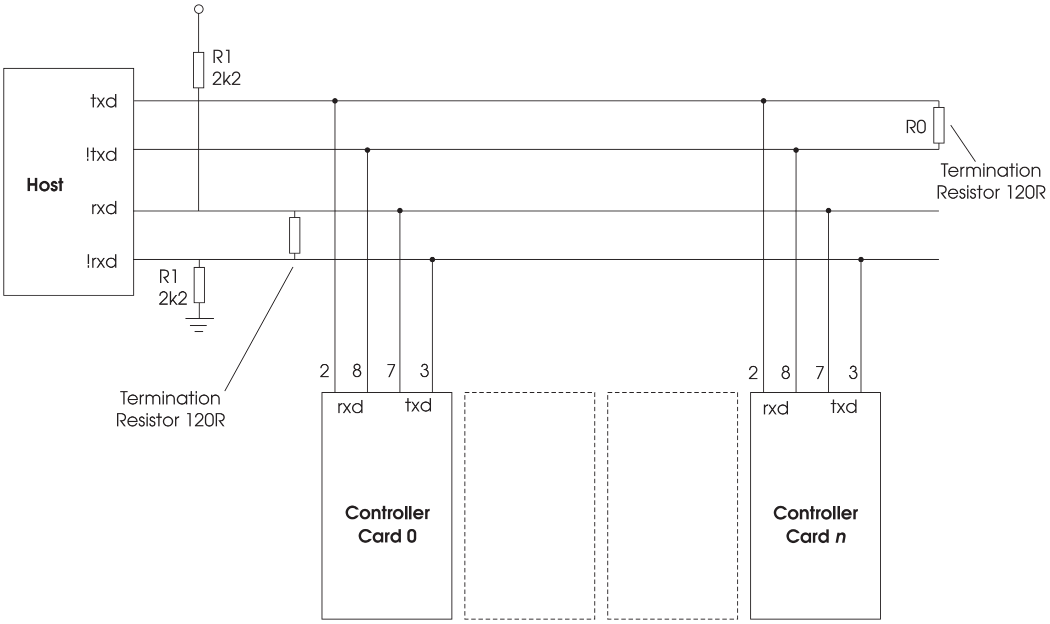


Figure 3-15: Multi-drop system

The rxd and txd lines should be terminated with 120Ω resistors at the receiving end as shown.

3.8.4 CAN Bus

CAN (Controller Area Network) is a 1Mb/s local area network. NextMove BX has two CAN communications channels for connection to other Baldor CAN nodes or for connection to other networks such as **CAN**open. CAN offers 125kbit/s serial communications over a two wire twisted pair cable up to a maximum of 500m (approx. 1640ft) in length. CAN offers very high reliability of communications in an industrial environment, the probability of an undetected error is 4.7x10-11.

A range of CAN based I/O expansion modules is available for NextMove BX. See section **5.2** for further details.

Several CAN peripheral devices may be attached to the same controller via the CAN link using the Baldor CAN protocol. 63 CAN peripheral devices of any assortment are allowed on the NextMove BX CAN network. However only 4 enabled keypads are allowed at any one time.

The CAN is brought out to two RJ45 connectors located on the top panel of unit.

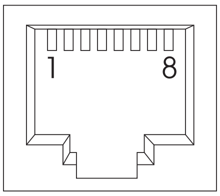


Figure 3-16: RJ45 Connector Pin Numbers

Pin	Signal	Function
1	**can1+**	CAN channel 1 negative
2	**can1-**	CAN channel 1 positive
3	**n/c**	Not used
4	**gnd**	Ground/earth reference for CAN signals
5	**can-V+**	CAN remote node power V+
6	**n/c**	Not used
7	**can2+**	CAN channel 2 positive
8	**can2-**	CAN channel 2 positive

Connection to the CAN networks is via two shielded RJ45 type connectors on the top of the unit, each of which carries **both** CAN networks.

When NextMove BX is at the end of a CAN network, the terminator for that channel must be activated. The terminators are activated by fitting a link on the jumpers located next to the RJ-45 connectors.

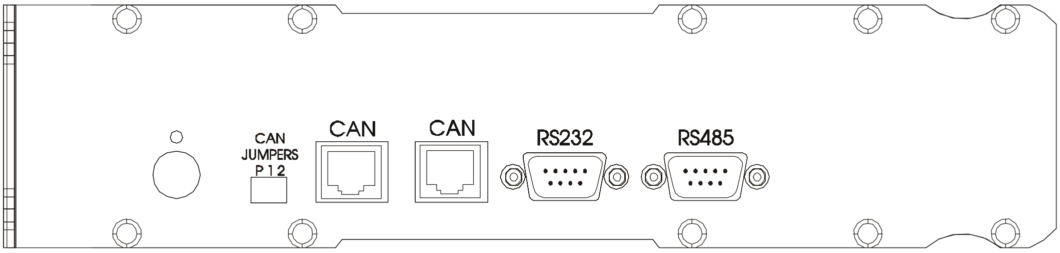


Figure 3-17: Top Panel

The power jumper connects 12V to the CAN-V+ net. This allows the controller to run with an expansion unit without the need for extra power supplies or cabling. If more than one expansion unit is connected, additional power is required and the power link should be removed. Units which require 24V cannot be powered from the controller.

A very low error rate of CAN communication can only be achieved with a suitable wiring scheme. The following points should be observed:

1. CAN must be connected via twisted pair cabling. The connection arrangement is normally a simple multi-point drop. The CAN cables should have a characteristic impedance of 120Ω; and a delay of 5ns/m. Other characteristics depend upon the length of the cabling:

Cable length	Max bit rate Non Isolated	Max bit rate Isolated	Specific resistance	Conductor area
0-40m (0-157ft)	1 Mbit/s	500 kbit/s	70mΩ	0.25-0.34mm^2
40m-300m (157ft-1180ft)	200 kbit/s	100 kbit/s	< 60mΩ	0.34-0.60 mm^2
300m-600m (1180-2362ft)	100 kbit/s	50 kbit/s	< 40mΩ	0.50-0.60 mm^2
600m-1000m (2362ft-3937)	50 kbit/s	25 kbit/s	< 26mΩ	0.75-0.80 mm^2

2. Terminators should be fitted at both ends of the network only.
3. To reduce RF emissions and more importantly, to provide immunity to conducted interference, shielded twisted pair cabling should be used. If two CAN channels are bundled in a cable then each requires a twisted pair.

Cable screens/shields should not be connected to 0V on connector sk4 and sk5 as this will cause ground loop interference into the 0V plane on the processor board.

4. The 0V rails of all of the nodes on the network must be tied together through the CAN cabling. This ensures that the CAN signal levels transmitted by a NextMove BX or CAN peripheral devices are within the common mode range of the receiver circuitry of other nodes on the network.

CAN cables are available. See the section 5.2 for details on CAN accessories.

See the Mint v4 CAN Programmers Guide for details on using CAN.

3.9 Reset State

The NextMove BX will go into **reset** if the power supply drops below approximately 4.75V in order to prevent any uncontrolled operation of any of the integrated circuits during power down.

When NextMove BX is in **reset** for any reason, most of the controlled interfaces fall into known states. This is explained further below.

Communications

During reset CAN controller will have no effect on the CAN bus. If a **reset** occurs during the transmission of a message CAN errors are likely to occur.

When the controller goes into a reset state all serial communications will be terminated immediately, this may result in incomplete or corrupted messages.

Digital Outputs

All of the digital outputs are inactive on power up regardless of their polarity. They will return to the inactive state whenever **reset** occurs.

Analog Outputs

All analog outputs are set to 0V by hardware during power-up and will return to 0V on a **reset**. However the output buffer circuit may have a small offset and so the actual voltage seen at the output may not be zero.

3.10 Battery Backup of Memory

The RAM is backed up with a battery to prevent loss of data when the main power is removed. Switching from the main power (VCC) to the battery power (VBAT) is done by the reset chip when VCC falls below VBAT. The power consumption of this switch is 1μA maximum at room temperature.

The backup battery is a 3 cell nickel metal hydride (NiMH) with a nominal voltage of 3.6V (1.2V/cell) and a capacity of 280mAh. A standard low power 0.5Mbyte SIMM requires approximately 1.2μA at 3.0V for data retention. This, coupled with the consumption of the battery switch, gives a total consumption of 2.2μA. Theoretically this would give a data retention time of 14 years. However, the self discharge characteristics of the battery mean that it will drop to 60% charge in 6 months at 20°C. Memory contents will be retained down to 95% discharge which takes approximately 3 years. This self discharge is faster at higher temperatures, at 45°C the battery will drop to approximately 45% charge in 1 month giving a data retention time of only 4 months. Should the battery become very discharged, it is recommended that it be removed and fully recharged outside the unit since its maximum capacity will have been reduced to about 80% of nominal.

3.10.1 Changing the Battery

Access to the battery is gained by removing the 2 screws at the bottom of the rear vertical extrusion and the opposing screws at the top of the extrusion. The extrusion and the side plate can then be removed giving access to the PCB. Once the PCB is exposed the battery can be removed by cutting the restraining cable tie and disconnecting it from the main board. Replacement batteries and cable ties can be obtained from.

When the battery is disconnected the program and other data held in RAM may be corrupted or lost. It is therefore advisable to back up all data on the controller before changing the battery.

Never attempt to open the unit while it is powered.

3.10.2 Charging the Battery

The charge state of the backup battery will not be known when the unit is first delivered. To fully recharge the battery using the built in trickle charge will take a maximum of approximately 80 hours.

3.11 EEPROM

NextMove BX has 8k bytes of EEPROM, most of which is used for the processor boot code. The remaining space (about 2k bytes) is used for non-volatile storage of other parameters such as the baud rate of the two serial ports, the card number in multi-card systems and the product count. Access to this memory is via specific keywords within Mint and is not available for general variables.

3.12 System Watchdog

The system watchdog is a hardware protection method so that in the event of a firmware or ‘C’ program malfunction, the controller is put into software reset.

3.13 LED Status Display

The LED display on the front panel of the NextMove BX provides an indication of the status of the controller. The following symbols will be seen during normal operation:

Display	Meaning
1-F	Running MINT, serial node number of the controller is displayed in hex. (1 – 15).
M	Running MINT, serial node number of the controller is 0 or greater than 15.

When the controller is turned on, the following sequence will be seen:

Display	Meaning
all segments	Board in reset.
B	Booting.
J	Starting Mint firmware.
M or 1-F	Firmware is running.

When updating firmware on the controller, the following sequence will be seen. When update is complete, the boot sequence above should be seen.

Display	Meaning
R	Performing RAM test.
F	Erasing FLASH memory.
L	Updating firmware.

The following symbols are error conditions. Errors are denoted by the flashing of the 'dot' on the display at approximately 10Hz. If the following conditions are seen, please contact technical support.

Display	Meaning
D	DUART (serial driver) failure.
C	CAN failure.
S	Memory not detected correctly.
R	Memory failed test.
F	Failed to erase FLASH.
E	Firmware update was not successful.
U	Cannot detect firmware. Try updating firmware again.

Operation and Setup

4

This chapter is step by step guide to setting up a NextMove BX servo control system. Basic familiarity with PC's and the Windows environment is assumed.

Introduction to servo systems and tuning. Determining system gains and fine-tuning.

4.1 Communicating with NextMove BX

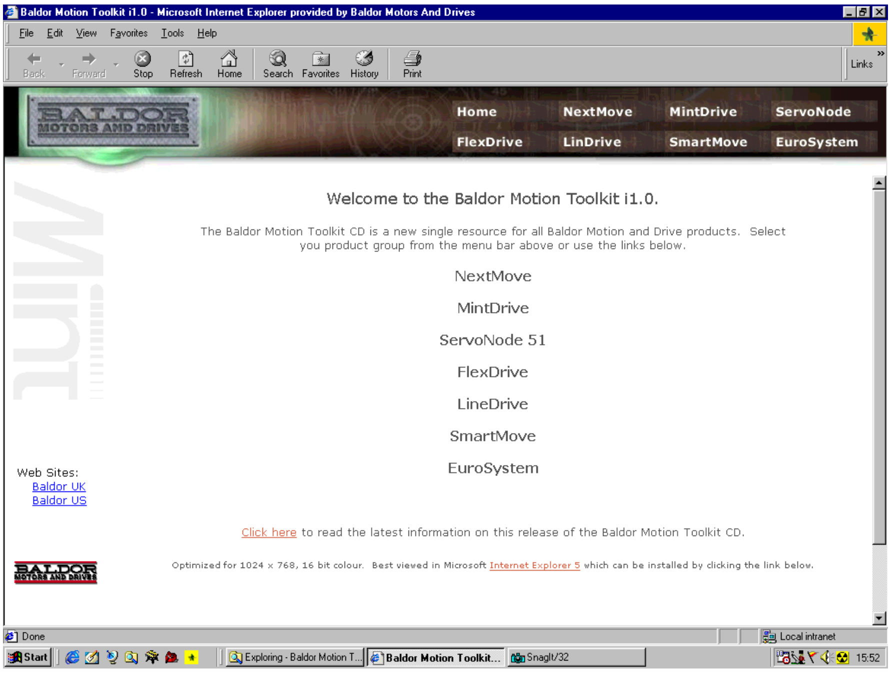
In order to communicate with NextMove BX, a RS232 or RS485 connection must be made to an AT style personal computer. The Baldor Motion Toolkit CD supports the following operating systems only: Windows 95, Windows 98 and Windows NT version 4.

The RS232 or RS485 cable is used to connect the controller to a computer for programming and system commissioning. A computer is not essential for operation of the controller, but is required for programming. A standard serial cable should be used or built according to the wiring diagram in section 3.8. An RS232 cable is available (order code CBL001-501).

Please note that the RS232 specification is a 'standard' that varies from manufacturer to manufacturer and therefore not all RS232 cables will work with the controller.

4.2 Baldor Motion Toolkit CD

Place the Baldor Motion Toolkit CD in the CD drive of the PC. The CD will auto-run and display the home page. If auto-run is disabled, browse the CD and double click the file ‘SETUP.HTM’.


Baldor Motion Toolkit i1.0 - Microsoft Internet Explorer provided by Baldor Motors And Drives
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Links
BALDOR MOTORS AND DRIVES
Home NextMove MintDrive ServoNode
FlexDrive LinDrive SmartMove EuroSystem
Mint
Done
Local intranet
Start
Exploring - Baldor Motion T...
Baldor Motion Toolkit...
SnagIt/32
15:52

Welcome to the Baldor Motion Toolkit i1.0.

The Baldor Motion Toolkit CD is a new single resource for all Baldor Motion and Drive products. Select you product group from the menu bar above or use the links below.

NextMove

MintDrive

ServoNode 51

FlexDrive

LineDrive

SmartMove

EuroSystem

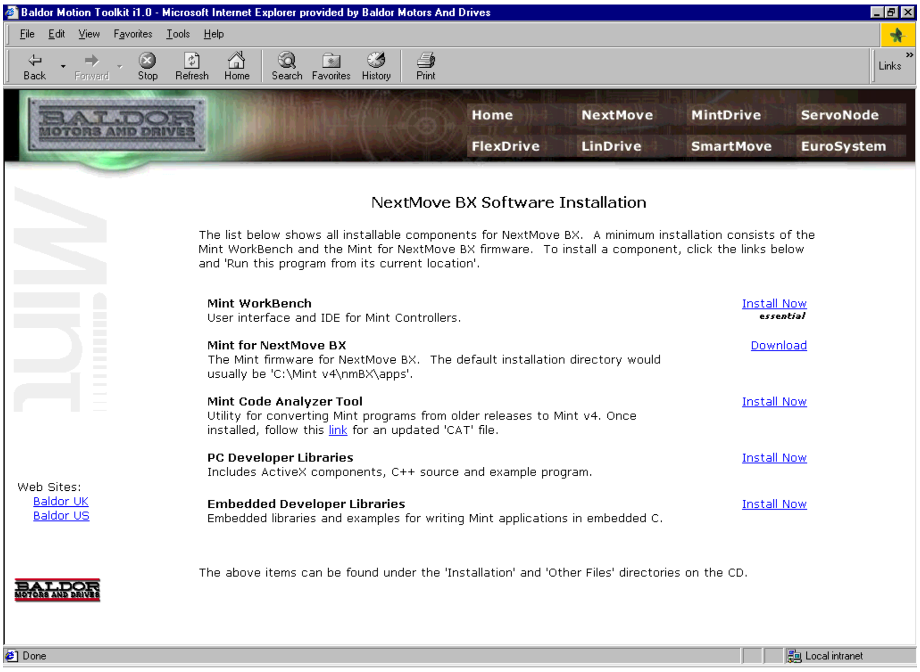
Web Sites:
Baldor UK
Baldor US

Click here to read the latest information on this release of the Baldor Motion Toolkit CD.

Optimized for 1024 x 768, 16 bit colour. Best viewed in Microsoft Internet Explorer 5 which can be installed by clicking the link below.

Figure 4-1: Baldor Motion Toolkit - Home Page

Select the NextMove link and then select the ‘NextMove BX’ option. This opens the page that allows the various NextMove BX related applications to be installed.


Baldor Motion Toolkit i1.0 - Microsoft Internet Explorer provided by Baldor Motors And Drives
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Links
BALDOR MOTORS AND DRIVES
Home NextMove MintDrive ServoNode
FlexDrive LinDrive SmartMove EuroSystem
Mint
Done
Local intranet

NextMove BX Software Installation

The list below shows all installable components for NextMove BX. A minimum installation consists of the Mint WorkBench and the Mint for NextMove BX firmware. To install a component, click the links below and 'Run this program from its current location'.

Mint WorkBench Install Now
User interface and IDE for Mint Controllers. *essential*

Mint for NextMove BX Download
The Mint firmware for NextMove BX. The default installation directory would usually be 'C:\Mint v4\nmBX\apps'.

Mint Code Analyzer Tool Install Now
Utility for converting Mint programs from older releases to Mint v4. Once installed, follow this link for an updated 'CAT' file.

PC Developer Libraries Install Now
Includes ActiveX components, C++ source and example program.

Embedded Developer Libraries Install Now
Embedded libraries and examples for writing Mint applications in embedded C.

Web Sites:
Baldor UK
Baldor US

The above items can be found under the 'Installation' and 'Other Files' directories on the CD.

Figure 4-2: Baldor Motion Toolkit – NextMove BX page

The **Mint WorkBench** is the IDE and user interface for communicating with a Mint controller.

The **Mint Configuration Tool** is a rapid getting started and configuration utility designed for use with a number of Mint v4 controllers. The rest of this chapter makes use of both of these applications and it is recommended that both of these are installed.

4.3 Configuring your System

This section shows you how to configure your system and check the system wiring.   The Mint Configuration Tool allows easy setup of NextMove BX and allows operational tests to be performed on the system.

A typical closed loop positioning system can be broken down into three elements:

1. **Position controller** – performs real time positional control of the motor(s), stores the application program and communicates with the user and other control equipment.

2. **Servo amplifier** – takes command signals from the position controller to control the torque or speed of the motor/actuator.

3. **Motor/actuator** – translates electrical power from the servo amplifier into rotary or linear movement. The motor is fitted with a position sensor that feeds the output position back to the controller.

The controller works by sampling the position of the motor at regular intervals and comparing this position with its target position. It then instructs the amplifier to drive the motor to correct any positional error. This process is repeated typically 1000 times per second to ensure that the motor is always in the correct position.

4.3.1 Minimum System Wiring Example

The following section is a guide to setting up a minimum system. A minimum system is one where the controller and drives are configured to work with as little external wiring as possible. It is recommended that motors are tested and set up 'on the bench' and not within the machine.

This step-by-step example covers setting-up a system with one servo axis. Figure 4-3 is a simplified wiring diagram for the system mentioned above. It should be noted that this is not the only possible configuration. It is important to read the associated text before attempting the set-up. For detailed wiring information, see section **Error! Reference source not found.**.

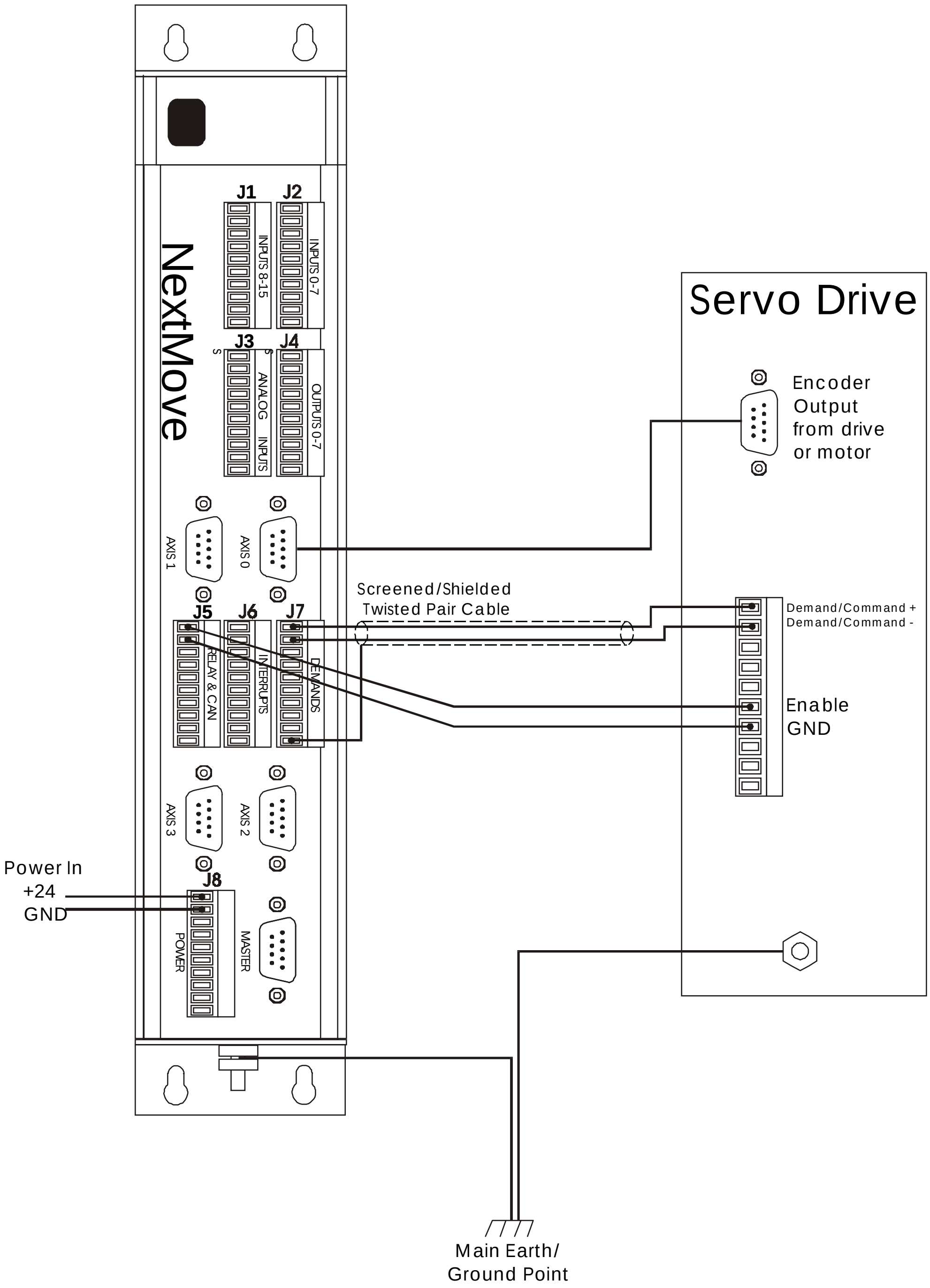
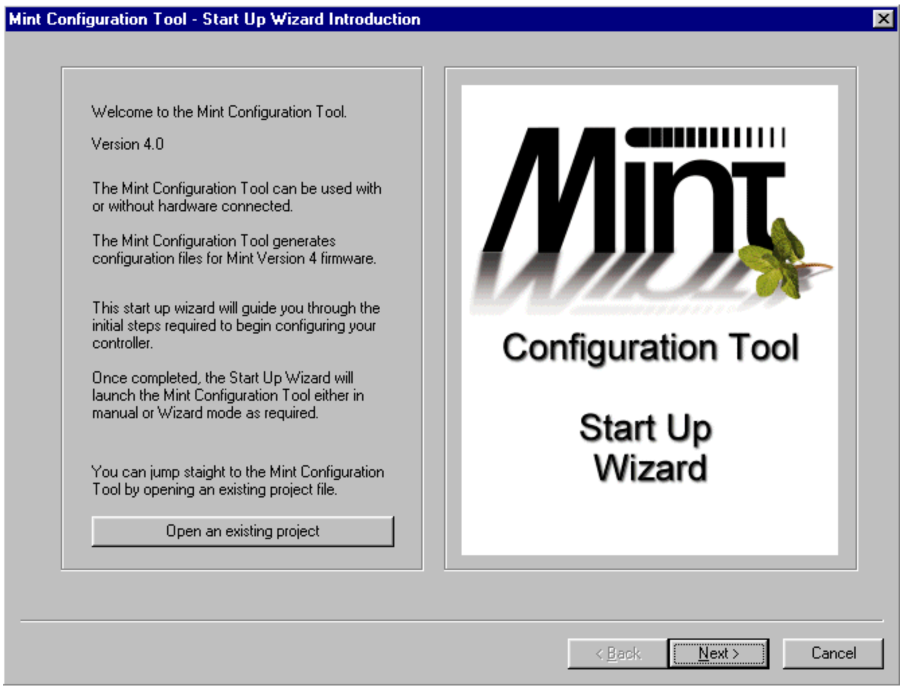


Figure 4-3: Minimum configuration for a 1 axis system

4.3.2 Starting with the Mint Configuration Tool

Start the Mint Configuration Tool by clicking the icon of the same name which can be found in the 'Mint v4' program group.



Mint Configuration Tool - Start Up Wizard Introduction

Welcome to the Mint Configuration Tool.

Version 4.0

The Mint Configuration Tool can be used with or without hardware connected.

The Mint Configuration Tool generates configuration files for Mint Version 4 firmware.

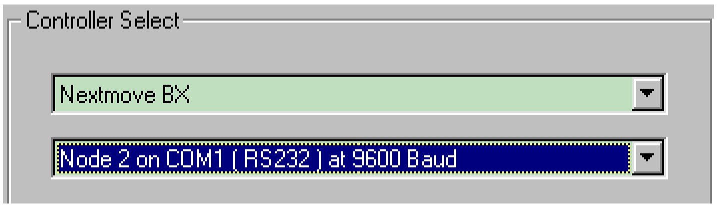
This start up wizard will guide you through the initial steps required to begin configuring your controller.

Once completed, the Start Up Wizard will launch the Mint Configuration Tool either in manual or Wizard mode as required.

You can jump staight to the Mint Configuration Tool by opening an existing project file.

Figure 4-4: Mint Configuration Tool Start Up Page

Select 'Next' and proceed to the 'Controller Type Select' page. NextMove BX should have been found automatically and will appear in the 'Controller Select' dropdown. If NextMove BX does not appear in the list then refer to trouble shooting in section **Error! Reference source not found.**.



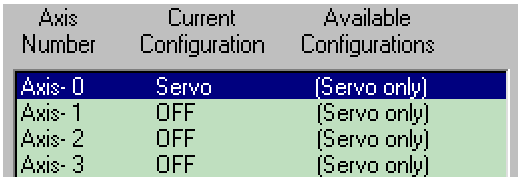
Controller Select

Nextmove BX

Node 2 on COM1 (RS232) at 9600 Baud

Figure 4-5: MCT Select Controller Drop-down

Clicking ‘Next’ will bring up the ‘Axes Selection’ page. From here, you can decide which axes you wish to configure in the Mint Configuration Tool. This example assumes a 4 axis NextMove BX. We will configure 1 axis.



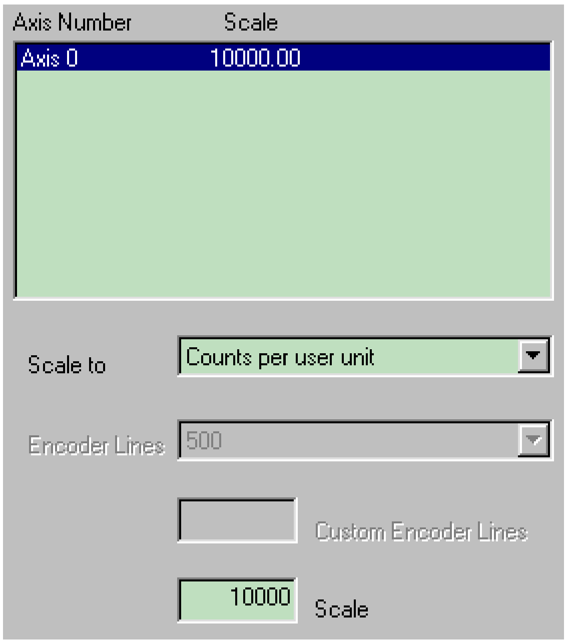
Axis Number	Current Configuration	Available Configurations
Axis- 0	Servo	(Servo only)
Axis- 1	OFF	(Servo only)
Axis- 2	OFF	(Servo only)
Axis- 3	OFF	(Servo only)

Figure 4-6: MCT Axis Configuration

From the list given, axis 0 has been selected as a servo.

NextMove BX is available in a number of axis variants: 2, 3 or 4 axes. Axes are labeled from 0 to 3. The axes selection screen will show the current configuration of each axis and the possible configurations. The Mint keyword VIEW CONFIG can also be used to show similar information. See the Mint v4 Advanced Programming Manual for further details on axis variants and mappings.

Click ‘Next’ to move to the ‘Scale Parameters’ page. Here you should set the scale factor for each axis.



Axis Number	Scale
Axis 0	10000.00

Scale to: Counts per user unit

Encoder Lines: 500

Custom Encoder Lines:

Scale: 10000

Figure 4-7: MCT Scale Settings

Mint defines all positional and speed related motion keywords in terms of encoder quadrature counts for servo motors or steps for stepper motors. The scale factor allows the system to be scaled to your own units to suit your application. The diagram below shows the effect of scaling on positional information:

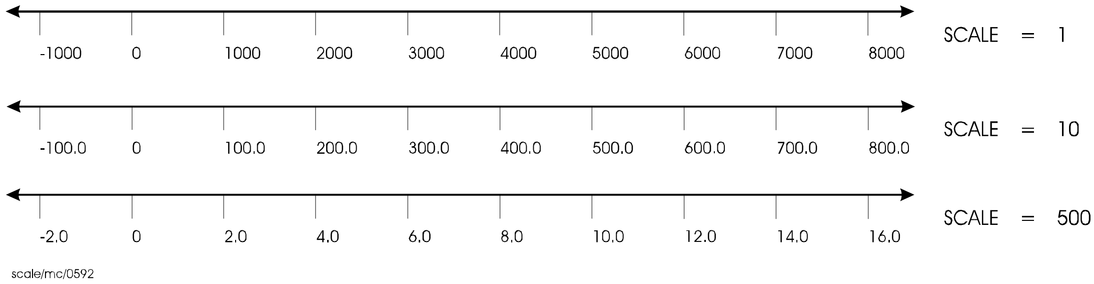


Figure 4-8: The Effect of Scaling on Positional Information

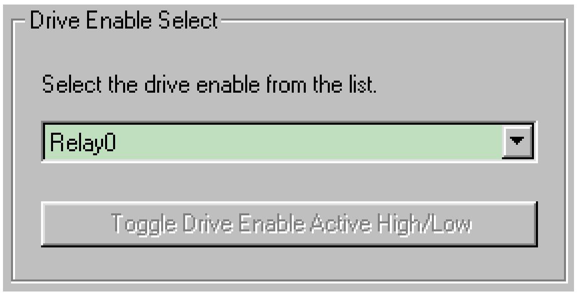
In an XY application, for example, you may want to define all positions in millimeters or inches.

For each servo axis, either manually enter a scale factor for ‘Counts per user unit’ or select ‘Counts per revolution’ and select the number of lines on the encoder.

4.4 Servo Setup

Clicking ‘Next’ brings up the ‘Test Select’ screen. In order to perform some basic tests on the system wiring, select ‘Perform Axes Configuration Test’.

The first test checks that the drive enable is correctly wired. By default NextMove BX does not associate any physical output with a drive enable. In this example the relay will be used as the drive enable channel. Select ‘Relay0’ from the drop down list.



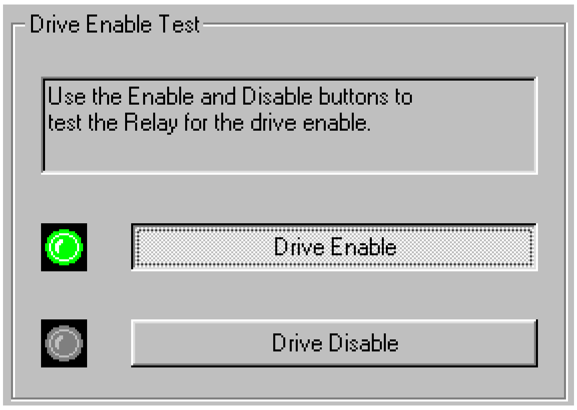
Drive Enable Select

Select the drive enable from the list.

Relay0

Figure 4-9: MCT Drive Enable Channel Drop-down

The assigned drive enable channel allows NextMove PCI to shut down the drive in the event of an error. Clicking the ‘Drive Enable’ button should enable the drive and the ‘Drive Disable’ button should disable the drive. If this is not the case, then the wiring and drive set-up should be checked.

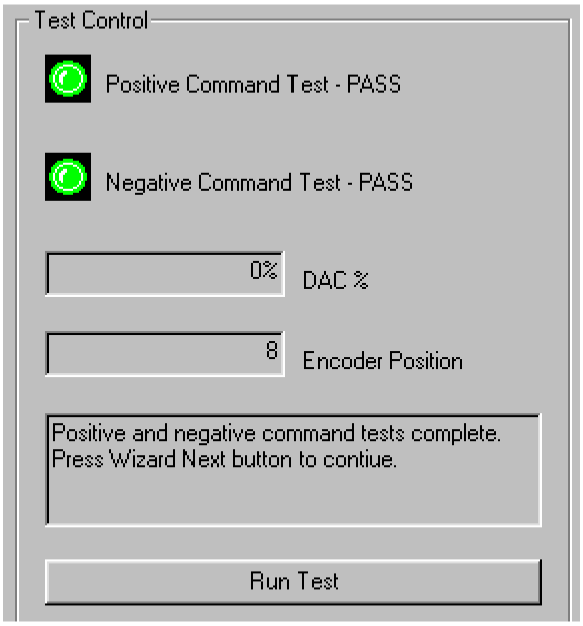


Drive Enable Test

Use the Enable and Disable buttons to test the Relay for the drive enable.

Figure 4-10: MCT Drive Enable Test

The next test checks that the command and direction signals to the drive. A positive command signal should result in a positive encoder change and a negative command signal should result in a negative encoder change.



Test Control

Positive Command Test - PASS

Negative Command Test - PASS

0% DAC %

8 Encoder Position

Positive and negative command tests complete. Press Wizard Next button to contiue.

Figure 4-11: MCT Command Test

If the encoder runs in the opposite direction when a command voltage is applied then the system may be re-wired. If the position does not change then check the following:

- The encoder cable is connected to the correct encoder input.
- The encoder has power and is correctly wired.

If the motor does not move, check the following:

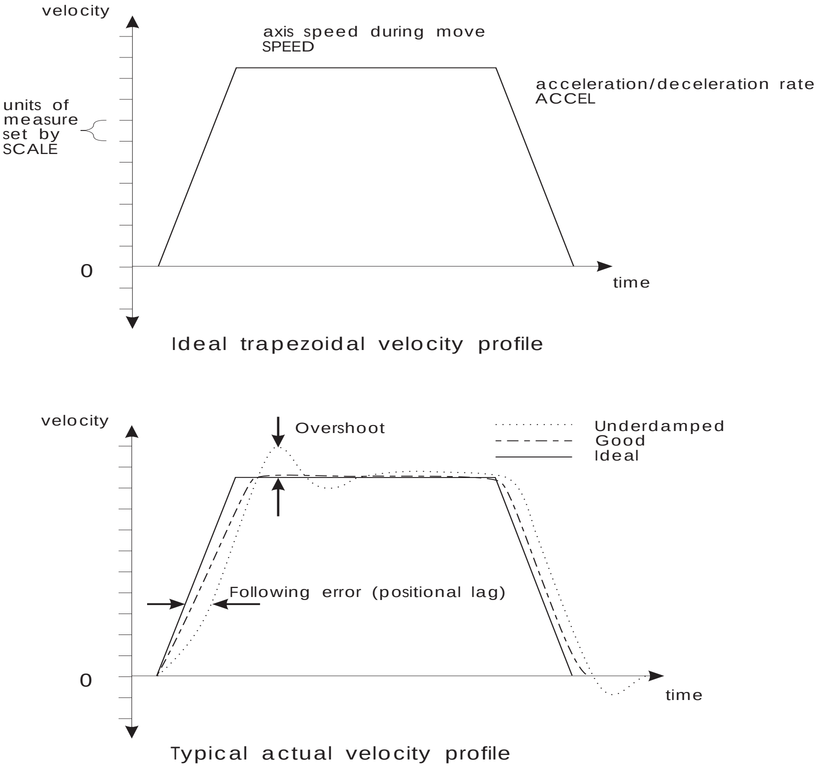
- The amplifier is enabled.
- There is a voltage output from the **command+** output.

4.4.1 Tuning a Servo Drive

At the lowest level of control software, instantaneous axis position demands produced by the controller software must be translated into motor demands. This is achieved by closed loop control of the motor. The motor is controlled to minimize the error between demand and actual position measured with an incremental encoder.

Every 1ms (or optionally 500us or 250us using the **`LOOPTIME`** keyword) the controller compares desired and actual positions and calculates the correct demand for the motor. The corrective signal is calculated by a PIDVFA (Proportional, Integral, Derivative, Velocity Feedback, Velocity Feed forward and Acceleration Feed forward) algorithm.

Control could be achieved by applying a signal proportional to the error alone, but this is a rather simplistic approach. Imagine that there is a small error between demanded and actual position. A proportional controller will simply multiply the error by some constant and apply the result to the motor via an amplifier. If the gain is too low, then the motor will not hold positional. As the gain is increased, the motor will present more resistance to positional error, but oscillations will increase in magnitude until the system becomes unstable.



Ideal trapezoidal velocity profile

Typical actual velocity profile

Figure 4-12: Velocity Profiles

To reduce the onset of instability a damping term is incorporated in the servo loop algorithm, called velocity feedback gain. Velocity feedback acts to resist rapid movement of the motor and hence allows the proportional gain to be set higher before vibration sets in. (In some applications, the velocity feedback is handled by the amplifier, called a velocity servo). The effect of too high proportional gain, or too low velocity feedback gain is illustrated by the "Under damped" line in Figure 4-12.

In NextMove BX, an alternative damping method is provided in the form of the derivative of the error signal. Derivative action has the same effect as velocity feedback if the velocity feedback and feedforward terms are equal. In torque controlled systems, derivative action is generally the preferred term.

Below is a description of the servo loop terms and their effect on the response of an axis.

Proportional Gain: This acts directly on the difference between the actual position of the axis and the desired position (following error). The larger the proportional gain the faster the axis will respond, however large values of proportional gain will introduce oscillation and result in a large settling times or in a worse case instability of the axis. Conversely, a small value of proportional gain will result in the axes responding slowly and never reaching the desired position.

Derivative Gain: This acts on the rate of change of following error. This term will speed up the response of an axis to the initial change in demand and reduce overshoot. As this term acts on the rate of change of following error when the axis is stationary the control effort generated by the derivative term should be zero. However in reality as servo axes are never truly at rest a large value of derivative gain will cause the axis to oscillate. In a worse case, the derivative term can introduce oscillation during motion which can lead to instability in the axis.

Integral Gain: This acts on the accumulated following error so that the steady state following error of an axis may be reduced to zero. This term is generally slow to respond as accumulated following error takes time to become large enough to be significant in the servo loop. Using a large value of integral gain will cause oscillation and instability in the axis. Most servo axes are very sensitive to integral gain and generally can only cope with a very small value. Because of this, the size of the demand caused by the integral term can be limited which allows a larger value to be used without fear of introducing instability during motion.

Velocity Feedback: This acts on the actual velocity of the axis. This term provides damping and will slug the response of the axis. This helps in reducing overshoot. If the effect of the velocity feedback term is dominant in the control law this will lead to instability in the axis.

Velocity Feedforward: This acts on the demand velocity as generated by the profiler. As such this term cannot introduce steady state instability. This term can be used to pull in any following error when the axis is moving at a constant velocity.

Acceleration Feedforward: This acts on the demand acceleration as generated by the profiler. As with velocity feedforward this term cannot introduce steady state instability. This term can be used to pull in any following error when the axis is moving at a constant acceleration.

Two types of servo amplifiers may be used with the controller:

1. Current or torque amplifiers use the demand signal to control the current flowing in the motor armature and hence the torque of the motor.
2. Velocity controlled amplifiers (velocity servo) use the demand signal as a servo speed reference.

For general purpose applications, the torque amplifier is cheaper and simpler to set up, but the velocity servo gives better control, especially in high performance applications. For torque amplifiers, velocity feedback must be used to stabilize the system, but this is not normally required for a velocity servo since it incorporates its own internal velocity feedback.

A block diagram of the complete control loop, showing controller, amplifier, motor and gearbox is presented below. The amplifier / servo may be a simple current amplifier, or incorporate internal velocity feedback via a tachometer.

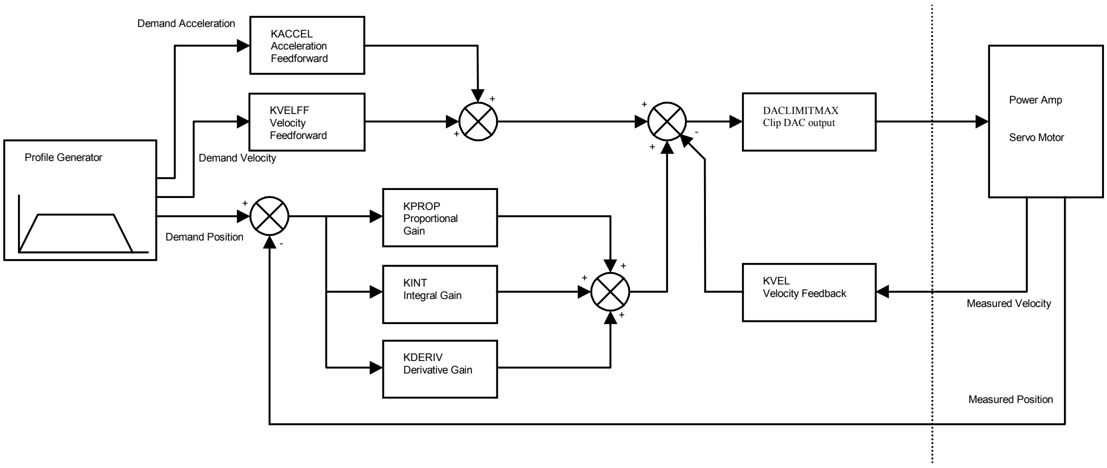


Figure 4-13: Servo Loop Block Diagram

The controller has six terms incorporating proportional, derivative, velocity feedback/feed forward, integral and acceleration feed forward gains. The equation of the loop closure algorithm is as follows:

$$\texttt{Command} = KP.e + KD.\Delta e/\Delta\tau - KV.v + KF.V + KI.\Sigma e + KA.A$$

Terms	Description
KP	Proportional servo loop gain
KD	Derivative of error
KV	Velocity feedback gain
KF	Velocity feed forward gain
KI	Integral gain
KA	Acceleration feed forward gain
e	Following error (quad counts)
v	Actual axis velocity (quad counts/sample time)
τ	Servo update period (sample time)
V	Demand axis velocity (quad counts/sample time)
A	Demand axis acceleration (quad counts/sample time^2)

Tuning the closed loop involves selecting values for some or all of the terms **KP**, **KD**, **KI**, **KV**, **KF** and **KA** to provide the best performance for a particular motor/encoder combination and load inertia. In view of the diversity of applications, these values all default to zero.

Two other functions, the **KINTLIMIT** and **DACLIMITMAX** are used to control the **command** output.

KINTLIMIT determines the maximum value of the effect of integral action, KI.Σe. This is specified as a percentage (%) of the full scale demand output in the range of ±10V. Therefore if the integration limit = 25, the maximum effect of integral action is ±2.5V.

DACLIMITMAX determines the maximum value of the demand output as a percentage of the full scale demand. Therefore if **DACLIMITMAX = 50**, the maximum demand output will be ±5V.

Tuning terms can be controlled in Mint using the following keywords:

Keyword	Abbreviation	Description
DACLIMITMAX	**DCX**	Limit maximum DAC output
KPROP	**KP**	Proportional gain
KDERIV	**KD**	Derivative gain
KINT	**KI**	Integral servo loop gain
KINTMODE	**KIM**	Integration mode during motion
KINTLIMIT	**KIL**	Range limit for integrator % of max DAC output
KVEL	**KV**	Velocity feedback gain
KVELFF	**KF**	Velocity feedforward gain
KACCEL	**KA**	Acceleration feedforward gain

4.4.2 Selecting Servo Loop Gains

All servo loop parameters default to zero, so the motor will have no power applied to it on power up. Most servo amplifiers can be set up in either current (torque) control mode or velocity control mode. The procedure for setting system gains differs slightly for each.

In order to check that the encoder and motor are wired up correctly, it is recommended that the motor is tested and commissioned 'on the bench' and not in the machine (the motor or gearbox shaft should be in free air).

The Mint Configuration Tool allows online tuning of the position loop. Continuing the example setup from section 4.4, proceed to the 'Servo Tuning' page. The 'Position Loop Tuning' tab allows tuning terms to be entered and a sample move performed. Once the move is complete, motion data is uploaded from the controller which allows the response of the axis to be seen.

The 'Following Error Fatal' value is the maximum permissible error between the axis desired position and the axis measured position. If an axis becomes unstable, when it exceeds the maximum following error, it will be disabled. Because of this, the maximum following error should be set at a safe value. If an error occurs, the 'Clear Errors' button needs to be pressed.

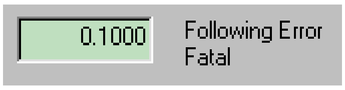
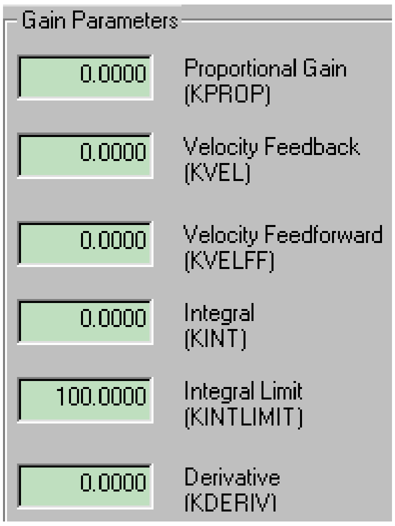

Following Error Fatal: 0.1000

Figure 4-14: MCT Setting Fatal Following Error Limit



Gain Parameters

0.0000 Proportional Gain (KPROP)

0.0000 Velocity Feedback (KVEL)

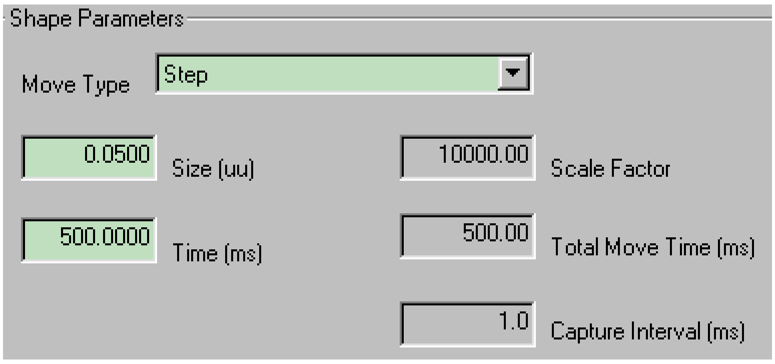
0.0000 Velocity Feedforward (KVELFF)

0.0000 Integral (KINT)

100.0000 Integral Limit (KINTLIMIT)

0.0000 Derivative (KDERIV)

Figure 4-15: MCT Tuning Terms are Entered in the 'Gain Parameters' Area



Shape Parameters

Move Type: Step

0.0500 Size (uu)

10000.00 Scale Factor

500.0000 Time (ms)

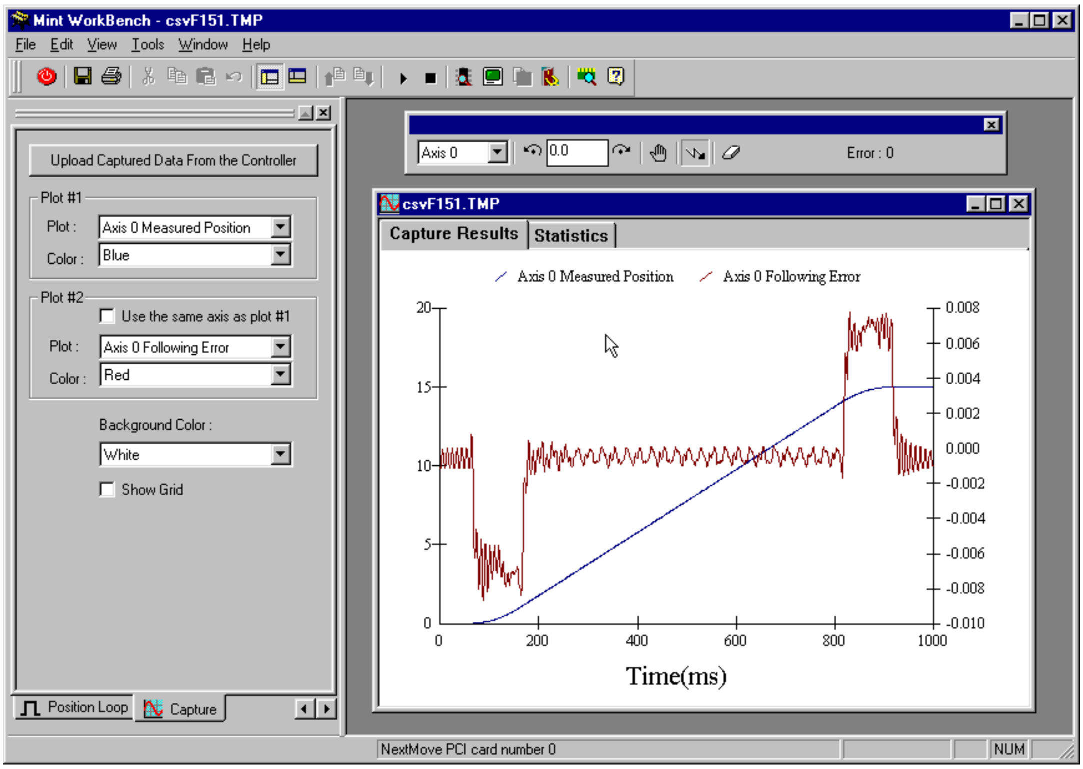
500.00 Total Move Time (ms)

1.0 Capture Interval (ms)

Figure 4-16: MCT Tuning Move

The 'rules of thumb' presented in the following sections for setting system gains, while adequate to get the system moving, will not provide the optimum response without further fine tuning of the system gains. Due to the number of parameters involved in tuning motors it is necessary to have a 'feel' for the effect that changing each gain term will have on the performance of an axis. In order to achieve an acceptable dynamic response, high gain values may be required, but these same values may cause the motor to hunt (a buzzing noise due to the motor vibrating on one encoder edge) when stationary. This can cause the machine to vibrate when at rest, especially if there is elasticity in the transmission such as a belt drive.

Further tuning may be carried out using the Mint WorkBench which provides a similar tuning interface to the Mint Configuration Tool.



Plot #1

Plot : Axis 0 Measured Position

Color : Blue

Plot #2

□ Use the same axis as plot #1

Plot : Axis 0 Following Error

Color : Red

Background Color : White

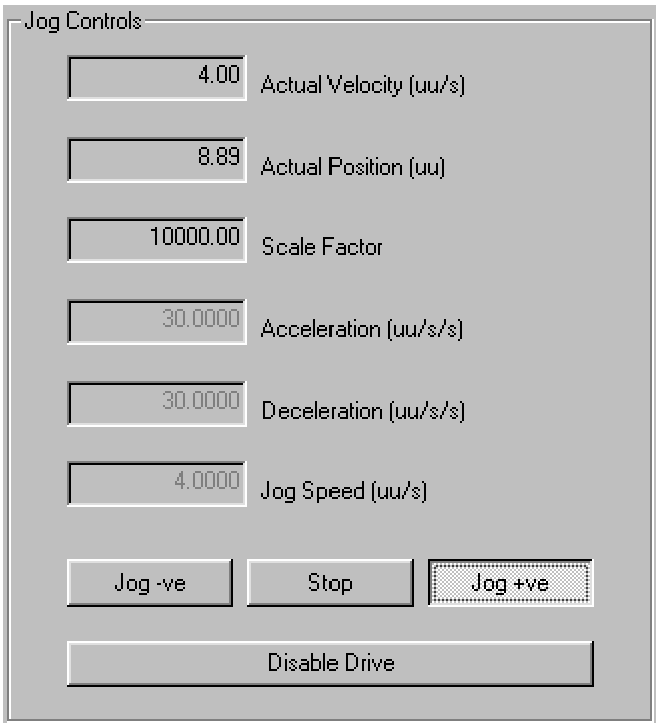
□ Show Grid

Axis 0 0.0 Error : 0

NextMove PCI card number 0 NUM

Figure 4-17: Mint WorkBench Tuning

After initial tuning has been completed, click ‘Next’ to proceed to the ‘Jog and Direction Test’ page. This allows a final check of system operation by jogging axis in either direction at selectable speeds, acceleration and deceleration rates.



Jog Controls

4.00 Actual Velocity (uu/s)

8.89 Actual Position (uu)

10000.00 Scale Factor

30.0000 Acceleration (uu/s/s)

30.0000 Deceleration (uu/s/s)

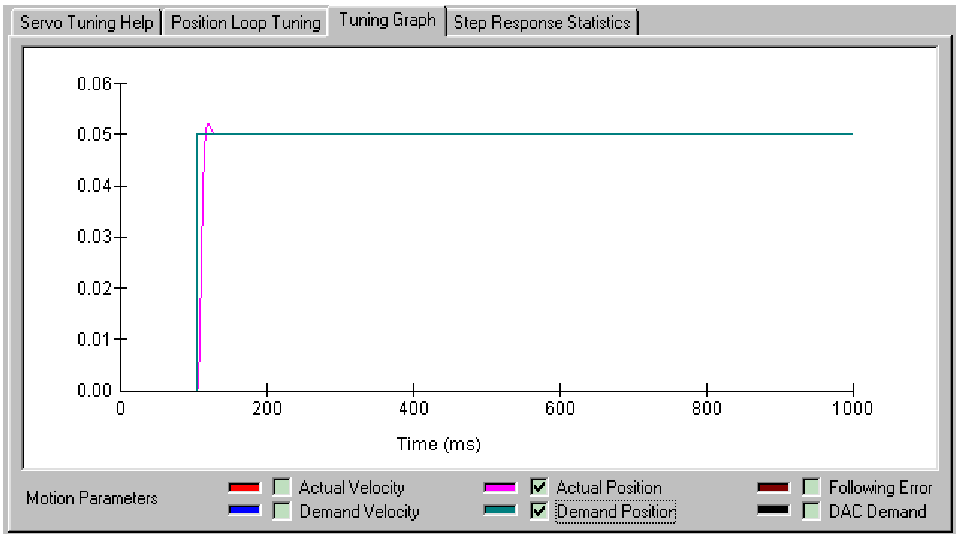
4.0000 Jog Speed (uu/s)

Figure 4-18: MCT Jog Test

4.4.3 System Gains for Current Control by Empirical Method

After having confirmed that the encoder and motor are correctly wired, start applying some velocity feedback, `KVEL`. Start with a value of 1 and increase it until you feel some resistance in the motor.

For some motors it may be necessary to apply fractional gains; all gain terms are floating point numbers. Once the feedback gain has been set, apply some proportional gain, `KPROP`. Start off with a value which is a quarter of the feedback gain. Select a tuning move such as the step response and view the results of the motion.

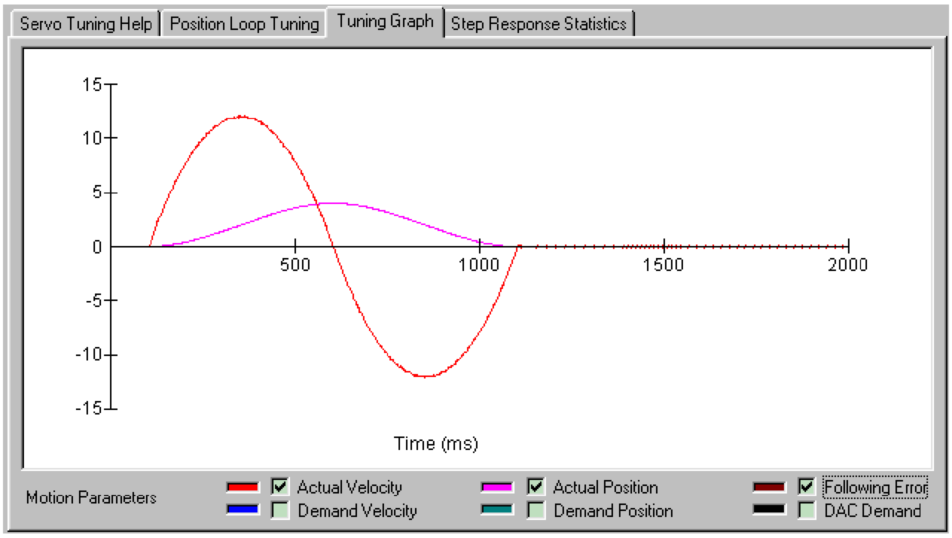


🟥 □ Actual Velocity
🟦 □ Demand Velocity
🟪 ☑ Actual Position
🟩 ☑ Demand Position
🟫 □ Following Error
⬛ □ DAC Demand

Figure 4-19: MCT Step Move Plot

If the motor starts to vibrate, increase the velocity feedback gain (damping), **KVEL**, or decrease the proportional gain, **KPROP**. Increase proportional gain, **KPROP**, until the motor shaft becomes stiff. Finally, set the velocity feed forward gain, **KVELFF**, to the same value as the velocity feedback gain, **KVEL**.

An alternative to using **KVEL** and **KVELFF** is to use the derivative term, **KDERIV**. **KDERIV** has exactly the same effect on the system dynamics as **KVEL** when **KVEL=KVELFF**.



🟥 ☑ Actual Velocity
🟦 □ Demand Velocity
🟪 ☑ Actual Position
🟩 □ Demand Position
🟫 ☑ Following Error
⬛ □ DAC Demand

Figure 4-20: MCT Sinusoidal Move Plot

4.4.4 System Gains for Velocity Control

Velocity controlled drives incorporate the velocity feedback term in the amplifier which provides system damping and therefore it is usually sufficient to have `KVEL = KDERIV = 0` on the controller. Usually, the value of the proportional gain, `KPROP`, will be less than with an equivalent current controlled system. Often a fractional value of proportional gain gives the best response. For example `KPROP=0.1` compared with `2` for current controlled drives.

Correct setting of the velocity feed forward gain, `KVELFF`, is important to get maximum response from the system. This is best performed using a storage oscilloscope (or the NextMove WorkBench) to record the tachometer output for fast point-to-point moves. This enables velocity/time profile for the motor to be seen in order to monitor actual acceleration and overshoot.

Referring to the servo loop block diagram, the velocity feed forward term is a block, which takes the instantaneous speed demand from the profile generator and adds this to the output block. Because `KVELFF` is a feed forward term, a very important difference between this and the other terms exists. `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 the other terms are set-up correctly.

In practice however, a very high value of `KVELFF` is of no benefit to system performance. Instead, it should be set such that a demand of x RPM from the profile generator results in a demand output to the velocity drive, which gives x RPM on the motor shaft (a 1:1 relationship).

When set-up correctly, `KVELFF` will cause the motor to move at the demand speed from the profile generator. This is true without the PID terms in the closed loop doing anything except compensating for small errors in the position of the motor due to analog drift. This gives faster response to changes in demand speed, with lower following errors.

Example calculation of KVELFF:

In order to calculate the correct value for `KVELFF`, you need to consider the workings of the servo loop closure algorithms. In the servo loop, speeds are expressed in quadrature counts/servo loop closure time. For instance, a speed of 100 is 100 counts every 1ms with NextMove PCI (note that the default loop closure time is 1ms).

In this example the velocity of the servo is 3000RPM with a +10V input, and the encoder has 1000 counts per revolution.

At 3000RPM we require an analog voltage of +10V. 3000RPM relates to:

$$\frac{3000}{60} = 50 \text{ revs per second}$$

Now the number of quadrature counts per loop closure time can be calculated by using the expression:

$$\frac{\textbf{speed in rev per sec * encoder line count * 4}}{\textbf{number of loop closures per second}}$$

The factor of 4 is included since the controller counts every edge of the pulse train coming from the encoder **A** and **B** channels, which gives four times better resolution than the number of lines.

$50 * 1000 * 4 / 1000 = 200$ quadrature counts per servo lop closure time

The DAC output has a resolution of 12 bits over the range -10V to +10V, therefore +10V = 2048 counts.

The feed forward term is therefore given by:

$$KVELFF = \frac{2048}{200} = 10.24$$

Increasing **KVELFF** above the calculated value will cause the controller to have a following error ahead of the desired position. Decreasing **KVELFF** below this value will cause the controller to have a more normal following error behind the desired position. The calculated value above should give zero following error in normal running.

It is possible to investigate the effect of velocity feed forward gain by jogging the motor at constant speed and monitoring the axis following error for different values of **KVELFF**. When attempting this, make sure that there is zero integral gain since this will cause the following error to tend to zero under steady state conditions, thereby negating the effect of changes in **KVELFF**.

4.4.5 Eliminating Steady-State Errors

In systems where precise positioning accuracy is required, it is often necessary to position to 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 amplifier which may not be enough to overcome mechanical friction (this is particularly so for current controlled systems). This error can be overcome by applying some integral gain.

The integral gain, **KINT**, works by accumulating following error over time to produce a demand sufficient to move the motor into the zero following error position. **KINT** can therefore also overcome errors caused by gravitational effects, such as vertically moving linear tables, where with current controlled drives, a non-zero **command** output is required to achieve zero following error.

Particular care is required when setting **KINT** since a high value can cause instability during moves. The effect of **KINT** should be limited by setting the maximum range of the integration (**KINTLIMIT**) to the minimum value that is sufficient to overcome friction or static loads.

Typical values are:

```
KINTLIMIT = 5
KINT = 0.1
```

where `KINTLIMIT` limits the integral term to 5% of the full DAC output range. `KINT` is usually a factor of 10 less than proportional gain, `KPROP`. With NextMove PCI, the integrator can be set to operate in various modes:

1. The integrator is always applied.
2. The integrator is only applied during periods of constant velocity.
3. The integrator is only applied when the axis is at rest.

This functionality is set using the `KINTMODE` keyword.

4.5 Methods of Programming

NextMove BX can be programmed using several different languages. These are:

Language	Location of Program	Description
Mint	On Controller	Basic style language supplied with controller.
Embedded C	On Controller	ANSI C compiled and linked using the Texas Instruments C31 compiler to libraries supplied by Baldor.
Visual C/C++	On Host PC	Microsoft Visual C/C++ compiled in conjunction with source code or COM server supplied by Baldor.
Visual Basic	On Host PC	Microsoft Visual Basic using COM server supplied by Baldor.
Delphi	On Host PC	Inprise Delphi using COM server supplied by Baldor.

All methods of programming are based around the same command set. In general all commands may be called from any language, thus giving the user maximum programming flexibility.

For example, to load a move of 10 user units on axis zero:

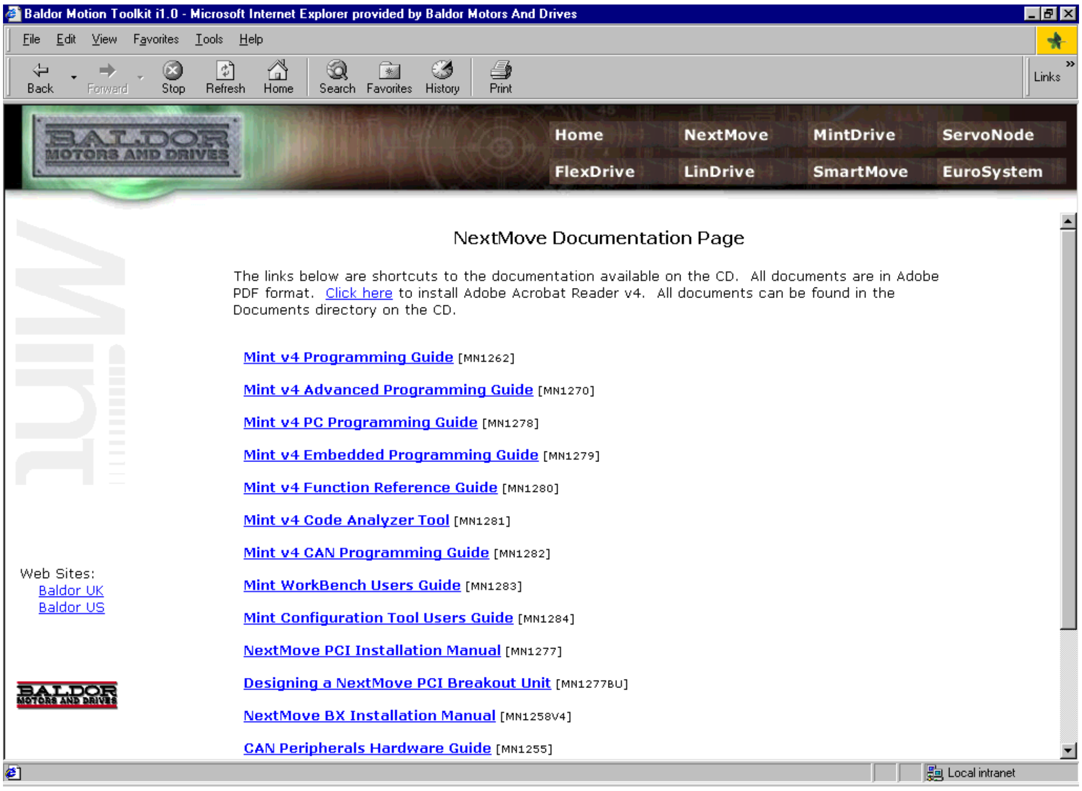
Language	Command
Mint	`MOVEA.0 = 10`
Embedded C	`setMoveA (0,10);`
Visual C/C++	`myPCI.setMoveA (0, 10);`
Visual Basic	`myPCI.setMoveA 0, 10`

For the host PC to communicate with NextMove BX the controller must be running either Mint or an embedded application. The controller can only run one application at a time (either Mint or an embedded application).

For further details on programming the controller in any of the above languages see the 'Mint v4 PC Programming Guide'.

4.6 Documentation

All NextMove BX documentation is available on the Baldor Motion Toolkit CD. Documents are in Adobe Acrobat format (PDF). The Acrobat viewer may also be installed from the CD.


Baldor Motion Toolkit i1.0 - Microsoft Internet Explorer provided by Baldor Motors And Drives
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Links
Home NextMove MintDrive ServoNode
FlexDrive LinDrive SmartMove EuroSystem
Local intranet

NextMove Documentation Page

The links below are shortcuts to the documentation available on the CD. All documents are in Adobe PDF format. Click here to install Adobe Acrobat Reader v4. All documents can be found in the Documents directory on the CD.

Mint v4 Programming Guide [MN1262]

Mint v4 Advanced Programming Guide [MN1270]

Mint v4 PC Programming Guide [MN1278]

Mint v4 Embedded Programming Guide [MN1279]

Mint v4 Function Reference Guide [MN1280]

Mint v4 Code Analyzer Tool [MN1281]

Mint v4 CAN Programming Guide [MN1282]

Mint WorkBench Users Guide [MN1283]

Mint Configuration Tool Users Guide [MN1284]

NextMove PCI Installation Manual [MN1277]

Designing a NextMove PCI Breakout Unit [MN1277BU]

NextMove BX Installation Manual [MN1258V4]

CAN Peripherals Hardware Guide [MN1255]

Web Sites:
Baldor UK
Baldor US

Figure 4-21: Baldor Motion Toolkit – NextMove Documentation Page

4.7 Mint

Mint is a structured form of Basic which has been custom designed for motion control applications. The Mint language has been written to allow users to get started quickly with simple motion programs and also provides a wide range of more powerful commands for complex applications.

Mint is used in thousands of applications worldwide, servicing many high demand industries such as textiles and packaging. Applications range from simple single axis applications to complex multi-axis, multi-controller applications via a host-controlled link. It is Mint's flexible and powerful command set that is able to provide a solution to the vast number of industrial motion control applications.

In addition to usual Basic type commands such as **PRINT, FOR..NEXT** and **IF..THEN**, Mint has a number of keywords dedicated to motion control and input/output.

Mint also provides full control over basic motor control parameters such as servo loop gains in addition to all the digital and analog I/O on the controller.

Mint splits motion keywords into 2 categories; motion variables and motion commands. Motion variables are keywords that set axis parameters. These can be read or written (although not necessarily both). Motion commands initiate motion. For example:

```
SPEED[0,1] = 10,20       : REM Set slew speed on axes 0 and 1
ACCEL[0,1] = 100,200     : REM Set acceleration on axes 0 and 1
MOVER[0,1] = 50,100      : REM Load positional moves
GO[0,1]                  : REM Start motion
```

The use of the square brackets controls 2 axes in the system, where axis 0 is the first axis followed by axis 1 and so on. The use of the square brackets is optional as Mint is very flexible in its multi-axis syntax. In this example, axis 0 is set up with a speed of 10 units/s, acceleration of 100 units/s^2 and a relative move of 50 units. Axis 1 is set up with a speed of 20 units/s, acceleration of 200 units/s^2 and a relative move of 100 units. **SPEED**, **ACCEL** and **MOVER** are all motion variables. The motion command **GO** is used to initiate motion. Most motion keywords can be abbreviated to 2 or 3 letters, for example, **SPEED** can be replaced with **SP** and **MOVER** replaced with **MR**. This saves both on code space and typing. The example above could be abbreviated to:

```
SP[0,1]=10,20     : REM Set slew speed on axes 0 and 1
AC[0,1]=100,200   : REM Set acceleration on axes 0 and 1
MR[0,1]=50,100    : REM Load positional moves
GO[0,1]           : REM Start motion
```

The utility called Squash within Mint WorkBench enables programs to be compressed by replacing keywords with their abbreviated counterparts.

At any time during motion, the position of the motor can be printed using:

```
PRINT POS.0       : REM Print position of axis 0
```

Position can also be monitored using the WatchWindow in the Mint WorkBench.

See the Mint v4 Programming Guide for more details on Mint syntax.

Engineering units can be applied to an axis. In a linear table for example, there may be 1000 encoder counts per mm. The keyword **SCALE** (or **SF** for short) can be used to set the new scale factor of the axis:

```
    SCALE = 1000
```

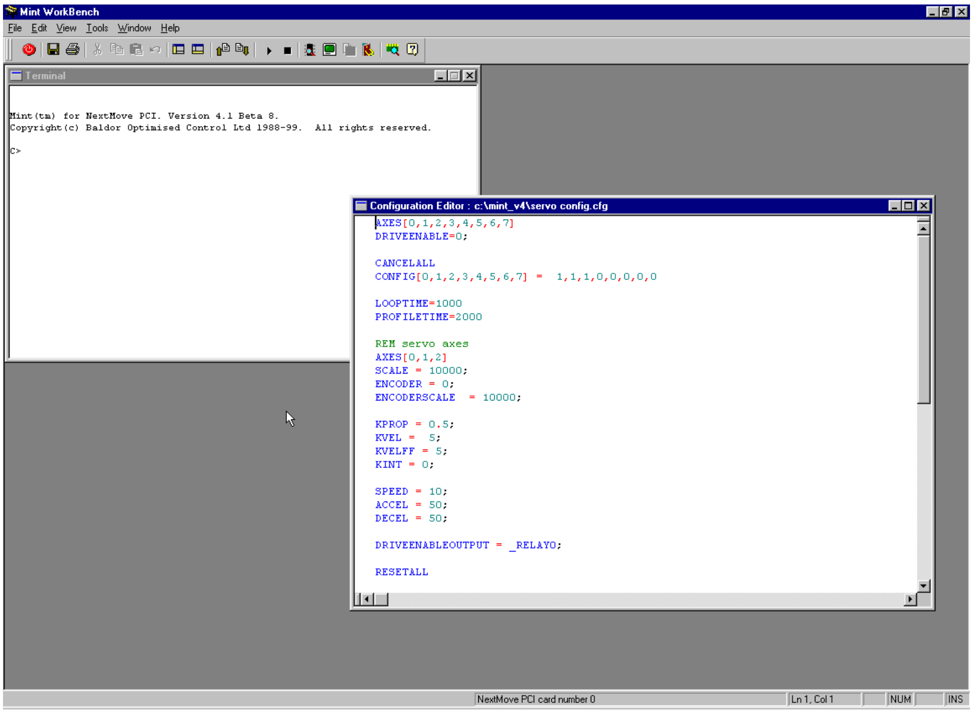
This enables positions to be specified in mm and speeds in mm/s.

Mint programs consist of two files. The Configuration Buffer stores information relating to the machine set-up, for instance the servo loop gains. The Program Buffer stores the actual motion control program. The two files can contain the same instructions, except that the Configuration Buffer is only 8K maximum size, while the Program Buffer can be up to 1Mb.

4.7.1 The Configuration File

The Configuration buffer is used to store information about a system such as IO configuration, motor tuning values and scale factors. If a part of the system is modified, then only the Configuration Buffer should require modification.

The Mint WorkBench has a built in editor which can be used to edit both Configuration and Program files. To create a new configuration file select ‘New…Config’ from the ‘File’ menu. This will open up an editor window into which you can type.


Mint WorkBench
File Edit View Tools Window Help
Terminal
Configuration Editor : c:\mint_v4\servo config.cfg
NextMove PCI card number 0
Ln 1, Col 1
NUM
INS

```
Mint(tm) for NextMove PCI. Version 4.1 Beta 8.
Copyright(c) Baldor Optimised Control Ltd 1988-99.  All rights reserved.

C>
```

```
AXES[0,1,2,3,4,5,6,7]
DRIVEENABLE=0;

CANCELALL
CONFIG[0,1,2,3,4,5,6,7] =  1,1,1,0,0,0,0,0

LOOPTIME=1000
PROFILETIME=2000

REM servo axes
AXES[0,1,2]
SCALE = 10000;
ENCODER = 0;
ENCODERSCALE  = 10000;

KPROP = 0.5;
KVEL =  5;
KVELFF = 5;
KINT = 0;

SPEED = 10;
ACCEL = 50;
DECEL = 50;

DRIVEENABLEOUTPUT = _RELAY0;

RESETALL
```

Figure 4-22: Mint WorkBench – Configuration File Editor

The configuration editor will syntax highlight all Mint keywords as they are typed. The correct syntax for the firmware being used can be uploaded from the controller by selecting the 'Load Syntax' option from the 'Edit' menu.

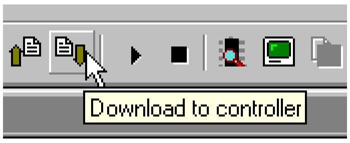


Figure 4-23: Download Button

In order to execute the configuration file in the editor window it must be downloaded to the controller by pressing the 'download' button.

Once the program has been downloaded to the controller it can be executed by either typing **RUN** at the Mint command line or pressing the 'play' button.

Whenever a Mint program is **RUN**, the Configuration Buffer is executed first followed by the Program Buffer. The Configuration or Program Buffer can be executed individually by typing:

RUN CON (for the *Configuration Buffer*)

or

RUN PROG (for the *Program Buffer*)

The following list of parameters is normally set-up in the Configuration Buffer:

- **Servo loop gains** - to tune the system response.
- **Scale factor** - to set the units of measure of the application.
- **Maximum following error** - to set a safe maximum difference between actual and desired positions.
- **Default speeds accelerations and decelerations for the system** - to determine the shape of the trapezoidal velocity profile.
- Error features such as hardware and software limits, stop inputs and error input.

The parameters in the Configuration Buffer are generally to be set-up only once for an application, but can at any time be altered in the Program Buffer.

The Mint Configuration Tool provides a graphical method for setting common parameters that would be placed in a configuration file. Having completed the Start Up Wizard, the Mint Configuration Tool can be started in wizard or manual modes. The wizard mode steps through each of the configuration screens for each axis selected during the Start Up Wizard.

Digital Inputs

Each of the digital input channels may be configured to be level (active high or low) or edge triggered (positive, negative or both edges). Digital inputs may also be assigned to axes for use as limit switch inputs etc.

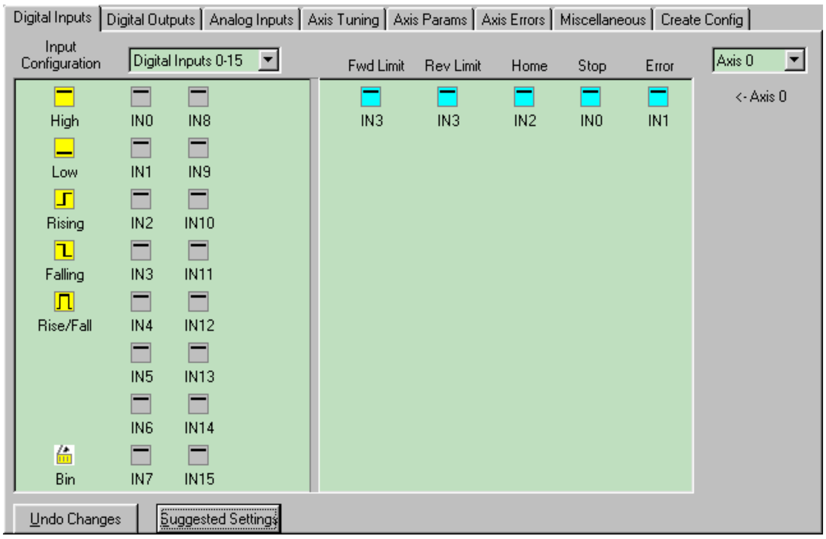


Figure 4-24: MCT Digital Input Setup

Digital Outputs

Each of the digital output channels may be configured to be active high or low. Digital outputs may also be assigned for use as drive enable channels or as a global error output signal.

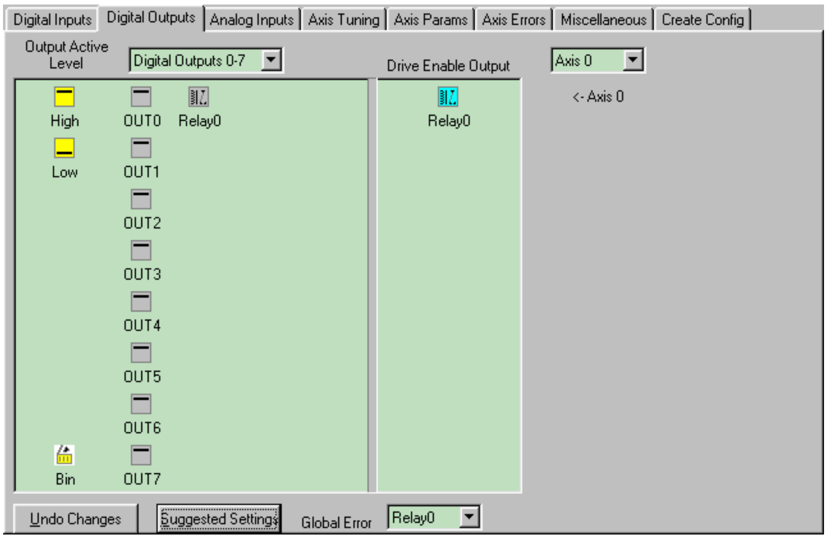
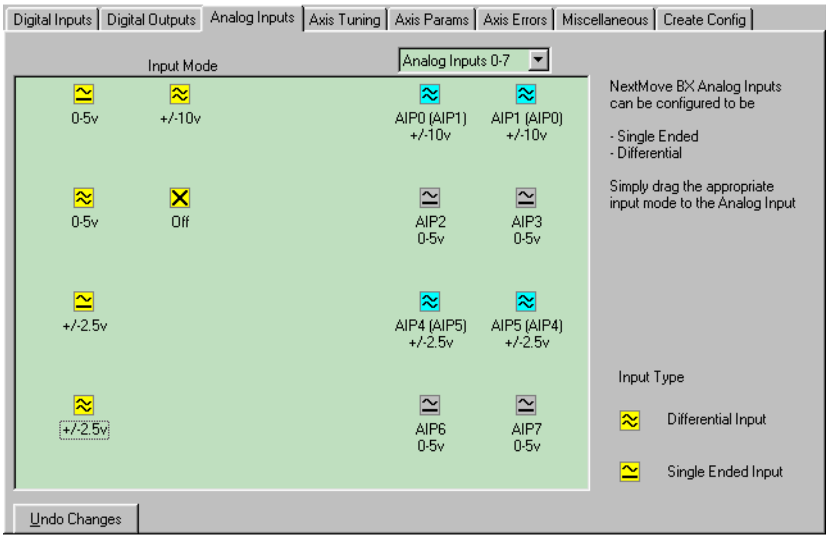


Figure 4-25: MCT Digital Output Setup

Analog Inputs

Each analog input channel can be configured to read a number of voltage ranges and as single ended or differential inputs.



Analog Inputs 0-7

AIP0 (AIP1) +/-10v
AIP1 (AIP0) +/-10v
AIP2 0-5v
AIP3 0-5v
AIP4 (AIP5) +/-2.5v
AIP5 (AIP4) +/-2.5v
AIP6 0-5v
AIP7 0-5v

NextMove BX Analog Inputs can be configured to be

- Single Ended
- Differential

Simply drag the appropriate input mode to the Analog Input

Input Type

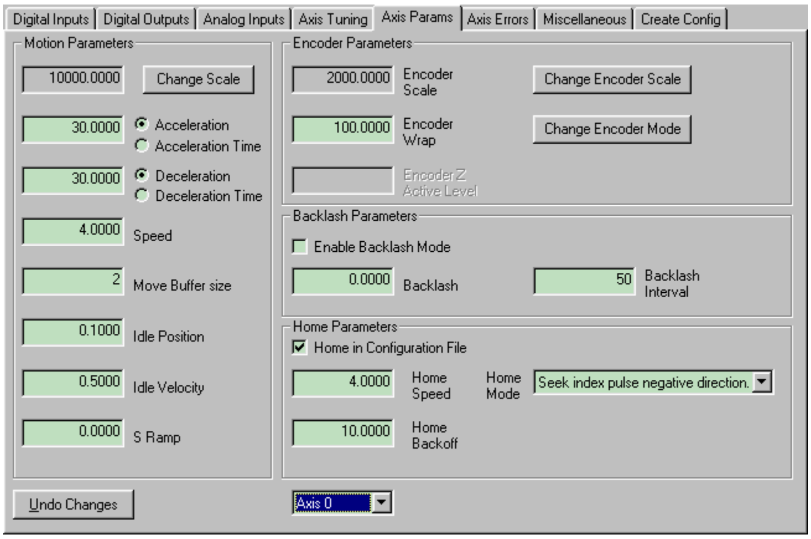
Differential Input

Single Ended Input

Figure 4-26: MCT Analog Input Setup

Axis Params

This page allows basic axis parameters to be setup such as speed and acceleration. You may also specify if a datum cycle is to be included in the configuration file.



Motion Parameters

10000.0000

30.0000 ● Acceleration ○ Acceleration Time

30.0000 ● Deceleration ○ Deceleration Time

4.0000 Speed

2 Move Buffer size

0.1000 Idle Position

0.5000 Idle Velocity

0.0000 S Ramp

Encoder Parameters

2000.0000 Encoder Scale

100.0000 Encoder Wrap

Encoder Z Active Level

Backlash Parameters

□ Enable Backlash Mode

0.0000 Backlash

50 Backlash Interval

Home Parameters

☑ Home in Configuration File

4.0000 Home Speed

Home Mode: Seek index pulse negative direction.

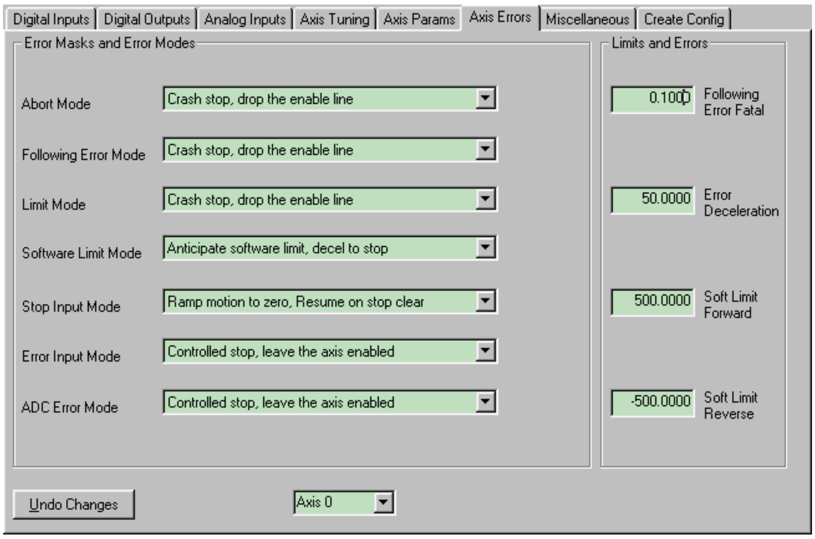
10.0000 Home Backoff

Axis 0

Figure 4-27: MCT Axis Parameters

Axis Errors

This page allows the error modes to be set for each error type. When an error occurs, the action specified will occur.



Abort Mode: Crash stop, drop the enable line

Following Error Mode: Crash stop, drop the enable line

Limit Mode: Crash stop, drop the enable line

Software Limit Mode: Anticipate software limit, decel to stop

Stop Input Mode: Ramp motion to zero, Resume on stop clear

Error Input Mode: Controlled stop, leave the axis enabled

ADC Error Mode: Controlled stop, leave the axis enabled

0.1000 Following Error Fatal

50.0000 Error Deceleration

500.0000 Soft Limit Forward

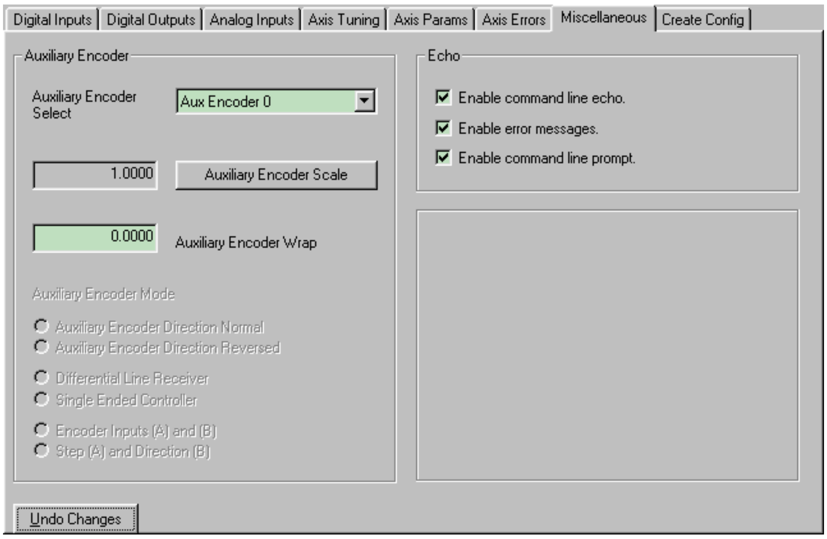
-500.0000 Soft Limit Reverse

Axis 0

Figure 4-28: MCT Axis Errors

Miscellaneous

This page allows the auxiliary encoder parameters to be set and the state of the Mint command line **ECHO** keyword.



Auxiliary Encoder Select: Aux Encoder 0

1.0000 Auxiliary Encoder Scale

0.0000 Auxiliary Encoder Wrap

Auxiliary Encoder Mode

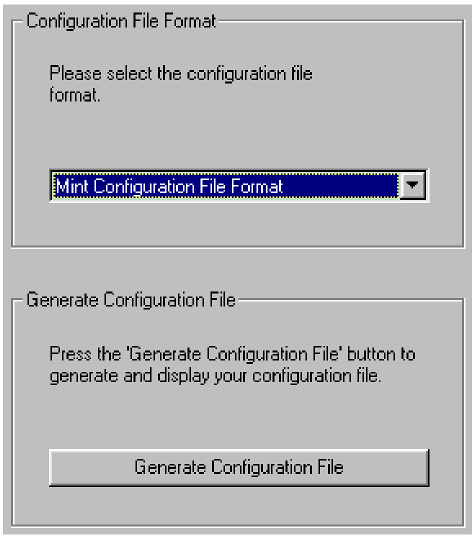
○ Auxiliary Encoder Direction Normal
○ Auxiliary Encoder Direction Reversed
○ Differential Line Receiver
○ Single Ended Controller
○ Encoder Inputs (A) and (B)
○ Step (A) and Direction (B)

☑ Enable command line echo.
☑ Enable error messages.
☑ Enable command line prompt.

Figure 4-29: MCT Miscellaneous Parameters

Create Config

This page allows you to select whether to generate a Mint Configuration file or C source code suitable for use in an embedded application.



Configuration File Format

Please select the configuration file format.

Mint Configuration File Format

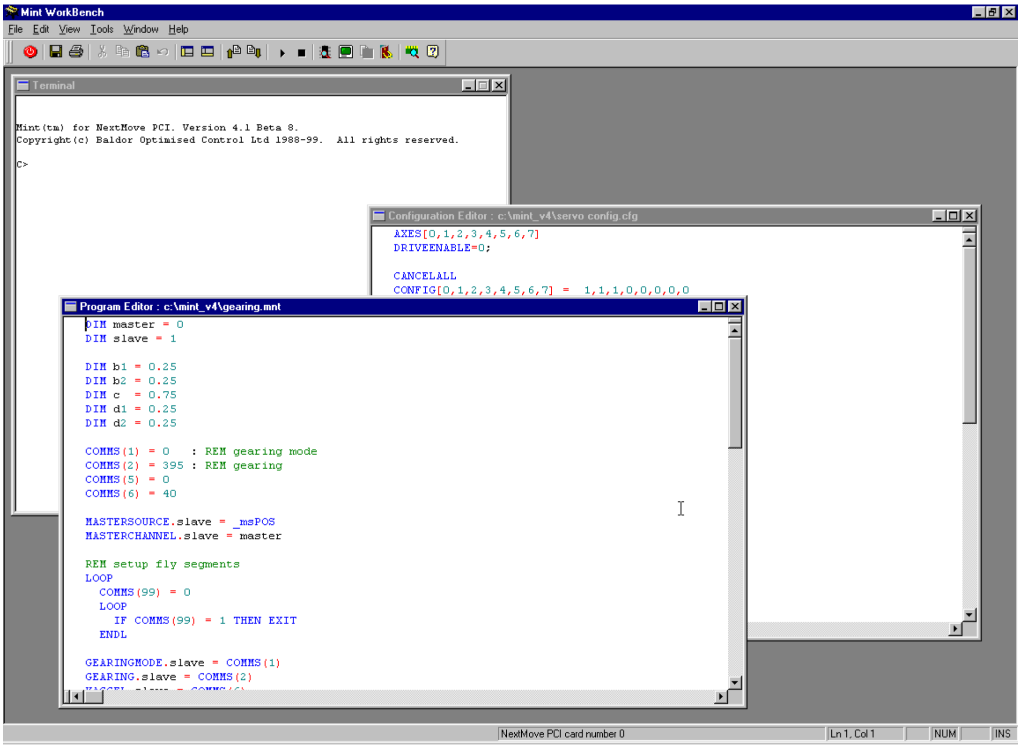
Generate Configuration File

Press the 'Generate Configuration File' button to generate and display your configuration file.

Figure 4-30: MCT Create Configuration File

4.7.2 The Program File

The Mint WorkBench has a built in editor which can be used to edit both Configuration and Program files. To create a new configuration file select ‘New…Program’ from the ‘File’ menu. This will open up an editor window into which you can type.


Mint WorkBench
File Edit View Tools Window Help
Terminal
Configuration Editor : c:\mint_v4\servo config.cfg
Program Editor : c:\mint_v4\gearing.mnt
NextMove PCI card number 0
Ln 1, Col 1
NUM
INS

```
Mint(tm) for NextMove PCI. Version 4.1 Beta 8.
Copyright(c) Baldor Optimised Control Ltd 1988-99.  All rights reserved.

C>
```

```
AXES[0,1,2,3,4,5,6,7]
DRIVEENABLE=0;

CANCELALL
CONFIG[0,1,2,3,4,5,6,7] =  1,1,1,0,0,0,0,0
```

```
DIM master = 0
DIM slave = 1

DIM b1 = 0.25
DIM b2 = 0.25
DIM c  = 0.75
DIM d1 = 0.25
DIM d2 = 0.25

COMMS(1) = 0   : REM gearing mode
COMMS(2) = 395 : REM gearing
COMMS(5) = 0
COMMS(6) = 40

MASTERSOURCE.slave = _msPOS
MASTERCHANNEL.slave = master

REM setup fly segments
LOOP
  COMMS(99) = 0
  LOOP
    IF COMMS(99) = 1 THEN EXIT
  ENDL

GEARINGMODE.slave = COMMS(1)
GEARING.slave = COMMS(2)
```

Figure 4-31: Mint WorkBench - Program Editor

As with the Configuration file, in order to execute the Program file, it must be downloaded to the controller.

Once the program has been downloaded to the controller it can be executed by either typing **RUN** at the Mint command line or pressing the ‘play’ button on the Mint WorkBench Toolbar.

4.8 Motion

NextMove BX supports a wide range of motion:

Type of Motion	Description	Associated Mint Keywords
Constant torque	Constant torque output.	`TORQUE`
Constant velocity	Constant velocity with imposed acceleration and deceleration ramps.	`JOG`
Homing	Datum to a known starting point.	`HOME`
Point to point	Absolute and relative position moves with a trapezoidal velocity profile.	`MOVEA, MOVER, GO`
Vector	Multi-axis absolute and relative position moves with a trapezoidal velocity profile.	`VECTORA, VECTORA, GO`
Circle	Circular motion.	`CIRCLEA, CIRCLER, GO`
Incremental	Positional move with a changing target position.	`INCA, INCR, GO`
Analogue based	Axis velocity based on error between analogue measured and desired values.	`HTA, GO`
Synchronized motion	Master / Slave following with imposed ratios.	`FOLLOW, FLY`
Software variable gearbox.	User definable software CAM profile.	`CAM, GO`
Spline	User definable cubic spline motion.	`SPLINE, GO`

For more details on motion keywords see the Mint v4 Programming Guide.

Options and Accessories

5

This chapter describes the option and accessories for NextMove BX.

5.1 NextMove BX

NextMove BX is supplied with a *software license* to control 2,3 or 4 axes. This license cannot be upgraded in the field.

Item		**Order Code**	**Description**
Card Type	No. of axes		
NextMove BX	2	NMX004-501	NextMove BX standalone controller.
NextMove BX	3	NMX004-502	
NextMove BX	4	NMX004-503	
Item	Order Code	Description	
NextMove BX Installation Manual	MN1258V4	Includes Baldor Motion Toolkit CD.	
Mint v4 Programmer's Manual	MN1262	How to use Mint v4.	
Baldor Motion Toolkit CD	SW1275	Mint WorkBench, Mint Configuration Tool and Libraries for developers.	

5.2 CAN Nodes

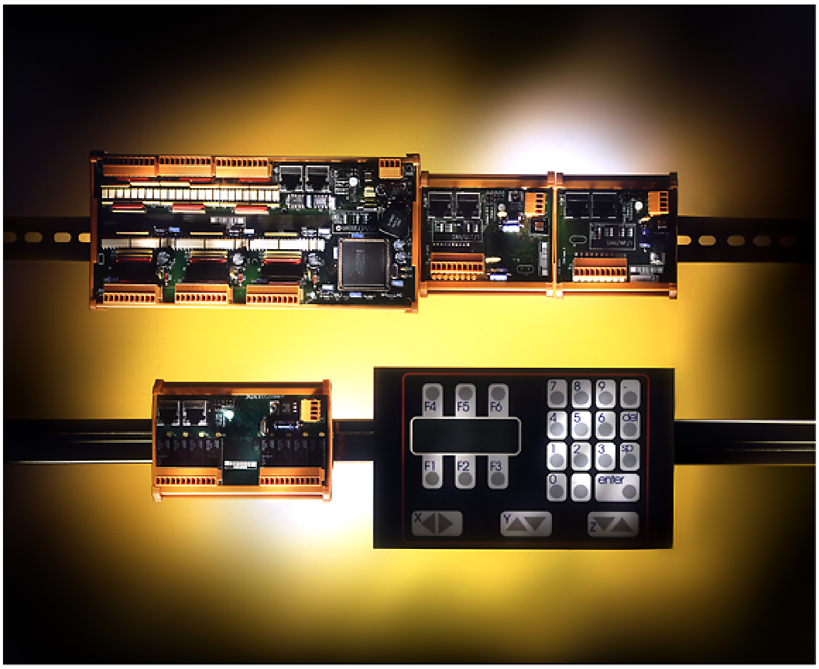


Figure 5-1: ***io*****NODE Product Family**

Digital I/O can be expanded easily on NextMove BX using the Baldor CAN bus interface. This provides a high speed secure serial bus interface to a range of I/O devices as described:

- *inputNode 8*: 8 opto isolated digital inputs.
- *outputNode 8*: 8 opto isolated digital outputs with short circuit and over current protection.
- *relayNode 8*: 8 relay outputs.
- *ioNode 24/24*: 24 opto isolated input and 24 opto isolated outputs.
- *keypadNode* : General purpose operator panel (3 and 4 axis versions).

Item	Order Code	Description
CAN Operator Panel – 3 Axes (keypadNode)	KPD002-502	27 key keypad and 4 line LCD display. Runs on Baldor CAN bus.
CAN Operator Panel – 4 Axes (keypadNode)	KPD002-505	41 key keypad and 4 line LCD display. Runs on Baldor CAN bus.
inputNode 8	ION001-503	8 digital inputs. Runs on Baldor CAN bus.
outputNode 8	ION003-503	8 digital outputs. Runs on Baldor CAN bus.
relayNode 8	ION002-503	8 relay outputs. Runs on Baldor CAN bus.
ioNode 24/24	ION004-503	24 digital inputs and 24 digital outputs. Runs on Baldor CAN bus.

5.3 Encoder Splitter/Buffer Board

This is a stand alone PCB that takes an encoder signal, either single ended or differential and gives differential outputs. This is useful for 'daisy chaining' an encoder signal from a master across a number of controllers.

Item	Order Code	Description
2-way encoder splitter	OPT008-501	Allows a single-ended or differential encoder pulse train to be shared between two devices
4-way encoder splitter	OPT029-501	Allows a single-ended or differential encoder pulse train to be shared between four devices

Specifications and Product Data

6

This chapter provides a product summary and describes the basis for CE marking and describes how to avoid common EMC problems when using NextMove BX.

6.1 Machine Control I/O

User Digital Inputs:	• 16 input lines. • PNP or NPN opto-isolated relative to common. • 12 to 24V ±20% on, 3V max off. • Software programmable as **limit**, **home**, **stop** or **error** inputs for any axis.
User Digital Outputs:	• 8 digital outputs driven through a Darlington array. • Software programmable as **drive enable** output for any axis. • 50mA continuous source on all channels. • Max. 350mA on any channel 750mA total @ 25°C.
Fast Interrupt:	• One fast plus three 'slow' fast inputs per controller. • Latches position of programmed axes within 30 microseconds / 1 millisecond on a falling edge.
Relay Output:	• Voltage free change over relay rated at 500mA @ 24V dc. • Contact sensitivity 10µA @ 10mV DC • 1 output per controller, software programmable. • Fail safe operation: relay de-energized on loss of power. • Software programmable to de-energize on an error.
Analog Inputs:	• 8 independent analog channels. Configurable as 8 single ended or 4 differential pairs. • 12 bit resolution. • Software selectable for ±10V (differential) or 0-5/±2.5V single ended operation.
Analog Outputs:	• 1 output per axis for motor **command** signal (software configurable). • ±10V output (±0.1%). • 14 bit resolution (1.21mV per bit).
Encoder Inputs:	• Encoder input per axis for positional feedback via incremental encoder. • Operates with differential (TTL or RS422) output type. • Accepts three channel incremental encoders (**A**, **B** and **Z**). **A** and **B** channels are quadrature decoded. • Minimum requirement: Channel **A** and **B** . • Maximum encoder frequency: 7.3MHz quadrature count.

6.2 Miscellaneous and Mechanical Specification

Power Input	• +24V DC (±20%) @ 700mA. • User Power: +12V to 24V ±20% at 850mA.
Internal Battery	• 3.6V 3 cell nickel metal hydride (NiMH) with 280mAh capacity & 5 year life. • Non-volatile RAM contents retained for 12 months when fully charged.
Dimensions	• 280mm (316mm including flanges) x 236mm x 59mm. • 11 in (12.45 including flanges) x 9.3 in x 2.32 in.
Weight	• Approximately 1.86kg / 4.1lb
Operating Temperature	• 0 - 40°C / 32° - 104°F Ambient.
Humidity	• 10% to 90% non condensing at sea level to 2000m/6560ft.

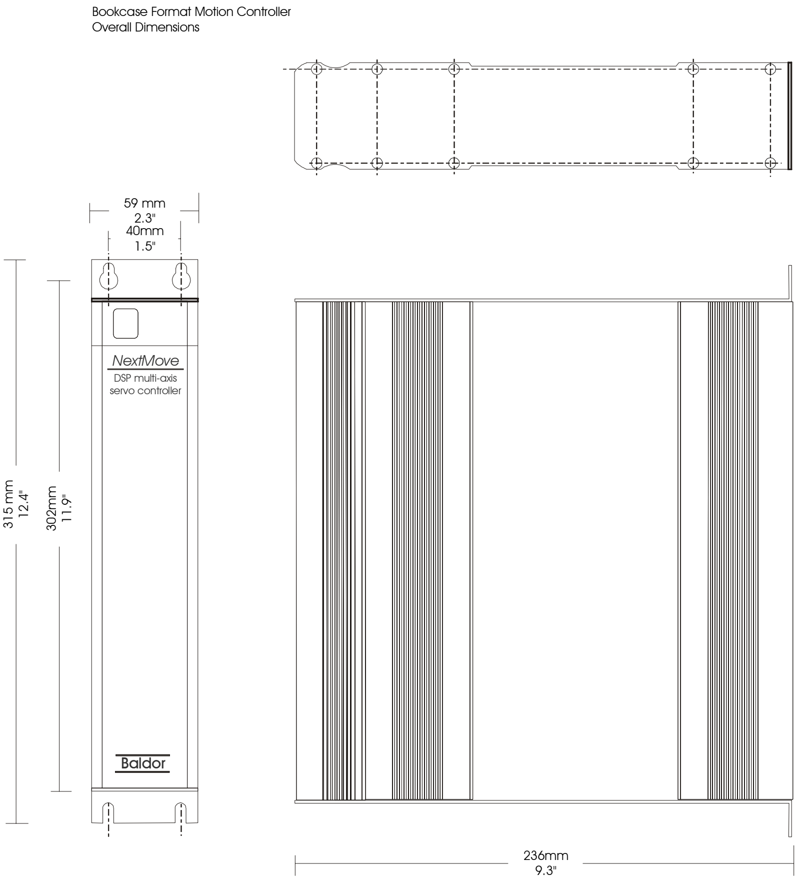


Figure 6-1: NextMove BX Bookcase Format Overall Dimensions

6.3 EMC & CE Marking

6.3.1 Machinery Directive 89/392/EEC

This relates to the safety of machinery. Any machine having a moving part has to comply with the essential requirements of this directive. This also applies to some mechanical sub-systems, such as fans. Electronic sub-systems, such as NextMove BX , do not fall within its scope. It should be noted that to meet the safety requirements of this directive, the primary machine safety system cannot be based on controller software. The paying of a notified body to audit the software and provide a safety case is prohibitively expensive. A hard-wired system using guard switches (to protect personnel or equipment) should be used.

6.3.2 Low Voltage Directive 72/23/EEC

Applies to equipment powered from 75V dc to 1500V dc or 50V ac to 1000V ac. Therefore this directive does not apply to NextMove BX .

6.3.3 EMC Directive 89/336/EEC

This directive applies to all 'apparatus liable to cause disturbance or the performance of which is liable to be affected by such disturbance'. The expression 'apparatus' is defined for the purpose of the regulations as '..an electrical or electronic appliance or system consisting of a finished product or products having an intrinsic function which is intended for the end user, and is supplied or intended for supply or taken into service or intended to be taken into service as a single commercial unit'.

This wording brings automated machines within the scope of the directive but not necessarily their electronic sub-systems. This is because of their lack of intrinsic function to the end user.

6.4 EMC Performance of NextMove BX

It should be noted that the equipment is suitable for light or heavy industrial use. The text from the full report is appended.

Test	Standard	Comments
Generic emissions, light industrial	Radiated Emissions EN 55081-1:1992	Connections to all ports as recommended in this manual, with the exception of connections to +**5V**, +**12V**, **-12V**, **0V**. Passed the B limit.
Generic immunity, heavy industrial	ESD EN 50082-1:1995 EN 61000-4-2:1995	4kV contact to case, had no effect. No contact to connector pins.
	Radiated immunity EN 55082-2:1995 EN 61000-4-3:1995 ENV 50204:1995	Connections to all ports as recommended in this manual, except no connections to +**5V**, +**12V**, -**12V**, **0V**, serial port operated in RS232 mode. Test covered 10V/m 26-80MHz, 10V/m 80-1000MHz with 80% 1kHz modulation, equipment functioned correctly throughout.
	Fast burst transients IEC801-4	2kV via clamp to **CAN**, **demand/command**, **Din**, **Dout**, RS232, RS485, Fast Interrupt. Equipment functioned correctly throughout. 2kV to power inputs.

6.5 EMC Advice

The apparatus shall be connected in accordance with the recommendations of this manual. There are certain restrictions regarding the length and type of cable:

Cable type	Ports
Unrestricted	**usr-V+**, **usr-gnd**, user inputs, user outputs, **home**, **limit**, **drive error**, **power** input, **drive enable** relay. The 24v to the PSU must be isolated.
Unrestricted but screening/shielding is advised	**demand**/**command**, analog inputs
must be screened/shielded	serial cables
Screened/shielded twisted pair	encoders, **CAN**
< 2.9m (10ft) long	+**5V**, +**12V**, -**12V**, **0V**

Troubleshooting Guide

7

This chapter covers common problems found when using the NextMove BX controller.

7.1 Trouble Shooting Guide

Symptom	Check
Cannot detect NextMove BX in the Mint WorkBench of the Mint Configuration Tool.	- The NextMove BX must be running a version of Mint v4 to be detected. If upgrading from Mint v3 firmware then the select 'controller with no firmware' from the Mint WorkBench and 'update firmware' to Mint v4. - Check that the correct serial port is in use and that the lead is plugged in at both ends. - Check wiring for the RS232 lead.
Status display blank and controller not functioning	- Check the power supply (24V dc) is connected and switched on.
Cannot communicate with controller. (cannot get `P>` or `C>` prompt by pressing return).	- Check that there is not a program already running on the controller (type `[Ctrl] + [E]` to abort the program). - Check that the terminal mode. Select 'Tools' and 'Terminal Mode' from the Mint WorkBench.
Controller appears to be powered-up and working but will not cause motors to turn over.	- Check that the connections between motor and controller are correct. Use the Mint Configuration Tool to perform the basic system wiring tests described in section 4.4. - Ensure that the amplifier is enabled and working when the controller is not in error. (When the controller is first powered up the amplifiers should be disabled if there is no program running (there is often an LED on the front of the amplifier to indicate status). - Check that the Configuration file is loaded into controller and has been **`RUN`**, or that the servo loop gains are correctly set-up. (Check the *Gains* window or type **`PRINT KP`** to verify that the controller proportional gain **`KP`** is not zero and refer to servo-system set-up).
Motor runs off uncontrollably when controller is switched on.	- Check that the encoders are connected to controller, have power through encoder V+ and are functioning correctly. (Use a dual trace oscilloscope to display both channels of the encoder and/or the complements simultaneously). - Check that the amplifiers are connected correctly to the controller and that with zero demand there is 0V at the amplifier demand input. - Verify that the controller and amplifier are correctly grounded to a common earth point.

Motor runs off 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.	• Check that encoder 0 and demand 0 are connected to the same axes of motion; repeat for axis 1 and 2. Check amplifier connection is correct with respect to polarity of amplifier demand. • Check that for a positive command signal, a positive increase in axis position is seen. 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 loop gains may be set too high. (Go through the servo system set-up procedure to establish correct gains.)
Motor is under control, but when moved to a position and then back to the start it does not return to the same position.	• Check that all encoder channels are clear signals and that they are correctly wired to the controller. (Use a dual trace oscilloscope to display channels **A** and **B** of the encoder at the controller Breakout Unit. Verify that when the motor turns, the two square wave signals are 90 degrees out of phase. Also check the complement signals.) • Check that the encoder signals are free from electrical noise. (Use the oscilloscope as above). • Ensure that the encoder leads uses screened twisted pair cable and that the screen is attached to the screen connection on the encoder plug **at the controller end only**.) • Verify that the controller and amplifier are correctly grounded to a common earth point.

Bibliography

8

Bibliography

[1] Mint v4 Programming Guide (MN1262)

[2] Mint v4 Advanced Programming Guide (MN1270)

[3] Mint v4 PC Programming Guide (MN1278)

[4] Mint v4 Embedded Programming Guide (MN1279)

[5] Mint v4 Function Reference Guide (MN1280)

[6] Mint v4 CAN Programming Guide (MN1282)

All manuals can be found in the Baldor Motion Toolkit CD which accompanies the controllers.