SmartStep/3

Hardware Reference Guide

Issue 1.2

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Optimised Control World-wide Offices:

Europe (Head Office):

Optimised Control Ltd
178-180 Hotwell Road
Bristol
BS8 4RP
U.K.
Tel: (+44) (117) 987 3100
FAX: (+44) (117) 987 3101
BBS: (+44) (117) 987 3102

United States:

Optimised Control Inc
3923 Coconut Palm Drive
Suite 107
Tampa
Florida
USA
Tel: (+1) (813) 626 0780
Fax: (+1) (813) 626 0361

Pacific Rim:

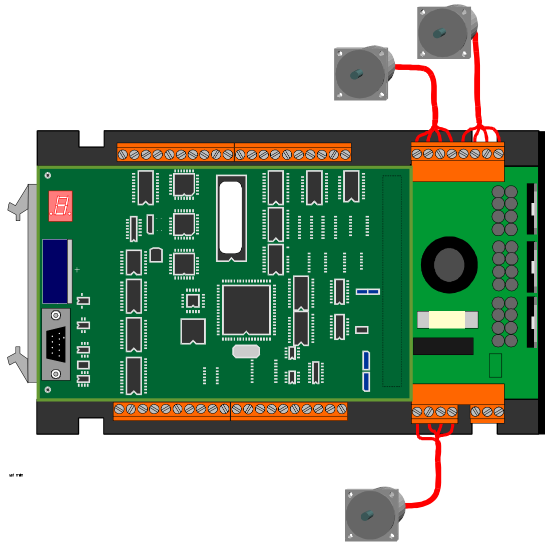
Optimised Control (NZ) Ltd
5 Matija Place
Red Beach
Hibiscus Coast
New Zealand
Tel: (+64) (0) 9426 6627
Fax: (+64) (0) 9426 6762

Revision History

Issue	Revision	Date	Reference	Comments
1	001	Jan 93	st3/ilw; M00110-001	First release of SmartStep/3 Hardware Guide
1.1	002	Aug 95	st3/ilw; MN00187-002	Addition of motor current resistor calculations
1.2	003	Mar 96	st3-12/RP; MN00187-003	EMC countermeasures discussed Added option boards to introduction Added Technical Spec.

1. Overview

The SmartStep/3 controller is a programmable computer designed specifically for the control of 3 independent stepper axes, integrated with a power supply and three small bipolar stepper drives, as a single compact unit. The drives provide 2A per phase at 40V in half step mode, which makes the system suitable for many frame size 23 and 34 motors. SmartStep/3 uses a highly flexible programming language, MINT™. The major features of the controller are as follows:



- Three axis position controller for open loop stepper motors
- Stand-alone operation or controlled by host computer over RS232/485 link, up to 16 controllers on RS485 multi drop link
- Panel mount unit for flat mounting. Screw terminations for ease of commissioning.
- Easy to use Basic-like motion control language, MINT™, with onboard program editor
- 28k bytes non-volatile program/data memory
- Circular and linear interpolation
- 8 uncommitted digital inputs and outputs for machine control
- Limit and Home switches
- Two 10 bit analogue inputs for interface to joy-stick or sensors
- Pulse follower input
- 18-28VAC input or 24-40VDC input, onboard power supply provides all other voltages required
- Expansion port for option boards such as extended I/O or user interface

1.1 Technical Specification

1.1.1 Machine Control I/O

Limit Inputs:	➥ 1 input per axis. Provides end of travel protection. Crash stop all axes when active. ➥ NPN non-isolated. Connect to normally closed switch to digital ground.
Home Inputs:	➥ 1 input per axis. Provides reference position for the axis. ➥ NPN non-isolated. Connect to normally closed switch to digital ground.
Stop Input:	➥ 1 input per controller. Brings all axes to a controlled stop when active. ➥ NPN non-isolated. Connect to normally closed switch to digital ground.
User Digital Inputs:	➥ 8 input lines. ➥ NPN non-isolated. ➥ Logical one when floating or high. ➥ Logical zero when pulled low.
User Digital Outputs:	➥ 8 output lines driven by ULN2803. ➥ 50mA continuous source on all channels. ➥ 400mA* max source per channel, 800mA* max for all 8 channels.
Fast Interrupt:	➥ 1 input per controller. ➥ NPN non-isolated. ➥ Latches position of all axes within 50 microseconds when pulled low.
Analogue Inputs:	➥ 2 independent analogue channels. ➥ 10 bit resolution. ➥ Jumper selectable for ±10V (differential) or 0-5V operation.
Pulse Counter:	➥ Counts rising and falling edge of pulses. Used for software gearboxes. ➥ Max input frequency of 500kHz. ➥ Non-isolated ➥ Non-isolated NPN direction input to change operation of up/down counter. ➥ Non-isolated NPN reset input clears counter on a falling edge.
Stepper Outputs:	➥ 3 independent ½ stepping drive outputs at 2A per phase max ➥ Selectable current level which applies to all 3 drive outputs. Factory set option.
Serial Port:	➥ RS232 or full duplex 4 wire RS485. Factory set. ➥ Connections brought out on 9-way male D-type connector. ➥ 9600 baud, 1 start bit, 8 data bits, 1 stop bit, no parity.

1.2 Miscellaneous Specification

Power Input:	➥ 24-40V DC at 3A. ➥ 18-28V AC at 3A.
Onboard Power Supply:	➥ On board power supply supplies the following: ➥ Stabilised +5V output at 500mA (not to be used for machine I/O). ➥ Stabilised ±12V outputs at 200mA (not to be used for machine I/O).
Weight:	➥ 0.85Kg
Operating Temperature:	➥ 0 - 45°.

* Absolute maximum value

Battery Life:
- 5 years.
- Will retain non-volatile RAM contents for up to 12 months when fully charged.

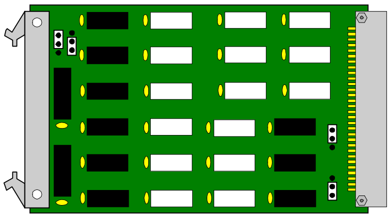
Warranty:
- 1 year return to manufacturer.

1.3 Expansion Boards

A number of expansion boards are available for SmartStep/3 for such options as expanded I/O and an operator panel. The expansion boards are connected to the SmartStep/3 controller via an IDC 50-way header. Contact your representative for further information on these boards.

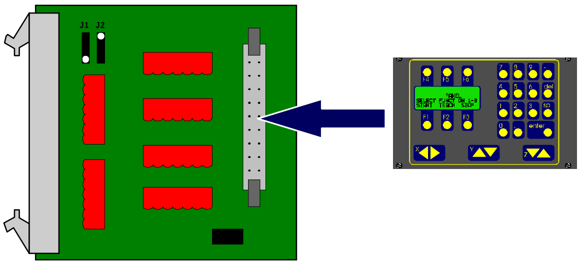
1.3.1 24 I/O Board

Provides the capability of expanding the I/O on SmartStep/3 by a further 24 inputs or 24 outputs. All the I/O is available optically isolated, either PNP or NPN. As standard, the 24 I/O board is supported in MINT using the XIO keyword.

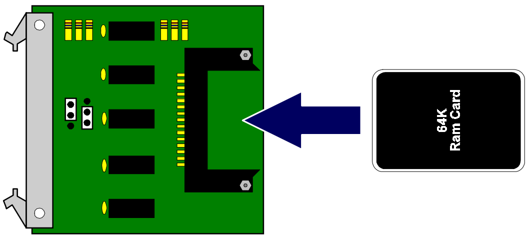


1.3.2 Operator Panel and Keypad Interface

Connected via an interface unit, the operator panel can be used to provide an operator interface for standalone operation. Both the keypad and display are supported as standard within MINT.



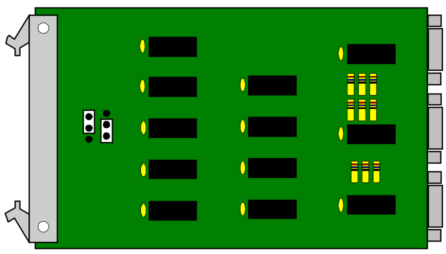
1.3.3 Memory Card Interface



The memory card interface can be used to provide memory expansion of array data and program storage as standard within MINT. An optional version of MINT allows the memory card to be used to expand the user program area.

1.3.4 Three Channel Encoder Interface

The three channel encoder interface board can be used to provide position verification of the stepper motor position. This board is supported as standard within MINT through the use of the XENCODER keyword.



1.4 Firmware Options

SmartStep/3 comes as standard with Interpolation MINT™. A number of other firmware options are also available:

MINT/3.28

MINT/3.28 is intended specifically for systems where a host computer sends motion control commands to the controller in real time. Motion control programs are not supported on the controller, but commands are sent by a host computer by means of datapackets.

MINT/3.28 only supports a subset of the MINT command set, namely the motion control commands. The Process MINT command set is not supported.

MINT/3.28 will operate over either an RS232 or RS485 link. The physical constraints of RS232 allow only point-to-point communication, i.e. one host computer can talk to one controller, RS485 provides longer transmission distances and allows a single host computer to communicate with up to 16 controllers on one multi-drop link.

Within a multi-drop 485 system using MINT/3.28, a controller cannot act as a host to other controllers on the system.

cTERM provides the facility to send instructions as MINT/3.28 datapackets to facilitate testing. The Applications and Utilities Diskette also contains the C source code (CLIB sub-directory) for creating MINT/3.28 datapackets for transmission.

HPGL

The HPGL EPROM (sometimes referred to as OCGL) provides a subset of the HPGL graphics language for use with pen plotters, routers and knife cutters. The following features are not supported:

- No support for text strings (LB command) or character fonts.
- No cross hatching (fill types)
- No scaling or plot windows
- Router mode (or Z control) does not support tool offsets.
- XON/XOFF software handshaking is not supported.

HPGL is not a programming language, but is a sequential command processor. Commands for vectored moves and arcs are sent, for example by a drawing package, for execution. In order to facilitate the setting up of a system, extended commands are implemented which are prefixed with !. Features available with the extended commands are:

- Position the Z axis to an upper or lower limit
- Set speeds and accelerations
- Switch outputs to drive solenoids

A limited macro facility is available allowing macros to be defined for:

- A pen up command (PU). This may control an output or drive the Z axis to a particular position.
- A pen down command (PD).
- A page feed. Commands can be used to page feed on receiving the !PG command which is available within Roland plotter as an extended command.

Macros can also be attached to the selected pen command (SP) for the following:

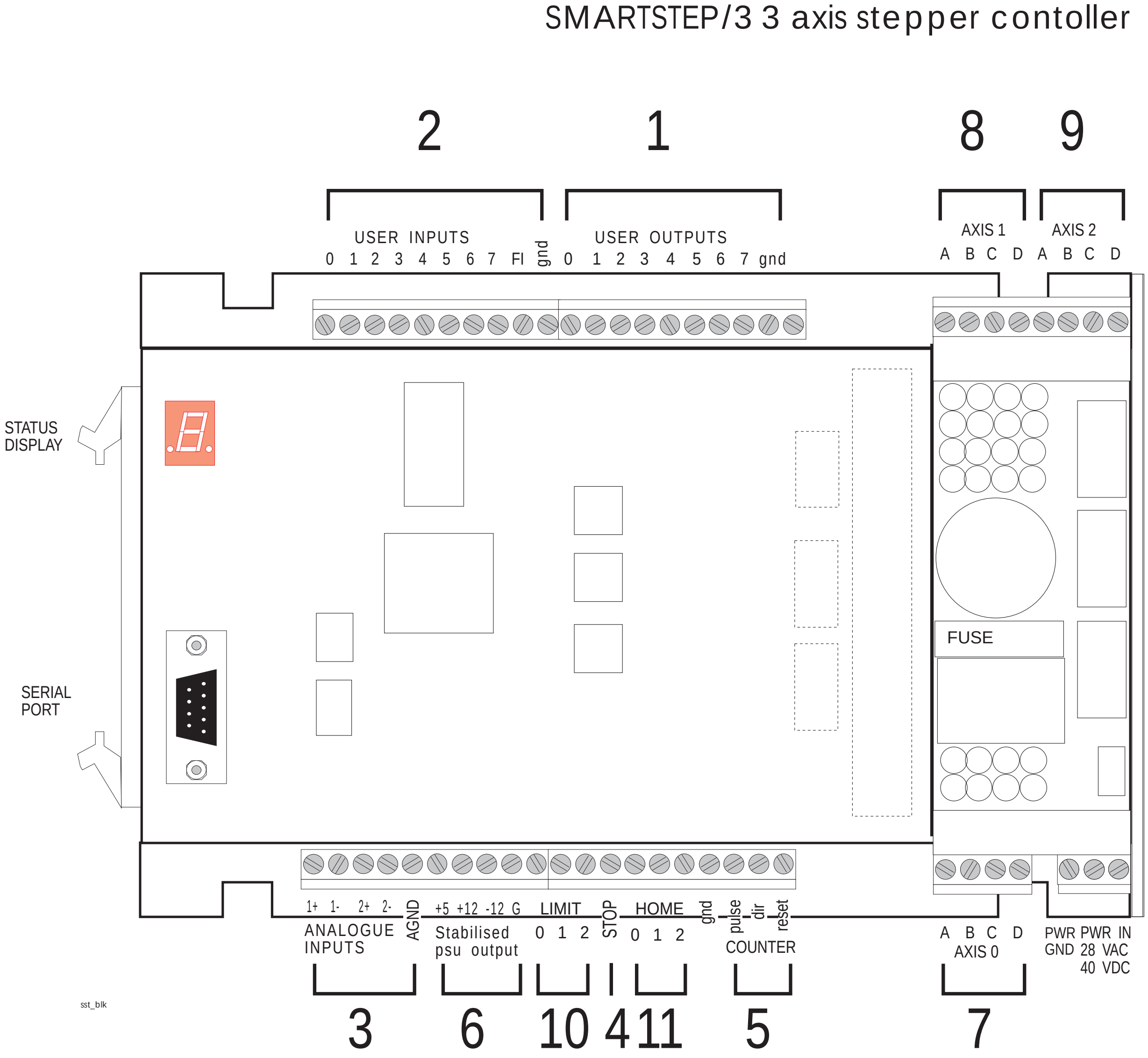
- ➥ Drive the Z axis to a lower position. Up to 9 tool depths can be defined using the SP macro. A different colour within the drawing would reflect a different depth on the work piece.
- ➥ Selecting a pen from a pen carousel. Both the X and Y axes can be moved to place a pen at the plotting position.

Due to the limitations of the macro language and the fact that HPGL is not a programming language, it is recommended that MINT™ is used to set up the system prior to inserting the HPGL EPROM. The calculated speeds and accelerations can be used to create an HPGL configuration file. Please also note that HPGL does not echo back characters typed in at the terminal screen. In order to see what is being typed, switch the local echo facility in cTERM to ON.

2. Connection Details

Referring to the diagram below, the connectors are numbered with details given under the section headings "Block <Reference Number>: <Connector Name>". For example "Block 1: User Outputs".

2.1 SmartStep/3



2.2 Minimum System Wiring

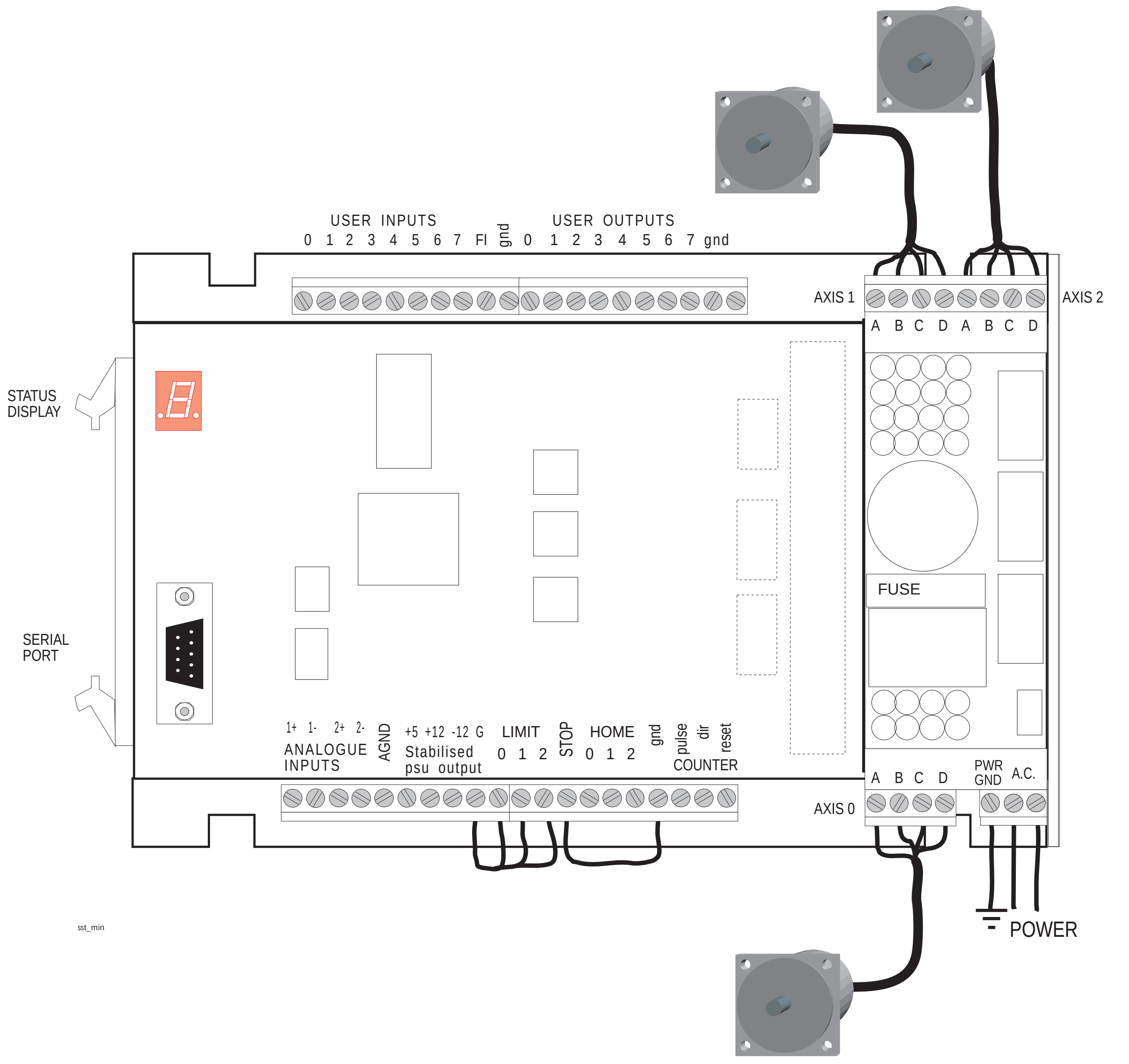
The figure below shows the minimum system wiring for a 2 axis system. Refer to the following sections for details on the connectors.

To enable to system to operate, the following inputs must be tied to GND:

➥ Limits for axes 0, 1 and 2

➥ Stop input

SMARTSTEP/3: Minimum System Wiring



2.3 Block 1: User Outputs

Label	Type	Description/Notes	MINT Keyword
0	Output	Output bit 0 NPN open collector	OUT0
1	Output	bit 1	OUT1
2	Output	bit 2	OUT2
3	Output	bit 3	OUT3
4	Output	bit 4	OUT4
5	Output	bit 5	OUT5
6	Output	bit 6	OUT6
7	Output	bit 7	OUT7
Gnd	Input	Return for outputs	

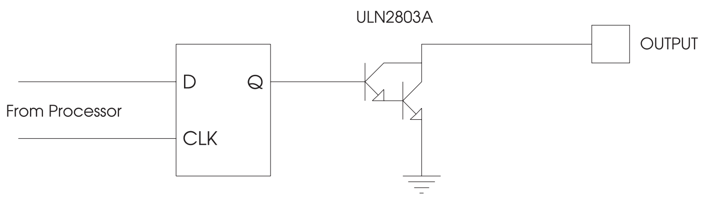
The controller provides 8 uncommitted digital outputs that are controlled through software.

The uncommitted digital outputs are driven by an octal darlington array (ULN2803 device). Each output is capable of sinking 50mA nominal continuously on all channels. A single channel can sink up to 400mA, however the total output for all channels cannot exceed 800mA. The circuit is shown in the figure.

Example:

```
OUT = 15
```

This example in MINT will turn on outputs 0 to 3 and turn outputs 4 to 7 off. See the MINT Programming Guide for more details on the OUT keyword.



Output driver circuit.

Note: Inductive loads require an external flyback diode

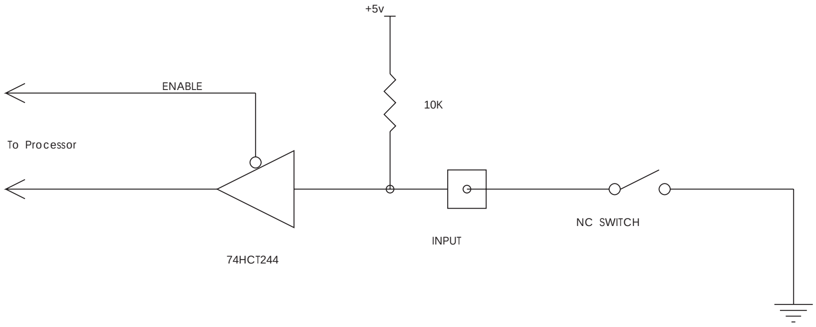
2.4 Block 2: User Inputs

Label	Type	Description/Notes	MINT Keyword
0	Input	Input bit 0 NPN internally pulled up to 5V	IN0
1	Input	bit 1	IN1
2	Input	bit 2	IN2
3	Input	bit 3	IN3
4	Input	bit 4	IN4
5	Input	bit 5	IN5
6	Input	bit 6	IN6
7	Input	bit 7	IN7
fast interrupt	Input	Latches the position within 25 micro-seconds and stores the value to the FASTPOS keyword.	FASTPOS
GND	Input	return for inputs	

The controller provides 8 uncommitted digital inputs which can be configured as interrupts within the MINT interpreter.

When read the uncommitted inputs will return a '1' if the input is not connected or pulled up to 5V and a '0' if the input is connected to ground. The state of the inputs is read using the MINT IN keyword.

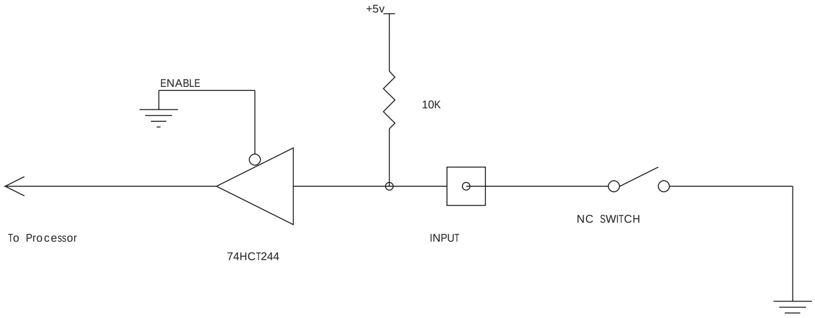
The input buffer circuit is shown in the figure below.



User inputs buffer circuit.

The fast interrupt is used to record the instantaneous position of all three axes. The Fast Interrupt has a fast response time and will capture spurious voltage spikes if care is not taken over cable connections. An individually screened cable should be used to connect to this signal, and the neighbouring User Gnd connection may be used to earth the respective screen.

The fast-interrupt buffer circuit is shown in the figure below:



2.5 Block 3: Analogue Inputs

Label	Type	Description/Notes	MINT Keyword
1+	Input	Positive input if +/-10V input used. Single ended input if 0 to 5V input used.	ANALOGUE1
1-	Input	Negative input. Connect to 0V for single ended operation.	n/a
2+	Input	Positive input if +/-10V input used. Single ended input if 0 to 5V input used.	ANALOGUE2
2-	Input	Negative input. Connect to 0V for single ended operation.	n/a

Three independent analogue inputs are provided, each with 10 bit resolution in the range of ±10V or 0-5V. These may be used for analogue sensor input or to provide a low cost joy-stick interface.

Each input is buffered and has a low pass filter to reject noise, (-3dB @ 2Khz). For ±10V operation, the inputs are differential which helps reduce the problems associated with differing ground potentials. This may be by-passed using jumpers JP2 and JP3 to allow 0 to 5V single ended operation.

Jumper Connection	Voltage Range
1 and 2	±10V
2 and 3	0 to 5V

On no account must the input voltage exceed the maximum rating shown above.

In the 5V configuration the inputs are single ended inputs through the positive input and are referenced to the controller analogue ground. In ±10V configuration the inputs are differential and not referenced to the controller ground. Normally the negative input is connected to the analogue ground of the external equipment. It is important that this connection is made to this external **analogue** ground, and not to external **system** or **digital** ground. Connection to the external system ground may result in erroneous input readings caused by the large return currents associated with motor control.

Each analogue input signal should be connected to the system using a screened twisted pair cable, and the cable screen should be connected to the earth pin on the power input (block 8). No other connection should be made to the cable screen, i.e. connect the screen at one end only.

The analogue inputs can be read in MINT as 10 bit values using the keywords ANALOGUE1 (A1) ANALOGUE2 (A2).

2.6 Block 4: Stop Input

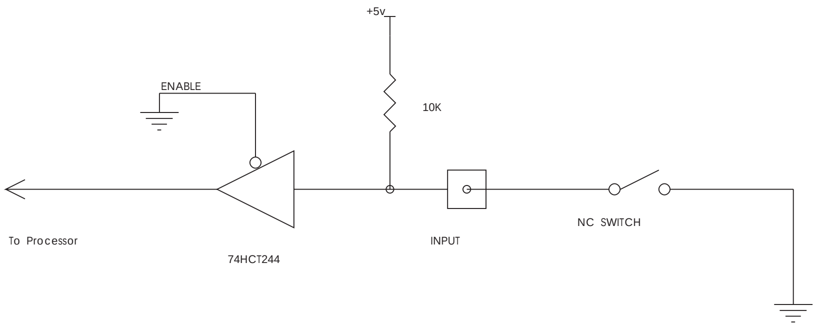
Label	Type	Description/Notes	MINT Keyword
stop	Input	Brings all axes to a controlled stop if asserted.	STOPSW
GND	Input	Return for STOP input	n/a

The STOP input, if asserted, will bring all axes to a controlled stop. The stop input is considered active when not connected and must be connected to GND to allow motion. If it is not used it must be connected to GND otherwise the controller will stay in the STOPed condition, which is indicated by an 'S' on the LED status display.

The stop input is useful where a controlled stop is required such as machine guards.

The state of the stop input can be read in MINT using the STOPSW keyword. A subroutine within MINT can be called in response to a rising edge on the stop input.

The stop input buffer circuit is shown below:



2.7 Block 5: Pulse Input

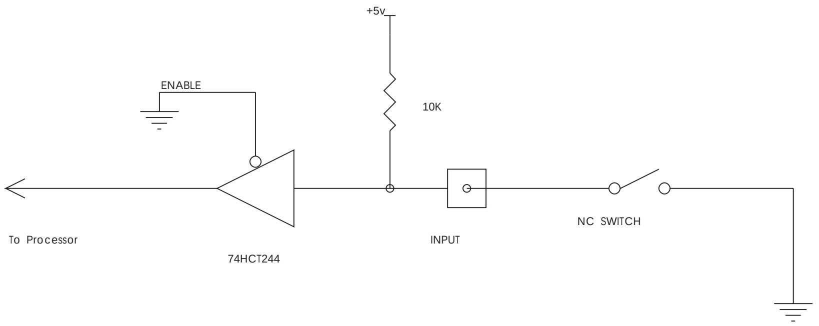
Label	Type	Description/Notes	MINT Keyword
pulse	Input	Pulse input train for software gear box. 500kHz max. input frequency .	PULSE
direction	Input	Direction of pulse input.	n/a
reset	Input	Resets the pulse input counter on a rising edge.	WRAP

The controller provide a pulse following interface which consists of 3 signals: Pulse Direction and Reset counter. The pulse and direction inputs go directly into an up-down counter in the microprocessor (after buffering). This counter changes on BOTH the rising and falling edges of the incoming pulse train. Reset counter will reset the counter to 0 on a falling edge. The counter value can be read in MINT using the TIMER keyword. This would commonly be used where one channel of an encoder provides the pulse train, and the index pulse resets the counter every revolution. The direction input, DIRECTION, determines whether the counter increments or decrements on each edge. If the direction signal is left unconnected or taken low then the counter will increment, if it is taken high (5V) then the counter will decrement.

The pulse input has a maximum input frequency of 500kHz. An individually screened cable should be used to connect to this signal, and the neighbouring Gnd connection may be used to earth the respective screen.

By using an external conversion circuit, the counter input can be used to accept a quadrature encoder signal.

The buffer circuit for these inputs is shown below:



2.8 Block 6: Stabilised PSU Outputs

Label	Type	Description/Notes	MINT Keyword
+5	Output	Stabilised 5V output	n/a
+12	Output	Stabilised +12V output	n/a
-12	Output	Stabilised -12V output	n/a
0V	Output	0V output	n/a

SmartStep/3 provides stabilised +5V and +/-12V outputs for general use. These voltages are provided for use with external equipment such as joysticks, analogue input amps or pots.

2.9 Blocks 7, 8, 9: Motor Connections

Label	Type	Description/Notes	MINT Keyword
A	Output	Phase 1 motor connection.	n/a
B	Output	Phase 1 motor connection.	n/a
C	Output	Phase 2 motor connection.	n/a
D	Output	Phase 2 motor connection.	n/a

Connection block 7 is for axis 0, 8 is for axis 1and 9 is for axis 2. The outputs for each block are identical.

The SmartStep/3 is set up *at the factory* to provides 2A per phase at 40V in half step mode. It is possible to change the motor drive current to all three motors by varying resistor 17 on the D771 PCB. The value of R17 is calculated as follows:

Ireq = Required Motor Current per phase

Iref = reference current

Vref = reference voltage

Vref = Ireq / 2.13

Iref = (5 - Vref) / 10,000

R17 = Vref / Iref

The table below shows some common values for R17 :-

Required Motor Current (A)	Iref (A)	Vref (V)	R17 (Ohms)
0.68	0.47	0.32	680
0.75	0.47	0.35	750
0.83	0.46	0.39	820
0.89	0.46	0.42	910
0.96	0.45	0.45	1.0K
1.07	0.45	0.5	1.1K
1.15	0.45	0.54	1.2K
1.38	0.43	0.65	1.5K
1.62	0.42	0.76	1.8K
1.77	0.42	0.83	2.0K
1.92	0.41	0.9	2.2K
2.07	0.4	0.97	2.4K

2.9.1 4 Wire Motors

4 wire motors are designed to be used with bipolar drives, and as such are the easiest to connect. Phase 1 (or A) of the motor should be connected to outputs A and B, with phase B (or 2) of the motor connected to outputs C and D.

If the motor moves in the wrong direction, this can be reversed by reversing the connections to one of the motor phases.

2.9.2 8 Wire Motors

8 wire motors are designed to be used with either bipolar or unipolar drives by having two coils wound together on each phase allowing current to be driven in either direction by using two drivers per phase. When wiring this type of motor to a bipolar drive the two coils can be wired in two ways.

With the two coils wired in series you effectively get a single coil with twice the number of turns which gives you increased torque with a fixed current drive. However with the resistance and inductance are also increased, this in turn increases the time taken to establish the set current in the winding. The overall effect of this is to reduce the torque at higher step frequencies and lower the effective top speed. This effect can be countered by increasing the applied voltage (up to the maximum).

With the two coils wired in parallel you effectively get a single coil with twice the conductor area which allows current to be established in the windings more quickly at a set voltage. The torque produced with this arrangement is less than that with series wiring. However the parallel arrangement can carry more current and this can be used to increase the torque (up to the maximum current).

2.9.3 6 Wire Motors

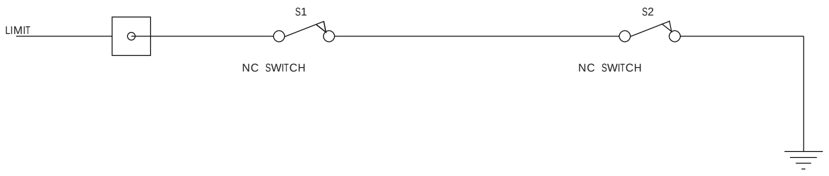
6 wire motors are similar to 8 wire motors with each pair of coils joined at one end (the common connection). Connecting across the individual wires, leaving the common unconnected is equivalent to an 8 wire motor in series. However they cannot be wired equivalent to an 8 wire motor in parallel.

2.10 Block 10: Limit Inputs

Label	Type	Description/Notes	MINT Keyword
0	Input	Limit input for axis 0.	LIMIT
1	Input	Axis1.	LIMIT
2	Input	Axis 2.	LIMIT

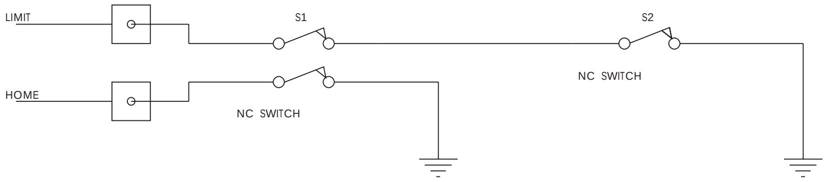
In a typical application, the limit switch inputs would be connected to normally closed micro switches on the axis. Hitting the limit switch will cause the switch to become open circuit, the respective input then becomes active internally, resulting in a limit error and the axis coming to an immediate stop. A limit error is indicated by an 'L' on the LED status display, and the ERROR keyword will return the value 3 when read. See the MINT Programming Guide for more details on the ERROR keyword and error handling within MINT.

Because there is only one limit input per axis, if two end-of-travel limit switches are fitted then they must both be connected in series as shown below.



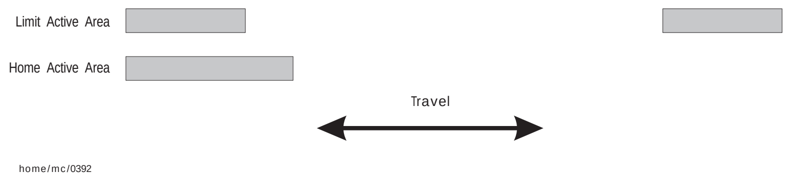
Dual Limit input switch connection.

A possible problem with this arrangement is that is it not possible to determine in software which end-of-travel switch has been hit by simply reading the limit input. This can be overcome by introducing a double pole limit switch at one end of the axis and connecting this to the home input or a spare digital input. This means that when a limit switch is hit the program can determine whether this is the forward or reverse limit by reading the status of the home switch or relevant digital input.



Dual Limit and Home/Input connection.

In many applications it is necessary to have separate limit and home switches. In these cases it is best to arrange the active areas of the switches to be set up as shown below.



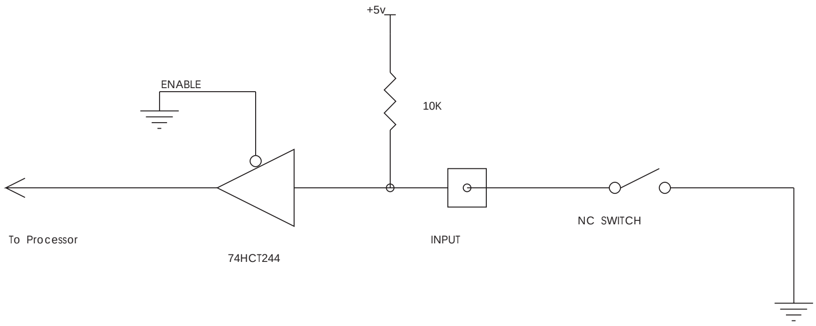
Limit/Home switch active areas.

Hitting a limit switch causes an error which is handled in software by the ONERROR subroutine, details of this are given in the MINT programming guide.

In an application where not all 3 axes are being used, the redundant axes must have their respective limit switches tied to GND for normal operation. Alternatively the MINT keyword DISLIMIT can be used to disable the detection of limit switches.

The state of the limit switches can be read using the MINT LIMIT keyword. A value of 1 (logically active) will be returned if the limit input is not connected (switch open) or pulled up to 5V and 0 (logically inactive) if connected to GND (switch closed).

The figure below shows the input buffer circuit and normal connections for all motion inputs.



Input buffer circuit for Limit

2.11 Block 11: Home Inputs

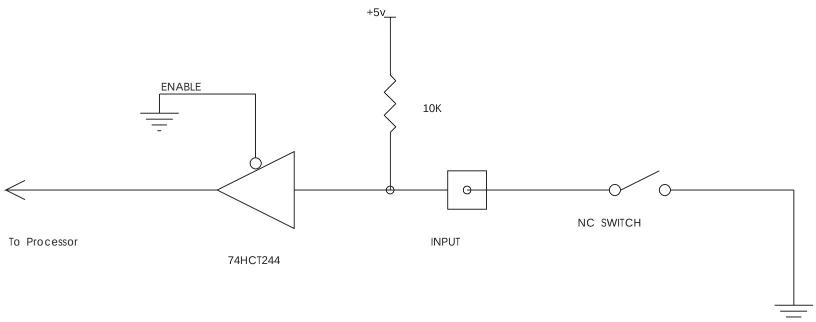
Label	Type	Description/Notes	MINT Keyword
0	Input	Home input for axis 0.	HOME
1	Input	Axis1.	HOME
2	Input	Axis 2.	HOME

Three home inputs are provided, one for each axis. Like the limits these inputs require normally closed switches for normal operation. Unlike the limit switches, however, they do not have to be connected if they are not used.

If the limit switch is used as a datum point, both the limit input and the home input must be connected together. Noisy environments can cause glitches on the limit switches which may result in a limit error during homing. A 100nF ceramic capacitor connected between the limit input and ground should eliminate this problem.

The state of the home switches can be read using the MINT HOME keyword. A value of 1 (active) will be returned if the home input is not connected (switch open) or pulled up to 5V and 0 (logically inactive) if connected to GND (switch closed).

The input buffer circuit is shown below:



2.12 Serial Port

The controller has a full duplex serial port which can be either RS232 or RS485. The serial port is set up for the following configuration:

- ➥ 9600 Baud
- ➥ 1 start bit
- ➥ 8 data bits
- ➥ 1 stop bit
- ➥ No parity
- ➥ Hardware handshaking lines (RS232) RTS and CTS must be connected.

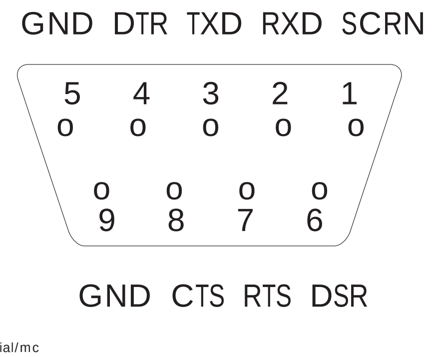
MINT will transmit a carriage return/line feed (<LF><CR>) combination but only expects a carriage return (<CR>) from the host terminal.

cTERM, a terminal emulator program is supplied pre-configured for use with the controller.

2.12.1 . RS232

The RS232 connections are brought out onto a male 9-way D-type connector on the front of the controller.

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. Both the output and input circuitry are single ended and operate between ±12V.



RS232 D-Type connector pinout

Pin No.	Signal Name and Function	Type
1	SCRN : Cable screen	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	Input
	(Internal Connection to pin 4)	
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 IBM PC 25 way or 9 way connector:

Controller Pin No.	Signal Name and Function	Wire to: 25 Way	Wire to: 9 Way
1	SCRN : Cable screen	-	-
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

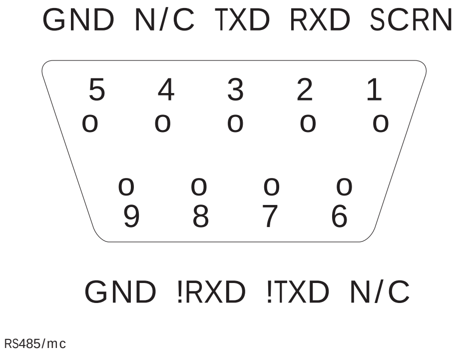
2.12.2 . RS485

The RS485 connections are brought out onto the male 9-way D-type connector on the front of the controller.

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

Fail safe operation of the receiving line is achieved by inclusion of line biasing resistors. The values of these resistors are set for operation with a small number of cards, where a larger number of cards are required on the same line the values may need to be altered.

The D-Type signals are also brought out on the 96-way connector.

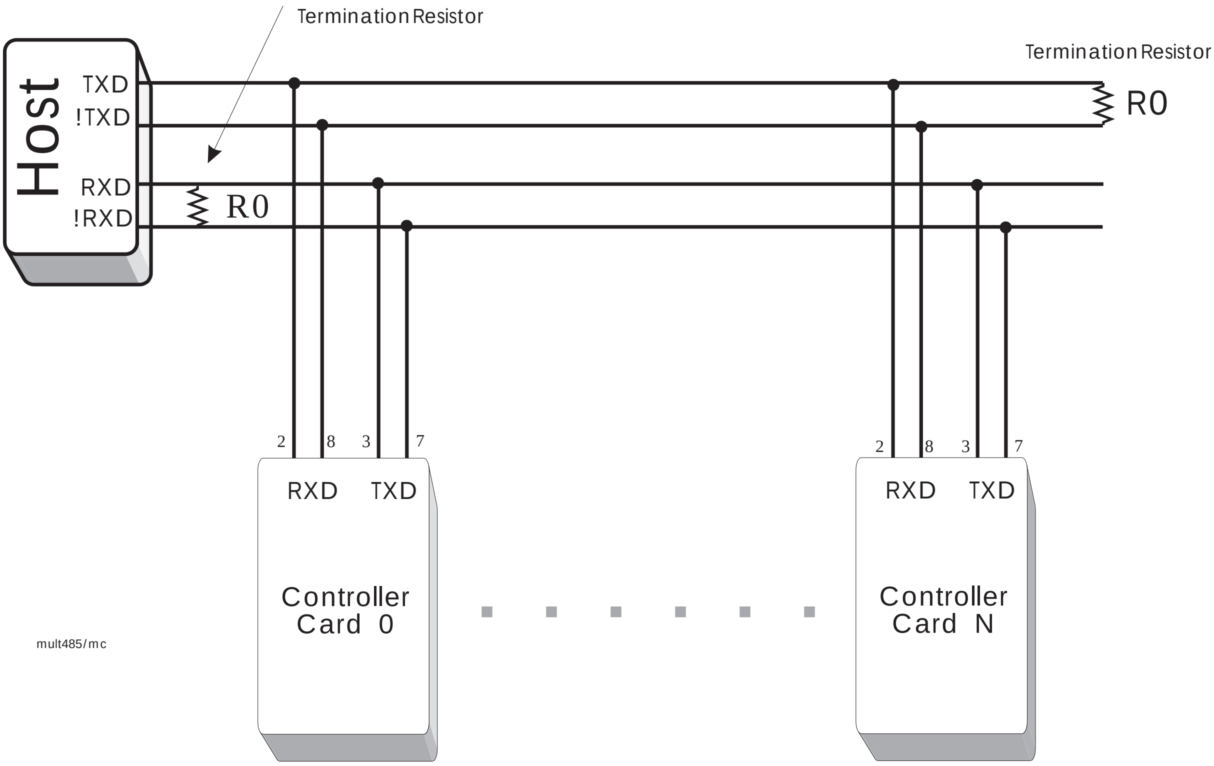


RS485 D-Type connector pinout

Pin No.	Signal Name and Function	Type
1	SCRN : Cable screen	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 Compliment	Output
8	!RXD : Receive Data Compliment	Input
9	GND : Signal Ground	

2.12.2.1 RS485 Multi-Drop

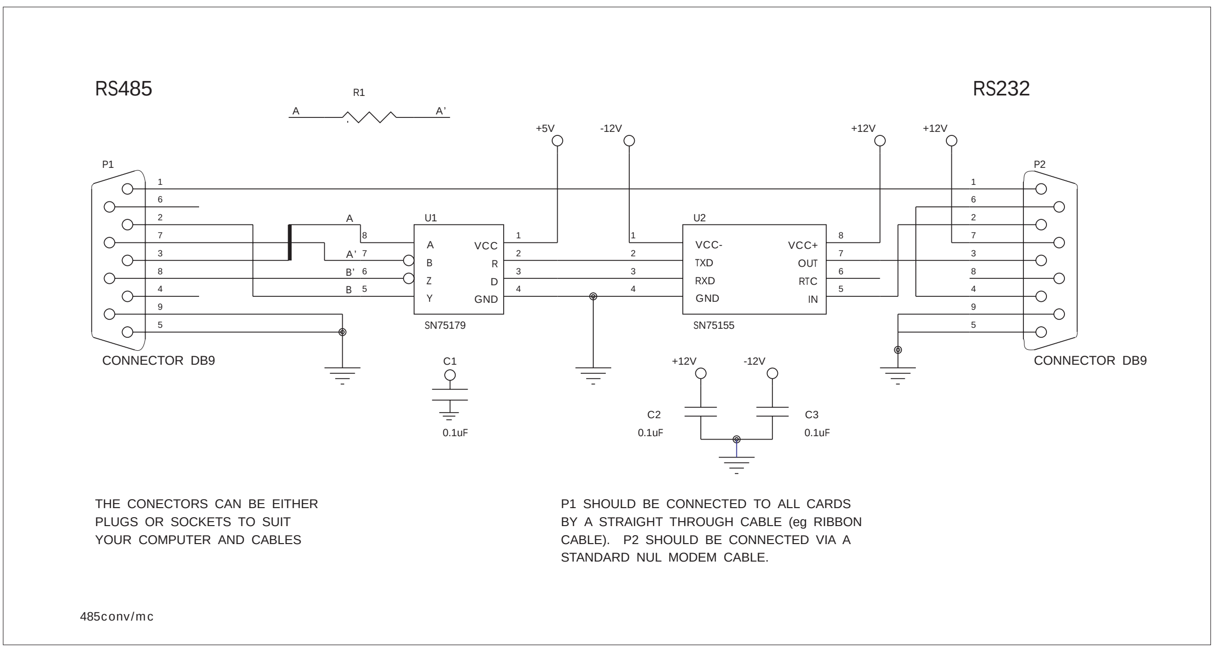
A multi-drop system can be easily configured using a ribbon cable and IDC D-Type connectors to the controller cards. A multi-drop layout is shown in the diagram below. The controller supports up to 16 cards on the serial line, where each card is distinguished by a unique address set by a 4 bit DIP switch. See section 3 for more details on the card address. Software details on multi-drop can be found in the MINT Programming Guide.



The RXD and TXD lines may be terminated with 120 ohm resistors at the receiving end.

2.12.2.2 RS485 to RS232 Converter

The following shows a schematic for an RS485 to RS232 converter. This is useful for connecting an IBM PC to a multi-drop link and using the PC as a host.



3. Option Card Header

The option card header (50-way IDC) allows the controller to access additional peripherals as discussed in section 1.3 to give additional functionality which is not part of the controller. This section describes the option card header in more detail.

The header interface consists of the Data Bus part of the Address bus some control signals and some power rails. All of the high speed signals are separated by ground lines to reduce any cross-talk or interference.

3.1 Pin Arangement

Description	Signal	Pin	Pin	Signal	Description
Data bus bit 0	AD0	1	2	GND	0V
Data bus bit 1	AD1	3	4	GND	0V
Data bus bit 2	AD1	5	6	GND	0V
Data bus bit 3	AD1	7	8	GND	0V
Data bus bit 4	AD1	9	10	GND	0V
Data bus bit 5	AD1	11	12	GND	0V
Data bus bit 6	AD1	13	14	GND	0V
Data bus bit 7	AD1	15	16	GND	0V
Address Latch Enable	ALE	17	18	GND	0V
Read Strobe	!RD	19	20	GND	0V
Write Strobe	!WR	21	22	GND	0V
Address bit 0	MA0	23	24	GND	0V
Address bit 1	MA1	25	26	GND	0V
Address bit 2	MA2	27	28	GND	0V
Address bit 3	MA3	29	30	GND	0V
Address bit 4	MA4	31	32	GND	0V
Address bit 5	MA5	33	34	GND	0V
Option Card Select	!OCS	35	36	EXTINT	External Interrupt
Reset Out	!RSTOUT	37	38	!RSTIN	Reset Input
Error In	ERRIN	39	40	ERROR	Error output
0V	GND	41	42	Vcc	+5V
+5V	Vcc	43	44	Vcc	+5V
0V	GND	45	46	+12V	+12V
+12V	+12V	47	48	GND	0V
-12V	-12V	49	50	-12V	-12V

3.1.1 Signal Discriptions

Signal	Description
Data Bus	These signals are bidirectionally buffered connections to the processors' multiplexed data/address bus and are used to convey data to and from the option cards.
ALE	This signal allows the use of peripherals which need to connect to a multiplexed bus and demultiplex it internally. (Currently unused)
Read/Write	These signals are buffered connections to the processor read and write pins, they are used as normal to indicate the direction of data flow and when data is available on the bus. Read is also used to set the direction of the data bus buffers on the controller and the option cards.
Address Bus	These signals are buffered connections to the processor address bus. They are used, with OCS to determine which card and then which location on the card is accessed. Bits 5 and 4 determine which card, giving a maximum of 4

Signal	Description
	cards. And bits 3-0 are used on each card to give a maximum of 16 bytes per card, 64 bytes in total.
OCS	This option card select signal indicates when access to one of the option cards occurs.
EXTINT	This signal is an open drain common interrupt signal from all option cards for any cards that require it. (Currently unused)
RSTOUT	This signal indicates when the processor or voltage monitor has caused a system reset. Any peripherals with hardware reset inputs are connected to this line.
RSTIN	Pulling this line low will cause a system reset. (Currently unused)
ERRIN	This signal is connected in paralell with the standard error in input.
ERROR	This signal is connected directly to the controller error output.
Power Rails	These are connected directly to the controller rails.

3.2 Prototyping

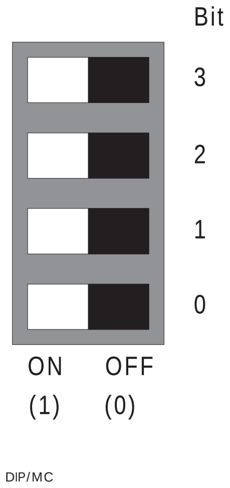
A prototyping board is available, for those who want to design their own option cards, which consists of:

- a connector
- data buffer
- PAL socket
- links for board number (0-3) selection
- a wire wrapping area
- space for a DIN41612 B,C,D or F connector

4. Card Address

Up to 16 controllers can be connected together over a multi-drop RS485 link for host control. Each card on the link is distinguished by a unique address set by a 4 bit DIP switch located next to the processor.

Controller Address Switch:



Switch Position 3 2 1 0	Address	LED
0 0 0 0	0	0
0 0 0 1	1	1
0 0 1 0	2	2
0 0 1 1	3	3
0 1 0 0	4	4
0 1 0 1	5	5
0 1 1 0	6	6
0 1 1 1	7	7
1 0 0 0	8	8
1 0 0 1	9	9
1 0 1 0	10	A
1 0 1 1	11	b
1 1 0 0	12	C
1 1 0 1	13	d
1 1 1 0	14	E
1 1 1 1	15	F

On power up, the controller will show the address number on the LED status for about 1 second. The DIP switch value can be read through MINT using the CARD keyword.

If the controller is used in a stand-alone system, the card address should be set to address 0.

5. EMC Countermeasures

5.1 Background

The unit consists of the established EuroStep controller which sits on a power board. EuroStep itself has been widely used in the industry, customers have taken the usual precautions of incorporating it into a shielded 19" rack and screening the control cables, by this means they have been able to achieve EMC compliance for CE marking. The amplifier board comprises circuitry switching at modest frequencies, 10-20kHz, with the modest slew rates associated with bipolar circuitry.

Customers have shown that SmartStep/3 can pass the emissions tests necessary for CE marking provided the unit is housed in a shielded enclosure and care is taken with cabling emerging from this enclosure. Use an enclosure with at least 20bB of attenuation in the range 30MHz-500MHz. Ensure that all apertures to the enclosure are screened (including ventilation). Extend connections through the enclosure wall using connectors which allow the effective use of screens, such as D-type connectors. The cabling outside the enclosure should definitely be screened for reasons of emissions and susceptibility.

SmartStep/3 can be incorporated into equipment which will pass the radiated susceptibility tests achieving this requires a shielded enclosure and care with the cabling.

SmartStep/3 can be incorporated into equipment which will pass the conducted susceptibility tests. Normally this test will only apply to the mains connection to the machine. If I/O from the machine is run over cables longer than 3m and the I/O is connected to SmartStep/3 then some additional filtering may be needed.

Some specific recommendations are given below:

5.2 Power supply

Use of mains filter is strongly recommended both for emissions and susceptibility. If the unit is powered from an SMPS (Switch Mode Power Supply) then susceptibility is unlikely to be a problem. Take care that the cabling from SmartStep/3 to the transformer or SMPS is short as this can itself form an antenna, in case of difficulty filter near to SmartStep/3. If compliance with EN60555-2 (Harmonic currents) is sought this is most easily achieved by using a compliant SMPS, less easy is to use a transformer + inductor (note that there will be a reduction in volts).

5.3 User Inputs, Outputs, Stop Input, Pulse Input

Screen all of these connections where they run outside the enclosure in order to achieve adequate immunity and noise levels. If the cable runs entirely within the machine and immunity to conducted interference is not considered a problem then it may be possible to attenuate emissions adequately using ferrite rings located at the aperture in the enclosure.

5.4 Analogue Inputs

Remarks as above. Require separate cabling.

5.5 Home and Limit Inputs

These should be screened and run in cabling distinct from all other connections.

5.6 Stabilised PSU Outputs

The outputs should only be used for circuitry local to SmartStep/3 such as a potentiometer on the front panel. Additional filtering will be required if the cables are run outside the unit both for emissions and immunity.

5.7 Motor Connections

It is absolutely imperative that these be screened and that the screen is connected to the enclosure case.

5.8 RS485 and RS232

In either instance the cable should be screened and a metal shell should be used. RS232 should not be used where immunity is an issue, for certification purposes this means a cable of no more than 3m.