6-3 MECHANICAL DRIVE SYSTEM

Referring to Fig 6.11, the drive system can be divided into three constituent parts:

- The rotate drive.
- The traverse drive.
- The PIC17C42 controller on the Machine Controller PCB in the PC.

The complete scanner mechanical drive system is assembled on a removable casting, which is attached into the base frame assembly by four anti-vibration rubber mounting bushes. The drum is vertically mounted and inclined backwards at an angle of 15° on 350i/355i, optimising the drum fitting procedure for the operator.

The optical scanning head assembly casting is attached to the traverse drive system and becomes a further integral part of the drive system assembly. The optical assembly arm passes upwards through the centre of the spindle holding the drum, to allow it to traverse the drum surface for scanning. A full description of the optical system can be found in Chapter 6-5.

The rotate and traverse servo systems are controlled by a PIC17C42 microcontroller located on the Machine Controller PCB in the PC. *Chapter 6-9.* Scanning is from bottom to top, with lateral reversal of scanned images achieved by rotating the drum in the opposite direction. The drum cannot rotate or the head move until the door interlocks are true. *Chapter 6-4.*

THE ROTATE DRIVE

The drum is rotated via a 1.6:1 belt drive from a 3 phase motor which is mounted on the drive system casting. The motor is powered from a dedicated Motor Drive 3Ø unit via the Rotate Isolation board (which form part of the Mains Assembly at the rear of the scanner), and which in turn is controlled by the Machine Controller PCB in the PC unit. Speed and position feedback is provided by track and marker information from an encoder which forms part of the scan spindle assembly. The drum speed is 200 to 1500 rpm during scan, with a maximum overspeed of 1800 rpm.

The scan spindle is circumferentially mounted in the drive assembly casting and has a hollow centre through which the optical arm passes to vertically traverse the drum. The hub contains bearings and an integral precision encoder. The drum attachment and locking mechanism is described in Chapter 6-4.

The precision drum encoder forms part of the spindle assembly and is not considered field replaceable. It can currently be of two design types. One design, by Heidenhain, requires an external reading head located adjacent to the bottom of the spindle, covered by the spindle belt guard. It also requires an Encoder Interface PCB (mounted on top of the Mains Assembly) to buffer the signals back to the Machine Controller via the ADC board in the PC. Alternative designs available in the future may not have a separate reading head or require an Interface PCB. The encoder is aligned such that the marker is active when the drum is at the reference position, i.e. the engraved line and locking pin are at the front centre.

ICG

Mechanical Drive System

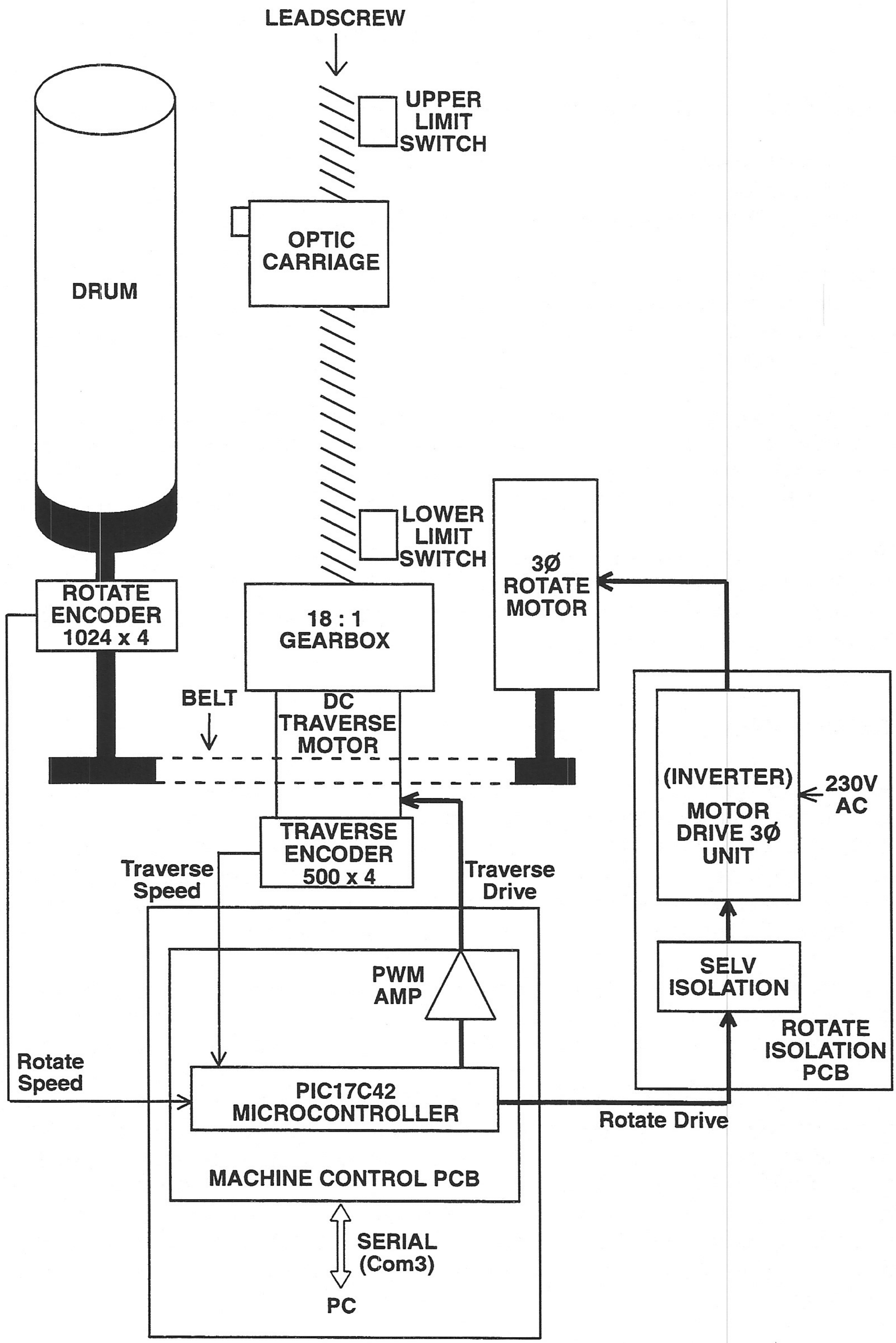


Fig 6.11: Mechanical Drive System - General Arrangement

The rotate servo system control is from timing derived from the rotate encoder on the drum spindle. The encoder has every encoder edge available to a PIC17C42 microcontroller located on the Machine Controller PCB, allowing 4096 cropping positions around the drum. The rotate speed is controlled by a servo program on the PIC17C42, the speed and control being set via an internal serial link from the PC unit (Com3).

Pulse width modulation is used to carry the analogue speed demand (0 to 10V) from the Machine Controller PCB to the Motor Driver 3Ø over the safety extra low voltage (SELV) isolation barrier located on the Rotate Isolation board. (Providing 3kV isolation between the PC and the mains supply based power source for the motor).

The braking energy of the Rotate Motor is absorbed in the lamp PSU, and assumes that a functioning lamp is fitted.

TRAVERSE DRIVE SYSTEM

The main optical assembly is traversed vertically upward and downward through the drum, by a motor-driven precision leadscrew. The optical assembly is attached to a slide system moving on guide rails, and coupled to the leadscrew using a sealed ball system, which also acts as a leadscrew cleaning system. The leadscrew must not therefore be lubricated. The leadscrew is in turn coupled to the motor by a flexible coupling, and 18:1 gearbox. The complete unit is precision aligned and with the exception of the traverse motor and flexible coupling should be considered as a complete replacement item in the event of a failure.

The traverse motor is a dc type with integral encoder, driven via an Interface PCB mounted adjacent to it, from the Machine Controller PCB in the PC. The motor can be single or quarter stepped for maximum positioning (cropping) accuracy. The traverse system leadscrew has a 5mm pitch, with traverse speed from 0.05 to 22 mm/s dependent upon resolution. The maximum positioning speed is 30 mm/s.

Lower and upper limit sensors are fitted to detect a home (park)/initialisation point and full travel point respectively, and are supplemented by mechanical end stops in the event of failure. In the event of overtravel, the software stops the motor on the flag, records the error, then overrides the flag error to slowly move away from the flag to home or into the mechanical end stop, to allow repositioning.

The traverse servo system is controlled by the PIC17C42 in the Machine Controller PCB. *See Chapter 10-9.* The timing for the traverse servo is derived from the rotate encoder, thus ensuring perfect synchronisation between the traverse and rotate system (any slight variations in drum speed being matched by a corresponding change in traverse rate).

As with the rotate servo, every edge from the associated traverse motor encoder is available to the PIC17C42, giving 2000 positions on each revolution of the motor. The 18:1 gearbox serves to increase the resolution of lines along the leadscrew (and incidentally multiplies the motor torque), so that each encoder pulse from the traverse system is <0.25 um along the drum. The lower limit switch is used to initialise the drive position.

The traverse motor is driven directly from the Machine Controller PCB, by a pulse width modulating (PWM) amplifier driving a DMOS bridge. This has additional circuitry to limit the current drawn from the supply. Under certain conditions the motor current requirement may be higher than the supply current, and in this case the switching amplifier acts as a DC transformer.

MACHINE CONTROLLER PCB MICROCONTROLLER PIC 17C42

The functions of the Machine Controller PCB fitted in the PC together with the PIC17C42 single chip microcontroller (with internal program space and RAM which acts to service built in timers, capture registers, and the UART serial port), is described in more detail in Chapter 6-9.

MOTOR CONTROL SEQUENCE

Referring to Fig 6.12.

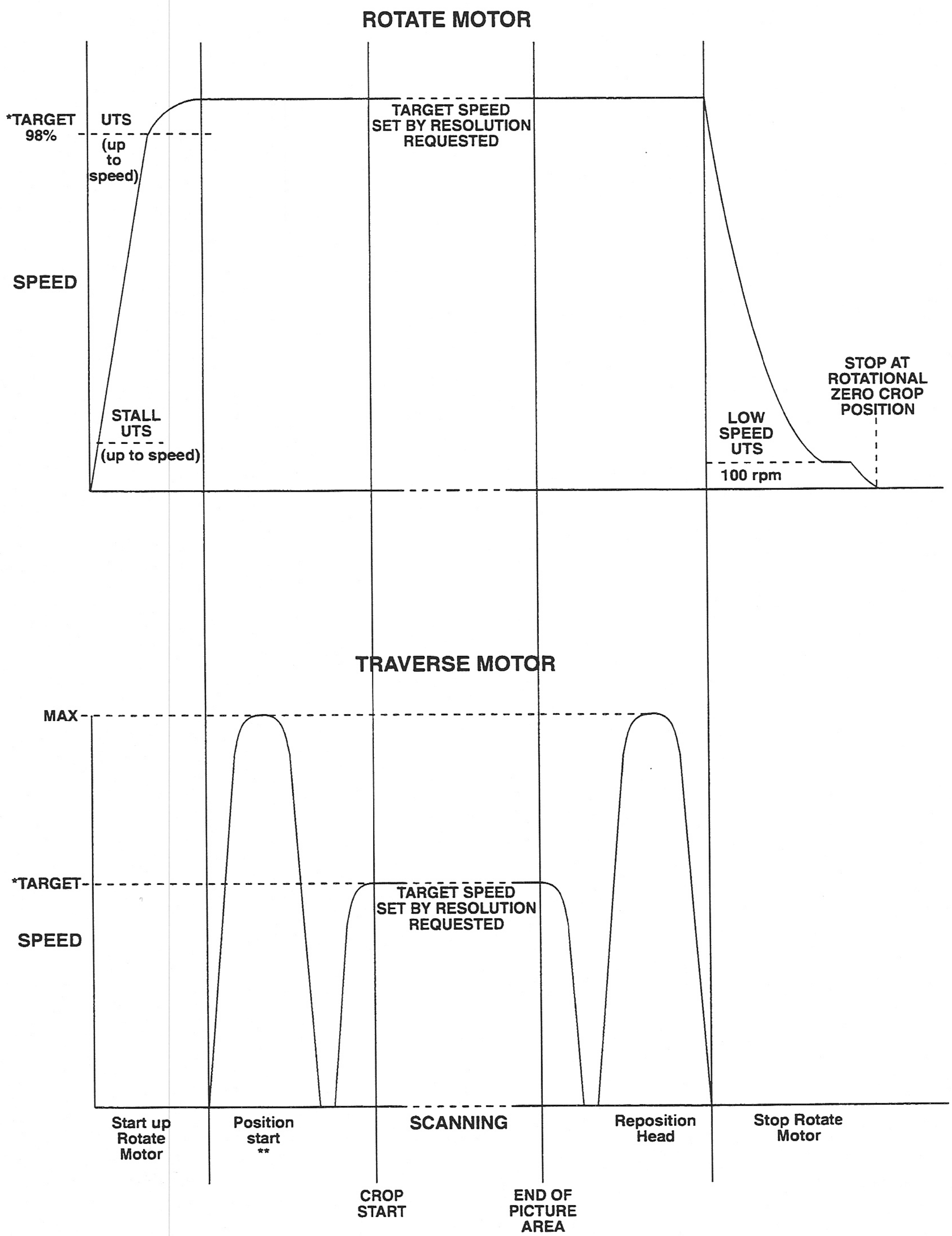
When a scan is demanded, the drum is rotated to a target speed (determined by the enlargement/resolution requested), before the traverse and scan can start. During the initial run up a "Stall UTS (up to speed)" threshold is detected. If the drum fails to reach this speed in a certain time, it is considered to have stalled and the scan is aborted. When the drum reaches 98% of its target speed an "UTS (up to speed)" is flagged and the head positioning (traverse drive) can commence, with the rotate motor holding its target speed.

With the drum rotating at its target speed the traverse motor is activated. The head will be moved at maximum speed to its first position, which may be the autofocus point, the balance point or to just before the start of the picture area to be scanned (crop point), dependent upon whether all three operations have been specified by the user. When all the positional movements have been accomplished the traverse system stops and the system is "ready to scan".

With the head now sitting just before the start of crop point, and the rotational speed correct, the traverse motor ramps quickly up to the scanning traverse target speed determined by the resolution/enlargement required (the horizontal distance to travel during each drum revolution), moving the head to the crop point and commencing the scan.

When the traverse has been completed, i.e. the required scan lines have been made, the end of the scan is flagged. The traverse motor ramps back to zero, stops, and then at maximum speed, repositions the head, either to the home position or to the next start of crop if a batch scan is being carried out. The rotate speed is maintained during this time.

When no further scans are called, i.e. the end of a single scan or the last scan of batch scan, and the head is parked, the drum rotation is stopped. To achieve this, the rotate system is set at a new low speed target of 100 rpm. This will cause the motor to brake to a low speed, the braking energy being absorbed by the lamp circuitry. When the drum reaches to the "Low speed UTS", a stop is initiated by a further controlled rotate to the zero rotate crop position i.e. the drum should stop with the drum release button to the front.



* TARGET Speeds:- These are set by the resolution requested

** If Autofocus and Autobalance are requested the traverse motor will position the head to the defined positions in turn at max speed before moving the head to crop start.

Fig 6.12: Motor Control Sequences