

# Mint<sup>MT</sup> Multi-Tasking Application Note

## **AN00187 –000 : Getting started with e100**

### Related Applications or Terminology

- **Ethernet Powerlink**
- **Drive Configuration**
- **Drive Tuning**

### Supported Controllers

- |                       |                                     |
|-----------------------|-------------------------------------|
| <b>NextMove e100</b>  | <input checked="" type="checkbox"/> |
| <b>MicroFlex e100</b> | <input checked="" type="checkbox"/> |
| <b>MotiFlex e100</b>  | <input checked="" type="checkbox"/> |

### References

- **MN1942 – MicroFlex e100 Installation Manual**
- **MN1941 – NextMove e100 Installation Manual**
- **MN1944 – MotiFlex e100 Installation Manual**

### Overview

This application note describes a typical connection method for a NextMove e100 with MicroFlex e100 drives over Ethernet Power Link (EPL). It contains a description of how to configure the motion controller and the drive to perform simple motion.

The purpose of this application note is to get a system operational “on the bench”, without a load connected to the motor. Some additional comments are added at the end to assist with tuning a loaded motor. The application note goes on to explain a basic program layout recommended for e100 products. At the end there is a section entitled “Where to go from here” which provides links to information on more advanced topics.

# Mint<sup>MT</sup> Multi-Tasking Application Note

## NextMove e100 Controller

The NextMove e100 is a programmable motion controller capable of controlling up to 3 axes of servo and 4 axes of stepper locally. In addition up to 240 positioning drive axes can be controlled over EPL. 8, 12 or 16 axes (depending on the part number) can be profiled by the NextMove e100 to perform interpolated moves.

The unit is programmed using the versatile language MintMT which provides a comprehensive set of motion instructions for creating motion control programs for many types of application.

NextMove e100 has both a RS232/RS422 serial port and a USB port for communication to the PC.



## MicroFlex e100 and MotiFlex e100 Drives

The MicroFlex e100 and MotiFlex e100 are sophisticated servo drives which have been designed to meet the requirements of multi-axis systems without additional unnecessary features to provide high performance in an economical unit.

In combination with the NextMove e100 they provide an ideal solution to many machine applications and are ideal components for machine builders.

In this application note we will describe setting up a NextMove e100 with a MicroFlex e100.

A MotiFlex e100 drive can be used in place of a MicroFlex e100. The setup procedure is similar.



**Mint<sup>MT</sup> Multi-Tasking** Application Note

## Installing a Simple Drive Positioning System

### Equipment Required:

- NextMove e100 Motion Controller.
- MicroFlex e100 Servo Drive.
- BSM motor with either encoder, SSI, Endat, Sin/Cos or BISS feedback.
- PC running Windows 2000, XP or later.
- Motor feedback cable terminated with suitable connectors at both ends.
- Motor power cable with a suitable connector at the motor end.
- Mains supply to the MicroFlex e100.
- 24V supply for the NextMove e100 and MicroFlex e100 logic supply and enable signal.
- USB cable.
- EPL Cable between the NextMove e100 and each MicroFlex e100.

The minimum wiring configuration between drive and motion controller requires 24V connected to the MicroFlex e100 enable signal. The enable signal can optionally be wired from an output on the NextMove. Further wiring details are available in the MicroFlex e100 Installation Manual MN1942.

## Recommended I/O connections

Three digital inputs on the MicroFlex e100 are provided to allow connection of signals such as home sensor and limit switches. Two of these can be used for high speed registration, capturing position in the order of  $\mu\text{S}$ . An additional input provides a hardware enable interlock. Two digital outputs can be configured for functions such as motor brake control and drive ready.

**Drive enable signal:** Each MicroFlex e100 drive needs to have a 24V signal applied to its enable input. This can be wired from an output on the NextMove e100 controller. The Output relay on the NextMove could also be used if the drive is in a remote cabinet. It is a good idea to wire the enable signal through a safety relay associated with a guard switch or Emergency Stop circuit.

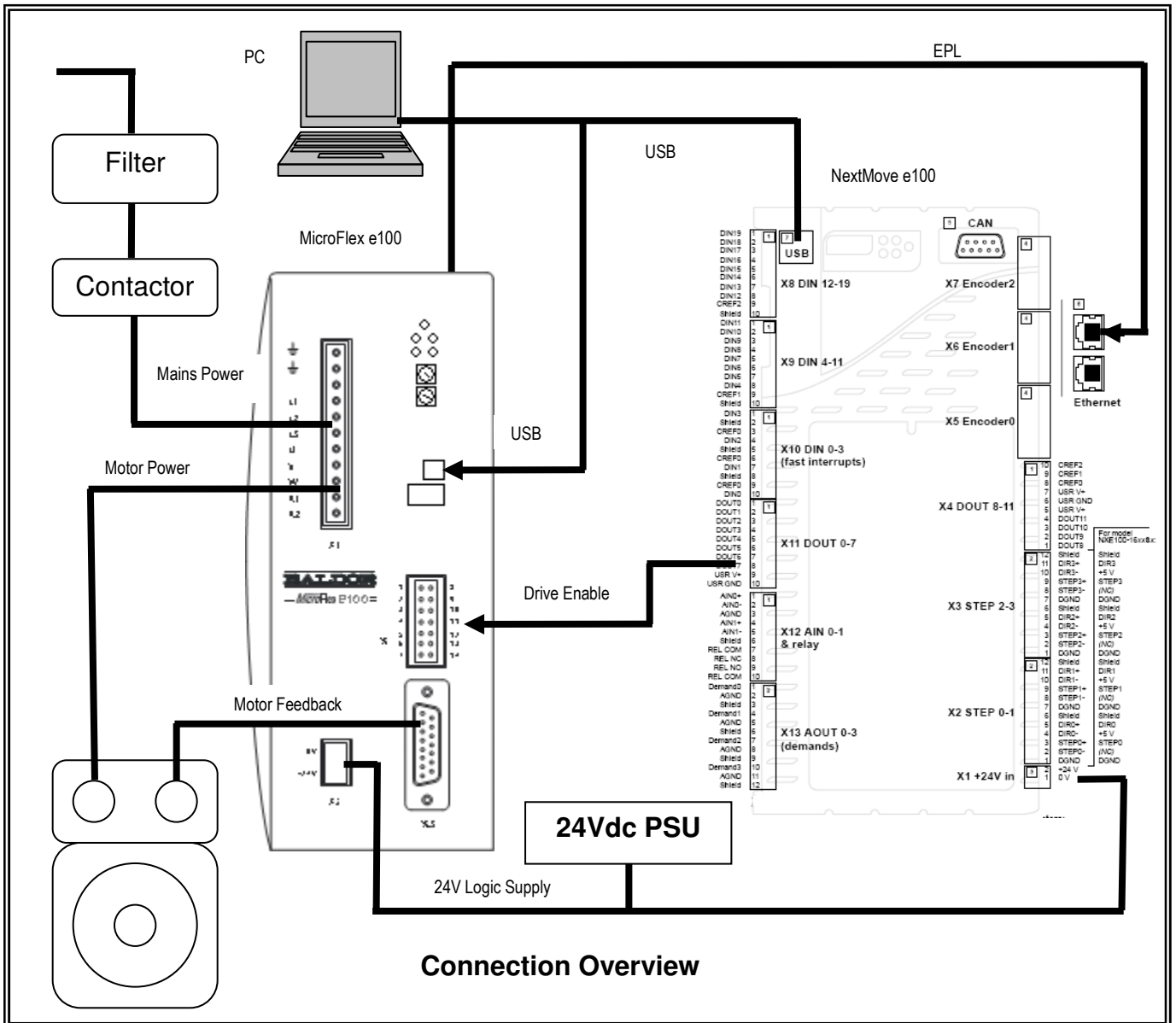
**Home input:** The MicroFlex e100 and MotiFlex e100 differ from other drives in that the homing switch must be wired back to one of the drive's digital inputs. The reason for this, is that motor encoder feedback is used locally in the position loop onboard the drive. If the NextMove e100 tried to track the axis position during homing there would be an error introduced due to delays in the EPL network. As a result the drive would not line up accurately to the homing switch and so homing is now done locally. Most of the Mint commands associated with homing are now saved as parameter settings on board the drive. They can be changed from the NextMove e100 using re-direction which is explained later in the section on homing.

# Mint MT Application Note

**Fast latching inputs:** Triggering a position capture on an input needs to be able to respond in the order of  $\mu$ S. EPL network delays preclude using the NextMove e100 to capture the position of remote axes. As a result, fast latching triggers must be wired to the MicroFlex e100. Most of the Mint commands associated with fast latching are now saved as parameters settings on board the drive. They can be changed from the NextMove e100 using re-direction.

**Motor Brake control output:** The MicroFlex e100 has 2 digital outputs that can be used to disable a motor brake. Most of the Mint commands associated with brake control are now saved as parameters settings on board the drive. They can be changed from the NextMove e100 using re-direction which is explained in the section on homing towards the end of this document.

**Emergency Stop input:** Each drive enable signal can be wired through a safety relay. Additionally an Emergency stop input from a safety relay can be wired back to the NextMove e100. This can then be assigned as an axis stop input.



**Connection Overview**

# Mint<sup>MT</sup> Multi-Tasking Application Note

## Feedback Devices

Motor feedback is essential for accurate “closed loop” control for both the Speed and Position loops. There are a number of different feedback devices commonly fitted to motors. For a brushless AC servo system it is important that the feedback to the drive provides both absolute positional information as well as speed. The positional information is used to commutate the motor. The speed is derived by measuring the rate of change of position (differentiated). The MicroFlex e100 drives have a built in position loop. It is not necessary to pass the encoder signal to an external motion controller.

## Switching Communication Between Devices

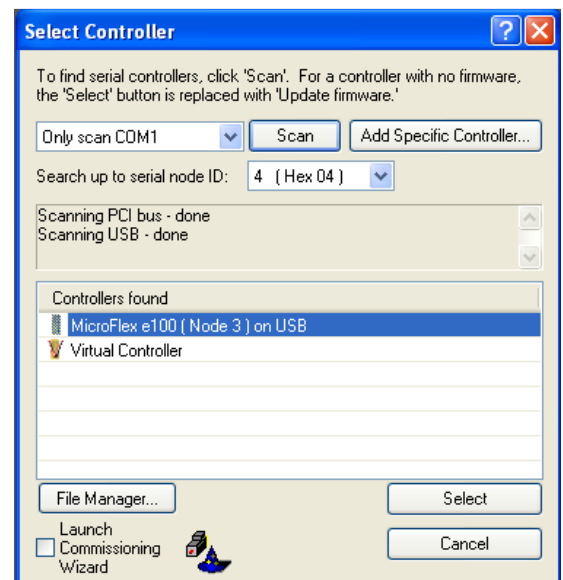
This application note was written using Workbench Version 5624. The Firmware on the NextMove e100 and MicroFlex e100 was 5615. It is recommended that this or more recent firmware is used.

During the configuration of the MicroFlex e100 and the NextMove e100 it will be necessary to switch the communications link between the devices. The USB cable will need to be moved back and forth between the NextMove e100 and each drive. This is referred to as a single port setup. Alternatively two copies of Workbench v5.5 can be used simultaneously provided the NextMove e100 and the MicroFlex e100s have different USB port addresses. Changing the USB port address is explained below.

If this is the first time you have used Workbench you will be prompted to install a USB driver when you first connect to the drive.

## Connecting to a MicroFlex e100

- The EPL address should be set on the front rotary switches of the MicroFlex e100. Ideally these should be set to 03h and 04h if a second drive is used. Set the switches before the drive is powered up. Note that these numbers are in hexadecimal format.
- Make sure the MicroFlex e100 has 230 VAC and 24 VDC applied.
- Connect to the MicroFlex e100 via the USB cable.
- Run WorkBench v5.5
- Workbench should detect the drive automatically and connection details will appear in the list. If this does not happen Click the *Scan* button.
- Make sure the *Launch Commissioning Wizard* box is checked. The *Launch Commissioning Wizard* box only needs to be checked when the drive is first setup.
- Click *Select* to connect to the MicroFlex e100.



# Mint<sup>MT</sup> Multi-Tasking Application Note

## MicroFlex e100 Commissioning

### Welcome Page

If the commissioning wizard does not automatically start it can be selected by choosing Tools->Commissioning from the Menu.

The Commissioning Wizard shows a sequence of screens displaying the current drive settings and requesting information required to commission the drive. When each page is complete click the *Next* button to continue through the Wizard.



The first screen describes the process and offers the opportunity to set all drive parameters to their factory default setting. Make sure the Reset to Factory Defaults box is checked and click the Next button.

Note: The reset to factory defaults is clicked here because we are starting with a new drive. This should not be done if the drive has already been partially configured. At the end of the wizard the user will be prompted to "Save and Reset" the controller OR cancel the changes.

# Mint MT Application Note

## Connectivity



Communication port	Node ID	Detail
USB ( Active connection )	3 ( Hex 03 )	
Ethernet	3 ( Hex 03 )	
Serial	2 ( Hex 02 )	57600 Baud
CANopen	1 ( Hex 01 )	500 KBaud

The connectivity wizard opens up. In this application note we would like to change the USB address to be different to the NextMove e100. It is set here to 3 which is the same as the EPL address.

## Select Motor

**Select your Motor**

You can choose your motor in one of three ways - by Catalog number, Specification number (for Rotary motors only) or by defining a "Custom" motor for one that does not exist in the database.

---

Select motor by Catalog number
 

BSM  140

Rotary Motor : Encoder w/Commutation(2000ppr)  
Motor ( No Shaft Seal ) with Flying Leads

---

Select motor by Spec. number
 

S1  001  009

---

I would like to define a custom motor

Select the correct motor type from "AC brushless rotary" OR "Linear" etc and click the Next button.

The following screen allows the motor catalogue number printed on the motor name plate to be selected. Be sure to copy the exact product code. The Spec number can also be used to identify the motor. Alternatively a custom motor can be entered although this will require more information from the motor manufacturer. Click the Next button. The next screen allows you to confirm motor and drive information. You can review the information here but need to go back to edit it. Click the Next button.

# Mint MT <sup>Multi-Tasking</sup> Application Note

## Feedback

### Motor Feedback

Please confirm that the feedback type and resolution are correct for your motor

<b>Motor Feedback</b>	
Encoder Channel	Encoder 0
Feedback Type	Encoder with Halls
<b>Feedback Options</b>	
Resolution	2000    × 4 = 8000 counts per motor rev

**Encoder Channel**  
Select or confirm the encoder channel to be used.

In this example the motor has Encoder feedback with a Halls sensor. Other feedback types will have a different setup screen to the one shown. Encoder motors have a fixed resolution.

## Operating Mode

### Select Operating Mode and Source

Select the default mode of operation for the axis. Also select the source of the commands for some or all of the operating modes.

<b>Operating Mode</b>		<b>Reference Source</b>	
Control Mode	<input checked="" type="radio"/> Position <input type="radio"/> Velocity <input type="radio"/> Torque <input type="radio"/> None	Control Ref. Source	<input type="radio"/> Can <input checked="" type="radio"/> EPL <input type="radio"/> Direct (Host/Mint)
Drive Enable Input Mode	<input type="radio"/> Crash stop disable <input checked="" type="radio"/> Ignore		
Drive Enable Mode	<input type="radio"/> Auto + hardware enable <input type="radio"/> Hardware enable <input type="radio"/> Auto enable <input checked="" type="radio"/> Normal		

**Operating Mode**  
The operating modes the drive supports are shown above. Please choose one.

< Back    Next >    Finish    Cancel    Help

# Mint<sup>MT</sup> Multi-Tasking Application Note

Unlike Analog MicroFlex drives, the MicroFlex e100 has a position loop onboard the drive. Since we will be testing basic positioning moves in this application you should select "Position" for the control mode. The reference source should be selected to EPL as the drive will be receiving its position reference from the NextMove e100 over EPL.

## Application limits

**Application Limits**

Specify the limits of your application. Also, configure the action to be taken in the event of an overload condition.

<b>Current Limit</b>			<b>Application Max Speed</b>		
Motor Rated Current	0.800	Amps (RMS)	App. Max. Speed	3000	RPM
Motor Peak Current	2.600	Amps (RMS)	Over Speed trip level	110	%
Drive Rated Current	3.000	Amps (RMS)	Max Motor Speed	5000	RPM
Drive Peak Current	6.000	Amps (RMS)	Max Theoretical Speed	10300	RPM
App. Peak Current	2.600	Amps (RMS)			
<b>Overload Protection Function</b>					
Motor Overload Action	<input checked="" type="radio"/> Trip drive <input type="radio"/> Foldback current <input type="radio"/> Ignore				
Drive Overload Action	<input checked="" type="radio"/> Trip drive <input type="radio"/> Foldback current				
<p><b>Current Limit</b> The current rating of the motor and drive are shown above. Enter the App Peak current limit to be applied (this should not exceed the motor or drive peak current)</p>			<p><b>App. Max. Speed</b> The maximum speed should be slightly higher than the fastest speed you would expect during normal operation.</p>		

< Back
Next >
Finish
Cancel
Help

The Application Peak Current cannot be higher than either the motor peak current or the drive peak current. If the setting is too low the drive will not run to speed as it won't be able to provide enough torque.

The motor overload response can also be set here. By default the drive will trip on an over-current condition. Sometimes it may be desirable to limit the torque by folding back the current.

At this point it is necessary to have a feel for how fast the motor is required to move in the application. If you don't know what the application max speed is likely to be at this stage then set this to approximately 75% of the motor max speed. If the application requires a speed in excess of the value typed here then it will not be able to attain the demanded speed and a drive over-speed trip error will be created. This will need correcting later and the system retuned.

Be aware that the maximum speed is limited both by the available bus voltage and the motor's physical maximum speed, therefore the speed entered at this point cannot exceed either of these two values which are displayed for your reference.

**Mint<sup>MT</sup> Multi-Tasking** Application Note

For applications that are designed to run at slower speeds it is advisable that the Application Max Speed is reduced to maximise the speed resolution available, this will improve speed accuracy at lower speeds. But always set this parameter to a value slightly in excess of the maximum required to avoid unwanted errors. It is best not to set this below 500 RPM.

**Select Scale Factor**

**Select Scale Factor**

Select the units and scale factors you would like to use in your application.

Scale Factor		
Position User Unit	Revs (r)	
Position Scale Factor	8000.00	Count(s) per Position User Unit
Velocity Scale Unit	Revs per second (r/s)	
Velocity Scale Factor	8000.00	Count(s) / s per Velocity Scale Unit
Accel Scale Unit	Revs per second sqd (r/s <sup>2</sup> )	
Accel Scale Factor	8000.00	Count(s) / s <sup>2</sup> per Accel Scale Unit

**Position User Unit**  
Select or type preferred unit of position measurement. An abbreviation can be added in brackets

< Back   Next >   Finish   Cancel   Help

The position, velocity and acceleration user units are set here. These are used mainly during the commissioning wizard. When the NextMove e100 sends a demand position to the MicroFlex e100 over EPL, the NextMove e100 will base these on the scalefactor associated with that axis on board the NextMove e100.

There are some exceptions to this rule. When setting the homing parameters such as homing speed and backoff speed, these parameters are based on the scalefactor stored locally to the drive.

Any motion commands initiated on the drive directly (e.g. via the Workbench command window) will also use the scalefactor set on the drive.

# Mint MT Application Note

## Profile parameters

**Profile Parameters**

Profiles (or ramp function generators) can be applied to the drive demand in each of the control modes. This provides a simple means of introducing a ramped demand where the analog input may for example be a step change from a simple PLC analog output.

Current Control Profile Parameters		
Rise Time	0	ms
Fall Time	0	ms
Error Fall Time	0	ms

Speed and Position Profile Parameters		
Positioning SPEED	50	r/s
Accel Time to SPEED	100	ms
Decel Time to SPEED	100	ms

Position Control		
Max Position Error	0.125	r
Idle Position Tolerance	0.125	r
Idle Velocity	2.5	r/s

**Current Control Profile Parameters**  
A ramp generator (profile) can be applied to current demand, when in current control mode.

The profile parameters shown above are used by the drive when it is set up for "Control Node Profiling". This means that the drive receives a single position demand from the NextMove e100 and the drive profiles the move itself. Later during the NextMove e100 setup the drive will be setup for "Manager Node Profiling". The MicroFlex e100 is referred to as the "Controlled Node", or CN and the NextMove e100 is referred to as the "Manager Node" or MN. During Manager Node Profiling the manager node profiles moves on behalf of the control node, sending continuously updated incremental demands to the drive. Further information on this topic can be found in the help file entry Contents->Fieldbus Networks->Ethernet Powerlink->DS402 modes of operation

Because we are going to control the drive later on as a managed node, the speed and position loop parameters set here will only be used during fine tuning. The NextMove e100 will set the parameters for the actual moves performed in the application. The "Current Control Profile" parameters are still relevant during normal operation as the drive will control the current loop.

Select "Finish" to move on to the Autotuning section. See below.

## Tuning the MicroFlex e100

The drive contains 3 nested control loops. The innermost loop is the current control loop. This is enclosed within the speed control loop. The outermost loop is the position control loop.

The current loop receives a torque demand from the speed control loop. The current loop then drives current into the motor which creates torque causing it to accelerate or decelerate.

# Mint<sup>MT</sup> Multi-Tasking Application Note

The speed control loop receives a speed demand from the position control loop. The speed control loop is important as it provides a good dynamic response, a reduced risk of erratic behaviour and makes the position loop far easier to tune for the majority of cases.

The Position and Speed control loops are closed control loops which require feedback from the motor. A transducer fitted to the motor generates a signal which is used to determine the actual position and speed of the motor. Any difference between this and the demanded position and speed causes a demand on the current controller which in turn causes the motor to react to close the gap. Each of these control loops has some associated gain terms, each of which require tuning to the system load conditions.

Before the tuning process can be started it is necessary to ensure that any brake fitted to the motor is released and an enable signal is provided to the MicroFlex e100 from the NextMove e100.

If a brake is fitted to the motor make sure 24V is applied and check that the motor shaft is free to turn. Motor brake control is now available locally on the MicroFlex e100 and MotiFlex e100 drives. See the section below entitled "Viewing and changing parameters" for information on how to change the motor brake control parameters.

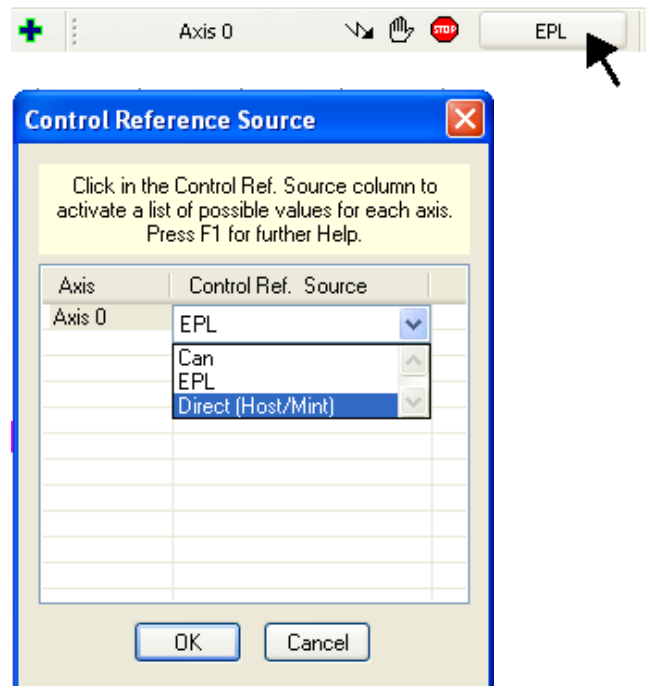


This application note is written under the assumption that the motor is being tested on a bench or at least under a light load. If there is a load suspended vertically from the motor and the brake is disengaged while the drive is disabled then the load will fall without any inhibition.

When setting up the MicroFlex e100 the drive has to be operated in Direct mode. This means that the "Control Reference Source" is Workbench over USB rather than the NextMove e100 over EPL.

Select the "Control Reference Source" on the toolbar on the top of the page. In the popup box select "Direct (Host/Mint)".

Workbench is the host in this case. If the drive was a MotiFlex e100 with a Mint option card then the drive would be Mint controlled during operation. You would select the Control Ref as Direct in that case as well.



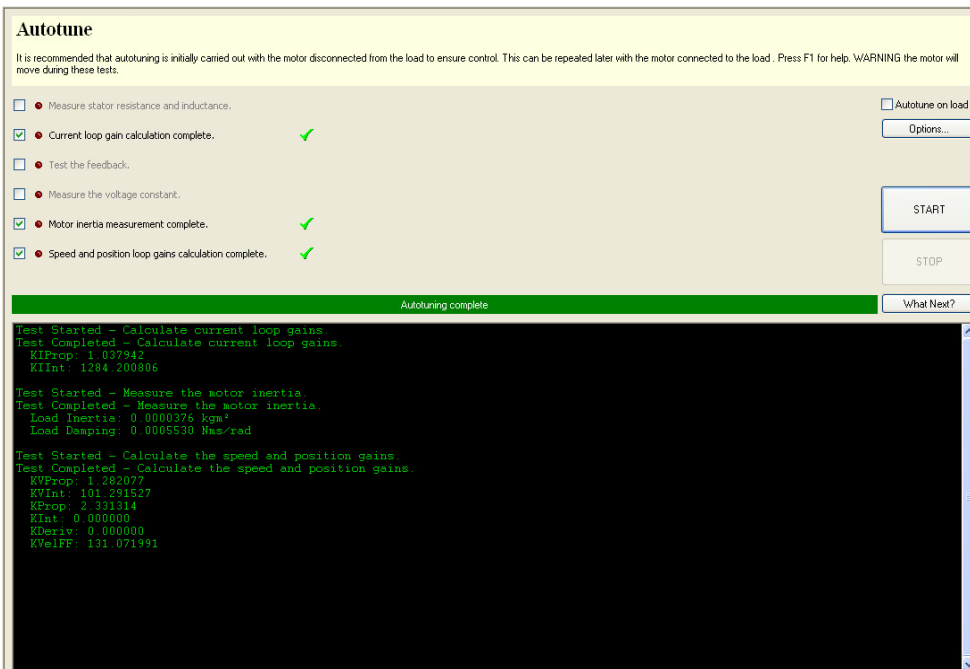
# Mint<sup>MT</sup> Multi-Tasking Application Note

## Autotuning



To begin with it is always advisable to AutoTune the system with the motor disconnected from the load. This ensures that the system is functioning correctly before moving the load and reduces the risk of causing damage. This application note assumes the motor is unloaded and free to rotate in either direction.

If you are using a standard Baldor motor selected from the database and the wiring is correct, it should only be necessary to complete the recommended Autotuning steps:- Calculate current loop gains, Measure the motor inertia, Calculate the speed and position gains.



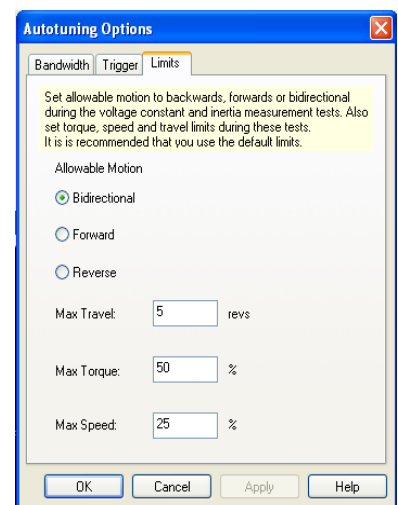
- Select the desired Autotuning options by clicking the tick boxes.
- Click the *START* button to proceed.

If Autotuning fails, selecting the other tuning options may correct some simple wiring or configuration faults. In particular you should select "Test the feedback".

If the errors continue to be generated check the wiring carefully and refer to the help files for more assistance on Autotuning errors.

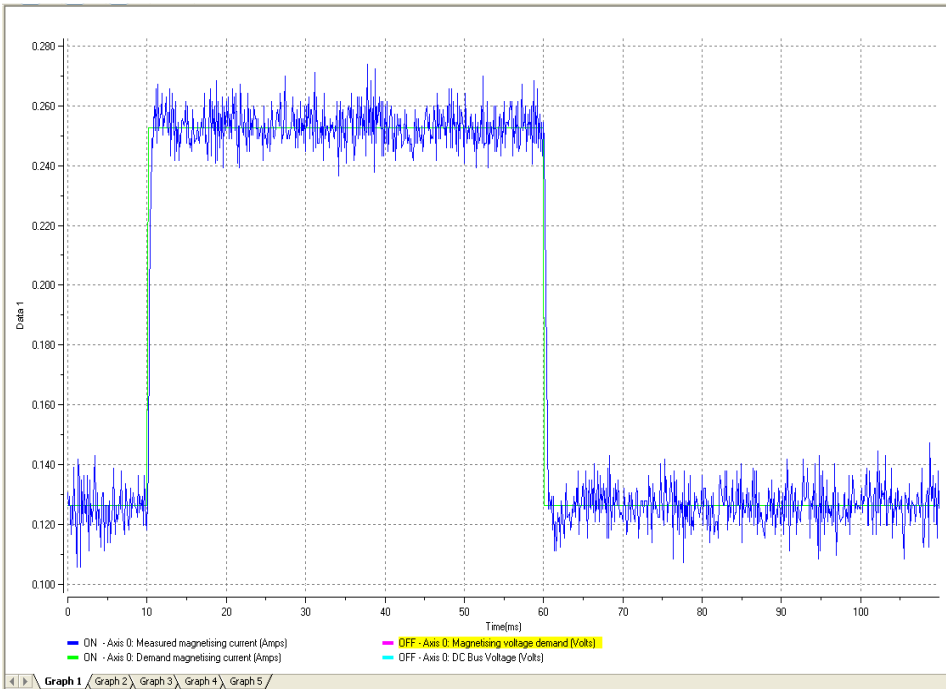
If the feedback is OK but autotune fails on the Motor Inertia measurement test this might be because there is not enough torque delivered during the test to move the motor. Select "Options" and then choose the "Limits" tab. Increase the percentage "Max Torque".

If the test fails when performed offload then this error would signify a wiring fault or a locked rotor shaft.



# Mint MT Application Note

## Fine Tuning the current loop



**Fine-tuning**

Axis 0 ?

---

**Current Plant**

Resistance:  Ohms

Inductance:  mH

---

**Flux Plant**

Volt. Const:

---

**Feedback Alignment**

---

**Current Control Terms**

KIPROP:

KIINT:

KITRACK:

---

**Test Parameters**

Type:  ▼

Current:  %

Duration:  ms

Speed Limit:  %

---

◀ ▶ Position \ Velocity \ **Current** \ ▶

The MicroFlex e100 current loop should be tuned quite well during the auto tune so you wouldn't normally have to look at this. If the motor is large then it is worth checking the current loop.

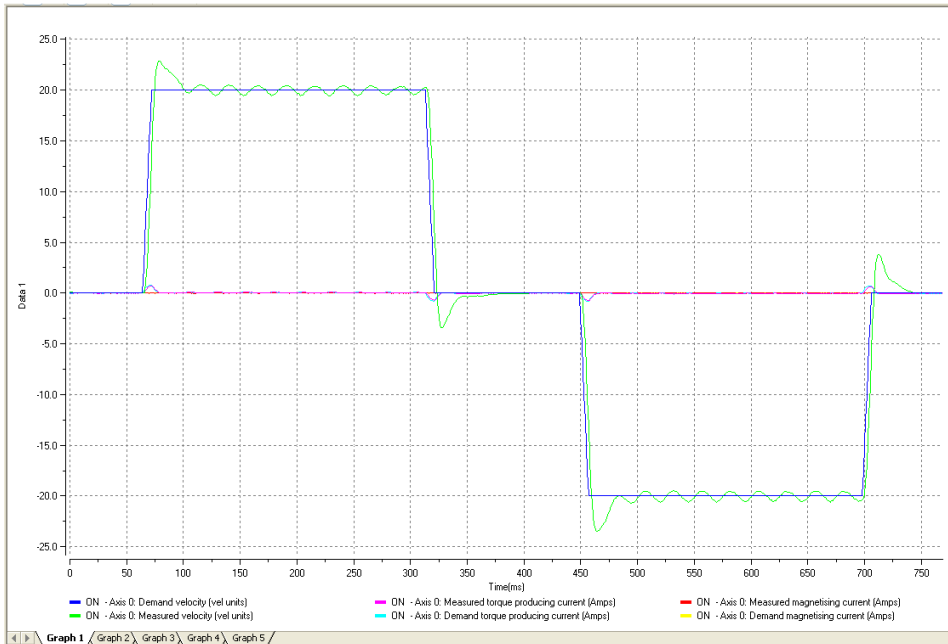
The test parameters can be left for a stationary type move with the current at 25% for 50ms. Press Go to start a test move. The motor will jerk slightly and the current data will be uploaded to workbench.

Turn OFF the graphs for "Magnetising Voltage Demand" and DC Bus Voltage". The graph will then re-scale to show the "Measured and Demand Magnetising Current" as above.

Increasing KITRACK can sharpen the response of the measured current. If the measured current tends to overshoot the demand at the start and end of the move then KITRACK may be set too high.

# Mint<sup>MT</sup> Multi-Tasking Application Note

## Fine Tuning the speed loop



**Fine-tuning**

Axis 0

---

**Velocity Control Terms**

KVPROP:	0.0000
KVINT:	0.0000
KVTIME:	0.0000
KVTRACK:	100

Apply Calculate...

---

**Load Model**

Inertia:	0.00001126	kgm <sup>2</sup>
Damping:	0.00017678	Nms/rad

Measure

---

**Profile Parameters**

Accl time max:	100	ms
Decl time max:	100	ms

---

**Test Parameters**

Move Type:	Bidirectional	
Velocity:	20	uu/utu
Distance:	5	uu

Go

---

Position Velocity Current

We will perform a test speed move. Make sure the *Velocity* tab at the bottom right corner of the WorkBench v5.5 screen is selected

This test move is set up to do a bi-directional move at 20Rev/s for 5 Revs. Click the *Go* button when these parameters have been typed in and you are ready to start the move. When the move is complete and the graph is displayed look at the Speed Measured and the Speed Command Demand, hopefully these will show a reasonable match.

If there is still some overshoot it can be easily reduced by decreasing the value of Tracking Factor (KVTRACK). Then try the move again. Other gain terms can be easily adjusted using the Calculate button and using the Bandwidth slider to increase or decrease the response of the motor. After each change to the settings try the test move again to see if there has been an improvement.

The graph above shows a typical response to a bidirectional move. The Demand Speed (Blue) and measured speed (Green) should closely match. Increasing KVPROP increases the damping effect on the oscillations during steady speed. Increasing KVINT improves the sharpness of the response during acceleration and deceleration.

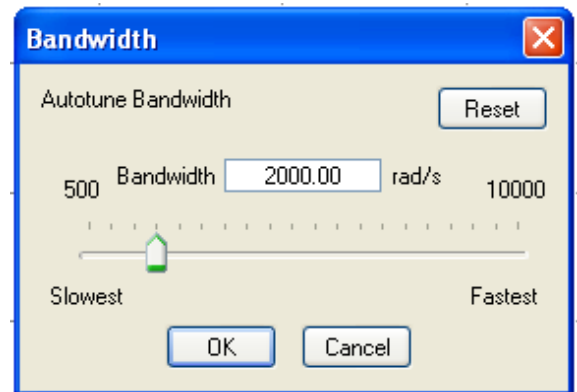
# Mint<sup>MT</sup> Multi-Tasking Application Note

The gain values can be calculated automatically by selecting "Calculate..." and adjusting the Bandwidth. The higher the Bandwidth is the higher the gain values will be. This will make the motors response to speed changes stiffer.

If the Bandwidth is too high the motor may overshoot on reaching the target speed.

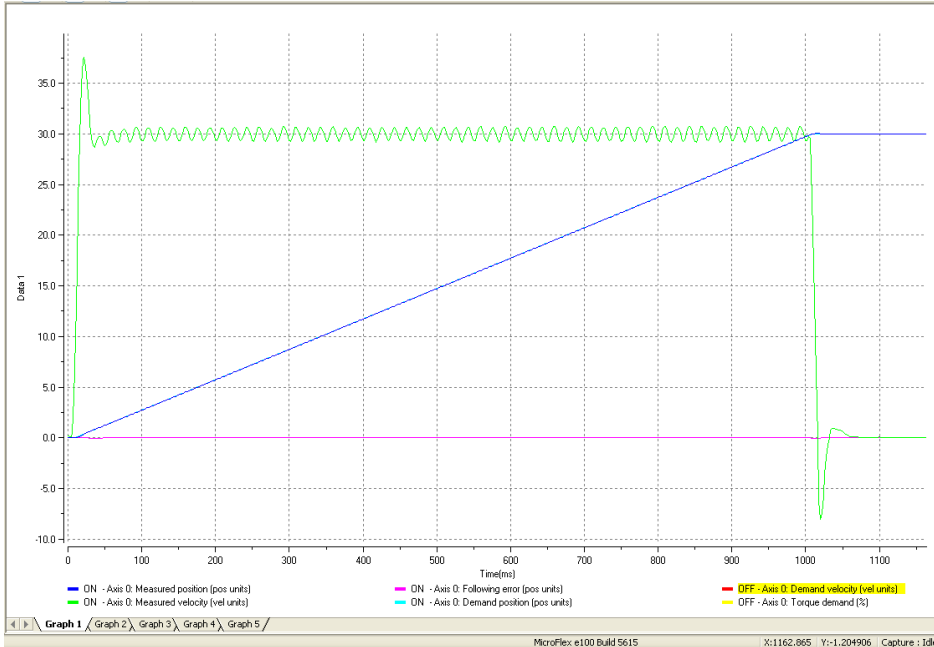
If the motor is going in the wrong direction it can be set by changing the MOTORDIRECTION parameter in the MicroFlex e100. See the section further on entitled "Viewing and changing parameters" for more information on this.

Once the velocity loop is tuned the drive is ready to have its position loop tuned.



# Mint MT Application Note

## Fine tuning the Position Loop



**Fine-tuning**

Axis 0

**Position Control Terms**

KPROP: 6.7797

KINTMODE: Always

KINT: 0.1005

KINTLIMIT: 100.0000

KDERIV: 174.1833

KVEL: 0.0000

**Feedforward Terms**

KVELFF: 0.0000

KACCEL: 0.0000

Apply Calculate...

**Profile Parameters**

Speed: 400000.00 c/s

Accel: 4000000.00 c/s<sup>2</sup>

Accel time: 100 ms

Decel: 4000000.00 c/s<sup>2</sup>

Decel time: 100 ms

Store Parameters on Controller

Perform bi-directional move

Move Type: Trapezoid

Distance: uu

Duration: s

Go

Position Velocity Current

Unlike the analogue MicroFlex drive, the position loop can be setup locally on the MicroFlex e100. The fine-tuning screen is the ideal tool to set the gains and test the response.

The gain values can be calculated automatically by Selecting "Calculate..." and adjusting the Bandwidth. The higher the Bandwidth is the higher the gain values will be. This will make the motors response to speed changes stiffer.

The value of KPROP (Proportional Gain) is normally determined experimentally. This means you need a starting point, a value of 0.1 is appropriate for most systems.

To test these values you need to define a suitable test move. Provided your motor is still unloaded it should be safe to make a move, a profile lasting about 1s is ideal. It is also best to choose accelerations and speeds that define a trapezoidal profile shape. In the Fine-tuning screen on the Position tab type in the following values which are suitable if scaled in Revs:

- Speed = 30 (rev/s)
- Acceltime = 100 (ms)
- Deceltime = 100 (ms)
- Distance = 30 (revs)

These values give a move time of 1.1s

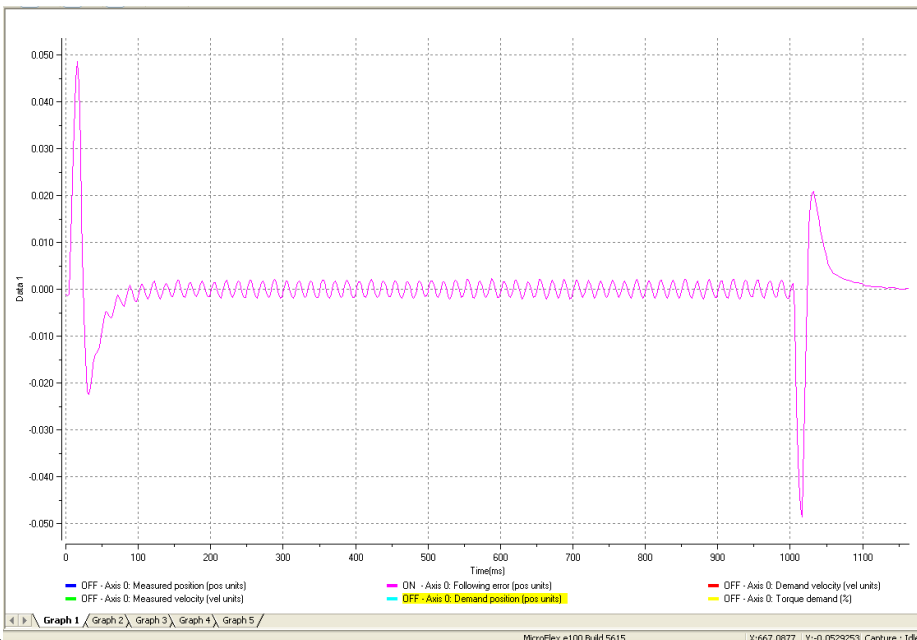
# Mint<sup>MT</sup> Multi-Tasking Application Note

Make sure the KPROP and KVELFF values have been typed in correctly and click the GO button.

The motor will perform the move and the captured data will be uploaded and displayed on the screen. If the motor vibrates excessively then the starting value for KPROP could be too high; this is more likely with high resolution systems. Try a smaller value of KPROP like 0.01.

In the diagram on the previous page the trapezoidal shaped line (in green) is the measured velocity trace and the "S" curve (blue) line is the measured position. It is also possible to turn on and off the Demanded Velocity and the Demanded Position, the objective of tuning is to get the measured line to follow the demanded line as closely as possible.

To fine-tune the gain terms it is best to look at the difference between the measured position and the demanded position, known as the following error. To see this on your graph make sure all other plots are turned off by un-checking the check boxes. Alternatively you could assign a new y axis on the graph to the same scale as the following error.



This is a typical plot of following error for a trapezoidal move. The peaks at the beginning and ends of the profile represent the acceleration and deceleration periods. The flat area in the centre is the constant speed section. Adjusting KVELFF will move the flat line up and down, the ideal is zero. This can be used to fine tune KVELFF. If the calculation has been done correctly only very small changes will be required (0.01 at a time)

Increasing KPROP will reduce the magnitude of the peaks during acceleration and deceleration, however an excessive value is likely to introduce oscillations. To fine-tune KPROP gradually increase its value, repeating the test move each time, until the peaks reduce in size or oscillations in the response start to appear. At this point the value should be reduced a little until no oscillation is observed. If KPROP is too high it will be particularly apparent when the motor is stationary as it will vibrate.

# Mint<sup>MT</sup> Multi-Tasking Application Note

Other gain terms can be added to improve the response, but this is beyond the scope of this document. Please refer to the manuals and help files for more information.

## Connecting a Load

When every part of the system has been tested and is working correctly it is time to connect the load. This will require some parts of the servo system be re-commissioned. The MicroFlex e100 will need to re-measure the load inertia and this will require the speed and position loop gains to be changed.

Adding an appropriate Accel and Decel Time is normally beneficial when tuning loaded motors as a step response is very difficult to achieve. Be very careful not to move too far or too fast during the test moves. It is always best to start with slow short moves and increase until a reasonable motion profile is attained.

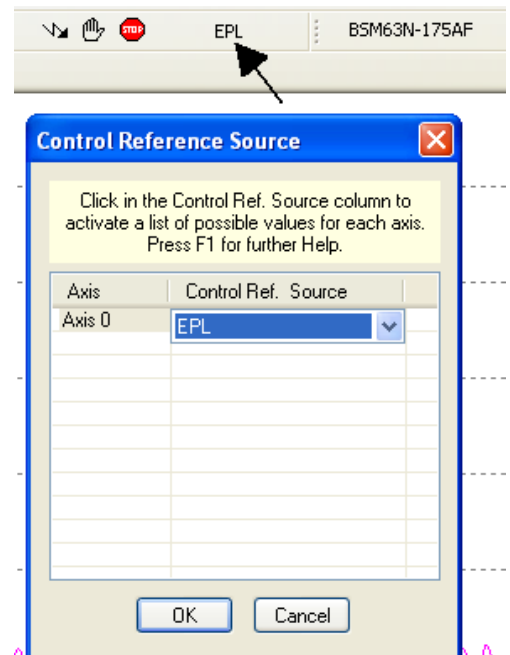
The KVELFF should not change its value but the KPROP may need to be modified. Again make sure any test moves do not exceed the limits of travel. Using scaled units may make this easier. Recalculate the scale factor to represent the mechanical system connected to the motor, use units appropriate to the type of movement (mm for linear travel, degrees or revs for rotary travel).

At this point it is a good idea to save the parameter file from the MicroFlex e100. Connect to the MicroFlex e100, select *Tools > Parameter Table > Upload*, find a suitable folder on the PC and give the parameter file a name "Axis 3 Settings.ptx" for example.

When commissioning the MicroFlex e100 is complete the drive needs to be switched back over to EPL as a Control Reference Source. This is selected from the Tool bar as shown.

The drive commissioning is now complete. You have a choice of repeating the drive setup procedure again on a second drive or moving on to setting up the NextMove e100.

It is assumed that two drives will be setup but one drive will be sufficient to complete the application note.



# Mint MT Application Note

## Viewing and changing parameters



During the drive setup the motor direction and motor brake setup were mentioned. These settings can be changed by editing the drive parameter table directly. Click on the Parameters icon on the toolbox on the left hand side of Workbench.

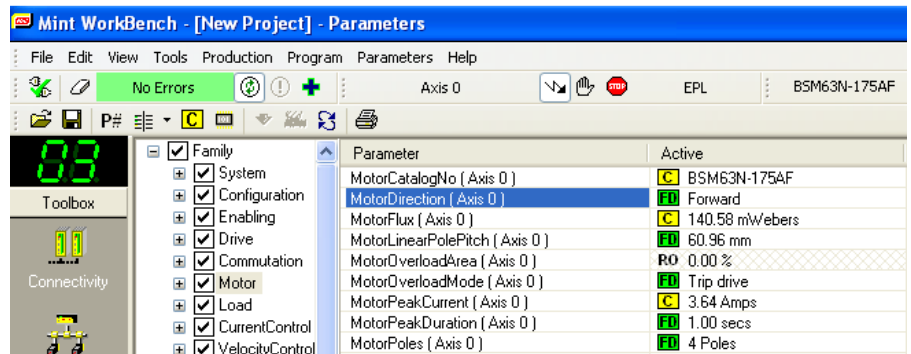
The screen that appears is divided into a parameter search tree on the left hand side and a parameter list for each subheading on the right hand side.

### Changing motor direction

Select Family->Motor from the search tree on the left.

The motor direction parameter is the 2<sup>nd</sup> one listed. Click on "Forward" and select the desired direction from the listbox.

MOTORDIRECTION is a keyword that can be set in the Workbench terminal window also.



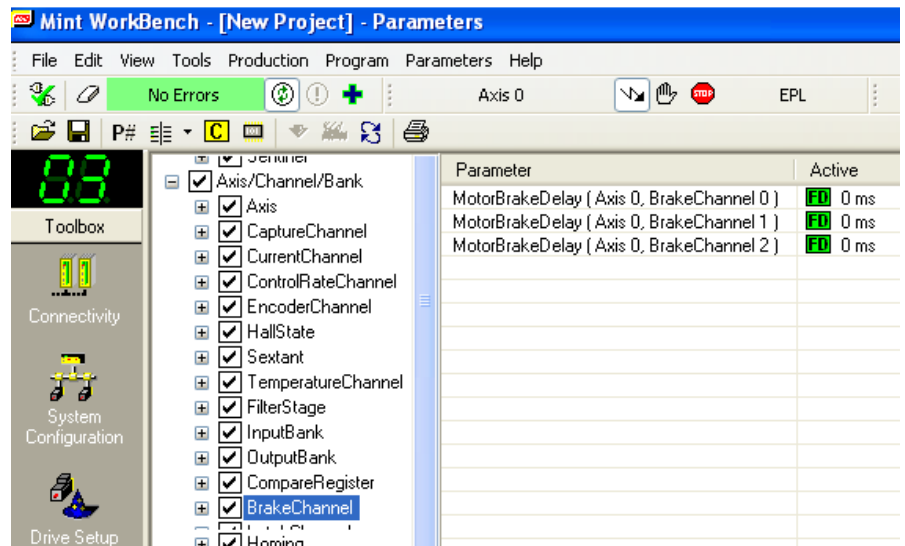
### Motor brake control

Select Axis/Channel/Bank-> Brake Channel. Three motor brake delay channels are listed. Each channel represents a timer.

Channel 0 is the time allowed to engage the brake before disabling the drive.

Channel 1 is the time allowed to disengage the brake before starting motion.

Channel 2 sets the delay between enabling the drive and it establishing servo control.



For further information on motor brake control read the help file in the following path: Contents->Hardware->Input/Output Handling->Motor brake control. The parameter table will automatically save to the drive when a parameter is edited. To save to a file choose Tools->Parameter Table->Upload.

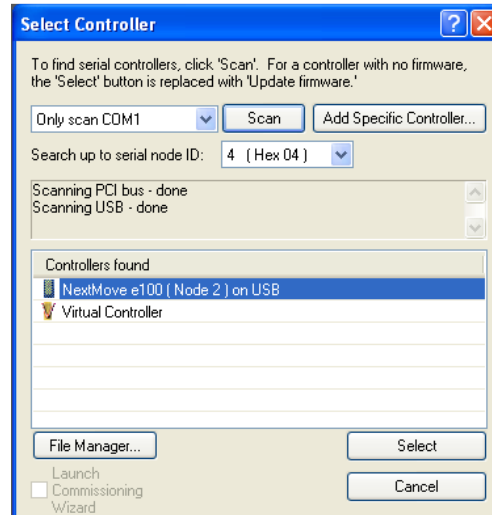
**Mint<sup>MT</sup> Multi-Tasking** Application Note

## Setting up drives on the NextMove e100 EPL Network

**Connecting to NextMove e100**

Make sure there is 24V power applied to the NextMove e100.

- Connect the USB cable to the NextMove e100
- Run WorkBench v5.5
- Select *Start New Project*
- Workbench should detect the NextMove e100 automatically and the connection details will appear in the list. If this does not happen Click the *Scan* button.
- Select the NextMove e100 when it appears in the list.



Note: WorkBench v5.5 project files contain information about your application, including:

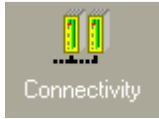
- Information about the controller that is currently connected.
- Links to the program files (**.mnt** file). But NOT the actual program file.
- Other desktop details.





The project file does not contain any program code - it is contained in the separate .mnt files. Always remember to "Save File" after making any program changes.

It is important that there is no program in the NextMove e100 when configuring, as settings from a different system may cause unexpected behaviour. To delete a program, select the menu option *Program > Delete Existing*.

# Mint<sup>MT</sup> Multi-Tasking Application Note

## Connectivity



Communication port	Node ID	Detail
 USB ( Active connection )	2 ( Hex 02 )	
 Ethernet	240 ( Hex F0 )	
 Serial	2 ( Hex 02 )	9600 Baud
 CANopen	2 ( Hex 02 )	500 KBaud


Select the Connectivity icon on the Workbench tool bar on the left hand side. As shown above this will open up the wizard shown above.

The NextMove e100's node address can be set for each of the networks it is connected to. The Ethernet address needs to be set on the rotary switches at the front. Note that these numbers are hexadecimal values. The Ethernet address should be set to 240 (F0 in hex) if the Nexmove e100 is to be used as a Manager node on an EPL network.

It is a good idea to set the USB address here to be different to the address on any of the MicroFlex e100 or MotiFlex e100 drives being commissioned.

# Mint<sup>MT</sup> Multi-Tasking Application Note

## System Configuration

 System Configuration	Select the System Configuration icon on the Workbench tool bar on the left hand side. This will open up the wizard shown below.
---	---

**Welcome to the System Configuration Wizard**

This wizard will aid you in configuring local and networked device resources such as digital and analog inputs and outputs and motion controlled axes.  
In the final step a Device Configuration File (DCF) will be created which you can save and apply to the controller.

Bus	Node	Details	
Ethernet Powerlink	240 (0xF0)	Manager	

To begin, choose from the options below and click the Next button:

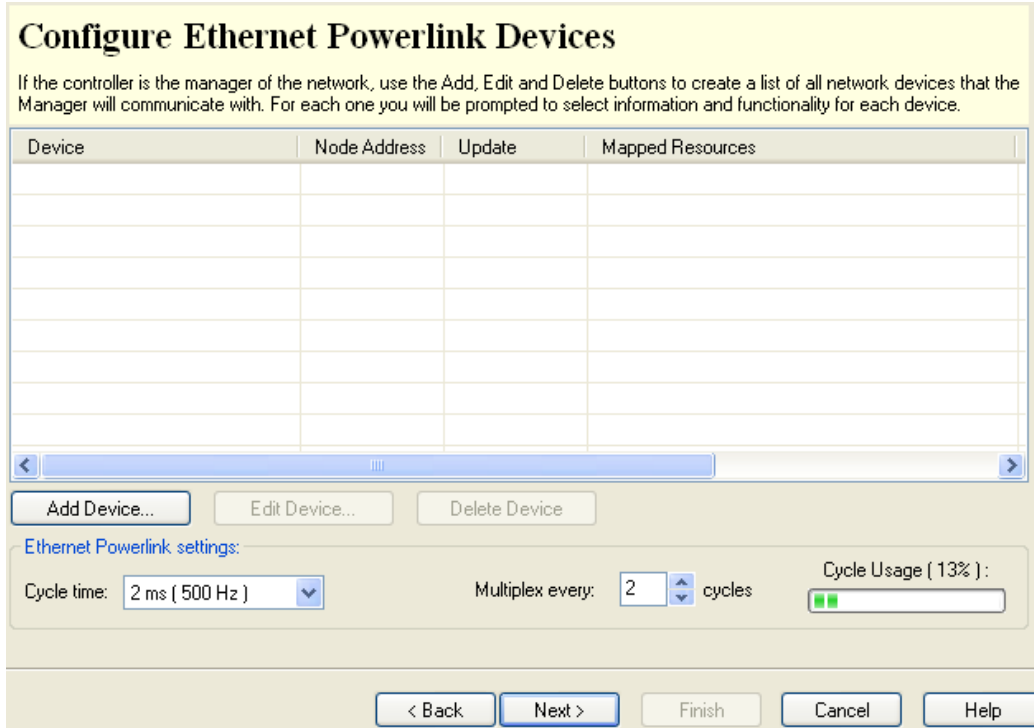
- Upload configuration from controller:   
Select this option to modify the controller's existing configuration file, which will be uploaded before the next step.
- Open existing configuration file:  ...  
Select this option to use a previously saved configuration file as a starting point.
- Start new configuration  
Select this option to create a new configuration file from the beginning.

< Back   **Next >**   Finish   Cancel   Help

This screen gives you a choice of Uploading the current configuration from the controller, opening an existing configuration file or starting a new configuration. We will start a new configuration in this example. Click on "Next".

# Mint MT Application Note

The devices and drives that are connected to the NextMove e100 on EPL are listed below. When setting up for the first time this list will initially be blank. Click on "Add Device...".

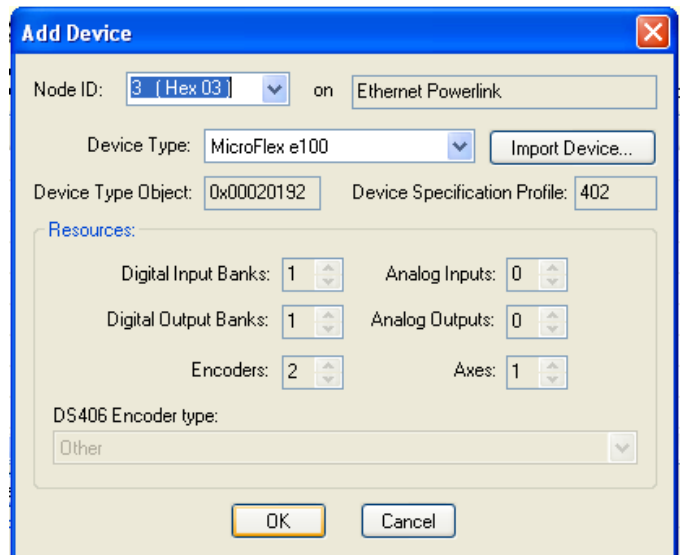


Choose MicroFlex e100 here as the device type.

The MicroFlex e100 node ID was set to 3 when the drive was setup so set it to 3 here.

Note that other, non Baldor, device types can be added here. You would select "Import Device" to do so although we won't be doing this in this application note.

Click on "OK" when everything is selected. The Resource Mapping screen will follow.

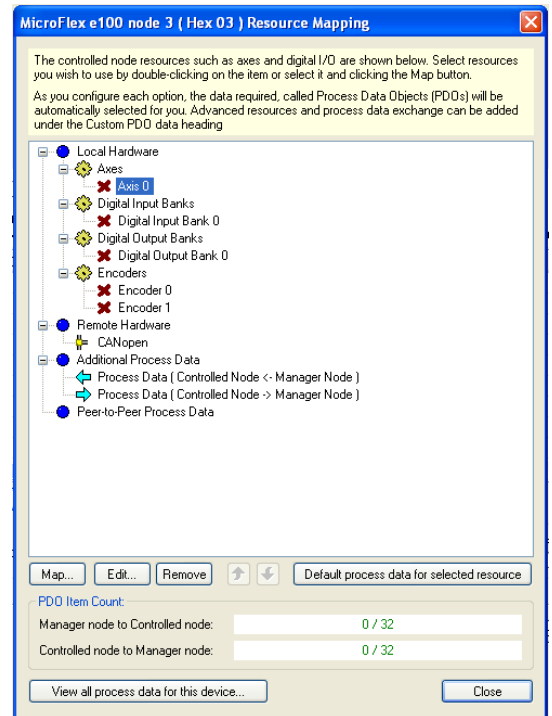


# Mint MT Application Note

Each device on EPL comes with many attributes or Resources. These can be mapped to the NextMove e100 on this screen.

At the moment the default axis number is 0. The NextMove e100 reserves encoder channels 0,1 and 2 for its local encoder inputs. It is a good idea to start the remote axis numbers from 3 onwards to avoid a conflict with local encoders 0 to 2.

Double click on Axes->Axis 0 To change the axis number.

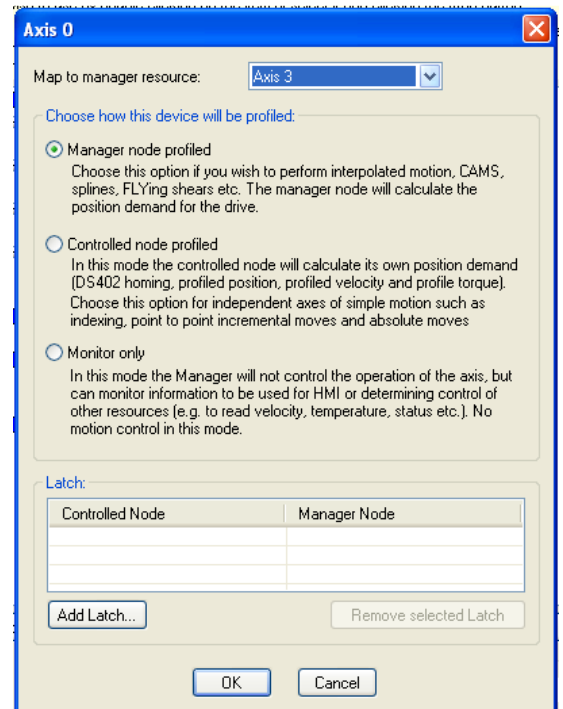


After clicking on Axes->Axis 0 on the Resource Mapping screen this popup shows up. Set the Axis number to 3 in this example.

See the sub section on "Drive Profile Parameters" above for a description of the different profile setups. Leave it selected for "Manager node Profiled".

You can map a MicroFlex e100 latch channel here to a NextMove e100 latch channel. Latching over EPL is beyond the scope of this application note. It is explained in more detail in application note :

"AN177 Cut to registration".



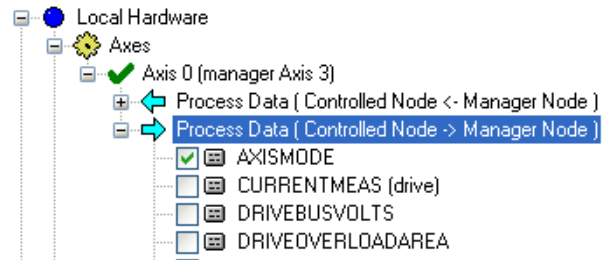
# Mint<sup>MT</sup> Multi-Tasking Application Note

Because the MicroFlex e100 is on an EPL network it is possible read and write to many of the parameters in the drive from the NextMove e100. There may not be enough bandwidth to write to them all. This depends on the cycle time and the number of axes. It is best to select only those required.

This setup procedure will automatically map the essential drive attributes for control of a remote axis. You don't need to add any but in this example, we will, so that you know how it is done.

"Axismode" is an example of a useful keyword that we can map. Double click or expand the Process Data tree and select Axismode in the tick box. As process data is mapped the PDO Item count will start to grow towards its maximum limit.

After clicking on Process Data on the Resource Mapping screen the PDO tree expands out to reveal more data that can be sent to and from the MicroFlex e100 to the NextMove e100 over EPL. Tick the box for Axismode in this example.



The Encoder value can be mapped through EPL.

After clicking on Encoders->Encoder 0 on the Resource Mapping screen this popup shows up.

Map the MicroFlex e100's encoder value to "Encoder 3" on the manager node (ie the NextMove e100). This is to make it compatible with the EPL address and axis number which we have already setup.

Once all these mappings have been completed, close the Resource Mapping Dialogue and click Next.



# Mint<sup>MT</sup> Multi-Tasking Application Note

If you have configured network-based motion axes, these will be shown below. In addition to these, some controllers have hardware support for analog servo and stepper axes (referred to as local axes).

Use the Add, Edit and Delete buttons to create a list of axes to control. For each one you will be prompted to select how that axis will be controlled and which hardware to use (e.g. stepper or analog outputs).

Axis	Config	Profiled	Profile Rate	Details
Axis 3	Remote	Manager	1 ms ( 1 kHz )	mapped to Axis 0 of node 3 ( Hex 03 ) on Ethern...

Profilers ( 2 / 16 ) :

Approx. CPU loading ( 30% ) :

NB Loading is calculated based on profiled axes performing simple move types, and as such, should only be used as a rough guide.

The remote axis list shows up again except that this time the axis you have just configured is listed. It is at this point that you can add another axis if you have more than one MicroFlex e100. The procedure just outlined would then be repeated.

When all the axes have been configured click Next.

# Mint MT <sup>Multi-Tasking</sup> Application Note

If you have configured network-based motion axes, these will be shown below. In addition to these, some controllers have hardware support for analog servo and stepper axes (referred to as local axes).

Use the Add, Edit and Delete buttons to create a list of axes to control. For each one you will be prompted to select how that axis will be controlled and which hardware to use (e.g. stepper or analog outputs).

Axis	Config	Profiled	Profile Rate	Details
Axis 3	Remote	Manager	1 ms ( 1 kHz )	mapped to Axis 0 of node 3 ( Hex 03 ) on Ethern...
Axis 4	Remote	Manager	1 ms ( 1 kHz )	mapped to Axis 0 of node 4 ( Hex 04 ) on Ethern...

Add Local Axis... Edit Local Axis... Delete Local Axis

Profilers ( 2 / 16 ):      Approx. CPU loading ( 30% ) :  
0%      150%

NB Loading is calculated based on profiled axes performing simple move types, and as such, should only be used as a rough guide.

< Back    Next >    Finish    Cancel    Help

The above screen shows the axes added over EPL. This example shows two MicroFlex e100s. They can be edited here. Local axes can be added here as well. Local axes are not mapped over EPL. They use one of the NextMove e100's Encoder inputs 0,1 or 2 and the speed demand to the drive is sent via an Analogue output. Click Next.

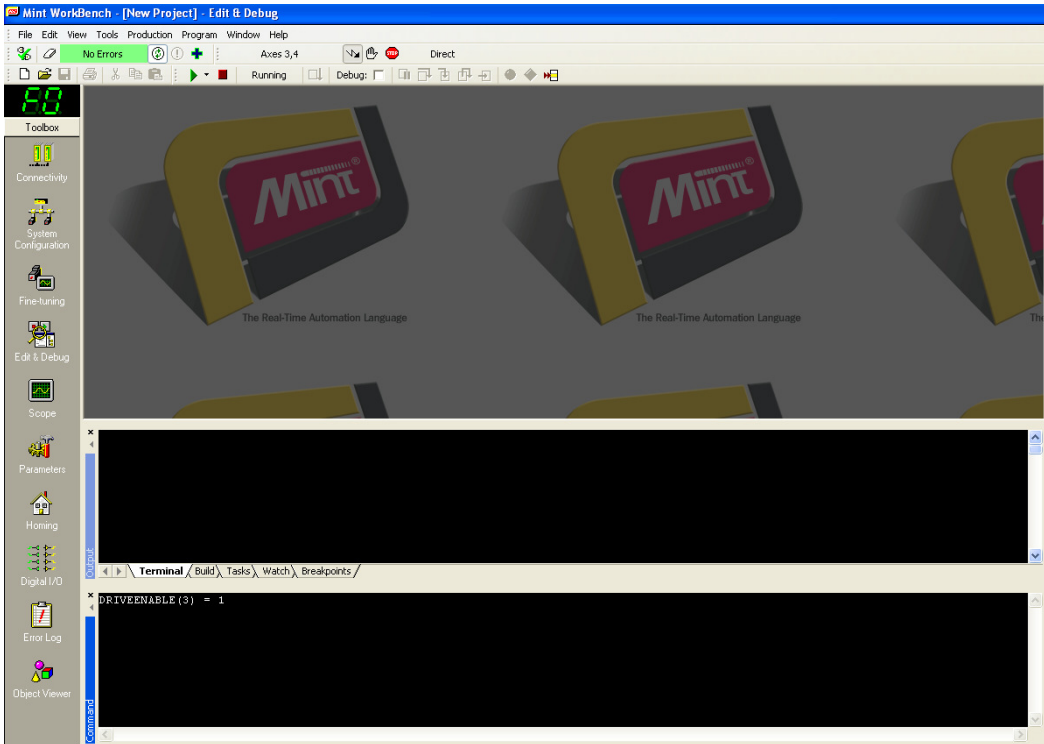
A summary screen follows this one. After the summary is the Configuration Complete screen. Here is a good opportunity to save the .dcf (Device Configuration File). Click "Finish" to download to the controller. It is a good idea to reset the controller after the download. This completes the configuration.

# Mint<sup>MT</sup> Multi-Tasking Application Note

## Performing test moves from the NextMove e100

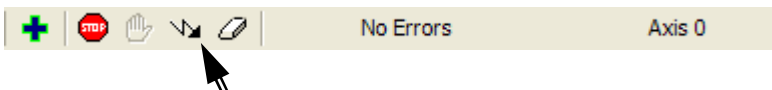


Check that all of the connections are correct and that the signals are working in the correct sense. Using WorkBench v5.5 connected to the NextMove e100 select the *Edit & Debug* icon and type the following instructions at the *Command Line*. This is the lower area of the workbench screen with a black background. You need to click in this area first to move the focus to it before typing.



We are ready to try to move the motor, ensure there are no obstructions and that the motor is free to turn with the brake released.

If the motor moves out of control be ready to click the Enable icon on the WorkBench v5.5 Toolbar to disable the drive. Alternatively you can push the stop sign.



**Mint<sup>MT</sup> Multi-Tasking** Application Note**Setting scale factor.**

To define motion in terms of useful units it is normal to set a scale factor. The scale is calculated by determining the number of encoder counts per user unit. Useful units would be motor revolutions (revs). In this case  $SCALEFACTOR(\text{axis number}) = \text{number of encoder counts per rev.}$



$SCALEFACTOR(3) = 10000$  (for the encoder in this application but check first)

$SCALEFACTOR(3) = 262144$  (for an SSI motor set to its maximum resolution)

**Note**

MintMT has an abbreviation for most of the keywords which is useful when typing at the command line as it reduces the amount of typing required. A few are listed below

DRIVEENABLEOUTPUT = DEO  
PRINT = ?

SCALEFACTOR = SF  
DRIVEENABLE = DE

These commands, and others, are all described in more detail in the WorkBench v5.5 Help files. Help can be obtained by pressing F1 with the cursor positioned on a MintMT keyword in the command line.

The use of abbreviated commands is not recommended for use in a program, it makes the code very difficult to understand at a later point in time or by other people.

**Trapezoidal moves.**

The scale factor should now be set so that a user unit of 1 corresponds to 1 rev. Now it's time to perform a few test moves. Type the following on the command prompt.



DRIVEENABLE(3) = 0	Disable the drive before changing the position.
POS(3) = 0	Set the absolute position to zero.
DRIVEENABLE(3) = 1	Re-enable the drive.
SPEED(3) = 5	Set the target speed of the move to 5 revs/s
ACCEL(3) = 20	Set the move acceleration rate to 20 Revs/s <sup>2</sup>
DECEL(3) = 20	Set the move deceleration rate to 20 Revs/s <sup>2</sup>
MOVEA(3) = 5	Perform an absolute move to position 5
GO(3)	Start the move with the GO command
MOVER(3) = 4 : GO(3)	Perform a relative move a further 4 cycles forward. Note that commands can be cascaded on one line with a colon.
MOVEA(3) = 0 : GO(3)	Perform an absolute move 9 Revs back to position 0.

# Mint<sup>MT</sup> Multi-Tasking Application Note

## Initializing the EPL network using Mint

The EPL network is configured in Mint WorkBench using the System Configuration Wizard. When the Mint code running on the NextMove e100 starts up it is a good idea to run some code at the start of the program to determine when both the EPL network and the remote devices are operational. This code is normally called from the NextMove e100 Mint [Startup module](#).

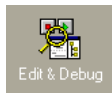
The recommended initialization sequence is as follows:

1. Check that the Ethernet network is operational or cyclic.
2. Check that all nodes are live.
3. Check that each node is capable of exchanging a Serial Data Object or SDO.
4. Check that each node is capable of exchanging a Process Data Object or PDO.
5. Check that the drive is in an operational state as defined by the DS402 protocol.
6. Finally check to see if the drive is in remote mode.

The full implementation of this code is explained in detail in the Workbench help file in the following path: Contents->Fieldbus Networks -> Ethernet Powerlink -> Initializing the EPL network using Mint.

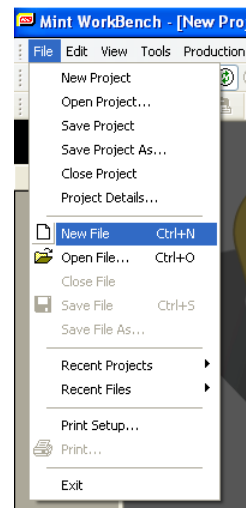
Rather than writing all this code by scratch, Workbench comes with standard code snippets which include the EPL initialisation code. These code snippets can be used in the start-up block. If nodes are expected to appear and disappear on the network then the Bus5 event can be used to reconnect to the node. In this case the help file should be consulted for a more detailed explanation of the code.

From the toolbox click on the Edit and Debug icon down to the left.



From the file menu choose New File. This is not to be confused with the project file that you are already viewing. The Mint code file is not contained in the project file.

The new program file will be blank when it is first opened.

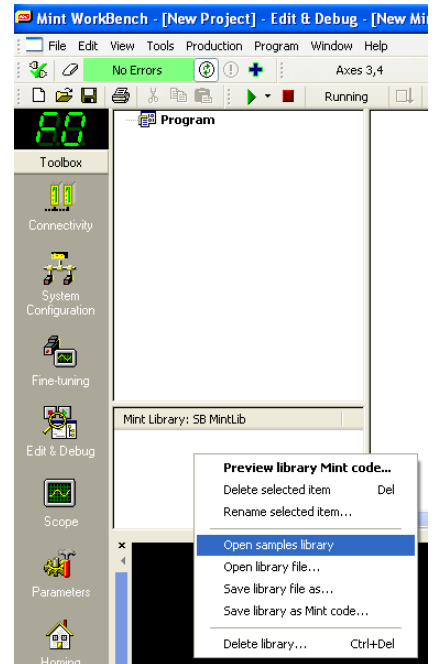


# Mint<sup>MT</sup> Multi-Tasking Application Note

On the lower left hand side of the program window is the Mint library. When you first use workbench 5.5 this window will be blank.

Right click on the Mint library window. A popup menu will appear. Choose "Open sample library".

A list of code snippets will appear.

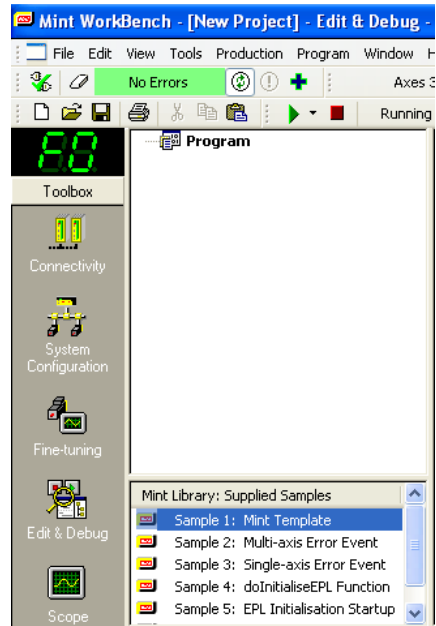


We will use the following code snippets shown here:

- Mint Template
- Function doInitialiseEPL
- EPL Initialisation Variable Declarations
- EPL Initialisation Startup code

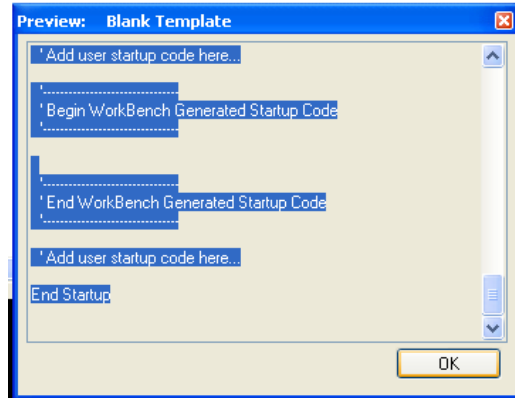
The first step is to have a suitable code structure to populate with your own code. The Mint Template is provided in the standard library for this purpose.

You can add the code to your program by dragging the icon from the library on to the editor.



# Mint<sup>MT</sup> Multi-Tasking Application Note

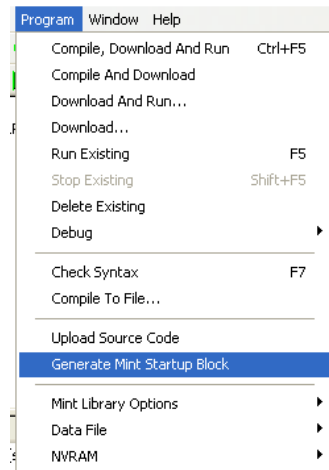
Alternatively, if you want to see a preview of the code first, open up the code by double clicking on it. The code preview dialog opens up.



Right click on the code and select it. It can then be copied.

Alternatively highlight the code by clicking in the window at the top and using the shift and arrow OR page down keys. Note that Ctrl-A doesn't work to select all text in this window. Copy the code using Ctrl-C and paste it into the program window using Ctrl-V

The next step in writing a program should be to update the program startup block with the current parameter settings for the axes we are using. The program startup block is executed once only when the motion controller starts running. This is the best place to set parameters such as scale factors etc which are not likely to change during running.



From the Program menu choose "Generate Mint Startup Block". This will populate the Startup block with the current settings. Note that this action will overwrite any existing code. You will see a warning dialog to this effect before you can proceed.

Once the Startup block has been written the next step is to copy in the code for initializing the EPL network. Select "Function doInitialiseEPL" from the Mint library and drag it into the new template code under the "Global Function" heading as shown here:

```
'-----
' Global Functions
'-----
Drag in Function doInitialiseEPL ..... Here
```

Now select "EPL Initialization Variable Declarations" and "EPL Initialization Startup code" from the Mint library and drag it into the program below the startup block heading as shown:

## Startup

```
'Remove comment from auto instruction if program needs to run
'automatically on power up...
Auto
' Add user startup code here...
```

**Mint** <sup>Multi-Tasking</sup> **MT** **Application Note**

```
Dim nEthernetNodes(3) As Integer = {2,3,4}
Dim nEthernetAxes(3) As Integer = {3,4,5}
Dim nEPLState As Integer
Repeat
  nEPLState = doInitialiseEPL(nEthernetNodes,nEthernetAxes)
Until nEPLState = _true
```

Note that this code example assumes that there are 3 EPL nodes and dimensions the nEthernetNodes and nEthernetAxes array's accordingly. In our example if two drives were setup as nodes then these array's should have dimension 2. The node's and axis numbers should also both be changed to {3,4} to match the Data Configuration File on the controller.

While here it is a good idea to un-comment the "Auto" keyword so that the program automatically runs on powering up the controller.

Congratulations ! You now have a program which will perform the initial checks on the EPL network before executing the main code.

The test moves performed in the previous section can also be written as lines of code in a Mint program. Describing how to program in Mint is beyond the scope of this application note. To find out more about Mint programming in general see the Help file section:  
Contents->Mint basic programming.

# Mint<sup>MT</sup> Multi-Tasking Application Note

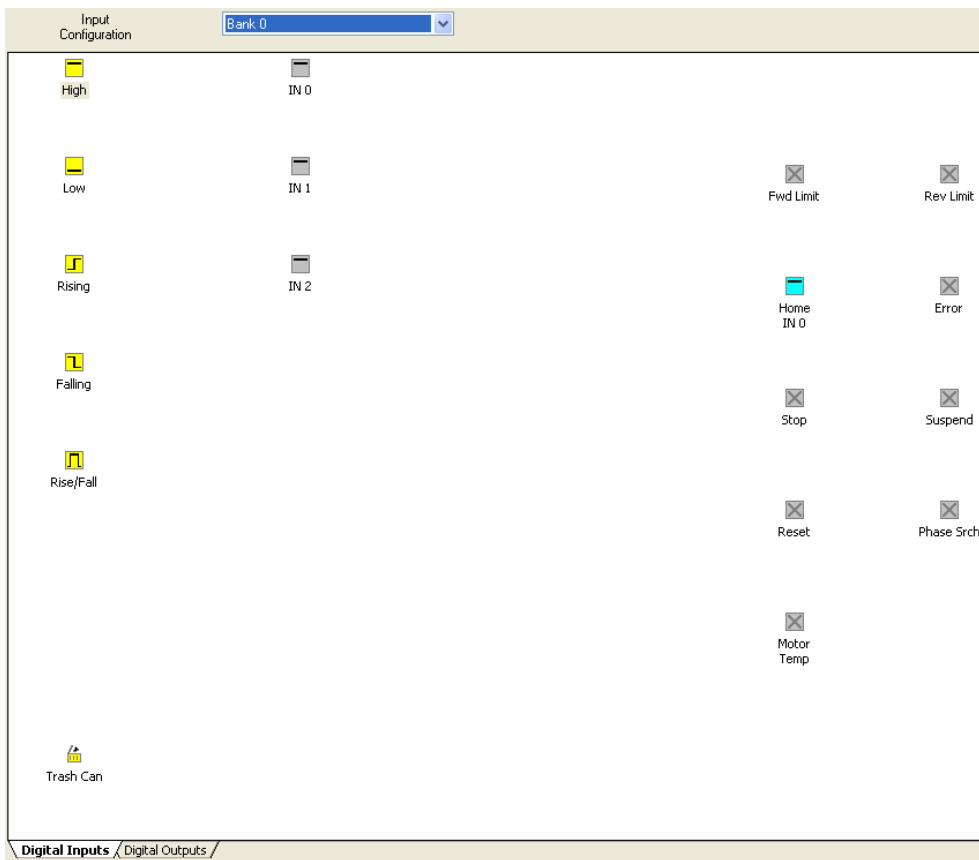
## Homing e100 series drives and controllers

The MicroFlex e100 and MotiFlex e100 drives can control homing locally on the drive. If they are being controlled over EPL from a NextMove e100 then homing must be controlled by the drive as there is too much delay over the EPL network to allow the NextMove e100 to control homing.

### Go online to the MicroFlex e100



Select Digital I/O in the tools bar on the left hand side.



Drag IN0 onto Home to make Digital input 0 the home sensor input on the drive.

**Mint<sup>MT</sup> Multi-Tasking** Application Note

Select Homing from the tools bar on the left hand side.

Search for:

- Home Input Switch
- Index Pulse
- Home Input Switch, backoff Switch, Index Pulse

Reverse seek for home input then backoff until home input inactive.

Apply Start Stop

Homing Parameters:

HomeSpeed: 1 t/s

HomeBackoff: 10

Backoff Speed: 0.10 t/s

HomeAccel: 30 t/s<sup>2</sup>

HomeDecel: 30 t/s<sup>2</sup>

Reference Position: 0 uu

Creep Speed: 0.1 t/s

Search Direction:

Reverse  Forward

The homing test screen allows the Homespeed and other drive parameters to be set locally on the drive. The homing type selected here is "Home input switch". You could select the drive to home on the index pulse if there is no switch at hand. If you have a switch it is better as you can choose when to toggle the switch which makes it easier to see what is happening. Remember to click "Apply" to save any changes.

**Note**

All these speed values are based on the scalefactor on the MicroFlex e100. The drive uses its local scalefactor when homing. This may be different to the scalefactor on the NextMove e100.

**Go online to the NextMove e100**

On the command line for the NextMove e100 type Home(3). The number (3) signifies `_hmPOSITIVE_SWITCH_INDEX` which is the homing type chosen. The MicroFlex e100 should perform a homing move back until the home switch is detected on DIN0. It then moves forward again more slowly until it moves off the switch.

Homing parameters can be set in the drive during the drive setup. You might want to set these parameters up from the program in the NextMove e100. To do this you can use redirection which allows you to read and write parameters over EPL. Redirection is explained in more detail in the help file in the following path:

Contents->Mint basic Programming->Programming Guide->Mint Motion Library->Redirection Use:

```
Dim DriveA As Controller= {_busETHERNET, 3}
```

to define an object variable called "DriveA" to represent the MicroFlex e100 on EPL node 3. The pointer notation -> is used to access the drives parameters such as HOMESPEED. Note the drive calls itself axis 0. All parameters refer to axis 0.

**Mint<sup>MT</sup> Multi-Tasking** Application Note

Type the following code in the program Startup block to set up the drive remotely for homing.

```
Dim DriveA As Controller= {_busETHERNET, 3} 'Set redirection to Node3
DriveA->SCALEFACTOR(0) = 10000 'There are 10000 Counts/Rev
DriveA->HOMEINPUT(0) = 0 'The homing input is DINO
DriveA->HOMEBACKOFF(0) = 10.0 'The back-off speed is 10% of the home
speed
DriveA->HOMESPEED(0) = 5.0 'The homing speed is 5 Revs/s
```

## Where to go from here ?

There are other differences between the NextMove e100 controller and the NextMove without EPL series. These differences are described in Help file topics and other application notes. This section here is a guide to where to find this information.

### Application Note 162-000 Moving from NextMove Classic to NextMove e100

This application note is an overview of the differences between the NextMove e100 and the non EPL NextMove series. The main differences are:

- |                        |   |
|------------------------|---|
| Hardware:              | The IO on the NextMove e100 is different to the NextMove ESB2   |
| Axis configuration:    | On the NextMove e100, this is done in workbench and stored in a .dcf file. It cannot be changed in the Mint program.  |
| Axis Reset:            | This keyword is no longer supported on the NextMove e100.   |
| Auxiliary Encoders:    | These are no longer supported on the NextMove e100.   |
| Error Handling:        | This has been re-written for the e100 series. See the help file Contents->Mint Basic Programming->Error Handling->Error Categories (e100)   |
| Fast Position Capture: | This functionality has been re-written on the e100 series. Read the Help file entry Contents->Hardware->Input/Output Handling->Fast Latching e100. Application notes "AN177 Cut to registration" and "AN180 Product Synchronisation" contain good examples of how this can be set up on an e100 system. |
| CAN Bus:               | The Baldor CAN protocol is not supported on NextMove e100. CANopen is still supported.  |
| Others:                | A number of other keywords are modified or not supported. This is explained in more detail in AN162-000.  |

### Other Topics on e100

For a guide to configuring other devices on EPL see the following help file entries Contents->Fieldbus Networks->Ethernet Powerlink->Configure Process Data Ethernet Powerlink and Contents->Fieldbus Networks->Ethernet Powerlink->EPL Devices