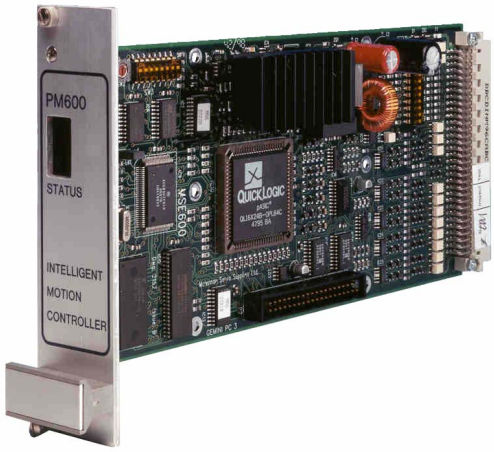
# Digital servo motor controller PM1000 (Provisional Data)

A fundamental feature of the PM1000 controller is the motion control algorithm developed to meet the most demanding accuracy requirements enabling precise motor control to be obtained.




Unlike many other motion controllers the processor is used to control the motion of a single motor rather than being required to manage simultaneous motion of a multi-axis system. Since the controller only has one motion to supervise it is able to achieve much tighter loop control resulting in near zero error. This, combined with the digital loop algorithm results in greater smoothness, stability and positional accuracy, even when remotely mounted high resolution encoding is employed. Where the sequential control of two axes is required however, a single PM1000 may be used to control both motors. The compact size and low unit cost of the PM1000 ensures that even where the control of multi-axis systems is required the PM1000 remains a space efficient and economic solution. In such systems the required number of controllers are simply linked together thereby providing the ultimate flexibility and maximum up-grade potential.

## Major motion control features

- **100% Reverse compatibility with the previous PM600 controllers**
- Analogue output to control servo motors using digital loop for increased accuracy.
- Digital output for use with stepper & digital servo drives
- Auto-tune and self optimisation of servo constants
- Digital control with maximum operating speeds $\geq$ 409,600 counts/sec. for use with 6,000 rpm servo motors equipped high resolution encoder or resolver feedback.
- Maximum acceleration rate $\geq$ 20,480,000 cps./s for 20 msec. motor time constant
- Programmable base speed and independent creep/distance to target position
- Maximum positioning range $\pm$ 2,000 Million counts
- Programmable application functions include:
- Stable positioning using direct monitoring of high resolution encoders equate to rotary resolutions and repeatability of 0.05 milli degrees or linear resolutions of 0.1µm.
- Alternative constant velocity operation
- Electronic gearbox
- Electronic cam
- Flying shears
- $1^1/_2$ axis to control 2 servo axes sequentially.

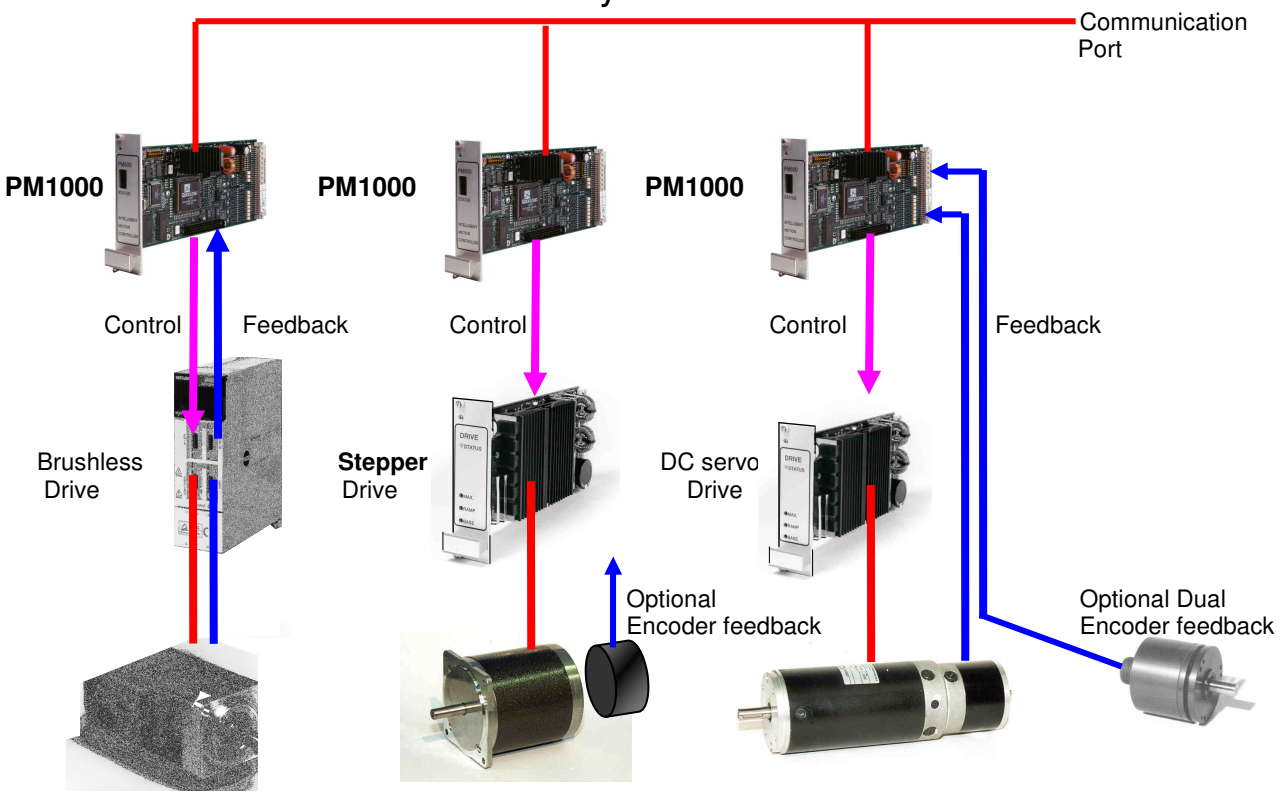
### Programmable I/O

- User definable programmable optically isolated 16 digital I/O
- Analogue I/O for use with load cells, temperature and volumetric transducers etc.
- Manual jog inputs with programmable jog, slow and fast rate control and optional joystick interface
- Direction sensitive limits
- Datum inputs for accurate zero positioning
- Emergency stop input

### Communication & Programming

- Multi Axis communication
- Choice of: RS232 daisy chain or RS485 multi-drop link
- Optional local display panel of position or speed
- Simple control language needs no additional software
- Standard screen editor for developing motion programme
- Multi-sequence capability for off-line operation

*PM1000 :* One controller for any motor

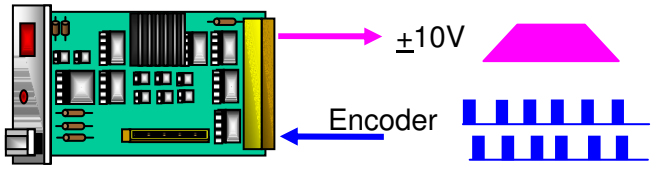



*AC Brushless Servo* *Stepper motor* *dc servo motor*

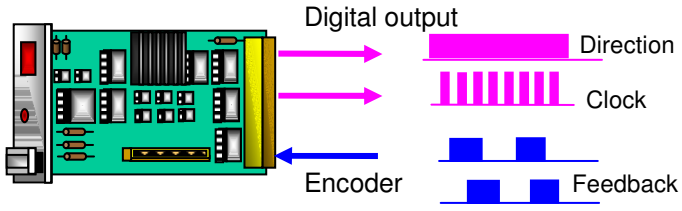
## Choice of output signals

PM1000 provides an analogue output control conventional servo motor requiring a ± 10V control signal, the amplifier being either configured for torque
In this form position feedback is derived dual track encoder fitted to servo

Either a dual track encoder providing differential output signals may be

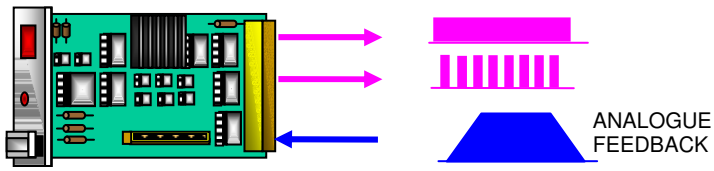



As an alternative the PM1000 provides as digital output for use with stepper or digital servo drives. In this mode encoder feedback is optional depending on whether an open or closed loop system is required.




It will be noted that the PM1000 monitors the leading and trailing edge of each encoder pulse to provide a x4 multiplication of each pulse cycle. Therefore by using a 500 ppr encoder a resolution of 2000 steps/rev is obtained.

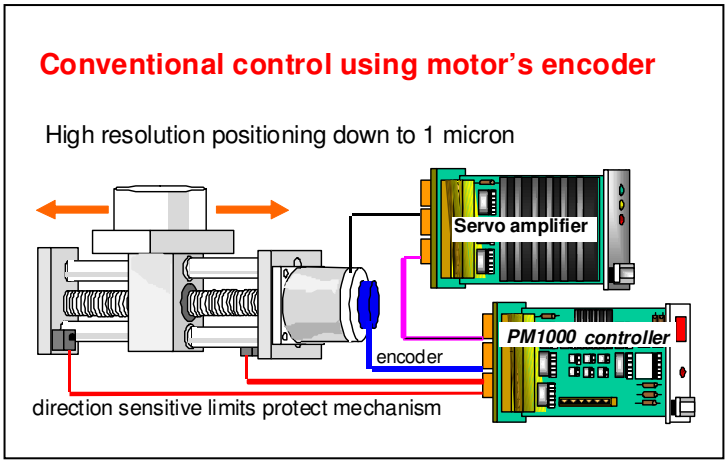
In applications that utilise an analogue feedback transducer such as an LVDT this can be connected to an analogue input port of the PM1000, configured to provide either analogue our digital output control signals




Other analogue feedback devices that can be employed include load cells and volumetric transducers.

## PM1000 controller major features

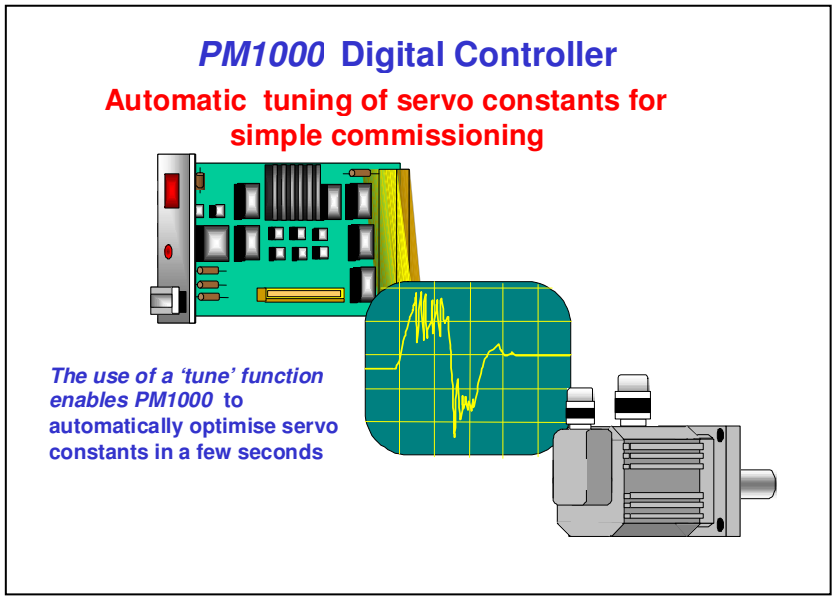
## High accuracy positioning




The Digiloop controller is an ideal high accuracy positioner for use with modern servo systems. It enables very high accuracy combined with fast response to be obtained. Standard features include datum signal inputs and directional sensitive limits to protect the driven mechanism against an over-travel condition. Software limits are also provided to eliminate possible programming errors.

## *PM1000* simplified commissioning

When high accuracy positioning of servo driven mechanisms is required it is important to be able to optimise servo loop constants. This can prove difficult for users who are not experts in servo technology. PM1000 simplifies set-up difficulties by providing two stages of self-tune.



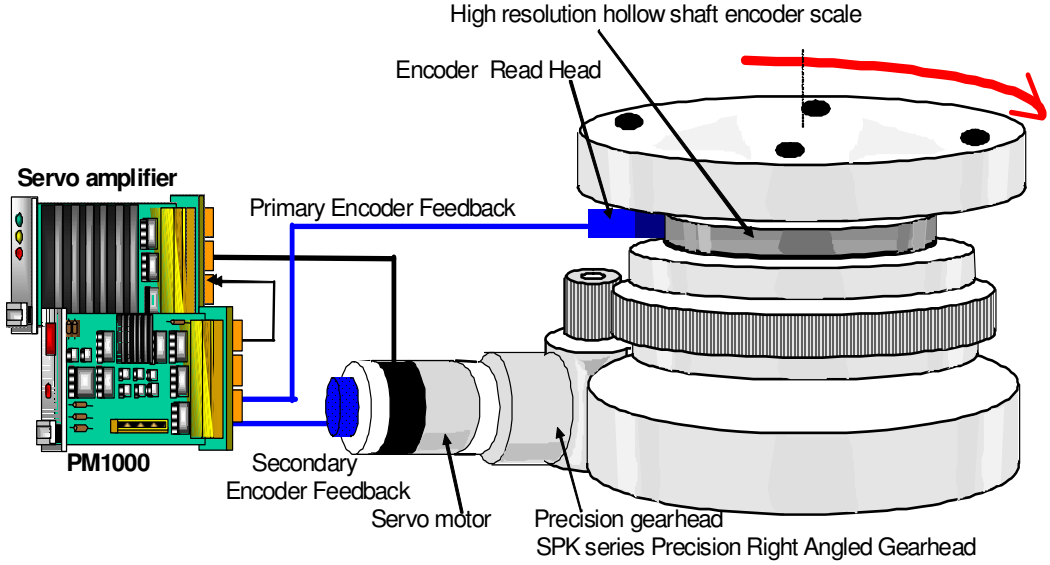
# *PM1000 controller using dual encoder feedback*

## Improved accuracy and stability using dual encoder feedback

When high accuracy positioning is required high resolution encoders can be mounted directly on the output of the driven mechanism. However, compliance and backlash in the transmission system can lead to instability which may require a deadband and reduced positioning velocity in order to maintain stable operation. The dual encoder system damps instability and enables the deadband to be eliminated and increased positioning velocity to be achieved.

Using this technique a positioning accuracy of 1 arc second and repeatability of better than 0.25 arc seconds have been achieved.

# Precision rotary table drive using dual encoder feedback




# multi-axis synchronised drives using *PM1000*

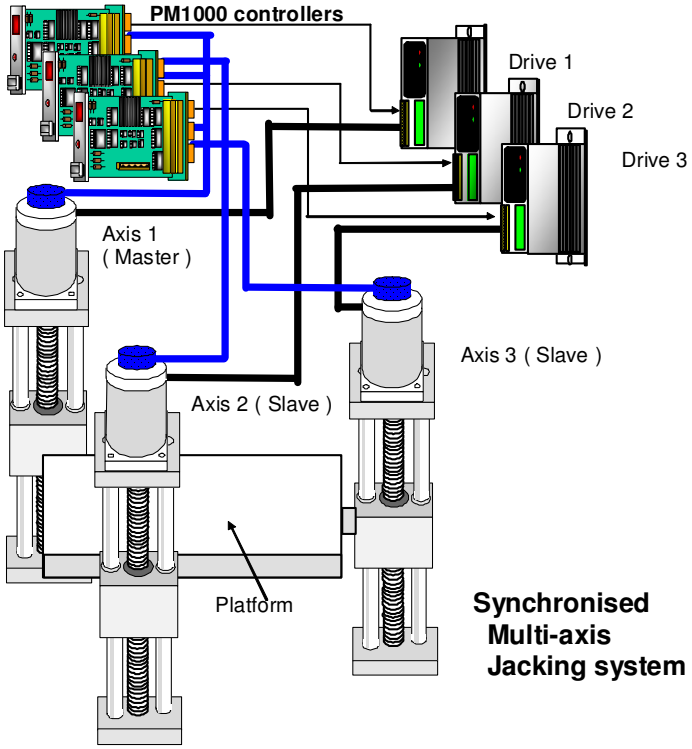
PM1000 controllers may be used In applications which require several axes to be synchronised by using the dual encoder input facility.

The example shown is a three axis jack used to raise and lower an experimental platform. Systems of this type have been successfully employed world-wide raising and lowering loads up to 1000 kg. with accuracy of better than 1 µm.

For parallel lift, axis 1 acts as a master, it's encoder being fed to each controller. The Digiloop's controlling axes 2 & 3 operate in 'Electronic gearbox mode' and track the motion of axis 1 to provide synchronised motion.

When the platform is to be tilted all controllers are set in positioning mode and operate independently to produce the degree of tilt required.

Once this is achieved axis 2 & 3 controllers may be re-set in 'Gearbox mode' to provide synchronised platform motion while maintaining the new tilt angle.

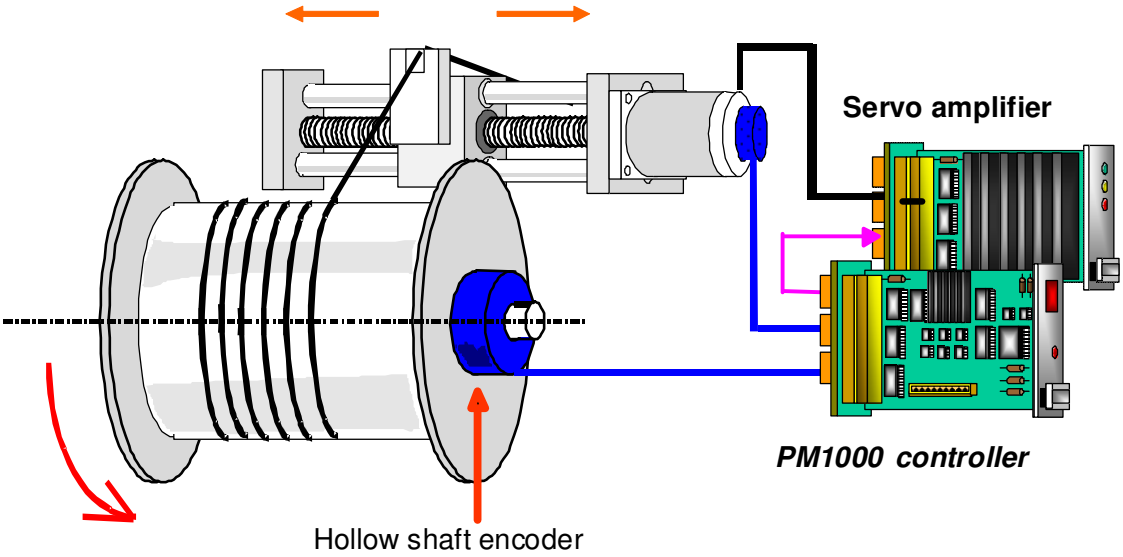



**Synchronised Multi-axis Jacking system**

# *PM1000* using dual encoder feedback & variable ratios

The use of 'electronic gearbox' is so called because it enables a *digiloop* controlled axis to be slaved to another axis of motion with a variable ratio. The ratio is entered as a nominator and denominator value, each being selectable from 1 to 32,000. This enables a different number of encoder counts on the master and slave axes to be accommodated and synchronised motion to be realised.

## *PM1000* using dual encoders with electronic gearbox for coil winding

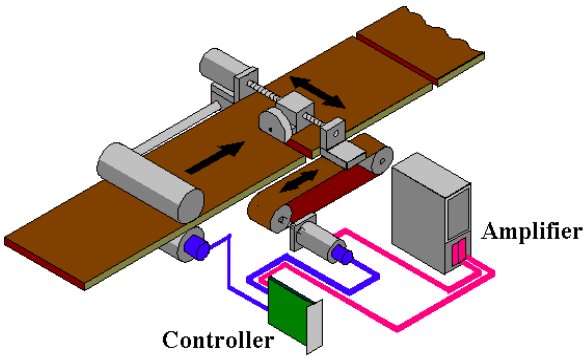



In this arrangement the PM1000 controller monitors the rotation of a driven cable drum by means of an encoder.
PM1000 controls the movement of a traverse unit so that it advances one cable pitch for each rotation of the drum. By synchronising the output of the driven motor's slave encoder to that of the master encoder the desired pitch is obtained by setting the appropriate pulse count ratio between the two encoders. The controller may be programmed so that automatic reversals occur at each end of the drum. When a cable of a different diameter is to be wound onto the drum the electronic gear ratio can be re-programmed so that the traverse distance of the traverse mechanism per revolution of the drum is the correct value.

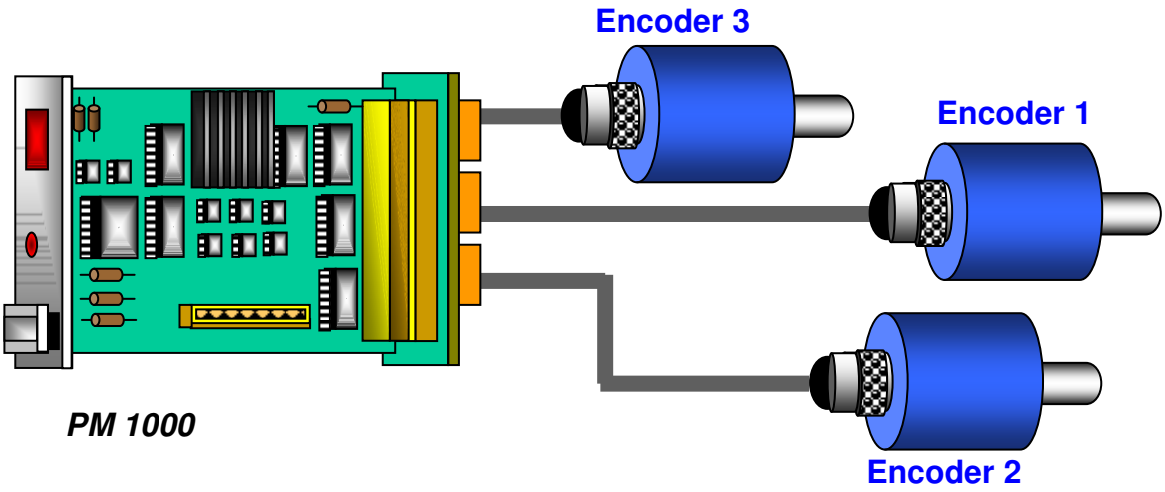
## *PM1000* using dual encoders with electronic cam for flying shears.

A variable electronic gear ratio can be programmed in the PM1000 controller if required. This is referred to as 'Electronic Cam'. This technique can be employed in applications such as flying shears.

Using an encoder connected to the drive wheels of a sheet feed mechanism the travel distance of the sheet is monitored by controller. By programming a cam profile, the motion of the traverse mechanism on which the cutter is mounted can be synchronised to that of the sheet once a required length of material has passed.
Once synchronised, the cutter can be driven across the sheet to produce a straight cut at right angles while the sheet is being fed through the feeder. If a different length of sheet is required the digiloop programme can be modified accordingly. The only limitations to the length of material that can be cut is the travel length of the traverse support mechanism, cutter traverse speed and the response capability of the drive motor.

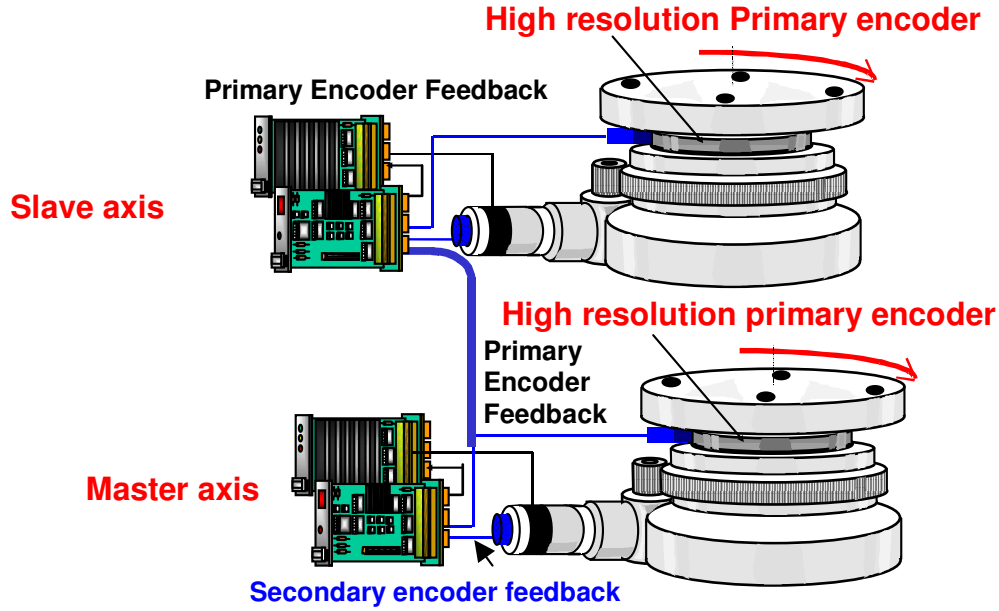


# Triple encoder feedback for synchronised drives using dual encoder feedback




A unique capability of the PM1000 is the ability to monitor three encoder inputs on one drive axis.
This enables two encoders to be used for the classical master-slave synchronisation function with the third encoder being used for the dual encoder stabilisation technique. This is a major operating advantage where master-slave operation at very high resolution is required.

# Synchronisation of high resolution systems




In the above example the slave axis requires three encoder inputs.
The primary encoder of axis 1 acts as the master
The primary encoder of axis 2 acts as the slave
The secondary encoder on axis 2 is used for digital damping of the mechanism

When using dual encoder feedback the PM1000 should be configured to provide a $\pm$ 10V analogue output to control the drive unit. The control capabilities of dual encoder systems is therefore only available with AC or DC servo motors

# PM1000 controller motion sequences

A number of sequences may be pre-programmed to enable repetitive movement cycles to be memorised within the PM1000 controller. These sequences can include responses which are conditional to input line status as well as sending signals to the controller's output lines.
The desired response to signals received on the input lines may be programmed by the user in a variety of ways. Conditional responses include:

wait commands — used to make the execution of the next step in the programme conditional on an input line state. This command may also be used to switch on an output line on completion of a movement.

'skip next' commands — are used to jump a line in the sequence if a given combination of input signals is detected. Since a sequence may contain other sub-sequences the controller user may arrange a master sequence that enables input lines to be used to initiate a number of routines such as a start-up cycle on power-on.

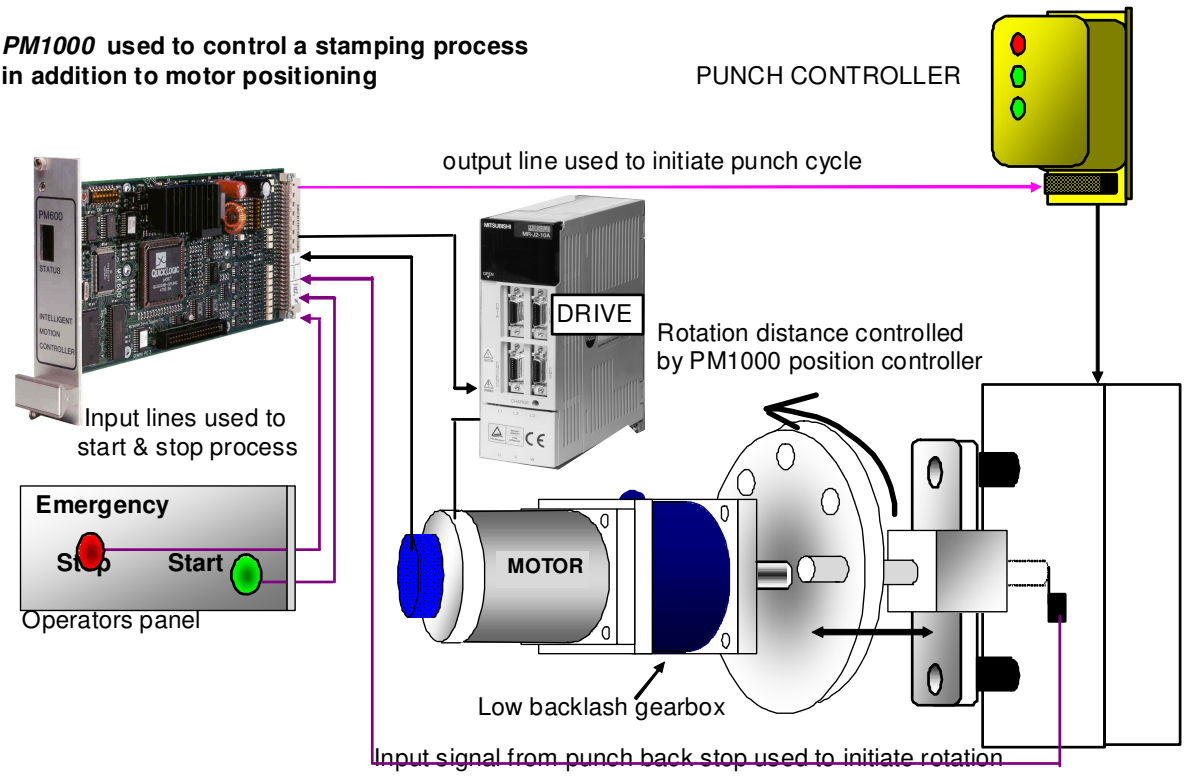
## digital I / O

Each controller is provided with 8 optically isolated output and 8 input lines which may be programmed by the user to enable the controller to be integrated with other machine functions.

When used as part of a sequence these I/O may be used to control a variety of conditional responses depending on the state of the I/O signal lines. Since each controller is provided with a total of 16 I/O, the use of several controllers in a multi-axis system will result in a large number of I/O lines being available. For example, a six axis system requiring 3 axes of simultaneous motion will utilise three controllers when 24 output and 24 input lines will be available. In many cases therefore PM1000 will provide sufficient control so that a separate PLC will not be necessary.
Since these user-definable I/O lines are in addition to dedicated signal lines used for datum & limit inputs etc. total freedom is provided to employ them to monitor application specific process signals.

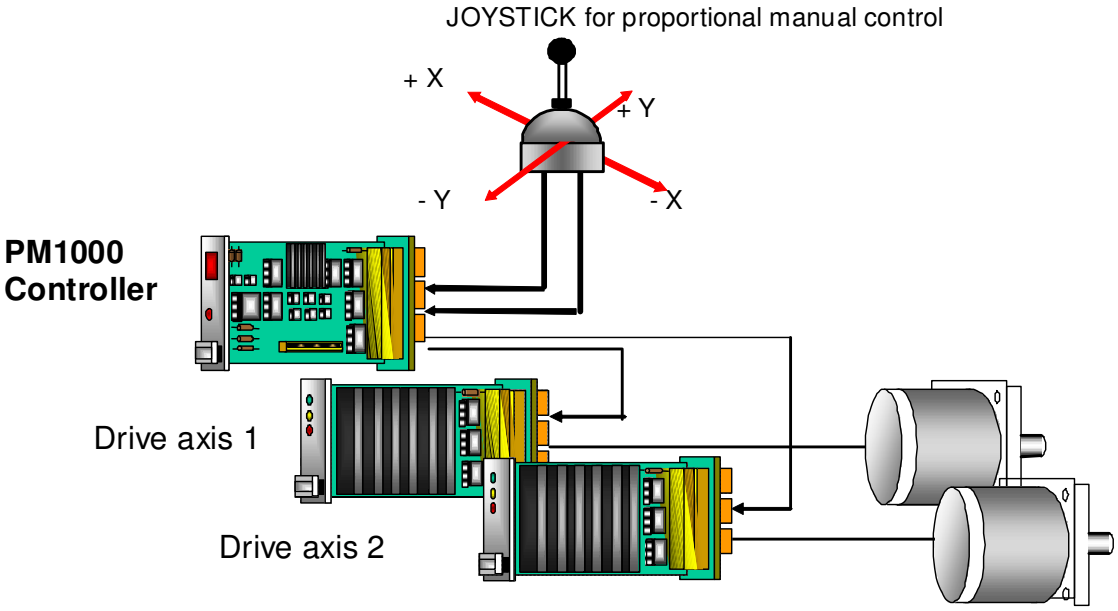
# using digital I/O in a motion control sequence

***PM1000* used to control a stamping process in addition to motor positioning**



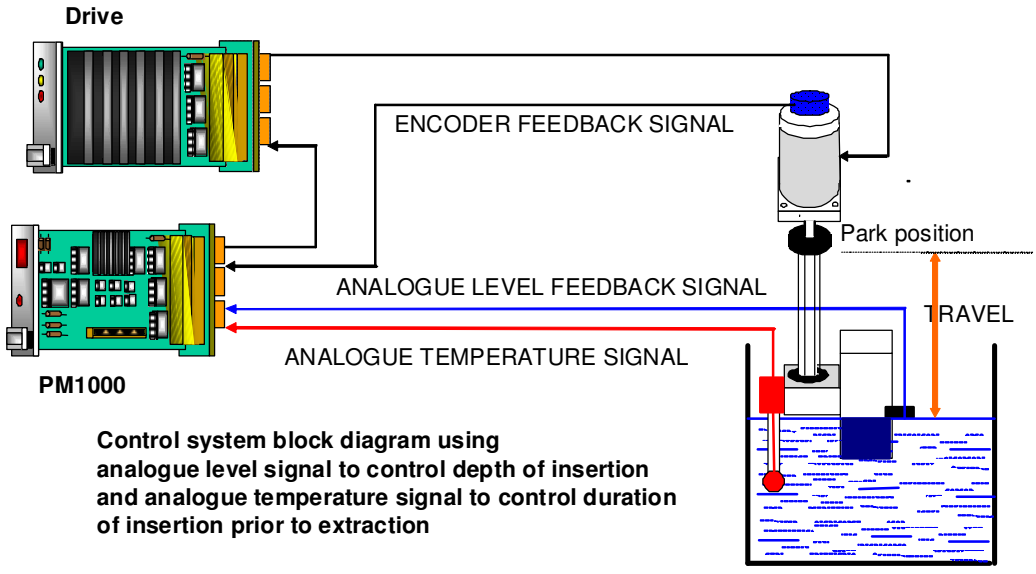
In addition to the optically isolated digital I/O, PM1000 is provided with 4 programmable Bi-polar analogue inputs that will accept input signals up to ± 10V. These may be further scaled to accept different signal levels, for example 0-5V, so that maximum resolution of the signal can be achieved.
Examples of how the analogue inputs can be used are shown below:

## using 2 analogue inputs for manual joystick control




## using analogue inputs for process control

The analogue input signals may be used to control a manufacturing process. The monitoring of these signals can be combined with movement demands within a sequence for operation off-line from the host controller. As an example, the programmed insertion distance for a product to be dipped into a hot fluid can be controlled using an analogue level sensor to ensuring that the insertion depth remains constant. A second temperature sensor fitted to the product carrier could be used to instigate the retraction from the fluid once the desired product temperature has been reached.



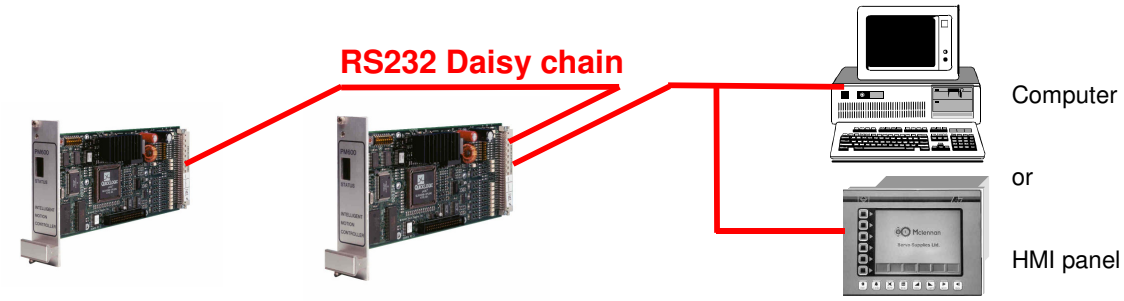

**Control system block diagram using analogue level signal to control depth of insertion and analogue temperature signal to control duration of insertion prior to extraction**

# *PM1000* controller choice of communication

The PM1000 controller is designed for use with a host computer or an HMI panel, communication in real time being via an RS232 daisy chain to provide multi-axis communication. Alternatively other interfaces may be specified such as RS485 may be specified. Up to 99 controllers can be interfaced using a single port

## Communication via RS232 daisy chain

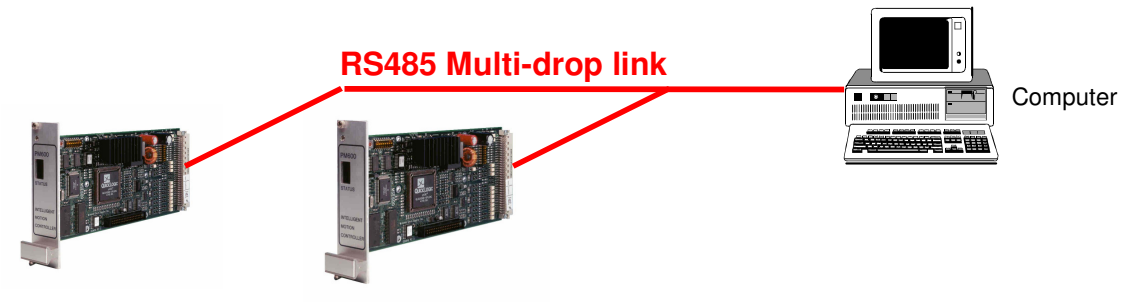
The RS232 daisy chain is a convenient means of communicating with the PM1000 when a PC is employed. Also, the increased availability of hand held and lap-top computers with an RS232 interface facility makes this an ideal means of communicating with up to 99 PM1000 controlled axes.




## Alternative communication options RS485 interface

*PM1000* controller options include an RS485 Multi-drop link which has a number of operating advantages in industrial control systems including:

- Differential signal line for improved noise immunity
- Parallel multi-drop communication up to 99 axes providing
- Improved system reliability
- Reduced communication time



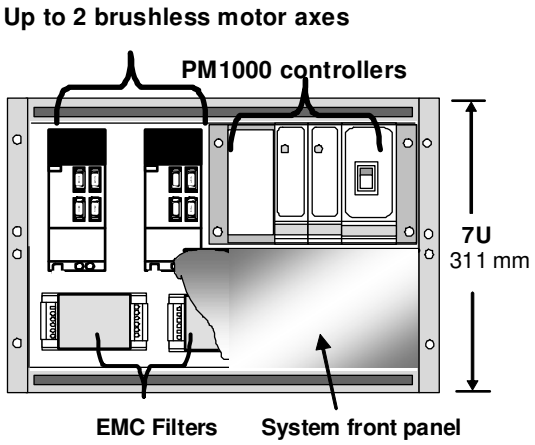
# PM1000 typical system integration

PM1000 series system control packages are based on 'in-service proven' modular technology. The units may be purchased in modular form for integration in customer systems or as pre-wired crates prepared to meet current EMC legislation. Mclennan's modular philosophy provides flexibility and a wide range of customer choices.

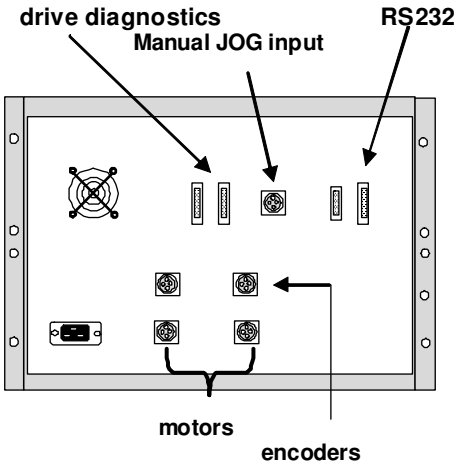
Base on maximum crate density the following packages are available with integrated power supplies for direct connection to a single phase AC supply.

## AC Brushless servo motor systems

Front panel layout

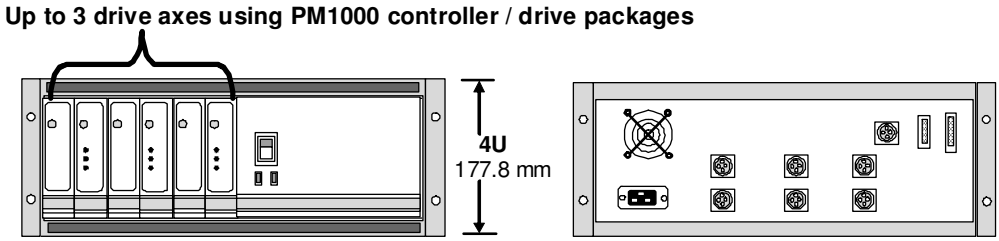



Typical Rear panel connections




Using PM1000 other motor technologies can be used in multi-axis systems in conjunction with AC servo drives to provide an optimum drive solution for the application. Typical installations using dc servo and stepper motors are shown below:

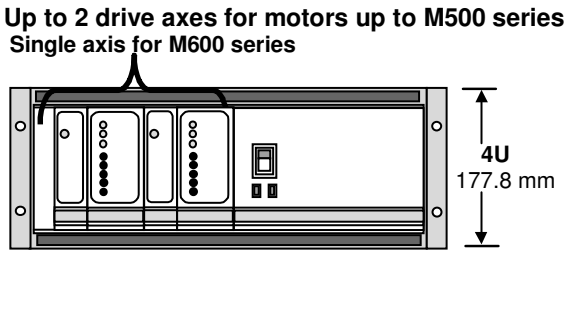
### Stepper motor systems



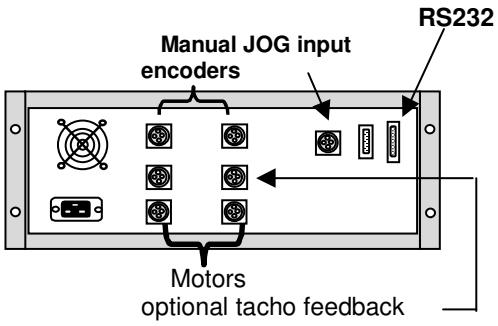

Where additional axis are required further crates may be interconnected Systems requiring up to 6 axis are supplied in 7U high Eurocrates.

## dc servo motor systems

Front panel layout




Typical Rear panel connections




Where additional axis are required further crates may be interconnected Systems requiring up to 4 axis are supplied in 7U high Eurocrates.