Motion Control System
and
Operator Interface* (VC1)

Installation Manual

Revision 1.2

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(*) Optional keypad and display

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1 DOCUMENT MANAGEMENT

1.1 Release

Issue	Date	Comments	Software
1.1	February, 2001	First release	V109.0
1.2	August, 2001	Iss C daughter board	V109.2

2 UNPACKING THE UNIT

2.1 General

Unpack the unit with care, and check that all the parts have been supplied.

2.2 Parts list

- 1 x PANAX value controller (optionally with keypad and display).
- 1 x 3½in floppy disk (bootable), containing PANTERMV programme for personal computer.
- 1 x 15-way low density D plug and shell (for digital inputs).
- 1 x 9-way low density D socket and shell (for digital outputs).
- 2 x 15-way high density D plug and shell (for position encoder and servo drive).

2.3 Optional parts

Made up leads may be ordered as optional items:

- 1 x 15-way low density D plug and 2 metre lead (for digital inputs).
- 1 x 9-way low density D socket and 2 metre lead (for digital outputs).
- 2 x 15-way high density D plugs & 2 metre leads (for position encoder and servo drive).
- 1 x lead with 9-way low density D plug on one end and socket on the other (for serial comms).

3 INTRODUCTION

3.1 General Description

This document describes the connections and setup of the Pan Controls motion control system. The system may optionally have an keypad and vacuum flourescent display.

The system controls a servo drive and motor with position feedback. It monitors a second position channel, and provides a second auxiliary analogue output. The second position channel can be used as an input to the system. For example, the servo channel can follow the position encoder. The system may be set up with a Personal Computer, using software provided. Programmes can be developed on a personal computer, and downloaded to the controller. These can then be stored on the controller.

Digital control systems are not simple, but can be very useful when applied correctly. It is important to understand the basics of the operation of the system before it is installed on an expensive machine. The system is completely programmable in all aspects of its operation, and it is recommended that users carry out training to experiment to familiarise themselves with the facilities available. This is best done on an off-line test machine which is not directly linked into a production unit.

3.2 Specification

AC supply voltage :		
	Minimum	85 Volts
	Maximum	264 Volts
AC supply frequency :		
	Minimum	47 Hz
	Maximum	63 Hz
DC logic voltage :		
	Minimum	19 Volts
	Maximum	29 Volts
Serial link (diagnostic terminal):		
	Signal levels	RS-232
	Baud rate	9600
	Data format	8 data bits, 1 stop bit, even parity
Encoder output :		
	Power supply	5V DC @ 500ma
Encoder inputs :		
	Input impedance	6kΩ
	Input signal levels	+5V
	Input cycle rate	250 kHz max
	Track A input leads track B input for positive movement	
Command signal output :		
	Isolated output range	±10V
	Resolution	12 bits
Digital Inputs (isolated):		
	Input signal levels	+24V
	Input current	10 ma typical at selected input voltage
Digital Outputs (isolated NPN Darlington outputs):		
	Load current	100ma maximum
Relay contacts :		
	Rated load	1A 60V d.c. 0.3A 110V a.c. (resistive)
		0.5A 60V d.c. 0.2A 110V a.c. (inductive)
	Carry current 2A	
	Switch voltage max	60V d.c. 125V a.c.
	Switch current max	2A d.c. 1A a.c. (resistive)
		1A d.c. 0.5A a.c. (inductive)
	Switch power max	60W 60VA (resistive)
		30W 30VA (inductive)
	Inductive load power factor	0.4 max
	Contact resistance	50 mΩ max
Environmental:		
	Temperature	0° minimum
		50° maximum

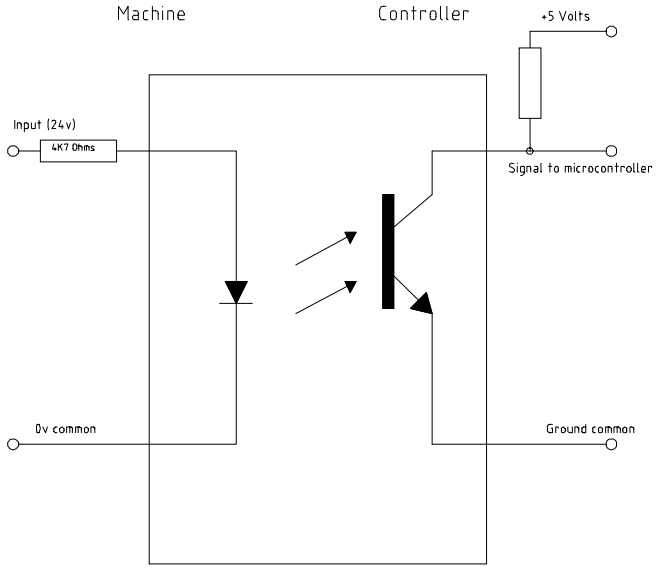
3.3 Status indication

Two LED's between the two 15-way miniature D-connectors indicate the following conditions:

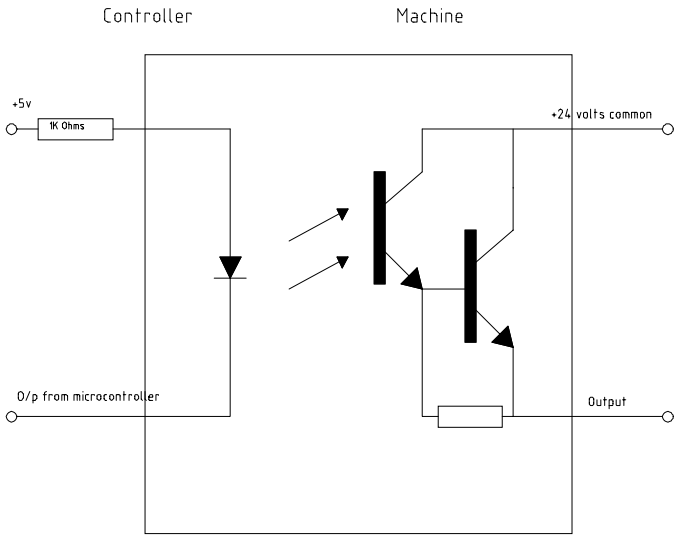
LED 1	Normal operation - flashes on and off at one second intervals.
LED 2	Normal operation - not illuminated. This LED is illuminated if the hardware watchdog timer has timed out.

3.4 Digital Input/Output Lines

The control system has fourteen isolated input and eight isolated output lines. Inputs may be programmed as a signal to execute a user-defined command sequence, or as limit switch inputs. Outputs may be controlled directly from command sequences if required. In addition, there is a dedicated error output line which may be programmed to give an indication of any serious system error condition. All the input lines indicate high if left unconnected.



Input circuit



Output circuit

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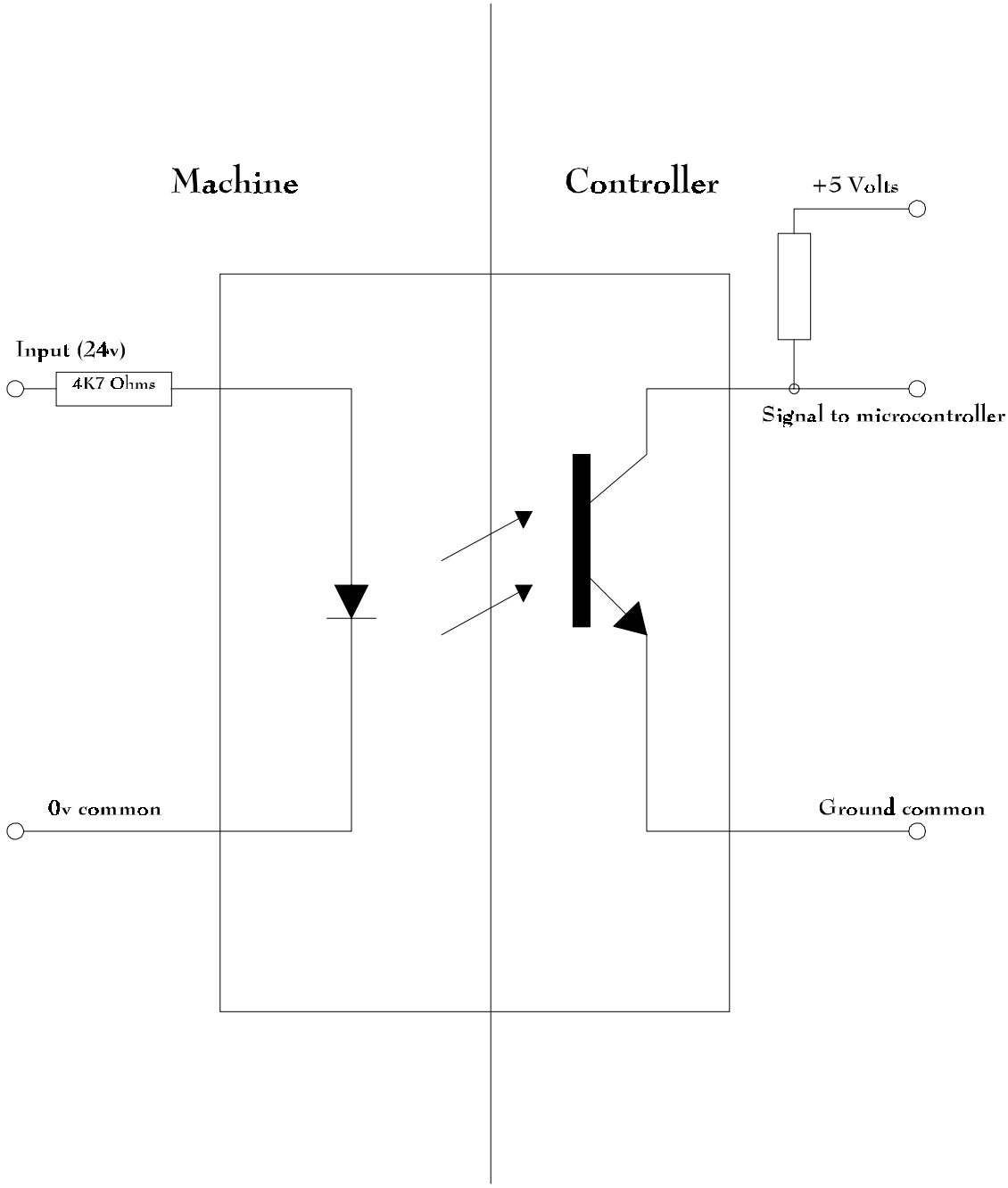
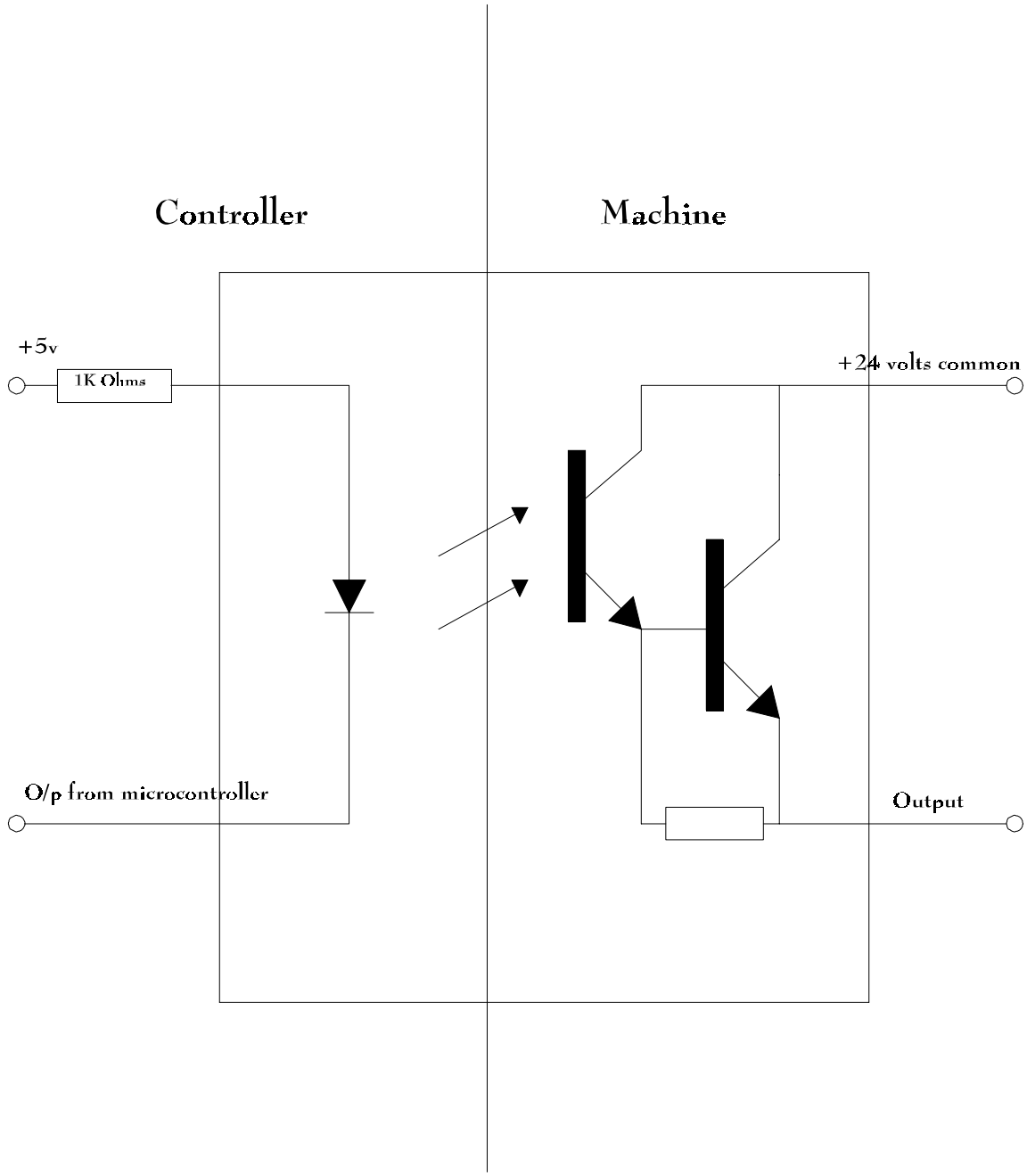
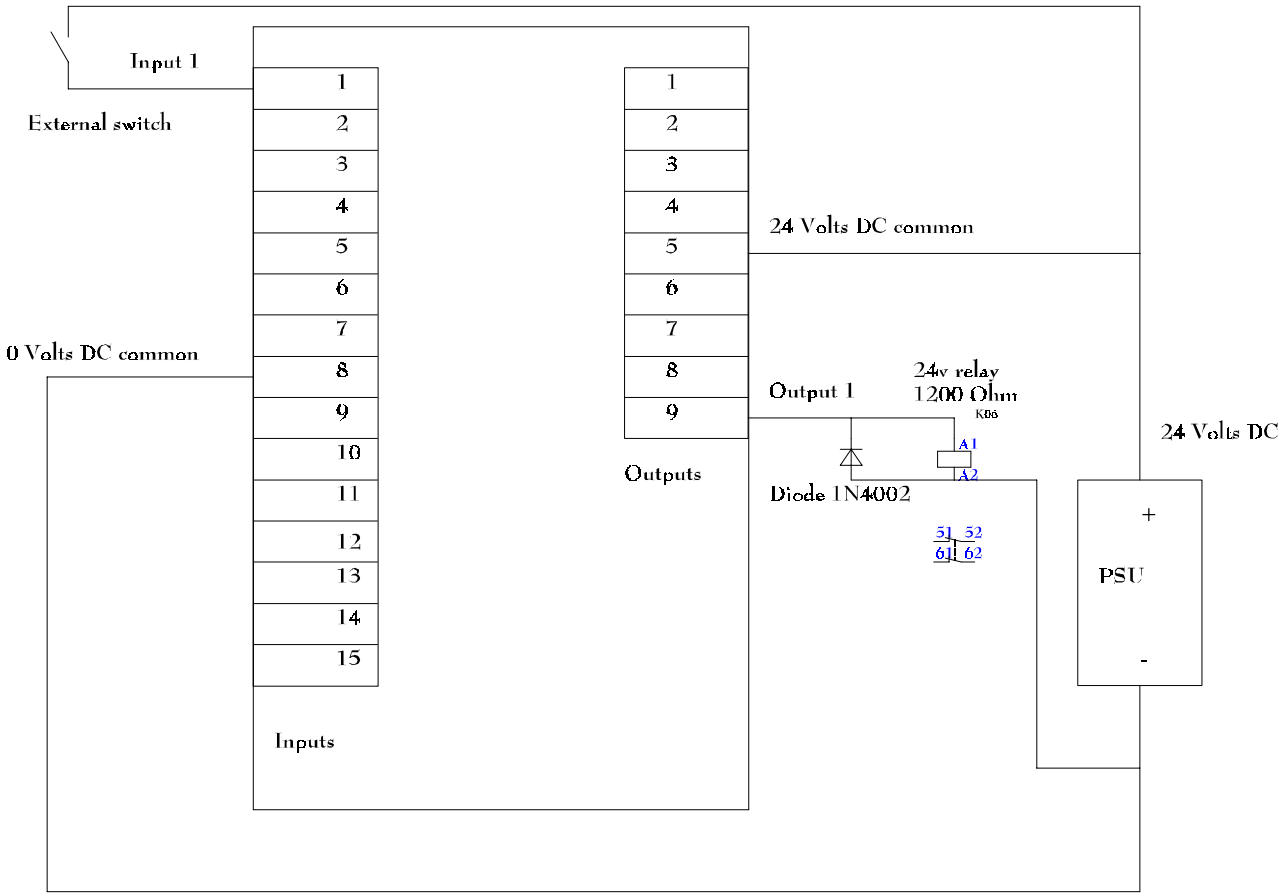


Input circuit



Output circuit

An example setup is shown below:



4 CONNECTORS

4.1 Connector 1. 15-way D connector (3 row), for position encoder, reference i/p, analogue o/p.

	Function	Input/output	Cable colour	
1	Encoder track A	Input	Brown	
2	Encoder track $\overline{A}$	Input	Yellow	
3	Encoder track B	Input	Red	
4	Encoder track $\overline{B}$	Input	Green	
5	Encoder track Z	Input	Blue	
6	No connection			
7	No connection			
8	Encoder power supply 0v	Output	Black	
9	Encoder power supply +ve	Output	White	
10	Encoder track $\overline{Z}$	Input	Orange	
11	Velocity signal	Output	Blue)	
12	No connection		)	
13	Velocity 0v (analogue ground)	Output	Green)	Black cable
14	Relay Common	Output	Red)	
15	Relay closed for normal operation	Output	Yellow)	

4.2 Connector 2. 15-way D connector (3 row), for position encoder, reference i/p, analogue o/p.

	Function	Input/output	Cable colour	
1	Aux encoder track A	Input	Brown	
2	Aux encoder track $\overline{A}$	Input	Yellow	
3	Aux encoder track B	Input	Red	
4	Aux encoder track $\overline{B}$	Input	Green	
5	Aux encoder track Z	Input	Blue	
6	No connection			
7	No connection			
8	Aux encoder power supply 0v	Output	Black	
9	Aux encoder power supply +ve	Output	White	
10	Aux encoder track $\overline{Z}$	Input	Orange	
11	Aux analogue signal	Output	Blue)	
12	No connection		)	
13	Analogue 0v (analogue ground)	Output	Green)	Black cable
14	Aux Relay Common	Output	Red)	
15	Aux Relay closed for normal operation	Output	Yellow)	

4.3 Connector 3. 15-way D socket. Isolated inputs.

Logical input number	Pin number	Cable colour
Input 1	1	Purple
Input 2	9	Blue
Input 3	2	Orange
Input 4	10	Green
Input 5	3	Brown
Input 6	11	Red
Input 7	4	Black
Input 8	12	Yellow
Input 9	5	White
Input 10	13	Pink
Input 11	6	Fawn
Input 12	14	Red/Yellow
Input 13	7	Red/Green
Input 14	15	Red/Black
Input common (0v)	8	Grey

4.4 Connector 4. 9-way D plug. Isolated outputs.

Logical output number	Pin number	Cable colour
Output 1	9	Purple
Output 2	4	Blue
Output 3	8	Orange
Output 4	3	Green
Output 5	7	Brown
Output 6	2	Red
Output 7	6	Black
Output 8	1	Yellow
Output common (24v DC)	5	White & Grey

4.5 Connector 5. 9-way D socket. RS-232 terminal connection.

1 Tx (data from controller)
2 Rx (data to controller)
3 No connection
4 No connection
5 Ground
6 No connection
7 No connection
8 No connection
9 No connection

4.6 Encoder inputs

The system is designed for use with digital incremental position encoders. These encoders provide two signals in quadrature (one is phase shifted by 90° relative to the other). The system can monitor these signals and determine both the direction and distance of any movement. The direction is defined by which signal leads the other. The normal definition for both channels is such that the track A encoder input leads the track B input for movement in the positive direction. The encoder inputs have differential input circuits for use with encoders with complementary output signals. The power supply for the encoders is derived from the VC1 controller.

The system generates four counts for each complete cycle of the input signals, such that an encoder with 1,000 counts per revolution is seen as generating 4,000 counts per revolution. The maximum count rate is 10^6 counts per second (1 MHz), giving a maximum encoder cycle rate of 250 kHz. On a 1000 line encoder, this is equivalent to a maximum speed of 250 revolutions per second, or 15,000 r.p.m.

The system relies on the position information from the incremental encoders, and any noise on the encoder signals can give rise to errors in the absolute position. Care must be taken in installation of the control module and the encoders to minimise any noise on the encoder signal lines. The encoder interfaces on the VC1 controller have differential input stages for use with encoders with complementary outputs, providing high rejection of common-mode noise. In addition, spurious signals on one encoder track produce both an up and a down count, and thus cancel out. However, in particularly electrically noisy environments it is still possible to get position counting errors. The system can be set up so that its position is continuously adjusted for any errors by using a repetitive reference signal to correct them. Without such facilities, such errors would otherwise be accumulated over long periods of continuous operation, unless the system was stopped at regular intervals to re-initialise the absolute position.

4.7 Demand outputs

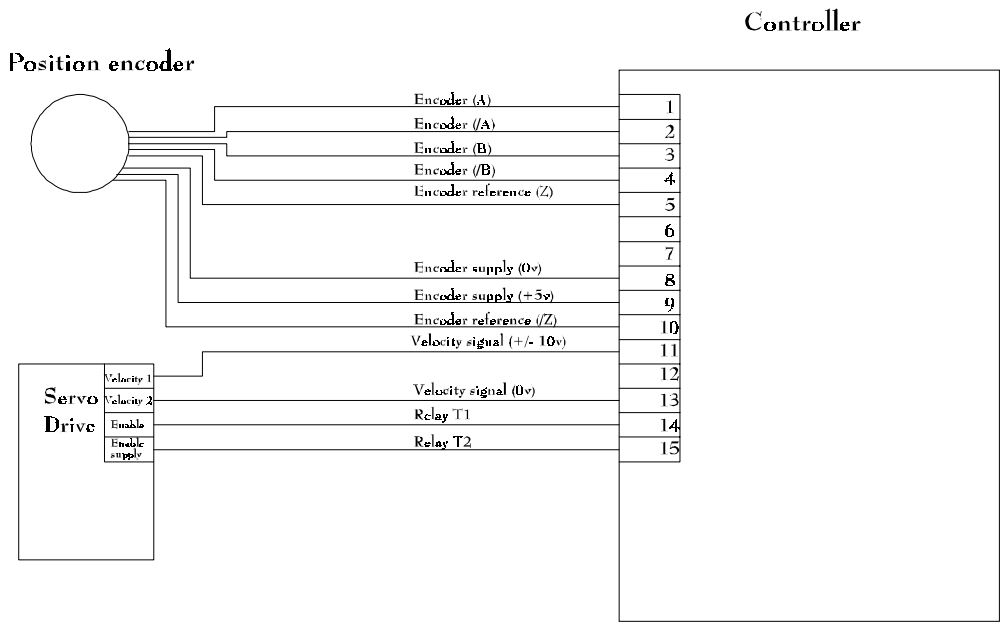
The demand outputs to the high power drives are analogue signals with a range of ±10V, at 12 bits resolution. These outputs are switched directly to 0V in the motor off state. The motor drives should be connected such that a positive demand output signal causes the motor to move in the positive direction. Screened cable should be used for the demand output.

4.8 Relay Contacts

The relays which switch the demand outputs to 0V in the motor off state have a spare set of contacts. These may be used to derive inhibit signals to the motor drives in the motor off state, or for example to switch a joystick onto a drive input to allow manual control of the motor.

4.9 Example connections to servo drive

An example of the connections to a servo drive system is shown below:



5 INSTALLATION

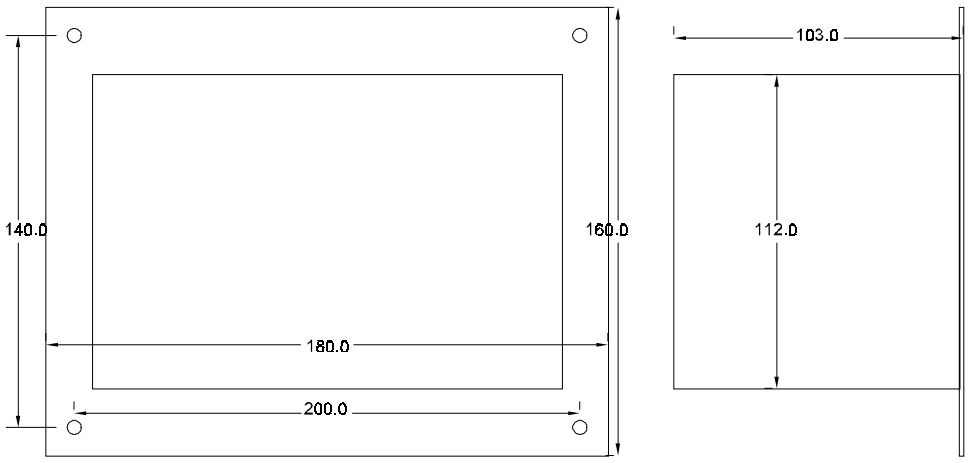
5.1 General

A successful system installation requires a properly engineered design with regard to details of system wiring, earthing, noise suppression, circuit protection, and conformance to local electrical codes, etc. It is necessary to mount the control system in a suitable cabinet.

5.2 Mechanical

5.2.1 Value controller without operator interface (VC1.N)

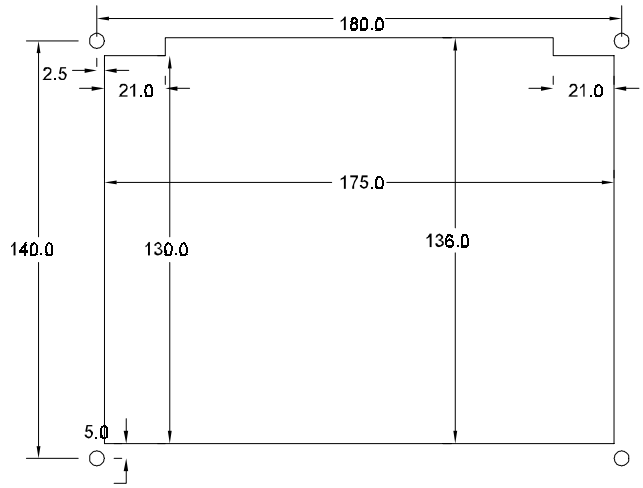
The VC1 controller without operator interface is designed for mounting onto a panel base plate. Mounting is by means of 4 x 5mm fixing holes.



Outline Dimensions

5.2.2 Value controller with operator interface (VC1.OI)

The VC1 controller without operator interface is designed for mounting onto a panel base plate. Mounting is by means of 4 x 5mm fixing holes.



Cutout - Value controller

5.3 Cooling

The control system has been designed to operate without fan cooling. However it should be placed at least 50mm away from hot devices such as transformers.

5.4 Circuit protection

The power supply to the VC1 motion controller should be protected by fuse or circuit breaker.

Recommended fuse or circuit breaker: 2 amps.

5.5 EMC Guidelines

The VC1 motion controller has been designed to be incorporated into part of a machine system. In order to function it requires a servo drive, motor, and position feedback. It can also be used in conjunction with other components such as programmable logic controllers (PLC).

The EMC performance of the VC1 motion controller is inextricably linked with the overall EMC performance of both the other components and the way in which the system is assembled. To ensure that the overall system meets the appropriate harmonized standard for EMC emissions and immunity (e.g. EN 50081-2 for emissions and EN 50082-2 for immunity), the system builder must pay particular attention to the way in which the system is constructed. The following guidelines should assist in the production of a system which complies with the regulations.

5.5.1 Earthing

- The system must conform to local electrical codes regarding earthing.
- Use earth conductors with the largest possible cross-sectional areas.
- Keep all earth connections as short as possible.

5.5.2 Filtering

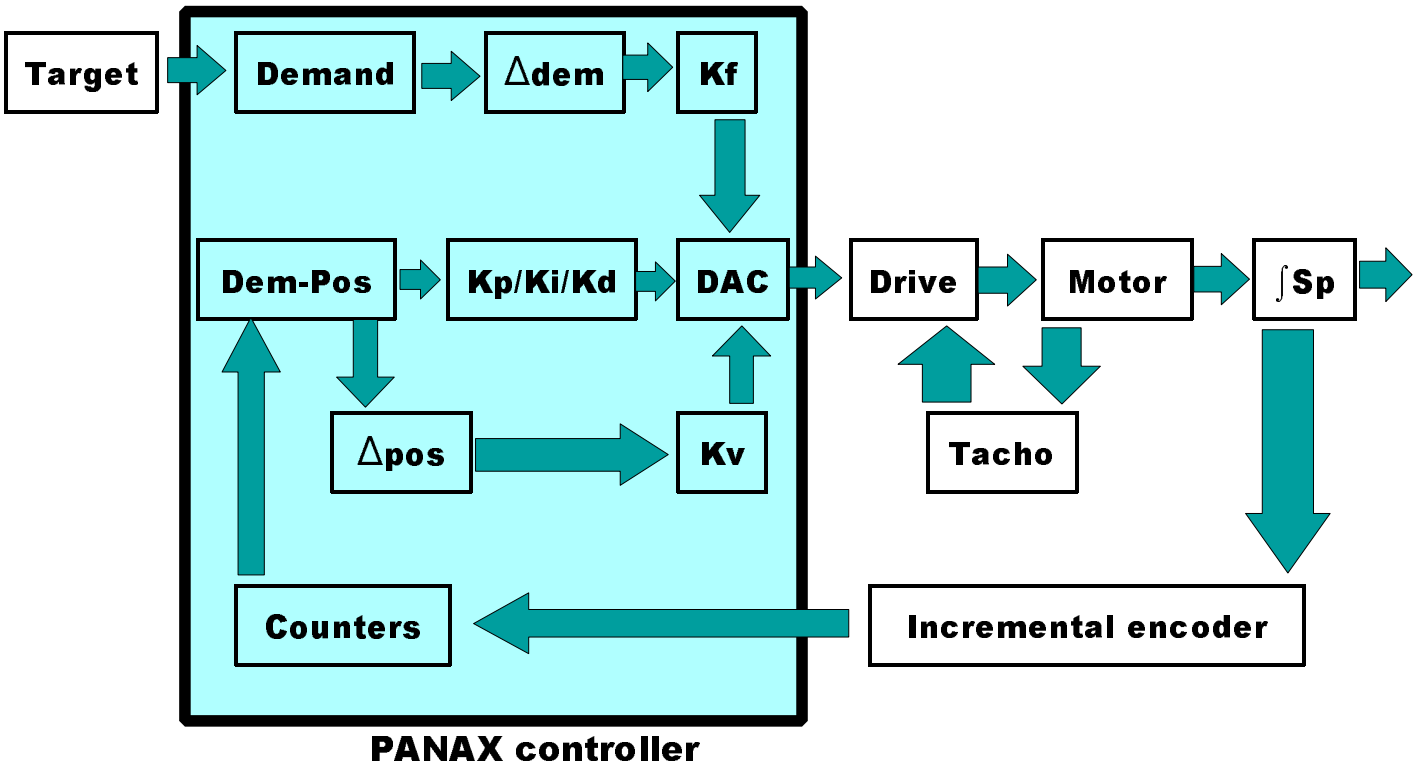
- The use of a high performance mains filter can greatly reduce the conducted emissions seen on the power lines.
- It should be noted that the earth currents flowing due to the filter capacitors may prevent the use of RCD protection devices.

5.5.3 Screening

- Analogue signal wires should use screened cable wherever possible. The screen should be connected at one end (preferably the controller end

6 SETTING UP THE CONTROLLER

The control systems consists of several elements, each of which should be tested separately before putting the whole system together.



6.1 Servo drive and motor

The servo drive and motor should first be set up independently of the PANAX controller, in accordance with the manufacturers instructions. It should be tested for velocity control using a ±10v DC supply. A positive voltage should result in a velocity in one direction, and a negative voltage will cause the motor to turn in the other direction.

6.1.1 Drive enable circuit

Most drive units have an enable circuit which allows a fail safe system to be wired into a machine. For example the enable circuit could be wired through a safety cover switch; when the cover is opened, so does the switch (i.e. "fail safe").

The PANAX controllers all have on board safety relays. Whenever there is a system error (e.g. following error, time out error, etc) the relay de-energises. This automatically puts zero volts onto the drive velocity signal. However there are a set of spare relay contacts which are available on pins 14 and 15 of the miniature 15-way D-connector. These are open when the system is in the "motor off" state (i.e. when the terminal sends a ":" prompt), and closed when the drive is under position control. It is suggested that the drive enable circuit is wired through these relay contacts.

6.2 Communication with a Personal Computer

A 9-pin lead to connect an asynchronous serial port of a personal computer to the serial port of the controller (9-pin male connector).

The PANTERMV programme should be installed on a personal computer. This runs under an MS-DOS shell. When the PANTERMV starts, it enters a terminal emulation mode. If the PANAX controller is then switched on (having previously been connected to the PC), it should send a startup message to the PC. Anything typed on the keyboard should be echoed back to the PC, and basic commands can be executed.

Example:

System	User	Comments
:	DP?↵	Request help on DP
DP Return current position		Single line help

Note that the floppy disk supplied is bootable. If the PC BIOS is set to that it tries to boot from a floppy disk first, it will automatically start the PANTERMV programme.

6.3 Incremental position encoder

The incremental encoder derives its power (5v DC) from the control system. Note that the controller requires complementary signals (at RS-422 levels) to reduce common mode noise. Having setup a personal computer to communicate with the controller, switch the controller off and connect the encoder lead to the miniature 15-way D connector. Plug this in to the socked marked "main" and switch the unit on. Type DP↵, and note the current measured position. Turn the encoder clockwise by one turn, and check that the reading has turned by the expected number of counts. Now rotate the encoder anti-clockwise by 2 turns and check the reading. Be aware of the fact that the controller defaults to using positive positions only. As a consequence, if the encoder turns negatively from position 0, it will wrap to the currently set bound position (default of 4,000,000).

6.4 Complete servo loop

Assuming that the encoder and drive system are functioning, it is now possible to connect all the components for closed loop control. It is important at this stage that the motor is not connected to anything which could be damaged by it running off out of control (e.g. ball screws etc).

After switching on the controller, a startup banner will appear on the screen, and after the internal SRAM test a full colon (:) will appear. This indicates that the system is in the "motor off" state. Type in PC↵. Either the motor will lock in a stationary position, or it will run off out of control before the onboard error detector sends a zero voltage to the controller (and disables it if the disable circuit is wired through the relays, see section 5.2.1, 5.2.2, 6.1.1). The system will have ended up in the “motor off” state. If you type in LE↵ (last error), it will display the cause of the motor running out of control.

If the system runs off out of control, then the sense of the position feedback is likely to be reversed. The system has a built in password protection for critical commands. It is now necessary to enter the privileged mode: PM↵. It will ask for a password, and the unit is shipped with a null password, so enter ↵ again. The system should respond with “OK”. The quickest way to correct the motor runaway is to use the Reverse Encoder command: type in RE↵. Now enter PC↵; the motor should now be stationary and under control.

If the motor is oscillating violently, then it is likely that the system gain is too high. Enter KP↵, and the system will respond with the current value of proportional gain, followed by a question mark. This allows the user to

enter a new value followed by ↵, or to enter a ↵ only (leaving the previous value intact). Carry on reducing the KP value until the motor stops oscillating.

It is now possible to test moving the motor: enter MR4000↵. The motor should move 4000 encoder counts. Note that quadrature signal increases the resolution of the encoder by a factor of 4. For example a 1000 line encoder will result in 4000 counts per revolution.

If there are reference pulses from the encoder, this can now be tested. Enter DZ1↵ to define the zero marker input on. Now enter IN+↵. The motor should turn in the positive direction until the controller sees the reference pulse. The internal counters are instantly set to zero, and the motor decelerates and moves back to the zero point.

6.5 Digital inputs

Start the test by using a 24v DC external source. Using the 15 pin low density D plug, apply the common 0v to pin 8, and switch 24v on and off to pin 1. With 24v applied, type RI1↵. The logic is the reverse of the voltage, so that the controller should respond with a 0. Likewise, with the 24v removed, the controller should respond with a 1.

6.6 Digital outputs

Apply Start the test by using a 24v DC external source. Using the 9 pin low density D socket, apply the common 24v to pin 5. Now read the output on pin 9 - this should read 0v. Now type CO1↵, and pin 9 should have 24v present. Note that the current available from the output drivers is limited to 100ma. It is possible to drive small relays (e.g. RS part number 351-588), provided that the driver is protected with a diode (e.g. type 1N4002, RS part number 261-1540). If a relay is driven without diode protection, large inductive switching voltages are generated which can destroy the output of the optocouplers.

7 PROGRAMMING EXAMPLES

7.1 Escape key sequence

The controller will start sequence 32 when power is applied. This displays various messages on the screen, and enables various keys. The escape key is programmed to execute sequence 32, which aborts any current activity, and then starts sequence 32 again. This approach can be used to ensure that the ESC key always takes the operator back to the same known point.

```
AS32        # Start sequence 32 when power is applied

# Escape key sequence
ES20
AB/XS32

# Start screen
ES32
ABK                                                     #Abort keypad activity
GS          #Stop any keypad waits
MI #/EI11/EI12  #Mask all inputs
MK                                                      #Mask all softkeys
EK12/EK19/EK28/EK35                                     #Enable F1 to F4 softkeys
MD          #Clear display & address each line
MD1"F1 - CONTINUOUS DRAW"
MD2"F2 - RUN MODE       "
MD3"F3 - EDIT RUN DATA  "
MD4"F4 - DIAGNOSTICS    "
SKA34           #F1 key executes seq 34 Continous Draw mode
SKB35           #F2     ditto       35                  Run mode
SKC40           #F3     ditto       40                  Edit Run mode
SKD50           #F4     ditto       50 Diagnostic Mode
SKE101          #F5     ditto       101 Clear Alarm
SKL20           #ESC    ditto       20
EK/MK13                                                 #Enable 'F' keys Mask knife
SK0

#
```

7.2 Interaction with machine signals

Input line 10 is used as a signal which has to go high, and then low for sequence 102 to be completed.

```
# Transfer Conveyor. This sequence will move the conveyor a set distance to help with
# the stacking of the bags that are being made.
ES102
OC1/WT128/OC0                                           #Start transfer pulse
WI10+           #Wait for TRANSFER COMPLETE signal to go high
WI10-           #Wait for TRANSFER COMPLETE signal to go low
```


7.3 Uploading programmes

This is a quick introduction to the PANTERM programme. This allows terminal emulation, and uploading of programmes developed using a standard editor. It runs under DOS or a DOS shell under windows. It requires an asynchronous serial port at RS-232 level. A suitable serial lead is supplied with the PANAX Value controller. There is an associated configuration file, panterm*.cfg, which contains information such as serial port, editor, etc. PANTERMV is the PANTERM programme which sets up a configuration file suitable for the Value controller.

The default editor is named "edit". This allows a programme consisting of a standard text file to be created.

8 INDEX

